July 21, 1942. E. A. BERTRAM 2,290,528

HEAT EXCHANGER

Filed May 1, 1940

Fig. 1.

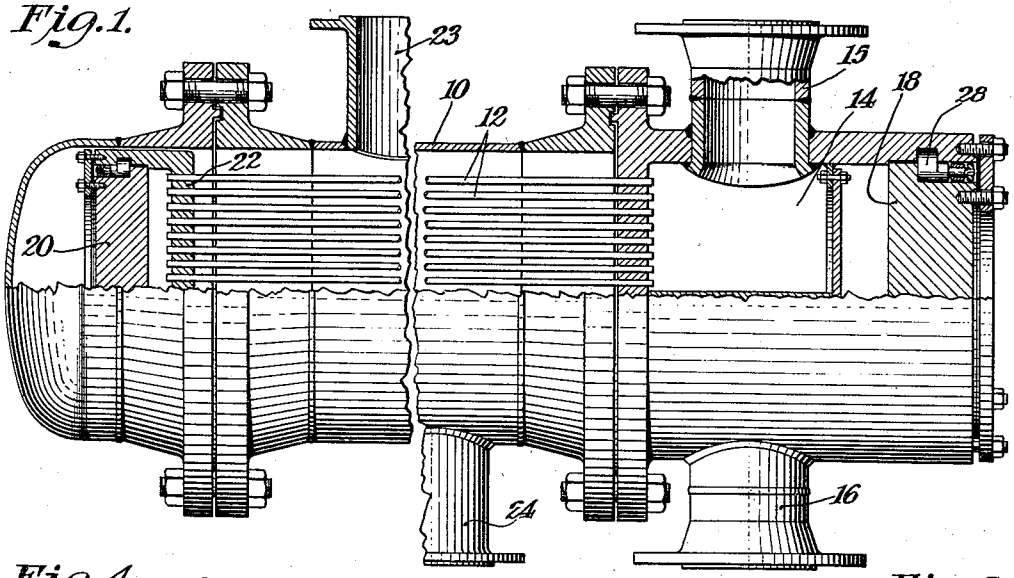


Fig. 4.

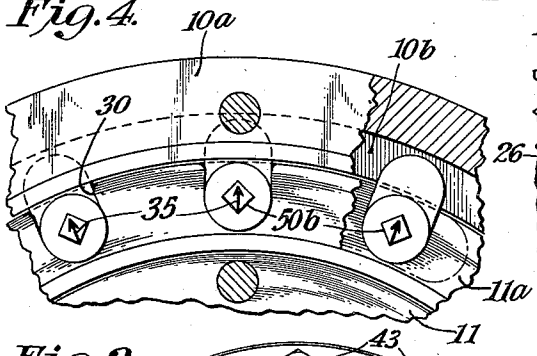


Fig. 3.

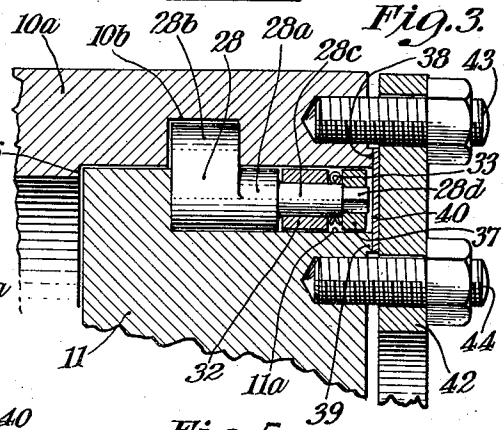


Fig. 2.

