

June 16, 1931.

A. MacPHEE

1,810,286

HEAT EXCHANGER

Filed April 6, 1927

3 Sheets-Sheet 1

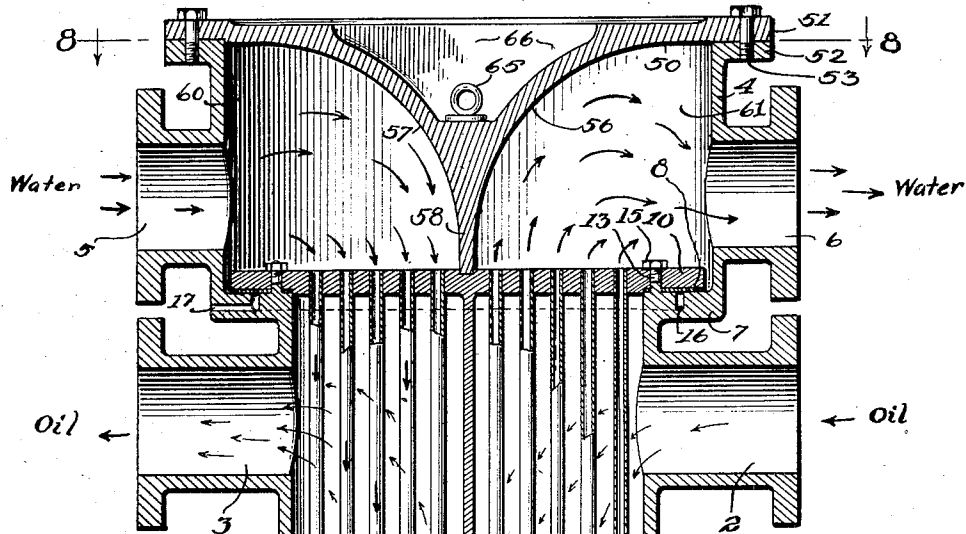
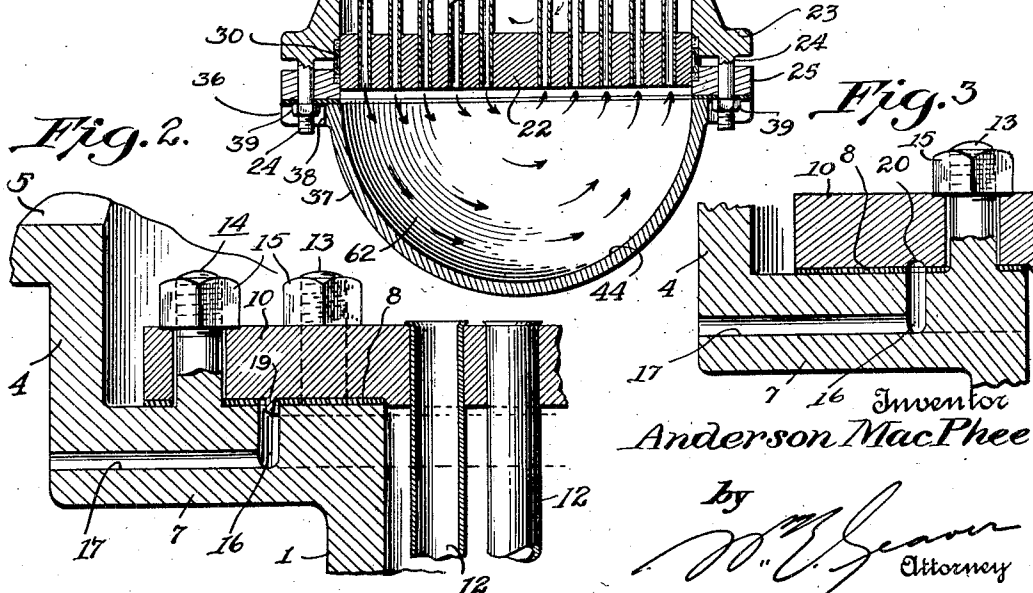


Fig. 1.



