Aug. 24, 1926. 1,597,479

J. PRICE

HEAT EXCHANGER

Filed March 3, 1925

Fig. 1.

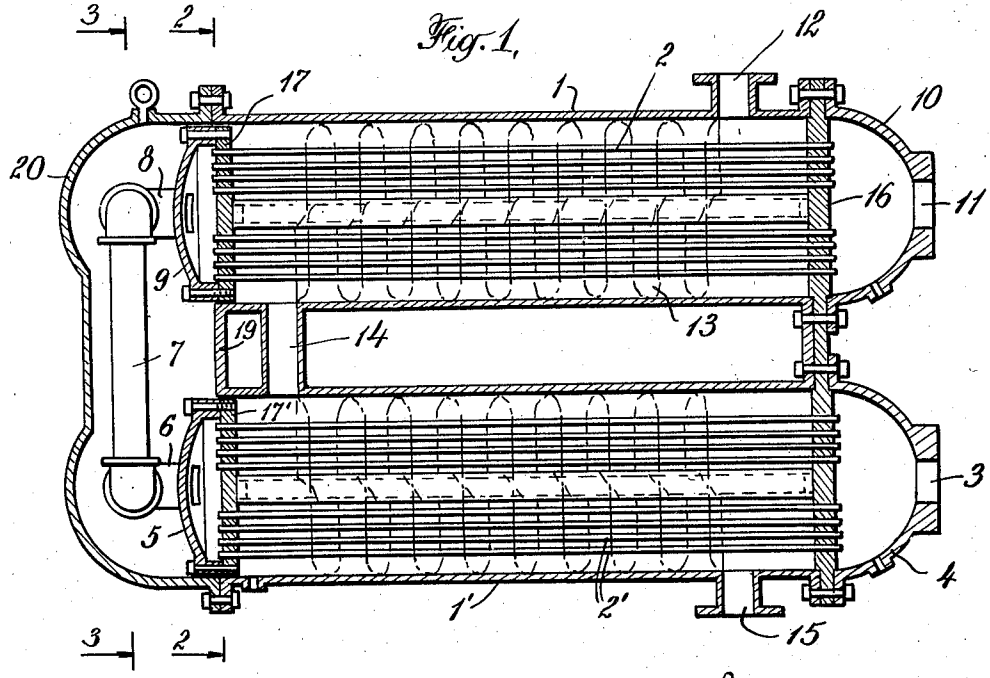


Fig. 2.

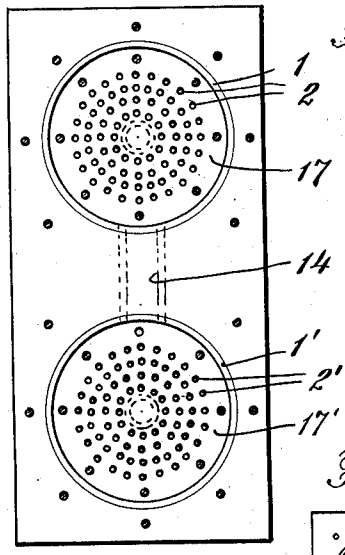


Fig. 3.

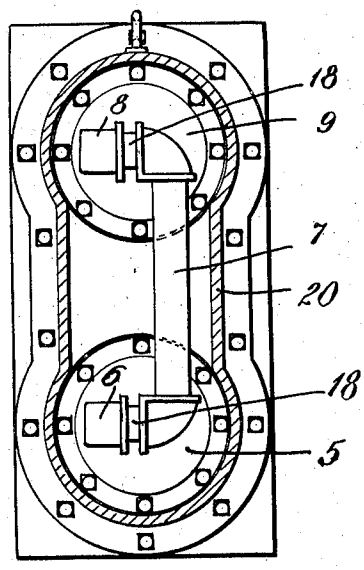
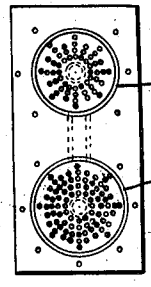


Fig. 4.



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UNITED STATES PATENT OFFICE.

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HEAT EXCHANGER.

Application filed March 3, 1925. Serial No. 12,907.

