Aug. 19, 1930. J. PRICE 1,773,200

HEAT EXCHANGER

Original Filed Jan. 11, 1927 2 Sheets-Sheet 1

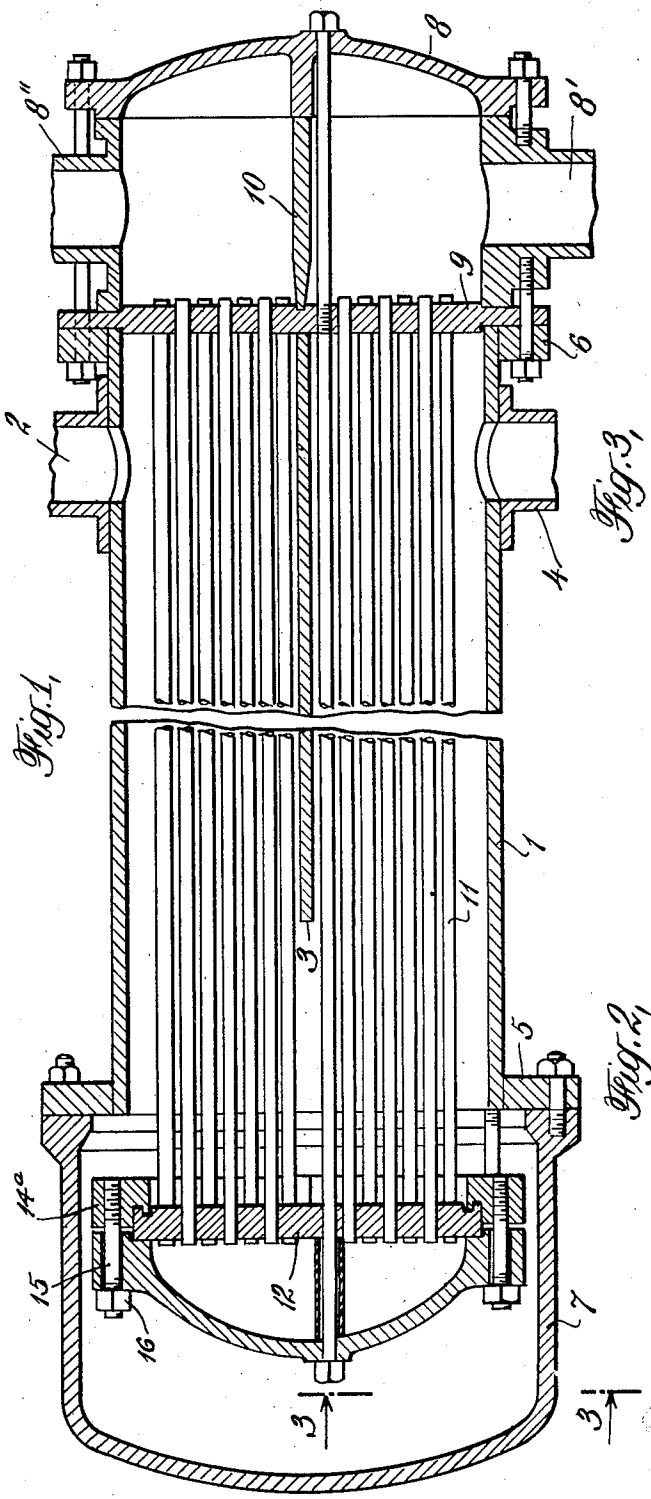

Fig. 1.

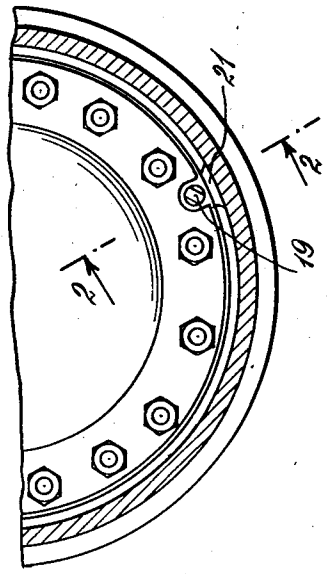

Fig. 3.