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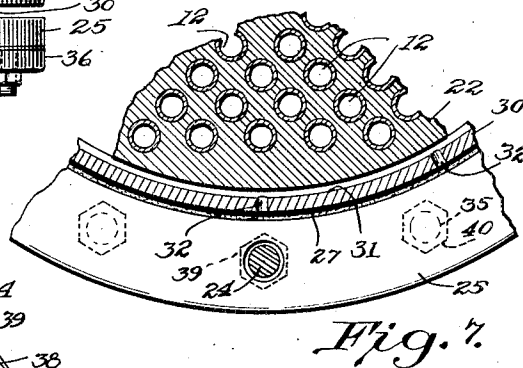
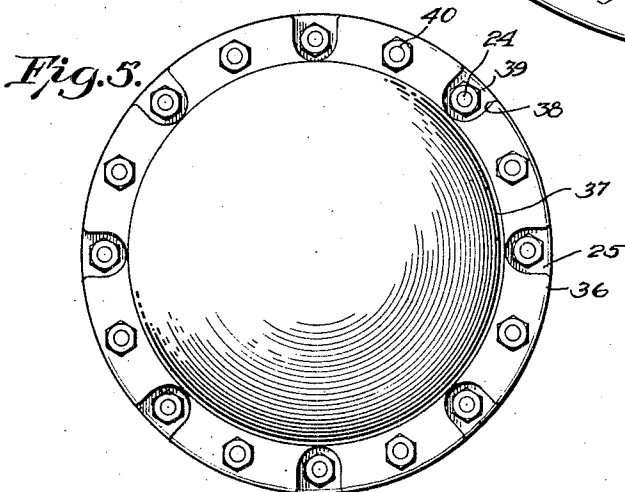
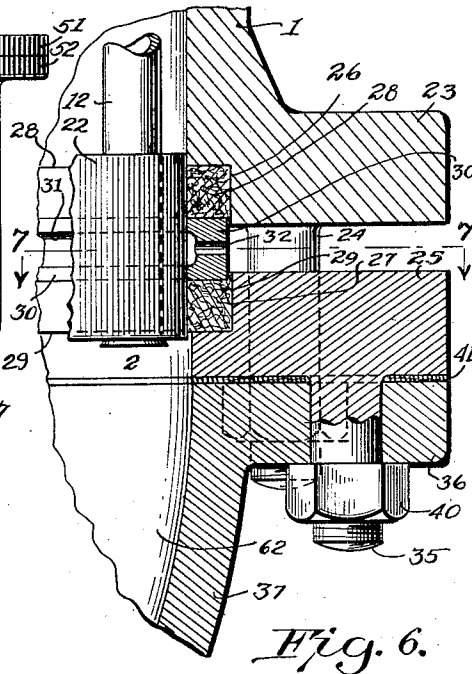
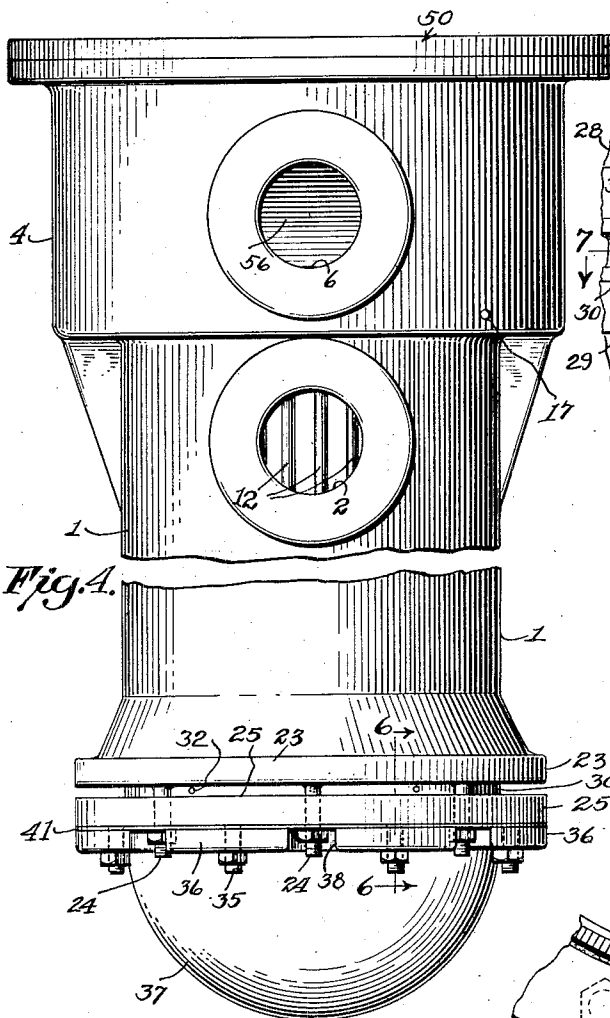
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3 Sheets-Sheet 2



