

Jan. 20, 1931.

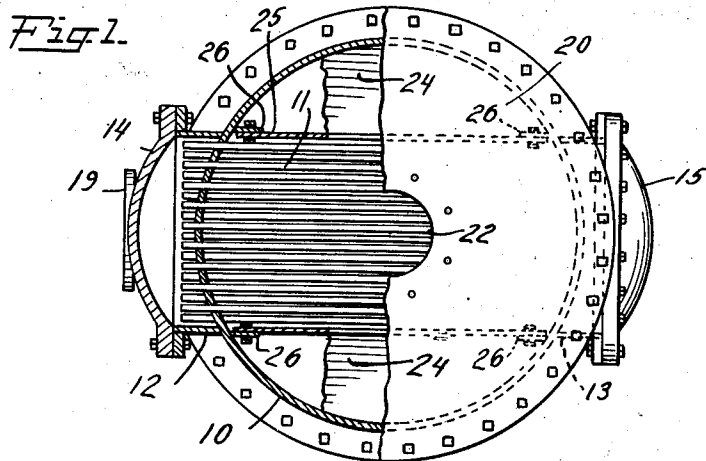
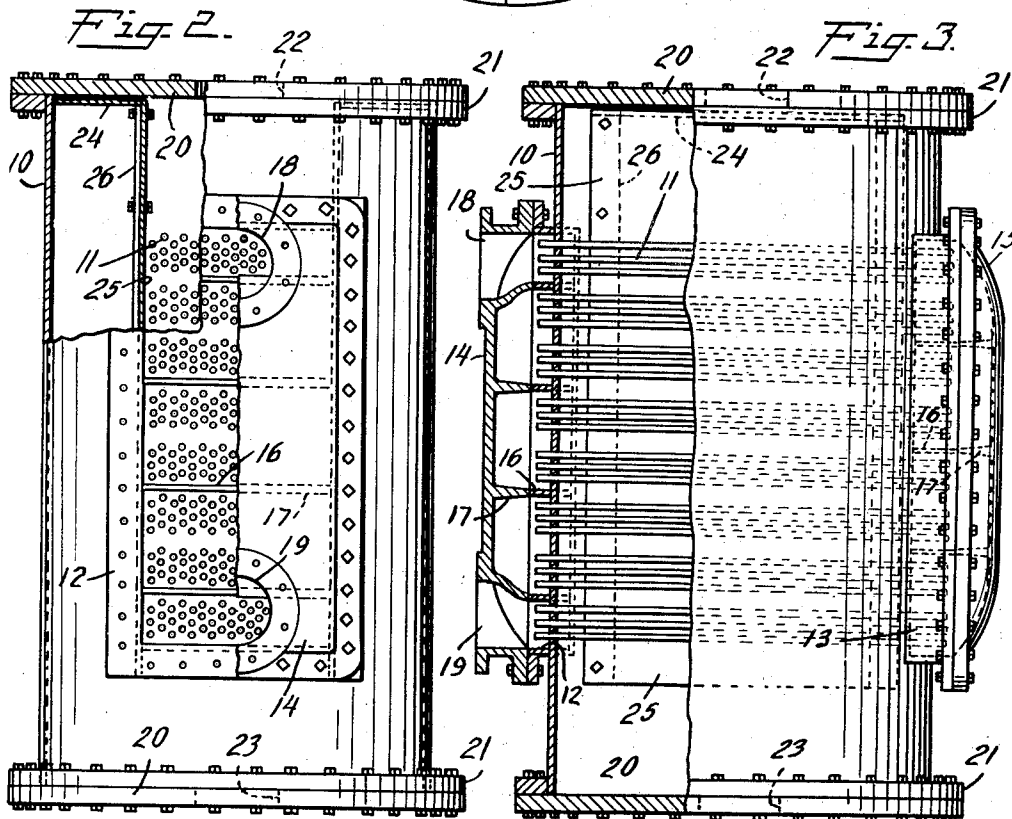
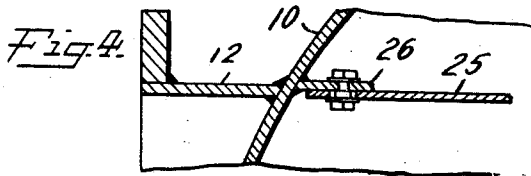
J. PRICE

1,789,880

OIL REFINERY CONDENSER

Filed April 15, 1929

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 5.