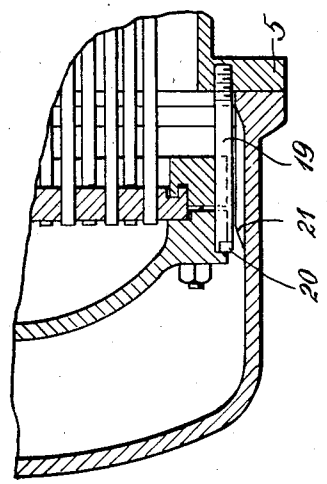

Fig. 2.

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Fig. 4,

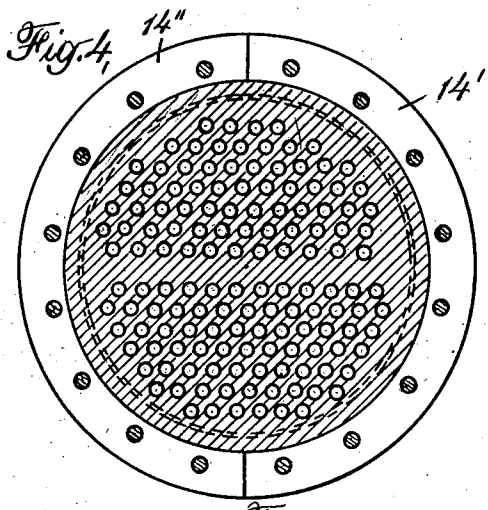


Fig. 5,

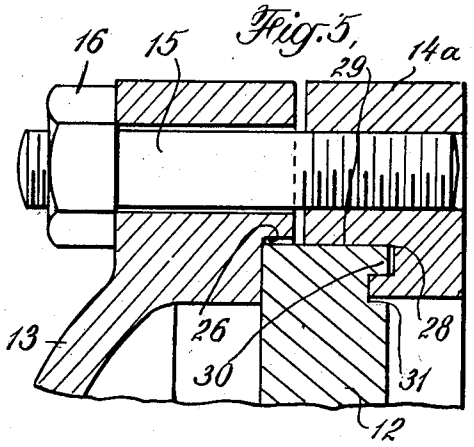


Fig. 7,

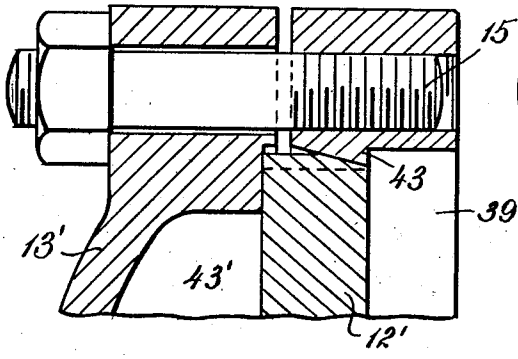


Fig. 6,

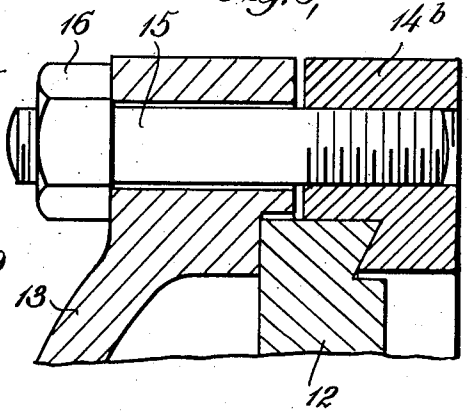
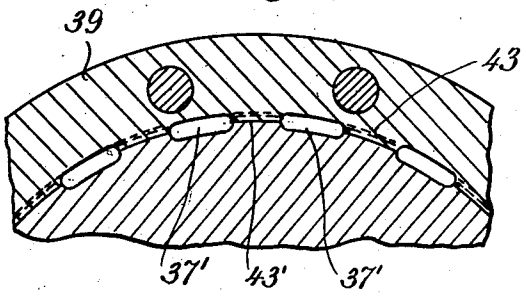


Fig. 8,



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Patented Aug. 19, 1930 1,773,200

UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

Original application filed January 11, 1927, Serial No. 160,324. Divided and this application filed August 13, 1927. Serial No. 212,676.

The present invention relates to improvements in heat exchangers of the type in which a plurality of tubes are placed within a containing shell, and which are commonly known as "shell-and-tube", or "surface type", heat-exchangers.