The present invention relates to heat exchangers, and has to do particularly with heat exchangers intended to carry out a heat exchange over a wide range of temperature such as for instance, in oil refining.

In oil refining, it is common practice to preheat the cold oil on its way to the still and to employ as heating medium the hot vapors issuing from the still. The incoming cold oil is commonly at atmospheric temperature or lower and since the vapors issuing from the still are at extremely high temperature, the parts of the aparatus in which the heat interchange between the two streams of oil is effected are subjected to great temperature differences. The result is that considerable difficulty is experienced in this class of apparatus in accommodating the expansion and contraction of the apparatus parts, particularly the tubes constituting the heat transferring element. This problem is further complicated by reason of the fact that, since the heat transfer is carried out over a wide temperature range, the heat transferring path must be of considerable length in order that the requisite change of temperature can be imparted to the fluid during its passage through the aparatus.

It is a principal object of this invention to provide a heat exchanger which is capable of effecting a heat transfer between fluids over a wide temperature range and is of such nature that objectionable mechanical stresses due to the expansion and contraction resulting from temperature changes and temperature differences are completely eliminated. To this end the heating element of the apparatus is divided into two sections or units which are mounted together and constitute a twin unit, each of the sections representing half of the total length of the fluid passage. Each of the tube bundles or units is mounted for individual movement to accommodate its expansion and contraction, and the two units are connected together by means of a flexible fluid-conveying conduit which serves to carry fluid from one unit to the other and at the same time permits relative contractional and expansional movement of the two units.

It is also an object of the invention to provide a heat exchanger of this type constructed as a compact unit which is characterized by ease of installation and cost of construction which is no more than that required in the present class of apparatus employed for this purpose. In present installations, two heat exchanging units are commonly installed with their heat-transferring paths connected in series relation. This type of construction is necessary due to the wide temperature range over which the fluid must be carried in its passage through the apparatus. In the present apparatus, the two units are combined into a single apparatus employing a common stationary tube sheet for supporting one end of the heat-transferring tubes, a shell which is essentially an integral shell for the two units and a common end cover for the units.

It is a further object of the invention to provide a heat exchanger of this class which is not only applicable for use in oil refining but is equally applicable for effecting a heat transfer between any two fluids, particularly in situations where the heat transfer must be conducted over a wide temperature range with the consequent necessity of minimizing stresses due to contraction and expansion under the influence of temperature change. The invention also contemplates means for providing an exceptionally long path through the aparatus for the fluid being cooled and at the same time positively bringing the fluid being cooled into repeated and intimate heat-transferring contact with the heat-exchanging tubes.

It is a still further object to provide an apparatus of this class designed particularly for handling oil or other similar fluid whose viscosity changes with changing temperature, wherein the cross-sectional area of the fluid passage is decreased in the direction of diminishing viscosity of the liquid. This arrangement permits of the most efficient liquid velocities for effective heat-transfer and at the same time serves to reduce the power required to maintain a proper flow of the viscous liquid through the apparatus.

A preferred embodiment of the invention is illustrated in the accompanying drawings in which Figure 1 is a longitudinal sectional view taken centrally through an apparatus embodying the invention; Figure 2 is a transverse sectional view taken on line 2—2 of Figure 1; Figure 3 is a transverse sectional view taken on line 3—3 of Figure 1 and Figure 4 is a view similar to Figure 2 illustrating a modified form of apparatus.

Referring to the drawings, 1 indicates the shell or housing of the apparatus and 2 indicates heat-transferring tubes disposed within the shell 1, which constitute the heat-transferring surface of the apparatus. The apparatus consists of two sections or units. The shell of the second unit is indicated at 1′ and the heat-transferring tubes of this unit are indicated at 2′. Cool liquid is admitted to the tubes 2′ through the medium of the inlet opening 3 in the head 4 which is in communication with the ends of tubes 2′. The cool liquid traverses the length of the tubes 2′ and is discharged into the chamber or head 5, from whence it passes out through the passage 6 and into pipe 7 which constitutes a connection pipe between the two sections of the apparatus. The pipe 7 discharges into the passage 8 which in turn communicates with the head or chamber 9 which is in connection with the ends of the tubes 2. The liquid entering the tubes 2 from chamber 9 traverses the length of the tubes and is emptied into the head 10 from whence it issues through the discharge opening 11.