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Fig. 8.

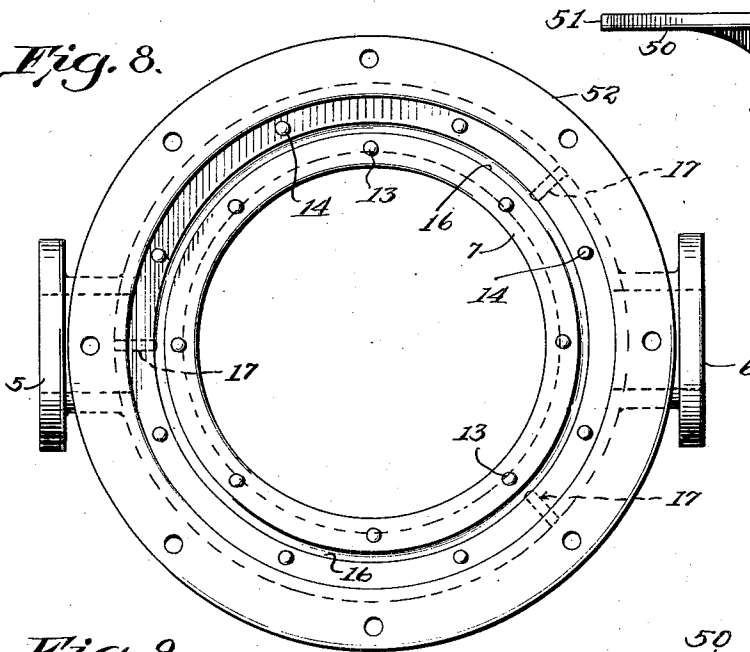


Fig. 9.

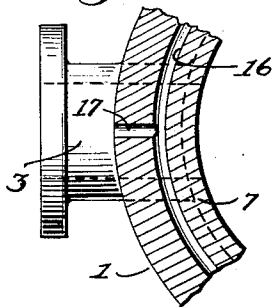


Fig. 10.

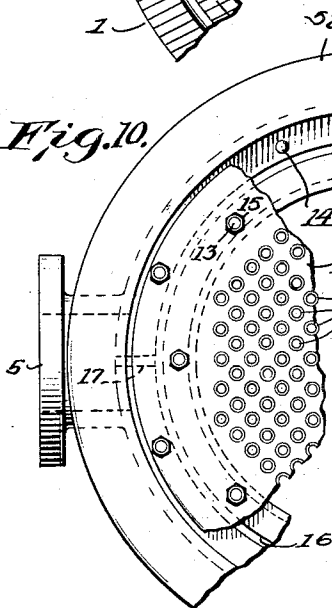


Fig. 12.

