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[54] **HEAT EXCHANGER**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **165/76,** 165/158, 165/176, 285/137, 285/368

[51] **Int. Cl.** **F28f 9/02**

[58] **Field of Search** 165/158, 76, 176; 285/131, 137, 363, 368

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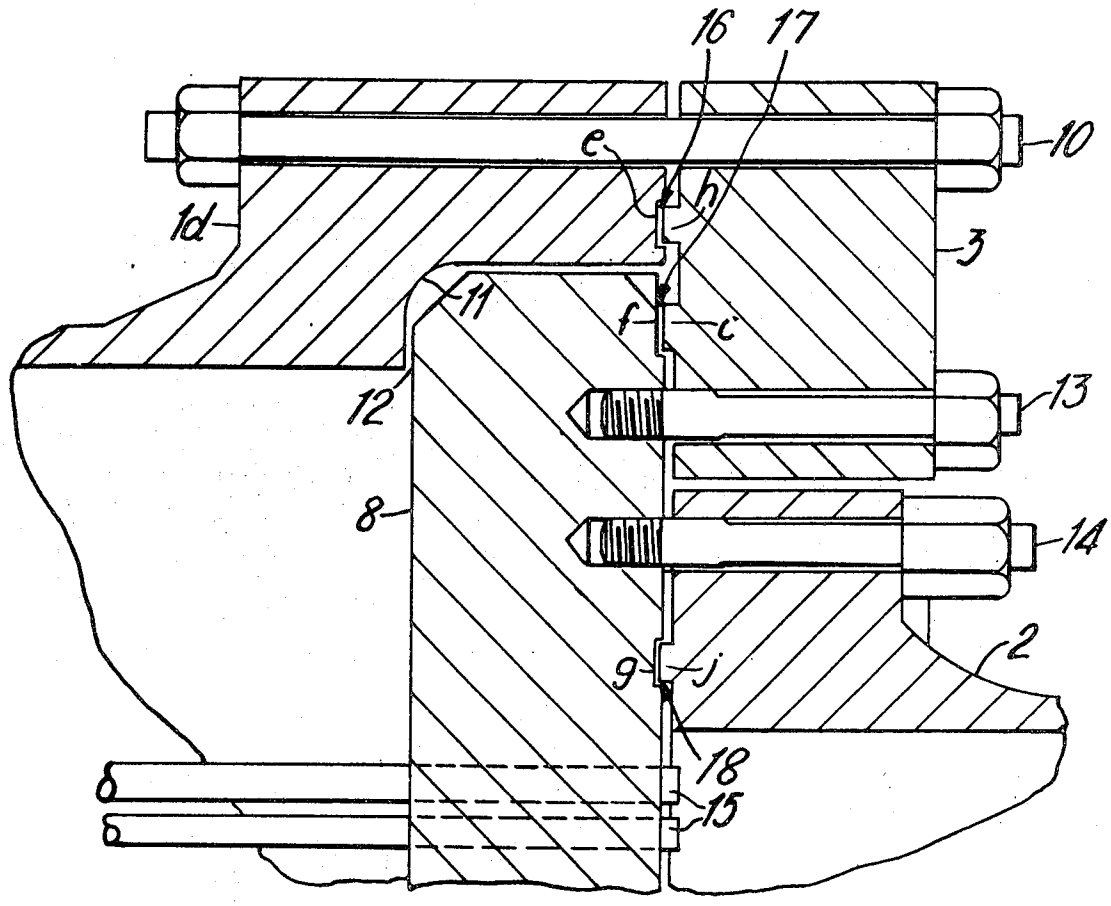
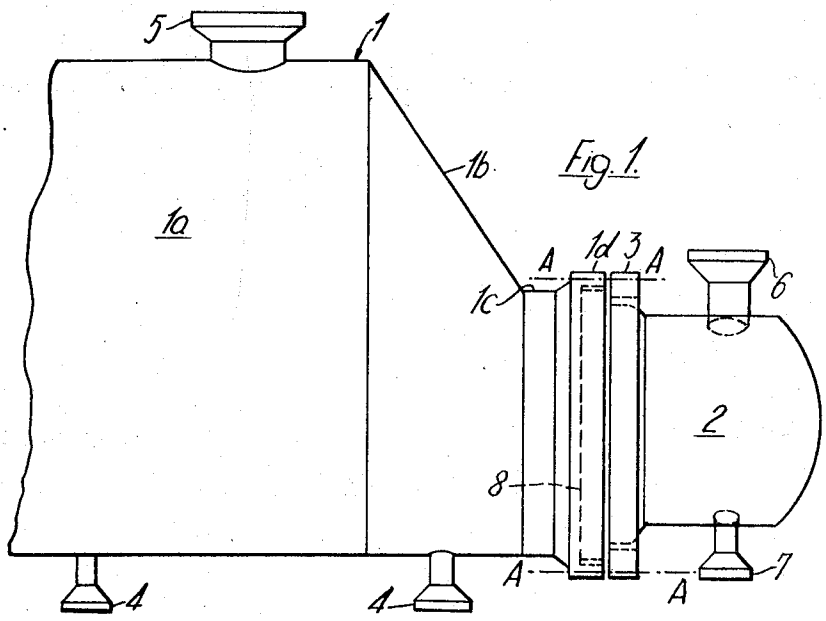
[57] **ABSTRACT**