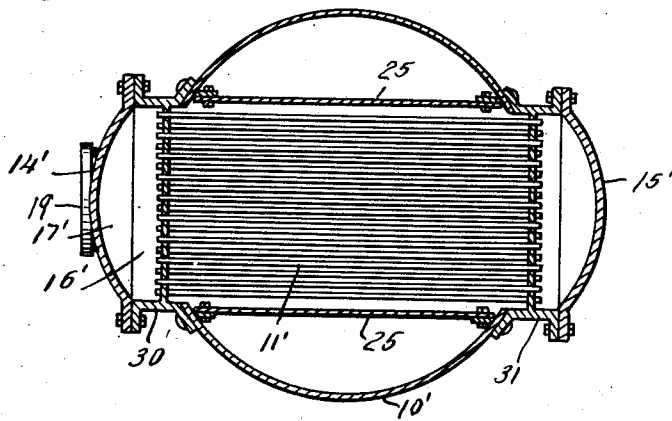
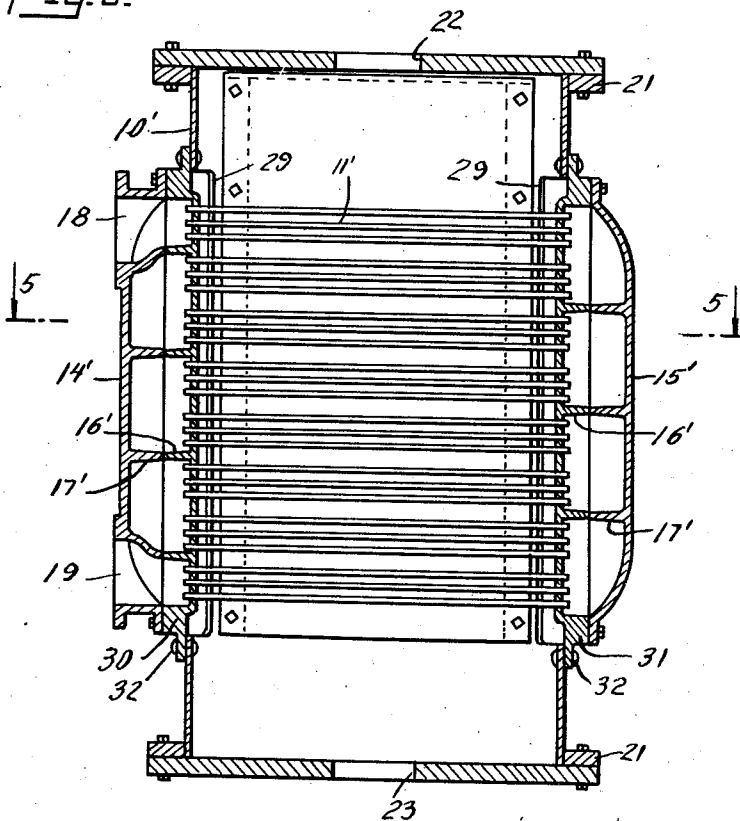


Fig. 6.



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OIL-REFINERY CONDENSER

Application filed April 15, 1929. Serial No. 355,090.

This invention relates to heat exchangers adapted particularly for cooling and liquefying vapors resulting from the distillation of petroleum and, more generally, for cooling gases or liquids of any kind.

The primary object of the invention is to provide an improved surface type heat exchanger in which the expansion and contraction of the tubes is provided for effectively and at small manufacturing cost.

Another object of the invention is to provide a heat exchanger in which comparatively high pressures can be accommodated in the shell without the expense of bracing the shell sides.

Another object of the invention is to provide a heat exchanger construction which is commercially practicable because of its simple arrangement and low cost of manufacture.

The invention will be understood from a consideration of the following description taken in connection with the accompanying drawings, in which

Fig. 1 is a plan view of the heat exchanger with the upper left hand portion broken away and showing the tube bundle in transverse section.

Fig. 2 is an end elevation of the heat exchanger in which the upper left hand corner is broken away to show a portion of the shell and tube bundle in central vertical section, and the left hand portion of one of the tube bundle caps is also broken away to expose the ends of the tubes.

Fig. 3 is a side elevation with the left hand portion broken away and showing a vertical section of the heat exchanger shell taken centrally of the shell.

Fig. 4 is an enlarged fragmentary section of the upper left hand portion of Fig. 1 showing certain details of construction.