For the purpose of securing an effective heat-transfer, a counter relation of flow of the heat-transferring liquids is resorted to. The hot fluid, such as for instance vapors or hot condensate from the oil still, are admitted to the shell 1 through inlet opening 12. This fluid is caused to circulate about in the space surrounding the tubes 2 and is directed into repeated contact with the tubes by means of suitable baffles indicated at 13. The baffles 13 may be omitted if desired, but the heat exchanger is preferably provided with baffles constituting a helical path through the apparatus as disclosed in the patent to Russell C. Jones No. 1,333,506, or with baffles which direct the fluid in a generally helical path through the apparatus and at the same time effect a continuous agitation of the fluid by causing it to splash from one baffle to the next after the manner disclosed in the patent to Russell C. Jones, No. 1,454,053. After passing along the length of the shell 1 in a generally reverse direction to that followed by the cooling liquid within the tubes, the hot fluid is passed into the shell portion 1′ through the medium of the connecting passage 14, whereupon it is directed along the length of the shell 1′, until it issues at the discharge opening 15.

In heat exchanging apparatus of this class as employed in oil refining work, there is frequently a temperature change of 400° F. during the passage of the fluid through the apparatus. In order to effect such an extensive temperature change a considerable length of fluid passage is required. Likewise, the high temperatures involved and the great differences in temperature between different parts of the apparatus give rise to a considerable elongation and contraction of the heat-transferring tubes. To accommodate such expansion and contraction, the respective tube bundles 2 and 2′ are secured at one end to a common tube sheet 16, while at their other ends they are supported respectively in tube sheets 17 and 17′ which are movable relative to the common tube sheet 16. With this arrangement, the tube sheets 17 and 17′ may slide along the length of the apparatus independently according to the expansion and contraction of the respective groups of heat-transferring tubes. These movable tube sheets are movable both relative to the stationary tube sheet 16 and relative to each other.

In order to permit independent relative movement of the respective tube bundles, a flexible connection is provided between the passages 6 and 8 at the movable ends of the respective tube bundles and the connection pipe 7. This flexible connection consists of a swivel joint 18 provided between the junction of the pipe 7 and the passage 6 and a similar joint provided at the junction between the pipe 7 and the passage 8. The joints 18 may be constructed by providing connecting elbows as shown between the pipe 7 and the joining pipes 6 and 8 and threading the connection between the elbow and the pipe which thus permits a limited rocking movement of the parts. With this construction, the respective tube bundles are permitted to move to different extents under the influence of temperature change, this independent relative movement being readily accommodated by the flexible connection.

The present apparatus, although it consists of two tube bundles each having its respective shell portion is essentially a single unitary apparatus. The stationary tube sheet 16 is common to both tube bundles and serves to support one end of all of the tubes. The flanges 19 are formed integrally with the shell portions 1 and 1′ and serve as a means for mounting the two portions of the unit in fixed relation to each other. Similarly the head or cover 20 at the end of the apparatus is common to both sections of the unit.

In the apparatus of Figure 4, the two shell portions are indicated at 21 and 21′, and the shell portion 21 is smaller than the shell portion 21′. With this construction the fluid passages in the shell portion 21 and the tubes within the shell are of respectively lesser cross-sectional area than the corresponding passages in the shell portion 21′. Since the two sections of the apparatus are serially connected, the velocities within the shell portion 21 will be greater than within the shell portion 21′; that is, when the apparatus is handling oils as the heat-transferring media, the velocity of flow will be greater in that portion of the apparatus

where the temperature of the fluid is greater and therefore where the fluid is less viscous.

The invention contemplates a heat-exchanger particularly capable of effecting heat interchange between fluids over a wide temperature range and of such construction that the parts of the apparatus have complete freedom of movement so that no objectionable mechanical stresses are introduced into the apparatus by reason of temperature change. The invention is defined in the appended claims.