Such heat exchangers are used chiefly in transferring heat between two liquids, such for example as in oil refining operations, and in transferring heat between a liquid and a vapor or gas, as for example in steam power plants and industrial establishments. When used for transferring heat between two liquids, one liquid, for example oil, is passed through the shell of the exchanger and comes into contact with the exterior surfaces of the cooling tubes, while the other liquid, for example water, is sent through the interior of the tubes. In transferring heat between a liquid and a gas or vapor, the gas or vapor such, for example, as steam, is usually passed into the shell, and the liquid forced through the tubes.

The particular form of shell-and-tube heat exchanger with which this invention is concerned is that form in which the tubes are secured at each end to a pair of spaced tube sheets, and suitable chambers are provided at each tube sheet to conduct the fluid first through a portion of the tubes and then return it through a different portion thereof before allowing it to leave the apparatus. The fluid therefore makes two or more passes through the tube bundle before being discharged.

Provision must be made for relative expansion between the shell and the tubes, inasmuch as it is frequently desirable to make the tubes of different metal from that of the shell. Thus the tubes might be made of copper and the shell of steel, and these metals having different coefficients of expansion, a greater lengthening or shortening of the tubes as compared with the shell will take place for a given temperature change. Moreover, even when the tubes and shell are made of the same metal, there is not infrequently a difference in temperature between the interior of the tube bundle and the surface of the shell which will set up expansion strains.

One very practical way of taking care of this question of expansion is found in the floating head construction which has come into quite general use. In this form of construction, only one of the tube sheets is secured fast to the shell, while the other tube sheet, i. e. the "floating" tube sheet, is so supported as to allow it to move bodily within the shell when expansion or contraction takes place. The cap or other element which forms the chamber or chambers for receiving the fluid from one portion of the tubes and redirecting it into another portion of the tubes, is secured to the floating tube sheet and moves with it.

It is highly desirable to construct such heat exchangers so that the tube bundle, including the two tube sheets, can be removed as a unit from the shell for the purposes of occasional repair and the periodical cleaning which the use of oil and other viscous liquids entails. It is also important that the tube bundle, as nearly as possible, fill the interior of the shell so as to prevent the tendency of the fluid within the shell to pass along this space instead of passing into the interior of the tube bundle into contact with the surface of the tubes, which is known as "short-circuiting."

One object of the present invention is to provide a heat exchanger of the floating head type of improved construction in which the outside diameter of the tube bundle is only slightly smaller than the inside diameter of the shell, the tube bundle therefore substantially filling the interior of the shell, the floating head being of an improved construction, whereby, among other advantageous results, the cap forming the floating chamber may be readily attached to or removed from the tube sheet, and the tube bundle then removed as a unit from the shell.

Another object is to provide an improved form of connection between the cap and the floating tube sheet, through the use of which the cap member can be readily removed from the tube sheet in an easy and improved manner in disassembling the heat exchanger.

It is a particular object of the present invention to provide such a clamping device as will permit the removal of the device either in

easy stages, as by sections, or as a single unit, when it is desired to take the tube bundle unit out of the shell.

While it has been heretofore proposed to effect engagement between tube-sheets and cap-members by means other than by bolting the caps directly to the tube-sheets, as by means of certain particular kinds of so-called sectional rings, yet it is equally true that these proposed structures have certain disadvantages. The chief difficulty encountered with these structures is the tendency of the sectional clamping rings to rotate or "cock" about the inner edge of the outer periphery of the tube sheet which they are intended to clamp squarely and securely onto the cap member. This condition obtains when the clamping bolts and nuts are set up.

Accordingly, it is a further particular object of the present invention to provide a heat exchanger in which the floating head is so constructed that canting or cocking of the clamping ring sections is eliminated, or reduced to an unobjectionable amount.

An important object of the present invention is to provide means for carrying the weight of the tube bundle and tube sheet when the shell cover and floating head cap are removed for the withdrawal of the tube bundle, thus facilitating assembly and disassembly.

Another important object of the present invention is to make possible such an interchangeable construction at the floating head end of the tube bundle above referred to, that greatly varying and extreme temperatures of work may be carried out by merely substituting a different composition of clamping device to coact with the cap member and tube sheet. That is, the cap can be made of a composition which is the best for the temperature work in question, though this material may not be hard or tough enough to itself hold the necessary tap-bolts, and these can be tapped instead into the clamping device itself, since this part can be made, by the present invention, of the material best adapted therefor.