A U-tube heat exchanger so designed that gaskets between the tube-plate carrying the tube bundle and the chambers through which the heat exchange fluids pass are accessible and replaceable without withdrawing the tube bundle.

4 Claims, 3 Drawing Figures





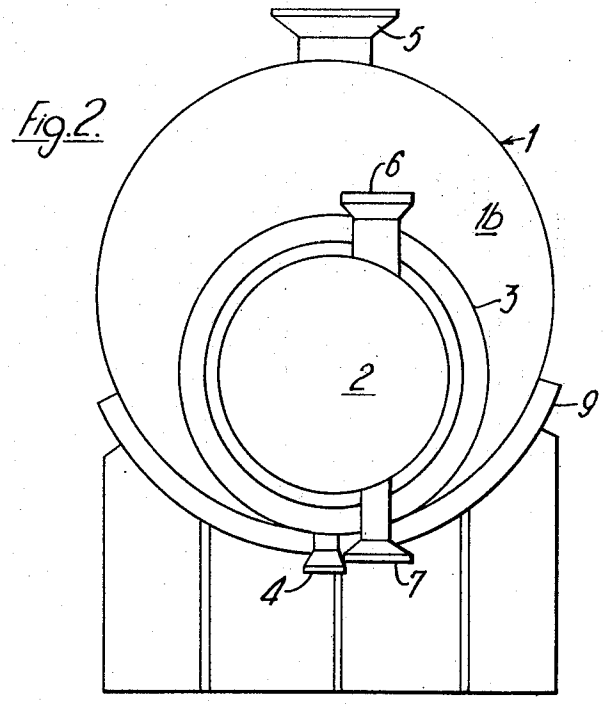


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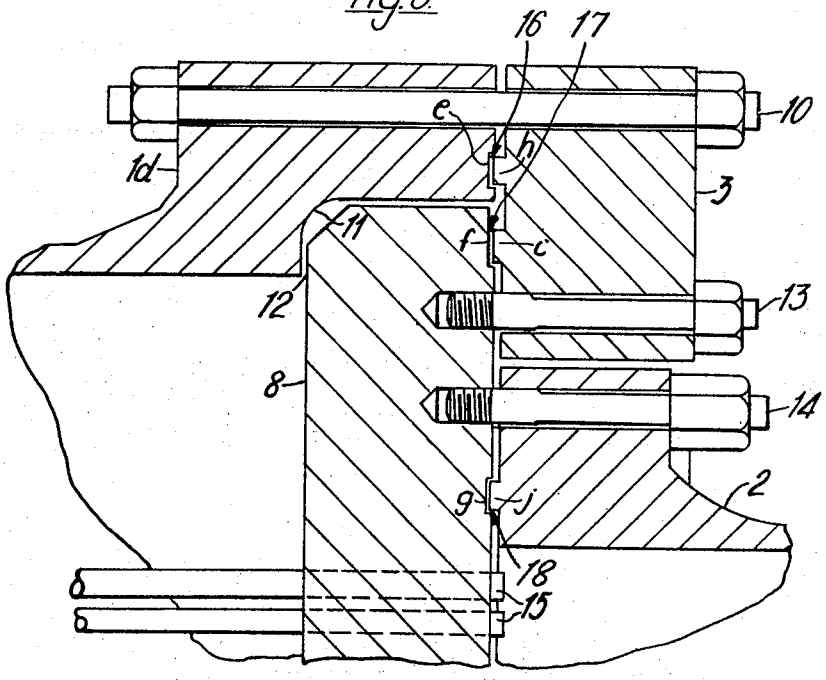
Fig. 3



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HEAT EXCHANGER

This invention relates to heat exchange vessels, and in particular to that kind of heat exchange vessel which comprises an elongate removable bundle or assemblage of tubes extending within a chamber through which one heat-transfer fluid is passed, the tubes collectively receiving and, after heat exchange has occurred, delivering another heat exchange fluid through one end boundary wall of the chamber that is formed by a disconnectable tube-plate to which the tubes are joined.

Heat exchangers of this kind may be of substantial size and one possible use is for cooling ethylene, itself perhaps later to serve as a refrigerant. Thus, ethylene may be passed through the tube bundle or assemblage and cooling effected by heat exchanger with liquid propylene continuously supplied to the chamber and in which the tube bundle or assemblage is immersed. The liquid propylene boils within the chamber and is continuously withdrawn as vapour.

An important requirement of any construction of heat exchanger of this kind is that the several distinct pieces which make up the overall heat exchanger should be secured together in a manner ensuring a proper seal between meeting surfaces to which the heat exchange fluids have access. Previous constructions have comprised, basically, three main parts, and these were, first a tube plate welded to the tubes and through which the end portions of the many tubes penetrate in a particular spacial manner such that tube inlets and outlets are collectively grouped together; second, a generally domed end part of the exchanger which is clamped against peripheral regions of the free face of the tube plate and, being suitably internally partitioned, co-operates with the tube plate to provide