Figs. 5 and 6 illustrate a modification, Fig. 5 being a horizontal section on line 5-5 of Fig. 6, and Fig. 6 a vertical section taken centrally through Fig. 5.

Referring to Figs. 1 to 4 of the accompanying drawings, the shell 10 of the heat exchanger is cylindrical or substantially cylindrical in form, and the tubes of the tube

bundle 11 extend transversely across the shell from one curved side to the other. The walls of the shell 10 are punched or drilled on opposite sides to receive the ends of the tubes. The tubes are inserted in these aligned holes and each end of the tubes is then expanded after the customary manner of securing tubes in tube sheets. In fact the drilled areas of the shell constitute curved tube sheets which are made integral with the side walls of the shell, the side walls themselves being curved to the same radius of curvature as the tube sheets.

The tubes of the entire tube bundle are preferably all of the same length for the sake of convenience, and the ends of the tubes will therefore project by varying amounts beyond the exterior surface of the shell, as indicated in the drawings. In order to provide for delivering and controlling the flow of fluid through the interiors of the tubes, these projecting tube ends on each side of the shell are covered by means of flanged members 12 and 13 having flanged caps 14 and 15 removably bolted thereto. The flanged members 12 and 13 surround the projecting ends of the tubes 11 and are curved on their inner edges to conform to the curvature of the shell 10. They are welded to the shell along the peripheries of these inner edges, so as to make a tight joint therewith and they form a chamber at each end of the tube bundle which is capable of withstanding considerable pressure.

The outer ends of the flanged members 12 and 13 extend just beyond the ends of the tubes so as to protect them when the caps 14 and 15 are removed. The heat exchanger illustrated in the drawings by way of example is an eight-pass heat exchanger, that is, the liquid is passed eight times across the heat exchanger shell before being allowed to leave the tube bundle. This is accomplished by subdividing the chambers at each end of the tube bundles by means of partition walls 16 within the flanged members 12 and 13, and ribs 17 in the caps 14 and 15 which register with these partition walls.

The partition walls 16 are placed in between the projecting ends of the tubes and

welded to the surface of the shell 10 while the ribs 17 are made integral with the caps 14 and 15, these caps being made preferably of cast iron. The arrangement of the partition walls 16 at each end of the tube bundle is indicated in the drawings. Fluid connections for admitting and discharging fluid to the interior of the tubes of the tube bundle are made with any of the chambers formed by partition 16 and rib 17 to obtain the desired circulation of fluid.

In the heat exchanger illustrated, a flanged connection 18 communicates with the uppermost of these chambers in cap 14, and a second flanged connection 19 with the lowermost chamber in the same cap. The fluid, for example cooling water, can be admitted through either of these connections and discharged through the other one. Assuming that it enters at the top, the cooling water will flow through the first pass consisting of the uppermost group of tubes to the opposite end of the tube bundle where it will be delivered by means of the chambers formed in the cap 15 to the next lower group of tubes by which it will pass back to cap 14. The flow continues in this manner through the eight passes and finally the water leaves the apparatus through the outlet 19.

The shell 10 is preferably constructed in the example shown in the drawings, of 5/8 inch steel plate rolled into cylindrical shape and welded along the longitudinal meeting edges. The shell is provided at top and bottom with closing discs 20 consisting of 1 5/8 inch steel plate which is bolted to flanges 21 welded on to each end of the shell. This shell, if inside diameter is not over 30 inches, will safely withstand a working pressure of 100 pounds per square inch and the same pressure may also be used on the fluid within the tubes.

The fluid, for example oil vapors which are to be condensed, enters the shell 10 through a central inlet opening 22 in the top closing disc 20, and the condensate leaves the shell through a similar opening 23 in the bottom closing disc. Because of the thickness of these closing discs, it is unnecessary to provide separate flanges for connection and the flanged pipe connections are studded directly to the surfaces of the closing discs 20 as indicated by the stud circles surrounding the openings 22 and 23.

In order to direct the incoming vapor over the surfaces of the tubes 11, transverse blanking off plates 24 are positioned to fill the spaces on each side of the tube bundle at the top, and longitudinal baffles 25 are also mounted at the sides of the tube bundle 11.

The longitudinal baffles are held in place by shouldered tap bolts which are set into longitudinal bars 26 that are welded to the interior surface of the shell along each side of the tube bundle. The holes in the baffle plates

are made considerably larger than the bolts so as to allow for expansion and contraction without stressing the baffle plates, and the bolts are provided with spring washers to hold the baffle plates snugly in place.