The invention will be better understood by referring to the accompanying drawings, in which there is illustrated by way of example a heat exchanger of the present invention, and intended chiefly for the purpose of transferring heat between water and oil, in oil refining operations. In these drawings,

Fig. 1 is a longitudinal section of a heat exchanger embodying the preferred form of floating head construction of the present invention;

Fig. 2 is a detail of the supporting means for the floating header;

Fig. 3 is a cross-sectional end view thereof;

Fig. 4 is a sectional view of the floating head with the cap or cover 13 removed showing the sectional clamping ring;

Fig. 5 is a detail view of the joint at the floating head of Fig. 1;

Fig. 6 is a modification or variation of this joint, and,

Figs. 7 and 8 show a further modification of the ring and joint.

Referring to the accompanying drawings, and first to Fig. 1, the invention comprises a heat-exchanger having a casing or shell 1 of any suitable form to handle a fluid such as oil, and provided somewhat in the usual manner, with an oil inlet 2 on its upper surface, a baffle plate 3 extending horizontally through its middle, an outlet 4 on its lower surface, flanges 5 and 6 at opposite ends of the shell, a shell cover 7 rigidly secured to the flange 5 at one end, a rigid plate or tube-sheet 9 at the other end, and a partitioned header 8 secured to the flange 6 over the tube-plate 9. A partition 10 in the header 8 engages with the tube-sheet in any suitable manner, and the header has a water inlet 8′ and outlet 8″, and extending longitudinally of the shell therefrom, and projecting into the shell-cover 7, are a series of tubes 11 forming a unitary, rigid tube-bundle. These tubes are anchored at one end in the specially constructed floating tube-sheet 12, which is made of a diameter only slightly larger than the perimeter of the tube-bundle, and just enough smaller in diameter than the shell to permit it to readily slide therethrough towards the other end of the shell.

Referring now to Figs. 5 and 6, the floating-head cover or cap member 13 is of a considerably larger diameter than the shell itself, and is securely attached to the tube-sheet 12 over a gasket by a clamping device comprising the ring 14^a and the stud bolts 15 and nuts 16. This clamping ring 14^a may be made in two or more arcuate sections, shown as 14′ and 14″ in Fig. 4, in order to provide for easy removal of the ring 14^a and floating chamber head 13 when it is desired to remove the tube bundle from the shell.

In Fig. 5 there is shown a detail of a novel joint between the cap member, the floating tube-sheet, and the clamping ring. In this joint, the cap member has an annular groove 26 in the inner edge of its flange, and into this groove, the plane, flat, outer surface of the rim of the tube sheet fits squarely. The interior curved surface 29 of the clamping ring is in contact with the periphery of the tube sheet 12. The inner portion of the clamping ring has a lip extending toward the center of the ring and over the inner edge of the tube sheet 12. A recess 31 is cut in the tube sheet near its periphery forming a rib 30, and the lip on the clamping ring is also recessed, as shown at 28, forming a tongue which extends over rib 30 and into recess 31.

With this construction, when the bolts 15 are tightened, and canting of the sectional ring commences, the tongue on the ring is

forced against rib 30 which prevents further movement in the plane of the tube sheet, and this forces the curved surface 29 of the sectional ring more firmly against the periphery of the tube sheet. The outer face of the ring is spaced from the rim of cap 13 even when the bolts are fully set up, and an effective clamping of the cap to the tube sheet results.

In order to provide a riding support for the complete floating head to allow it to move under action of expansion and contraction of the tubes, and to support the tube-sheet and clamping ring while the rest of the tube bundle is being disassembled, a stud bolt 19 is tapped into the flange 5 as shown in Fig. 2, and may have its head slabbed as at 20 to receive a wrench or other removing tool. There may also be provided on the shell-cover 7, a guideway 21, shown in Figs. 2 and 3.

Removal of the tube bundle is effected by removing the shell cover 7, then removing the floating head cover 13, removing the upper section of the split ring 14, jacking up the floating tube sheet 12, removing the lower sections of the split ring and then readily withdrawing the entire tube bundle from the stationary end.