I claim:

1. A heat exchanger of the class described comprising a plurality of heat transferring tubes, a fixed tube sheet for supporting said tubes at one end, a plurality of independent movable tube sheets supporting separate groups of said tubes at the other end thereof and a flexible connection for effecting transfer of fluid between said groups of tubes and permitting independent movement thereof.

2. A heat exchanger of the class described, comprising two heat transferring tube bundles, a fixed tube sheet for supporting one end of each of said bundles, independent tube sheets one for supporting the opposite end of each of said bundles, said independent tube sheets being movable relative to the stationary tube sheets to thereby accommodate expansion and contraction of the said tubes, and a flexible fluid conveying connection between said tube bundles.

3. A heat exchanger of the class described, comprising two heat transferring tube bundles, a fixed tube sheet for supporting one end of each of said bundles; independent tube sheets for supporting the other ends of said respective bundles, said tube sheets being movable relative to the stationary tube sheet to thereby accommodate expansion and contraction of the said tube bundles, passages at the movable ends of said respective tube bundles in communication with the tubes thereof for conveying fluid to and from said bundles, a pipe interconnecting said passages and a swivel connection between the said pipe and each of said passages, whereby a fluid conveying connection is established and each bundle is movable under the influence of expansion and contraction in the direction of its length.

4. A heat exchanger of the class described having two units, each of said units comprising a shell for containing one of the heat interchanging fluids, means within said shells for directing the fluid therein into intimate heat transferring relation with said tubes, a tubular heat transferring element within each of said shells for conveying the other heat interchanging fluid, a fixed common tube sheet for supporting one end of the tubes of both of said units, independently movable tube sheets for supporting the other ends of the tubes of said respective units, and a flexible connection between said tubular elements for permitting independent expansion and contraction thereof.

5. A heat exchanger of the class described comprising a pair of shells for containing one of the heat exchanging fluids, connections between said shells for conducting fluid therethrough in series relation, a plurality of heat transferring tubes within each shell for conveying the other fluid, a common stationary tube sheet for supporting one end of the tubes contained within both of said shells, independently movable tube sheets for supporting the other ends of the tubes in said respective shells and a flexible fluid conveying connection interconnecting the tubes of the said respective shells.

6. A heat exchanger of the class described comprising a pair of shells for containing one of the heat exchanging fluids, connections between said shells for conducting fluid therethrough in series relation, a plurality of heat transferring tubes within each shell for conveying the other fluid, a common stationary tube sheet for supporting one end of the tubes contained within both of said shells, independently movable tube sheets for supporting the other ends of the tubes in said respective shells and a flexible fluid conveying connection interconnecting the tubes of the said respective shells, said shells having a common flange whereby they are united into an essential unitary structure.

7. A heat exchanger of the class described comprising a pair of shells for containing one of the heat exchanging fluids, connections between said shells for conducting fluid therethrough in series relation, a plurality of heat transferring tubes within each shell for conveying the other fluid, a common stationary tube sheet for supporting one end of the tubes contained within both of said shells, independently movable tube sheets for supporting the other ends of the tubes in said respective shells, a flexible fluid conveying connection interconnecting the tubes of the said respective shells, and a common cover for both of said shells.

8. A heat exchanger of the class described comprising a shell, heat transferring tubes within said shell fixedly mounted at one end and freely movable at the other end, a second shell of smaller diameter than said first mentioned shell, a lesser number of heat transferring tubes within said shell fixedly mounted at one end and freely movable at the other end and a flexible fluid conveying passage serially connecting said groups of tubes, whereby independent expansion and contraction of said tubes is permitted and fluid is passed through said smaller group of tubes at relatively high velocity.

In testimony whereof I affix my signature.

JOSEPH PRICE.

1,597,479

4.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,597,479, granted August 24, 1926, upon the application of Joseph Price, of Stapleton, New York, for an improvement in "Heat Exchangers," errors appear in the printed specification requiring correction as follows: Page 1, lines 13, 28, and 83, for the misspelled word "aparatus" read *apparatus;* page 2, line 41, for the patent number "1,333,506" read *1,335,506;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of October, A. D. 1926.

[SEAL.]

WM. A. KINNAN,
Acting Commissioner of Patents.