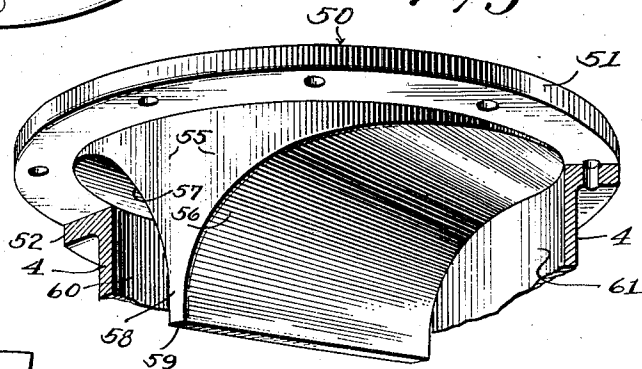
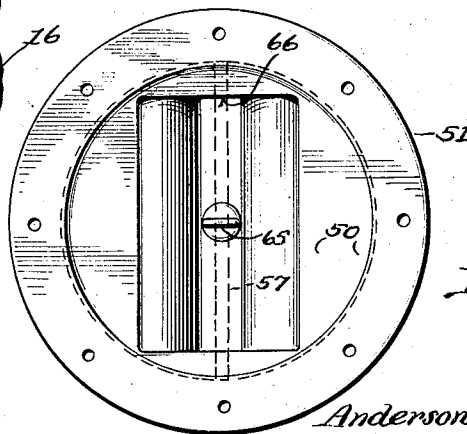
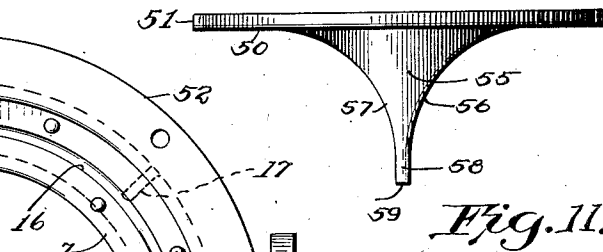


Fig. 13.



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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

Application filed April 6, 1927. Serial No. 181,464.

This invention relates to heat exchangers and has for its object to provide a device more simple in construction and more efficient in operation than those heretofore proposed.

With these and other objects in view the invention consists in the novel details of construction and combinations of parts more fully hereinafter disclosed and particularly pointed out in the claims.

Referring to the accompanying drawings forming a part of this specification in which like parts are designated by like numerals in all the views:

Fig. 1 is a vertical sectional view of a device made in accordance with this invention;

Fig. 2 is an enlarged detail sectional view disclosing a securement of the fixed tube sheet to the casing;

Fig. 3 illustrates a modified form of construction of the parts shown in Fig. 2;

Fig. 4 is a side elevational view of the parts shown in Fig. 1, the figure being broken away to conserve space in the drawings;

Fig. 5 is a bottom plan view of the parts shown in Fig. 4;

Fig. 6 is a fragmentary vertical sectional view, taken as on the line 6—6 of Fig. 4 and looking in the direction of the arrows, of the mounting of the floating end of the internal tube nest of this device, and the joint between the return cover and the casing proper;

Fig. 7 is a fragmentary horizontal sectional detail view of the parts illustrated in Fig. 6 taken as on the line 7—7 of said figure and looking in the direction of the arrows;

Fig. 8 is a top plan view of the casing with the cover and internal tube nest removed;

Fig. 9 is a fragmentary horizontal sectional view illustrating the construction of the casing adjacent the fixed tube sheet to allow for any leakage from said casing;

Fig. 10 is a fragmentary top plan view of the device with the cover removed to illustrate the manner of mounting the fixed tube sheet on the casing;

Fig. 11 is a side elevational view of the cover at the fixed tube sheet end of the device;

Fig. 12 is a perspective view partly in section illustrating the relation between the

cover shown in Fig. 11 and the end of the casing; and

Fig. 13 is a top plan view of the cover illustrated in Figs. 11 and 12.

This invention is directed to a heat exchanger, or a device adapted to extract heat from one fluid by the use of another fluid. As a concrete example, this device is peculiarly adapted to the recooling of lubricating oil by the use of water, but it is to be understood that the device is equally applicable as an oil-to-oil heat exchanger, or as a water-to-water heat exchanger, as well as for the recovery of heat from waste or other liquids and fluids.