distribution and reception chambers for a first heat exchange fluid, e.g. ethylene, and, third, a shell which encloses the tubes and is provided with inlet and outlet means for a second heat exchange fluid, this shell also being clamped against peripheral portions of the tube plate but on the opposite side from the domed end part. With this kind of construction there are two principal regions where leakage of fluids might occur and these are between the tube plate and the shell and between the tube plate and the domed end part, and accordingly in order to ensure an effective seal in these two regions, gaskets are fitted and the parts are clamped together.

The Applicants have found that while such constructions perform satisfactorily, considerable inconvenience is occasioned by the need, when replacing the gasket situated between the tube plate and the shell, to withdraw the tube bundle fully from the shell in order that a fresh gasket may be fitted. Not only is the tube bundle and associated tube plate bulky and of considerable weight as well as being not very robust, but also the need to leave sufficient room adjacent the heat exchanger free of fixtures and other obstructions is an unwelcome constraint on plant layout.

The Applicants have designed an alternative construction which is equally satisfactory in performance and which does not suffer from the need to withdraw the tube bundle when gaskets are to be replaced.

The present invention provides a heat exchanger of the general kind aforedescribed wherein the tube plate is secured on its outward or "free" face, with an intervening gasket seal, to an end part of the exchanger that defines with the tube plate distribution and reception chambers for the heat exchange fluid which flows through the tube bundle and also on that face, with an intervening gasket seal, to an annular structural member that surrounds the said end portion of the exchanger, and the adjacent end portion of the shell of the heat exchanger overlaps and surrounds the tube plate and is secured with an intervening gasket seal to peripheral portions of the annular structural member that extend radially outwardly beyond the edges of the tube plate.