In Fig. 6, there is shown a detail of a modified form of joint. In this modification, the co-acting surfaces between the lip on the sectional ring and the inner face of the tube sheet 12 are made sloping so as to form a dove-tailed joint, instead of the square faced joint shown in Fig. 5. The dove-tailed interlocking joint has the advantage that the tighter the bolts 15 are drawn, the closer the curved surface of the sectional ring 14^b is forced against the periphery of the tube sheet. Because of this fact, it is substantially impossible for any canting whatever to occur in this form of joint.

Another modification is shown in Figs. 7 and 8. In order to adapt the general inventive idea outlined in the objects of the invention to abnormally high temperature and high pressure work, it is contemplated by the present invention to use a single, solid clamping ring 39 to carry the stud-bolts 15 for clamping the cap member 13′ to the tube-sheet 12′. With this modification the ring may be removed from the tube sheet by a slight, easy rotation and then a pull, and no repetition of these motions is necessary.

The single, solid clamping ring 39 of Figs. 7 and 8 is provided, around its inner periphery, with a series of equally spaced groups of wedge-members, 43, the wedge members thus alternating with clear spaces or slots 37′. The floating tube-sheet 12′ is provided on its periphery with complementary wedge-shaped members 43′, likewise alternating with clear spaces or slots 37′. The outer face of the tube sheet 12′ is plane. Thus, when the ring 39 is placed against the tube-sheet and slightly rotated until its wedges engage those on the tube-sheet, setting up the bolts 15 will serve to effectually clamp the cap to the tube-sheet without binding, cocking, or canting.

The floating head structure of this form of the present invention can be disassembled by merely removing the cap member, rotating the solid ring until the wedge members on one piece register with the openings 37′, and then slipping the ring outwardly off the tube-sheet, all in a very easy, rapid manner.

This application is a divisional application of a copending application by Joseph Price, filed January 11, 1927, Serial No. 160,324.

I claim:

1. A heat exchanger of the class described comprising a shell, a tube bundle therein, a movable tube sheet for one end of the tube bundle, a cap for said tube sheet of a larger diameter than the shell, the rim of the cap lying against the outer face of the tube sheet, a sectional ring in spaced relation to the cap and having a curved interior surface in contact with the outer periphery of the tube sheet and having a lip extending over the inner edge of the tube sheet, and an interlocking joint between said lip and the tube sheet for preventing outward movement of the lip in the plane of the tube sheet, and a plurality of bolts for drawing the sectional ring toward said cap thereby clamping the cap to the tube sheet.

2. A heat exchanger of the class described comprising a shell, a tube bundle therein, a movable tube sheet for one end of the tube bundle, a cap for said tube sheet of a larger diameter than the shell, the rim of the cap lying against the outer face of the tube sheet, a sectional ring in spaced relation to the cap and clampingly associated with the periphery of the tube sheet and the rim of the cap, and a plurality of bolts therebetween for securing said parts together, the sections of the sectional ring each having a portion extending circumferentially of the tube sheet, and a portion in contact with the inner face of the tube sheet, and interlocking formations on said latter portion and the tube sheet respectively, by which the stress in said bolts causes said circumferential portions of the ring sections to be forced against the periphery of the tube sheet, so as to reduce the tendency of the ring sections to cant when the bolts are tightened.

3. A heat exchanger of the class described comprising a shell, a tube bundle therein, a movable tube sheet for one end of the tube bundle, a cap for said tube sheet of a larger diameter than the shell, the rim of the cap lying against the outer face of the tube sheet, a sectional ring in spaced relation to the cap and having a curved interior surface in contact with the outer periphery of the tube sheet and having a lip extending over the in-

ner edge of the tube sheet, the tube sheet having a recess in its inner face near the edge, a tongue on said sectional ring disposed within said recess, and a plurality of bolts for drawing the sectional ring toward said cap thereby clamping the cap to the tube sheet.

4. A heat exchanger of the class described comprising a shell, a tube bundle therein, a movable tube sheet for one end of the tube bundle, a cap for said tube sheet of a larger diameter than the shell, the rim of the cap lying against the outer face of the tube sheet, a sectional ring in spaced relation to the cap and having a curved interior surface in contact with the outer periphery of the tube sheet and having a lip extending over the inner edge of the tube sheet, and a dove-tailed joint between said lip and the tube sheet for preventing outward movement of the lip in the plane of the tube sheet, and a plurality of bolts for drawing the sectional ring toward said cap thereby clamping the cap to the tube sheet.

In testimony whereof I affix my signature.

JOSEPH PRICE.