The tube bundle 11 illustrated in the drawings consists of 432 3/4-inch outside diameter No. 14 B. W. G. steel tubes. The tubes may, however, be made of copper or other non-ferrous metal if desired.

The modified form of heat exchanger illustrated in Figs. 5 and 6 is similar in dimensions and construction to the form just described in connection with Figs. 1 to 4 inclusive except that the ends of the tubes, instead of being secured directly in the walls of the shell, are secured in separately formed tube sheets which are mounted upon opposite sides of the cylindrical shell.

To this end the shell 10' is provided with apertures 29 which in the form shown in the drawings are rectangular in shape, in which tube sheet members 30 and 31 are mounted. These tube sheet members are preferably made in the form of steel castings which are separately attached to the shell around the periphery of the openings 29 by means of rows of rivets 32 or by welding. The lateral and longitudinal extents of these tube sheet members are such as to leave a considerable space at both sides of the tube bundle and also at the top and bottom of the tube bundle for a purpose which will hereafter appear.

With this form of construction the tube sheets formed in the tube sheet members 30 and 31 are flat so that the apertures for the tubes can be made somewhat more easily than in the case of the construction shown in Figs. 1 to 4 inclusive. Also the ends of the tubes of the tube bundle 11' project uniformly beyond the tube sheets.

The tube sheet members 30 and 31 are provided with partition walls 16' corresponding to those shown in Figs. 2 and 3 for the purpose of co-acting with ribs 17' formed on the interior of the caps 14' and 15' for the purpose of controlling the flow of liquid through the tubes.

The diameter of the shell of my improved heat exchanger is made considerably larger than the width of the tube bundle so as to give considerable curvature to the sides of the shell opposite the sides of the tube bundle and thereby permit these sides to flex or become slightly distorted under the forces accompanying expansion and contraction of the tubes of the tube bundle. This flexing is evenly distributed throughout the sides of the shell, and some flexing may even occur in the portions of the shell which serve as tube sheets in Figs. 1 to 4. The flexing of these portions of the shell will be relatively small, however, but in any event the moving of the axes of the tube openings which accompanies this flexing is taken up in a slight bowing of the tubes

without placing severe strain upon the tube joints.

The shape of the tube bundle in end view is preferably rectangular since in this way the maximum number of tubes can be placed in a given area. Also the tube sheets, either the integral form shown in Figs. 1 to 4, or the separate form shown in Figs. 5 and 6, are then parallel with the sides of the shell and the stresses caused by expansion and contraction are evenly distributed lengthwise of the shell. The tubes can be arranged, however, in bundles of circular, elliptical or other cross-sectional shape if desired. The ends of the shell are extended both above and below the tube bundle so as to facilitate the further distortion of the shell under the forces of expansion and contraction when the ends of the shell are closed by non-flexing members such as the closing discs 20.

In heat exchangers used for oil refining work, it is necessary to provide for frequent cleaning of the tubes because of scale forming impurities which are present in the cooling water available in many localities. This accessibility is provided for in the present heat exchanger by the mere removing of the caps 14 and 15 after which the straight tubes of the tube bundle can be readily cleaned in any ordinary manner.

The improved heat exchanger of the present invention has been found to be of extremely practical construction because of the fact that provision for compensating for the expansion and contraction of the tubes has been provided for in an extremely simple and inexpensive way. Moreover, the same principles of construction which provide for expansion and contraction also provide for exceptional strength in the shell. The present heat exchanger therefore can be manufactured at extremely low cost and at the same time is well adapted use where considerable expansion and contraction is apt to take place and where relatively high pressures must be employed both in the shell and in the tubes.

The foregoing is to be considered as a mere exemplifying disclosure of my invention, and the invention includes such variations as come within the terms of the appended claims.

I claim:—

1. An apparatus of the type described comprising a shell substantially cylindrical in cross section, a pair of tube sheets operatively supported opposite one another by the cylindrical sides of the shell, and a bundle of tubes having their ends secured in the tube sheets and extending transversely of the cylindrical shell, the cylindrical shell being substantially larger in diameter than the width of the tube bundle so as to leave flexible portions in the sides of the shell between the tube sheets for taking up the

change in length of the tubes caused by expansion and contraction.

2. An apparatus of the type described comprising a shell substantially cylindrical in cross section, a tube sheet supported by each side of the shell, and a bundle of tubes operatively supported by the tube sheets and extending transversely of the cylindrical shell, the lateral extent of the said tube bundle being substantially less than the diameter of the shell, and the longitudinal extent of the tube bundle being substantially less than the length of the shell so as to leave flexible portions in the sides of the shell surrounding the tube sheets for taking up the change in length of the tubes caused by expansion and contraction.