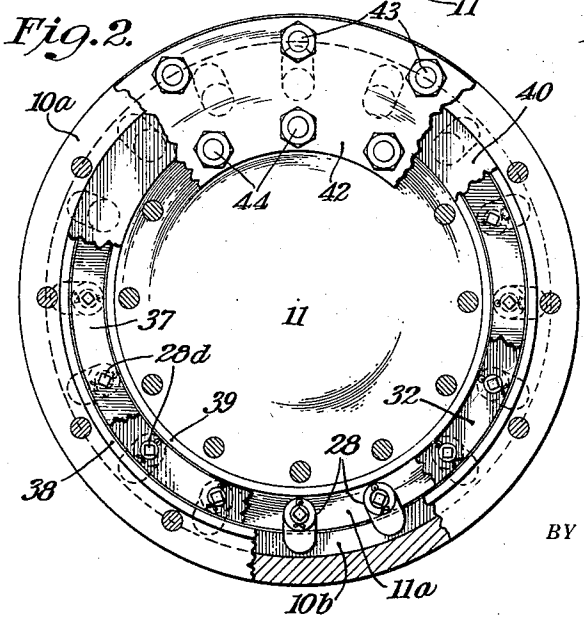
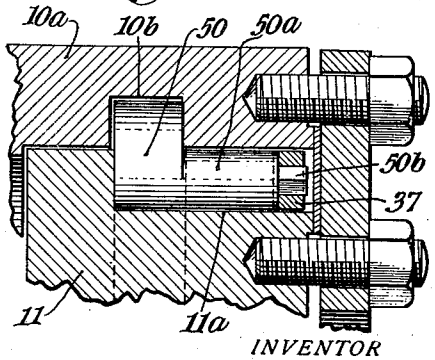


Fig. 5.



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HEAT EXCHANGER

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Application May 1, 1940, Serial No. 332,656

5 Claims. (Cl. 220—55)

This invention relates to improvements in closures in pressure vessels and more particularly to heads or closures for vessels which may be subjected alternately to pressure or vacuum conditions.

It has heretofore been pointed out that with heavy duty pressure vessels in which temperatures and pressures are relatively high, the effective sealing of a closure is accomplished only with difficulty. I have provided a closure for such a pressure vessel, more particularly a shell and tube type heat exchanger, which has the desirable characteristics of low cost, simplicity, direct transfer of hydrostatic loads from closure to vessel wall, and an externally rugged construction in which an external gasket is used to seal imperforate parts and by which inspection of the pressure seal during service is accomplished.

In accordance with my invention, I provide a cover locking means for such a construction, which can be assembled independently of the cover and which will lock the cover against movement in either direction so that it will be permanently fixed, even though the pressures to which the cover may be subjected change from superatmospheric to subatmospheric, or vice versa.

A more particular feature of my invention is to provide an integrated series of rotatable dogs or shear keys for locking a closure to a vessel in which the locking dogs are supported by a common supporting ring which will permit their rotation, and in which a key ring is provided which will lock all of the dogs in a predetermined position so that the entire assembly may be freely inserted or removed and when locked closed, the entire series of keys is covered by the sealing gasket and leakage, except at the gasket, is impossible.

Further objects of my invention will appear from the following disclosure of a preferred form of embodiment thereof taken in connection with the attached drawing, in which

Fig. 1 is a side elevation with parts broken away and in section of a shell and tube type heat exchanger to which my invention is applied;

Fig. 2 is an end elevation with parts broken away and in section of the channel end or floating tube sheet end of the heat exchanger shown in Fig. 1;

Fig. 3 is an enlarged vertical section showing the details of the gasket and locking dog construction;

Fig. 4 is an end elevation of a part of a modified form of cover construction showing the details of the locking dog arrangement;

Fig. 5 is a vertical section similar to Fig. 3 showing other details of the modified form of construction of Fig. 4.

In accordance with the preferred form of embodiment of my invention, the heat exchanger 10 is used to represent a type of pressure vessel which is subjected to elevated pressures which require an especially rugged closure member. Such heat exchanger has the customary tube bundle 12, the one fluid for which may enter and exit through a channel chamber 14 having the inlet and outlet nozzles 15 and 16. In such case the channel chamber may be under a very high pressure, which requires an exceptionally rugged channel cover 18. With high pressure on the tube side of such an exchanger, the tube sheet cover 20, which cooperates with the floating tube sheet 22, must also be of a very rugged construction. A heat exchanger of this particular type is frequently used as a condenser with high pressure fluids on the tube side, such pressures being in the range of 350 lbs. per square inch and upward.