In heat exchangers of types heretofore known it has been extremely difficult, if not impossible, to make repairs or adjustments without seriously disrupting the pipe connections leading to said exchangers, which must frequently be done due to the leaks that occur from time to time. That is to say, in the types heretofore known it has been necessary to remove the entire end of the casing in order to gain access to the nest of internal tubes with which said exchangers are provided. This, however, has been accompanied with disastrous results to the adjacent supply pipes leading to the exchangers in that the said end could not be removed from the casing without straining the inlet and outlet pipes associated with the exchangers and thereby causing leaks to develop in the packed joints between the sections thereof, thus often necessitating the piping lines to be dismantled, repacked, and reassembled for a considerable distance away from the exchanger. Attempts have been made to overcome this defect by employing a removable end to which no supply pipes were attached, but insofar as is known these removable ends have been constructed to cause the fluid to pass therethrough before entering or leaving the exchanger. This has the undesirable result of causing the fluid to pass numerous bends with resultant diminution of pressure and the creation of pockets for lodgement of sediment and other foreign matter necessitating more frequent shut-downs for cleaning, etc. This invention, on the other hand, over-

comes and avoids the serious draw-backs found in prior known constructions, in that not only need the piping connections not be disturbed to gain access to the tube nest, but a free circulation of the fluid is insured.

Referring to the drawings 1 indicates a tubular shell or casing of suitable material provided with a flanged inlet 2 and a flanged outlet 3, for the oil. At one end, the casing is provided with an enlarged concentric cylindrical chamber 4 provided with a flanged inlet 5 and a flanged outlet 6 substantially diametrically opposed to each other for the passage of water through the device. The chamber 4 is connected to the main body portion of the cylinder 1 as by the transverse web 7 having the surface adjacent the chamber 4 machined or otherwise suitably prepared for the reception of an annular gasket 8 which, from Fig. 1, will be seen to be disposed between the web 7 and the fixed tube sheet 10 associated with the nest of tubes 12 with which the device is provided. The fixed tube sheet may be secured in any suitable manner to the web but it has been found from experience that an inner row of studs 13 and an outer row of studs 14, either rigidly or integrally attached circularly to the web and each provided with a nut 15, has been most satisfactory, see Figs. 1, 8 and 10. Between these circular rows of studs 13 and 14 is provided a deep annular groove or recess 16 formed in the web 7, said groove being provided at frequent intervals with drains 17 formed by radial bores extending from said groove outwardly through the web, whereby any fluid reaching the groove may pass out of the casing through said bores. By providing a great plurality of studs 13 and 14 the fixed tube sheet 10 may be forced tightly against the gasket 8 to prevent a leakage of fluid from out of either the casing 1 or the chamber 4.

It is essential to have a tight joint between the fixed tube sheet 10 and the web 7 due to the fact that different fluids are used in the heat exchanger. In the example given, it would not do for water to pass the gasket 8 and reach the oil in the cylinder 1, nor would it be desirable to have the oil from the cylinder 1 pass the gasket 8 and reach the water in chamber 4 for reasons that are perfectly obvious. Due to the high temperatures of the fluid adapted to pass into and out of such an exchanger as herein disclosed, the gasket 8 will in time allow a slight leakage of the fluids, this being augmented by the expansion and contraction of the metal of the device. By employing the construction above disclosed, any fluid leakage that will develop will reach the groove 16, pass to the outside of the device through the bores 17, and be easily visible, whereupon the power plant can be shut down and adjustments made in the exchanger to stop said leakage.

In Figs. 2 and 3 are disclosed two forms of the gasketed joint above described. In other words, Fig. 1 shows the fixed tube sheet 10 with a perfectly plane undersurface resting upon the gasket 8, whereas in Fig. 2 said undersurface is provided with a depending circular tongue 19 of a width slightly smaller than the width of the annular groove 16 and registering therewith so that in assembling the parts either two separate concentric packing gaskets will be required or else the tongue 19 will cause a break in a continuous gasket 8 (as shown in Fig. 1) inserted by mistake by the workman. The purpose of this improved packing joint is to provide a gap across which the fluid cannot travel and in this respect a further modification of the tube sheet 10 is shown in Fig. 3, wherein its undersurface is provided with an annular groove 20 adapted to register with the groove 16 in the web 7 to doubly insure the passage of the leaking fluid to the outlet bores 17. In the last mentioned construction the gasket 8 will be provided with suitable apertures registering with the grooves 16 and 20 to accomplish the desired result.