It will be seen that with this construction all gaskets are accessible on simple removal of the end part of the heat exchanger and the annular structure member; there is no necessity for removing the tube plate and tube bundle from its location within the shell.

Advantageously, the end part of the heat exchanger which provides for the supply and withdrawal of heat exchange fluid to the tubes is detachable from the tube plate without the need also to remove the annular structural member. The end portion of the shell may surround the tube plate with small clearance only and the tube plate may be received into an annular recess provided in the terminal portion of the shell.

Advantageously, so as to favour good gasket sealing, confronting portions of the tube plate and the annular structural member and the end part of the exchanger where the gaskets are fitted are provided with corresponding shallow recesses and projections, the recesses receiving the gaskets.

The annular structural member and the end part of the exchanger may each be satisfactorily attached to the tube plate by means of stud bolts tapped into the tube plate and fitted with tightenable clamping nuts at their outward free ends. The annular structural member is conveniently attached to the end of the shell by bolting to a terminal flange of the shell.

The terms "annular" and "radial" as used herein are not intended to denote a requirement for circular form for the members described. In practice, the shell would undoubtedly be of circular cross-section and for the greater part of its length would be circular cylindrical. Likewise in practice the tube plate would be circular and the annular structural member and the end part of the exchanger would also be round but, clearly, these parts might take any other form desired, say, oval, elliptical, oblong or square, without in any way interfering with the provision of accessible gaskets. Thus, "annular" is intended merely to describe a continuous closed form and "radial" to indicate the outward dimension relative to the general direction of extent and location of the tube bundle.

One form of heat exchanger in accordance with the invention will now be described by way of example in greater detail with reference to the accompanying drawings in which:

FIG. 1 is a general side view of the part of the heat exchanger,

FIG. 2 is an end view of the part of heat exchanger, shown in FIG. 1,

FIG. 3 is an enlarged cross-sectional view taken in the plane of FIG. 1 of part of the heat exchanger and showing in particular the tube plate, the terminal portion of the shell, some of the end part of the exchanger and the gasket seals.

Referring to FIGS. 1 and 2 of the drawings, the heat exchanger comprises a main shell body 1 (part only of its length shown) a domed end part 2 and a clamping

ring 3. The shell 1 is mostly circularcylindrical as for the indicated portion 1*a* thereof, but the shell tapers unsymmetrically towards its one end to a substantially smaller diameter. The tapering portion is indicated by the reference 1*b* in FIGS. 1 and 2. The terminal portion of the shell, 1*c*, carries a flange 1*d* to which the ring 3 is secured by bolting at closely spaced intervals. The chain lines A—A in FIG. 1 indicate typical placements for bolts.

The ring 3 surrounds the domed end part 2 with uniform radial separation and does not obstruct removal of the domed end part 2.

The shell 1 is provided with inlets 4 (two only shown) and outlets 5 (one only shown) for one heat exchange fluid at spaced positions along its length and the domed end part 2 has an inlet 6 and an outlet 7 for another heat-exchange fluid.

The domed end part is internally partitioned so as to provide distribution and reception chambers for its heat exchange fluid. In the assembled heat exchanger, the distribution and reception chambers are in communication with one another through numerous folded, i.e. elongated U-shaped, heat exchange tubes (not shown in FIGS. 1 and 2) which collectively extend with parallel outgoing and incoming lengths along substantially the whole of the length of the shell 1 and occupy the lower part of the interior thereof. These tubes which are conveninetly termed "U-tubes" protrude through a tube plate which is shown in dotted outline in FIG. 1 and is given the reference 8. The tubes end portions are welded to the tube plate 8. The joints are "soft joints" allowing movement under thermal stress. (There may, for example, be close to 200°C difference in temperature between different parts of the tube plate when the heat exchanger is used for ethylene/propylene heat exchange with a "double-pass" flow arrangement of the tube bundle, i.e. the ethylene flows through two groups of U-tubes in series). The heat exchanger is supported overall on a cradle 9 (see FIG. 2).