It is, of course, to be understood that the shell side of the heat exchanger is provided with fluid flow through the inlet and outlet nozzles 23 and 24 and that the fluid on the outside of the tube bundle surrounds the tubes and the floating tube sheet cover. Under some circumstances, the pressure on the exterior of the tubes may exceed the pressure within the tubes, but ordinarily the pressure within the tubes is the higher. It is, therefore, necessary that the cover 20 be held immovable and, for standardization and uniformity, it is desirable that the cover 18 be held in a fixed position.

It will be noted that in each case the cover 18 or 20 is adapted to be recessed within the vessel wall, although in each case the opening in the vessel wall may not be the smallest diameter of the vessel. The shoulder 26 thus formed prevents the inward movement of the cover. Other and equally satisfactory forms of abutments can also be provided as, for example, a recessed ring, but for simplicity of manufacture, the recessed diameter is the easiest to manufacture and satisfactorily serves to prevent the movement of the cover in one direction. As shown in Fig. 3, which may be a section of any vessel, the wall of the vessel is indicated at 10a and may be considered to be the wall to which a cover, generally indicated as 11, may be attached.

The principal feature of my invention is the use of locking dogs or shear keys, generally indicated at 28, to lock the cover to the vessel wall.

In the preferred form, they are provided with a substantially cylindrical shank **28***a* and an angular portion or enlarged locking surface **28***b*, which locking surface is adapted to fit within a recess **10***b* in the wall of the vessel **10***a*. As shown in Figs. 3 and 4, the recess **10***b* may be continuous inasmuch as such construction is the easiest to manufacture. It is, of course, within the scope of my invention to use discontinuous recesses if for any reason such construction is found necessary for the purpose of greater strength.

The dogs **28** have a nominal width, that of the shank **28***a*, and this is the determining factor in the width of the recess **11***a* in the cover **11**, which is formed by reducing the diameter of the outer part of the cover which provides a continuous recess as illustrated in Fig. 2. With such a recess, it is desirable that the dogs **28** be uniformly spaced around the periphery of the cover, and this is effectively accomplished by a spacing or assembly ring **32** which embraces the reduced cylindrical portion **28***c* of the shank of the dogs **28**. A cotter key **33** can be used to establish the fixed position of all of the dogs **28** in the spacing ring **32**.

The shank of the dogs **28**, in addition to the cylindrical bearing portion **28***a* and the reduced portion **28***c*, is also preferably provided with a key portion **28***d* at the end, which is of any desired polygonal configuration. With such a shape, the dogs **28** can be readily turned into the holding position in the recess **10***b* or into the free position in the recess **11***a* in the cover. An indicating arrow **35**, as shown in Fig. 4, will indicate the position of the locking portion **28***b*.

Preferably, the dogs **28** are all locked in a predetermined position. If the cover is being disassembled, all of the dogs are turned about the longitudinal axes of their shanks to their released position, in which position a locking ring **37** can be placed over the polygonal shanks **28***d* so that all of the locking dogs can be handled as a unit and so that the portions **28***b* will not accidentally engage in the vessel wall. This ring is also of advantage after assembly, as when the locking dogs are all turned into locked position, the ring **37** may be replaced to lock each dog and assure the permanence of their engagement with the vessel wall.

The locking dogs will effectively hold the cover against outward movement and the shoulder **26**, heretofore mentioned, will prevent the movement of the cover in an inward direction. Regardless of changes of pressure, therefore, the cover is in a fixed position.

Sealing of the peripheral space between the cover and the shell is accomplished by an external gasket which permits effective inspection and prevents hidden leaks. It more specifically embraces a pair of annular ribs, one of which is indicated at **38** and extends from the end of the wall **10***a* while a similar rib **39** projects from the cover **11**, such ribs serving as the pressure-contacting surfaces for the gasket generally indicated at **40**. The gasket is preferably held in position by a ring **42** which is in turn anchored to the cover and to the vessel wall by a series of studs **43** and **44**. The ring **42** may be in one or two annular pieces and is adapted to exert an effective sealing pressure between the gasket and the respective cover and vessel wall ribs. As the gasket is on the outside of the cover and the vessel wall and completely covers all locking lugs, etc., any leaks can be readily ascertained and corrected by variation of the tension on the studs **43** and **44**.