3. An apparatus of the type described comprising a pair of tube sheets having a bundle of tubes mounted therebetween, a shell for supporting the tube sheets and directing fluid into contact with the exterior surfaces of the tubes, the sides of the shell joining the sides of the tube sheets extending outwardly from the tube bundle in sweeping curves and forming flexible portions for taking up the change in length of the tubes caused by expansion and contraction.

4. An apparatus of the type described comprising a shell substantially cylindrical in cross section, a pair of tube sheets operatively supported opposite one another by the cylindrical sides of the shell, a bundle of tubes having their ends secured in the tube sheets and extending transversely of the cylindrical shell, the cylindrical shell being substantially larger in diameter than the width of the tube bundle so as to leave flexible portions in the sides of the shell for taking up the change in length of the tubes caused by expansion and contraction, baffles transversely positioned at the top of the tube bundle for filling the spaces between the sides of the tube bundle and the sides of the shell, and baffles arranged longitudinally at the sides of the tube bundle thereby causing the fluid in the shell to be held in contact with the surfaces of the tubes.

5. An apparatus of the type described comprising a shell substantially cylindrical in cross section, a bundle of tubes having their ends secured in the sides of the cylindrical shell and extending transversely thereof, the cylindrical shell being substantially larger in diameter than the width of the tube bundle so as to leave flexible portions in the sides of the shell for taking up the change in length of the tubes caused by expansion and contraction, and chambers surrounding the protruding ends of the tubes at each side of the shell for directing the flow of fluid through the tubes.

6. An apparatus of the type described comprising a tube bundle and a metal enclosure for said bundle, at least a portion of said enclosure having edges fixed with respect to the ends of the tube bundle and having substan-

tially the entire section intermediate the said edges curved to provide sufficient flexibility to accommodate expansion and contraction of the tubes.

7. An apparatus of the type described comprising a pair of tube sheets having a bundle of tubes mounted therebetween and a shell having sides joining the sides of the tube sheets and extending outwardly from the tube bundle in sweeping curves and forming flexible portions for taking up the change in length in the tubes caused by expansion and contraction.

8. An apparatus of the type described comprising a shell substantially cylindrical in cross section, a pair of tube sheets operatively mounted opposite one another on the cylindrical sides of the shell, a bundle of tubes having their ends secured in the tube sheets and extending transversely of the cylindrical shell, the cylindrical shell being substantially larger in diameter than the width of the tube bundle so as to provide flexible portions in the sides of the shell for taking up the change in length of the tubes caused by expansion and contraction, and baffles arranged longitudinally at the sides of the tube bundle thereby causing the fluid in the shell to be held in contact with the surface of the tubes.

9. An apparatus of the type described comprising a shell substantially cylindrical in cross section, a pair of tube sheets operatively mounted opposite one another on the cylindrical sides of the shell, a bundle of tubes having their ends secured in the tube sheets and extending transversely of the cylindrical shell, the cylindrical shell being substantially larger in diameter than the width of the tube bundle so as to provide flexible portions in the sides of the shell for taking up the change in length of the tubes caused by expansion and contraction, baffles arranged longitudinally at the sides of the tube bundle, and means for preventing the by-passing of fluid around the tube bundle, between the said baffles and the shell.

10. An apparatus of the type described comprising a pair of tube sheets having a bundle of tubes mounted therebetween, a shell having sides joining the sides of the tube sheets and extending outwardly from the tube bundle in sweeping curves to provide flexible portions for taking up the change in length of the tubes caused by expansion and contraction, means for supplying fluid to the shell and means within the shell for confining the fluid in contact with the external surfaces of the tubes.

11. An apparatus of the type described comprising a shell substantially cylindrical in cross section, a pair of tube sheets supported by the shell at opposite sides thereof, a bundle of tubes having their ends secured in the tube sheets and extending transversely of the cylindrical shell and closure plates secured to

the ends of the cylindrical shell, the shell being substantially larger in diameter than the width of the tube bundle so as to provide flexible portions in the sides of the shell, between the tube sheets for taking up the change in length of the tubes caused by expansion and contraction, and the said tube bundle being spaced apart from said closure plates.

In testimony whereof I affix my signature.

JOSEPH PRICE.

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