Referring to FIG. 3 of the drawings, a typical bolt connection between the ring 3 and the flanged end portion 1*d* of the shell 1 is shown at 10. The flanged end portion 1*d* of the shell 1 receives the tube plate 8 within a recess 11 of closely matching dimensions and there is close confrontation at 12, with a small gap remaining, between the tube plate 8 and the shell 1.

The ring 3 is secured to the tube plate 8 at numerous points by stud bolts 13 (only one shown) tapped into the tube plate 8. Similarly, the domed end part 2 of the exchanger is secured to the tube plate 8 by stud bolts 14 (one only shown).

Two representative heat exchanger tubes of the tube bundle are shown at 15 protruding through the tube plate 8.

There are annular gasket seals provided between the ring 3 and the shell flange 1*d*, the ring 3 and the tube plate 8, and the domed end part 2 and the tube plate 8. The positions of these gasket seals are indicated in FIG. 3 by arrows 16, 17 and 18 and the surface regions of the shell flange 1*d*, the ring 3, the tube plate 8 and the domed end part 2 between which the gaskets are confined are provided with spacially related recesses *e*, *f* (in fact, a "one-sided" recess), and *g* and projections or "nibs" *h*, *i*, and *j*, the gaskets being accommodated within the recesses. The provisions of these "nibs" and recesses makes for efficient sealing between the clamped parts.

As will be evident, especially from FIGS. 1 and 3, these gasket seals are adequate to the needs of the exchanger and are readily accessible by removing ring 3 and domed end part 2. The tube plate 8 and tube bundle may remain in situ during gasket replacement. On-site machining facilities can be used to refurbish the recesses 8*e*, 8*f* and 8*g*.

What we claim is:

1. A heat exchange vessel of the kind comprising an elongate removable bundle or assemblage of tubes extending within a chamber through which one heat-exchange fluid is passed, the tubes collectively receiving and, after heat exchange has occurred, delivering another heat exchange fluid through one end boundary wall of the chamber that is formed by a disconnectable tube-plate to which the tubes are joined, having an outer face which is releasably the tube plate is secured, with an intervening gasket seal, to an end part of the exchanger that defines with the tube plate distribution and reception chambers for the heat-exchange fluid which flows through the tube bundle, the outer face of the tube plate also being releasably secured, with an intervening gasket seal, to an annular structural member which surrounds the said end portion of the exchanger and which has peripheral portions extending radially outwardly beyond the edges of the tube plate, the adjacent end portion of the shell of the heat exchanger overlapping and surrounding the tube plate and being releasably secured, with an intervening gasket seal, to said peripheral portions of the annular structural member.

2. An exchanger as claimed in claim 1, wherein the end part of the heat exchanger which provides for the supply and withdrawal of heat exchange fluid to the tubes is detachable from the tube plate without the need also to remove the annular structural member.

3. An exchanger as claimed in claim 1 wherein the tube plate is received into an annular recess in the terminal portion of the shell.

4. A heat exchanger comprising: a hollow shell having an outwardly facing axial recess in one end and an axially facing end wall surrounding the recess; a tube plate disposed within said recess, the plate having dimensions which closely match those of the recess and having an outer axial face; a plurality of tubes disposed within the shell, each tube having both ends joined to the tube plate whereby the tubes can receive and discharge a heat exchange fluid through the tube plate; a heat exchanger end part and means releasably securing the end part to the outer face of the tube plate with an annular gasket clamped therebetween, the end part defining with the tube plate distribution and reception chambers for the heat exchange fluid which passes through the tubes; a rigid structural clamping ring surrounding the heat exchanger end part so as to permit removal of the latter while the clamping ring is in position, means releasably securing the clamping ring to the outer face of the tube plate with an annular gasket clamped therebetween, and means releasably securing the clamping ring to the axially facing end wall of the shell with an annular gasket clamped therebetween, whereupon removal of the heat exchanger end part and the clamping ring all of the aforesaid gaskets are accessible.

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