The fixed tube sheet 10 has disposed therein the ends of a plurality of tubes 12 swaged or otherwise rigidly secured in said sheet, as well understood in constructions of this character, said tubes being parallelly disposed to each other and extending longitudinally of the cylindrical casing 1. The other ends of the tubes 12 are suitably secured in the same manner in a plate 22 which is adapted for movement longitudinally of the casing 1 under expansion and contraction of the metal of the device, the plate 22 being usually termed the "floating end" of the tube nest. The casing 1 at the floating end of the device is provided with an annular flange 23 extending outwardly and rigidly or integrally carrying therewith a circular row of studs 24 adapted to pass through apertures provided therefor in the gland member 25. The inner surface of this extremity of the casing 1 is provided with a shouldered recess 26, and the inner surface of the gland member 25 is likewise provided with a shouldered recess 27, each recess adapted to receive the packing material 28 and 29 respectively, between which lies a metallic ring 30 provided on its inner surface with a circumferential groove 31 having associated therewith, at spaced intervals, radially extending bores 32 leading to the space between the flange 23 of the casing 1 and the gland member 25, the internal diameter of the metallic ring 30 being such as to give a sliding fit between said ring and the machined outer circumferential floating tube plate, all as will be readily understood from Fig. 6.

The gland member 25 is provided on the under side thereof with a plurality of studs 35 rigidly or integrally formed therewith, each

adapted to pass through apertures provided therefor in the flange 36 of the return cover 37 for the casing 1. With particular reference to Figs. 4, 5, 6 and 7 it will thus be seen that the studs 24, are for securing the gland member 25 to the flange 23 of the casing, whereas the studs 35 are for securing the return cover 37 to the gland member 5. By this construction the return cover may be removed from the heat exchanger without disturbing the packing associated with the floating tube plate 22, to enable the tubes 12 to be cleaned or otherwise operated upon as may become necessary from use of the device. To aid in the securement of the parts just mentioned the flange of the return cover 37 is provided with radial peripheral openings 38 of slightly larger dimension than the nuts 39 associated with the studs 24 so that the length of said studs may be materially reduced. In addition, this construction avoids the necessity of drilling registering holes in the flange 36 to receive said studs, and reduces the weight of said cover. Nuts 40 secure the cover 37 in place by bearing on the outer surface of the flange 36 thereof, all as will be clear from said figures. A circular gasket or other packing 41 is provided between the flange 36 of the return cover and the gland member 25 to provide a leak-proof joint therebetween. The wall of the return cover 37 is semi-spherical in shape so that the smooth inner surface 44 thereof, which concentrically registers with the inner surface of the gland member 25, as well as the casing 1, provides a free return for the water from one half of the tube nest to the other half, as indicated by the heavy arrows in Fig. 1.

By providing the packed joint, as above described at the floating end of the tube, any leaks which may develop will be readily visible because the fluid will pass from the inside of the exchanger to the outside thereof through the openings 32 in the ring 30. By particularly noticing through which openings the fluid is leaving the device, and then tightening the nuts 39 and 40 adjacent said openings, thus placing additional pressure on the packing element at the point of leak, the leak will be stopped. This obviates the necessity of shutting down the power plant, which has to be done where heat exchangers of the heretofore known types are employed, because by this invention the leak is visibly indicated as soon as it develops whereas heretofore the leaks were not visible, thus permitting a mixture of the two fluids which was not ascertained until damage resulted, or the plant stopped for inspection.

The open end of the chamber 4 is provided with a cover generally indicated by the numeral 50 comprising a circular plane portion 51 constituting the flange adapted to rest upon the companion flange 52 of the chamber and

secured thereto in any suitable manner as by the bolts 53.