A slightly modified form of construction is shown in Figs. 4 and 5 in which the vessel wall **10***a* is similar to the one heretofore described, and is adapted to receive the cover **11** which is also of a similar size and shape. In this case, however, the locking dogs or shear keys **50** are slightly different in that the shank portion **50***a* is of substantially uniform diameter up to the key portion **50***b* and in this case, the bearing for the shank portion **50***a* is supplied by the independent recesses **30** as shown in Fig. 4. In such case, each of the lugs is independent during the locking or unlocking operation and each lug must be independently removed, although while locked or unlocked, they may be held in the desired position by the locking ring **37**, heretofore described. Such construction may be preferred where the size of the dog is predetermined and where the diameter of the holding ring **32** would be so great as to be impractical. Uniform peripheral spacing is obtained in a satisfactory manner by this means.

It is, of course, to be understood that the shear keys have the principal function of serving as a mechanical lock between the cover and vessel wall and the keys might be recessed in the vessel wall, if it were sufficiently thick, and be turned into position by a stem or shank projecting out of the vessel wall. Preferably, the vessel wall should be imperforate to avoid any possibility of leaks, and the reduced cover diameter appears to be cheapest for the desired purpose. The keys could be readily placed, part in the cover and part in the vessel wall, if any advantage would result from such an arrangement. As the cover need not be turned to release the holding key means, the shape may be polygonal or other than circular, if such shape is found more advantageous in particular cases.

While I have shown and described a preferred form of embodiment of my invention, I am aware that modifications may be made thereto and I desire, therefore, a broad interpretation of my invention within the scope and spirit of the description herein and of the claims appended hereinafter.

I claim:

1. A pressure vessel of the class described having an opening, a cover for said opening, said cover being smaller than the opening and adapted to fit therein, the vessel wall adjacent said opening having a shoulder to limit the movement of the cover into the opening, means to resist the tendency of the cover to move out of the vessel under internal pressure, and means to seal the joint between the cover and the vessel, said cover being provided with an external peripheral recess extending partially across the thickness of the cover, the wall of said vessel adjacent to the opening having an internal circumferential recess in line with the base of the cover recess, the cover movement resisting means consisting of a series of rotatable keys each having a shank portion extending longitudinally along the margin of the cover and being rotatable about the longitudinal axis of its shank portion, said keys having an angular portion of substantially the same width as the recess in the wall of the vessel and rotatable into and out of said wall recess, whereby when said keys are in appropriate position, the angular portions will be in close fitting shear relation to resist outward movement of the cover.

2. A pressure vessel as claimed in claim 1 in which the external peripheral recess in the cover is continuous and an assembly ring fits within said recess and engages and spaces each of the key means whereby the key means may be handled as a unit.

3. A pressure vessel of the class described in claim 1 in which the shank portion of each of the key means has a polygonal portion, and a locking ring having polygonal openings engages said shank portions to lock the key means against turning from either the locked or unlocked position.

4. A pressure vessel of the class described in claim 1 in which an assembly ring engages and spaces each of the key means whereby the key means may be handled as a unit, and a locking ring positioned in the peripheral recess of said cover, each of the shank portions being keyed to the locking ring to lock the key means against turning from either the cover locking or unlocking position, and the recess in the cover is of sufficient depth and width to receive the entire key means, assembly ring, and locking ring.

5. A pressure vessel as claimed in claim 1 in which the external peripheral recess is provided with spaced radial outwardly opening notches to space the key means and form a bearing therefor, and a locking ring positioned in the peripheral recess of said cover, each of the shank portions being keyed to the locking ring to lock the key means against turning from either the cover locking or the unlocking position.

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