The remainder of the cover 50 constitutes the portion 55 provided with opposed plano-concave surfaces 56 and 57 each having one end in the plane of the flange 51 and their other ends meeting in a web 58 disposed diametrically of the cover and in a plane at substantially right angles to the plane of the flange 51. This construction is clearly brought out in the perspective drawing constituting Fig. 12. The side extremities of the plano-concave surfaces lie in a cylindrical plane of a diameter equal to the internal diameter of the chamber 4. The cover 50 is of such size that when in fixed position with relation to the chamber 4, the end 59 of the web 58 will lie in close fitting contact with the outer face of the fixed tube sheet 10, in a diametrical plane thereof with the plano-concave surfaces 56 and 57 dividing the chamber 4 into two compartments 60 and 61 so that the water entering through the inlet 5 into the compartment 60 will strike the plano-concave surface 57 and be deflected through an arc of substantially 90° into the open ends of the tubes 12 communicating with said compartment. The water will then pass through the said tubes into the semi-spherical space constituting the return chamber 62 of the return cover 37 and will be deflected as indicated by the heavy arrows through substantially 180° into the open ends of the other half of the tubes 12, to be passed from the other end of said tubes into the compartment 61 where said water will strike the plano-concave surface 56 which assists the deflection of said water through an arc of substantially 90° into and through the outlet 6, all as will be clear from Fig. 1. For convenience in removing the cover 50 from the heat exchanger there is provided an eye 65 disposed in the recess 66 of the cover lying between the metal walls forming the plano-concave surfaces 56 and 57.

The oil to be cooled will enter through the inlet 2 to the inside of the casing 1, flow around the outside of the tubes 12, and pass out of the casing through the outlet 3, giving up part of its heat to the water in the tubes 12 in said passage, all as readily understood. This invention is not limited to any specific form of oil circuit but in the drawings the fixed tube sheet 10 is shown as having rigidly secured thereto a longitudinally extending baffle plate 70 reaching not quite to the floating tube plate 22, so that the oil in passing through the device is made to flow longitudinally thereof on one side of the baffle and then back through the length of the device as indicated by the light arrows in order to gain the outlet 3 from the casing 1. Any other suitable construction may be employed to cause a tortuous path over which the fluid to be cooled must pass.

Thus it will be seen that by this construction there is provided a casing of substantially cylindrical formation provided with an inlet and an outlet for the fluid to be cooled, said casing having disposed therein a nest of tubes for the cooling fluid. Further the nest of tubes is provided with means to rigidly support one end thereof in said casing and the other end is adapted to float in the casing under the varying temperature conditions all as well understood.

The fixed tube sheet 10 and the plate 22 at the other end of the nest of tubes comprise means for confining the fluid to be cooled in the casing.

One end of the casing is provided with a closure comprising the gland member 25 and the return flow cover 37 rigidly secured thereto so that any adjustments that may be necessary can be made without the removal of the cover. Interposed between the gland member 25 and the end of the casing is a packing means adapted to prevent the leakage of either the cooling fluid or the fluid to be cooled, but should there be a leakage of said fluids, the same will be visible due to the fact that said fluid will pass through the radial apertures associated with the annular groove in the packing ring 30, with the result that those bolts adjacent the leak are the only ones necessary to be tightened to stop the leak.

The other end of the casing is enlarged to provide the chamber 4 having an inlet and an outlet for the cooling fluid and the cover associated with the said chamber is adapted to divide the same into two compartments to cause the cooling fluid to flow smoothly from the inlet into one section of the tube nest and from the other section of the tube nest to the outlet. By "flow smoothly" is meant a substantially unobstructed or circular path for the fluid created by the plano-concave surfaces 56 and 57 and the curved surface 44 of the return cover, whereby the pressure on the liquid is not diminished.

It is obvious that those skilled in the art may vary the details of construction as well as the arrangements of parts without departing from the spirit of the invention, and therefore it is not desired to be limited to the above disclosure except as may be required by the claims.

What is claimed is:

1. In a heat exchanger including a casing adapted to contain a nest of tubes for the cooling fluid about which the fluid to be cooled is circulated, a packed closure including a removable cover for one end of said casing, a gland member supporting said cover and secured to said casing, and a sealing ring between said gland member and said casing, said closure adapted to visibly indicate a leakage of either fluid as well as to per-

mit free access to said tubes without disturbing the mounting thereof in said casing.

2. In a heat exchanger including a casing adapted to contain a nest of tubes for the cooling fluid about which the fluid to be cooled is circulated, a closure including a flat circular gland member secured to said casing with an interposed packing comprising a grooved and apertured ring for visibly indicating a leakage of either fluid as well as a cover provided with an outwardly extending flange removably secured to said member, said closure being for one end of said casing and adapted to permit free access to said tubes.

In testimony whereof I affix my signature.

ANDERSON MACPHEE.