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STRAIGHT TUBE FUEL OIL HEATER

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The present invention relates to fluid heat exchangers and has to do particularly with heat exchangers wherein the heating element consists of a number of straight heat transferring tubes extending between suitable tube sheets or supports which are secured to the shell or frame of the apparatus.

In the use of oil as a fuel, such as for instance in marine installations, industrial plants, and the like, the oil should be in limpid condition when it is passed to the burners. Many crude oils and the like which are used for fuel are of high viscosity at ordinary atmospheric temperatures and are therefore incapable of being properly atomized without being subjected to a preliminary treatment before delivery to the burner. The viscosity of these oils decreases rapidly upon increase in temperature, and most of the oils are sufficiently fluid at temperatures of from 200° to 300° F. to be readily handled by the burners. Accordingly in oil burning plants it is customary to preheat the fuel oil before it passes to the burners, and it is particularly to heat exchangers for effecting this heating of the oil that the present invention relates although it is to be understood that the apparatus of this invention may be used for other purposes as set forth in this application.

Fuel oil heaters of the type commonly employed for preheating oil on its way to the burners or for similar service are closed heat exchangers in which the heating element consists of a relatively large number of small diameter heat transferring tubes. The oil is passed through the tubes while the heating medium, for instance steam, is circulated about in the space surrounding the tubes. The tubes are supported at their respective ends in tube sheets or plates and appropriate headers are provided for effecting distribution of the oil to the tubes. In heat exchange apparatus of this kind practically no difficulty is encountered from the formation of scale deposits on the heat transferring surface and for this reason it is not necessary to resort to specially constructed heat transferring elements designed to facilitate scale removal. The tubes of the heat transferring elements are ordinarily straight tubes arranged in parallelism and supported at one end in a fixed tube sheet rigidly secured to the apparatus shell while at the other end they are supported by means of a floating head construction which permits of a limited movement of the tube sheet longitudinally of the shell to compensate for differences in expansion particularly between the tubes of the heat transferring elements and the shell. The heat exchangers of this general class as heretofore used are open to various objections and it is the object of this invention to provide a heat exchanger of this type which will not be subjected to these difficulties which are ordinarily present.

It is a principal object of this invention to provide a heat exchanger employing heat transferring tubes extending lengthwise of the apparatus in which the differences in expansion and contraction are accommodated without necessity of providing a floating head construction or other expensive special arrangement. Due to the characteristics of oils the heat transferring tubes of fuel oil heaters are ordinarily made of steel rather than of brass, copper or the like. These heat exchangers may also conveniently have a shell formed from steel plate, so that the difference in expansion between the tubes and the shell will not be great. Some differences will occur, however, due to the fact that the operating temperatures of the different parts will vary to a certain extent. The present invention contemplates a construction by which these relatively small discrepancies in expansion may be accommodated and yet in which the tube sheets may be attached integrally to the shell. The expansion is provided for by means of a tube sheet construction in which a limited amount of flexibility is secured between the body of the tube sheet and the flange by which the tube sheet is attached to the apparatus shell. This specially constructed tube sheet is simple in construction, is easy to manufacture, and may be utilized to produce an essentially integral heat exchange apparatus with no apparent provision for expansional and contractional strains yet which satisfactorily accommodates all such changes normally occurring during the operation of the apparatus. It is a further object to provide a heat exchanger construction of this type which can be manufactured at a low cost not greatly exceeding the cost of manufacture of a...
heat exchanger of rigid tube sheet construction wherein the tube sheets are bolted directly to the shell without provision for inequalities in expansion. A further advantage of the present apparatus is that its weight may be materially less than apparatus heretofore employed in which provision for expansion and contraction was made.

A preferred embodiment of the invention is illustrated in the accompanying drawings in which Figure 1 is a longitudinal sectional view taken centrally through a heat exchanger embodying the invention; Figure 2 is a partial sectional view showing in detail the construction of the expansion joint and Figure 3 is a detail view similar to Figure 2 illustrating a modified construction.

Referring to the drawings, 1 indicates the shell of the apparatus and 2 indicates the bundle of heat transferring tubes which extend longitudinally of the shell 1 and constitute the heat transferring surface of the apparatus. The shell 1 is preferably of relatively thin steel plate and the tubes are of similar metal for the reason that steel tubes satisfactorily resist the corrosive action of oil. The tubes 2 are supported in tube sheets 3 and 4 with which there are associated means for accommodating the expansional and contractual differences between the heat transferring tubes and the shell, shown in detail in Figure 2. Oil enters the apparatus through the inlet opening 5 provided in the header 6 which is bolted or otherwise secured to the tube sheet 3 at one end of the apparatus as shown. The oil passes through the interior of the heat transferring tubes 2 and issues through outlet opening 7 provided in the header 8 which is secured to the tube sheet 4 at the other end of the heat exchanger. In the arrangement here shown a single-pass construction is employed. It will be understood, however, that the heating element may be divided up into any desired number of passes according to the necessities of the particular installation. Heating steam is admitted to shell 1 through the inlet opening 9 and circulates about in the shell coming into direct contact with the exterior surfaces of the heat transferring tubes 2. The condensate drains toward the lower end of the apparatus and is discharged through the outlet 10 provided for the purpose. A baffle 11 is here shown for deflecting the incoming steam and distributing it into contact with a large proportion of the tube surface.

The construction of the tube sheets 4 and 5 and the means for accommodating inequalities in expansion of the parts of the apparatus are shown in detail in Figure 2. The body of the tube sheet 4 is extended to form a flange 12 which overhangs the end of the shell 1 as shown. An integral connection between the flange 12 and the shell 1 is established by welding the two parts together as indicated at 13. The tube sheet 3 at the other end of shell is also integrally secured to the shell so that the shell, together with the two tube sheets at its respective ends and the tubes extending between the tube sheets, constitutes an essentially integral heat exchange unit. The headers 6 and 8 may be secured to the tube sheets in any desired fashion as for instance by bolting the two parts together. In the construction here shown the flange 12 is provided with studs 14 fixedly secured in the flange. The header 8 is provided with a corresponding flange 15 having in it a series of bolt holes which fit over the respective studs 14. Connection between the parts is established by screwing down the nuts 16 upon the upper threaded portions of the studs 14. For the prevention of leakage, a gasket 17 between the headers and the tube sheet is provided.

For the purpose of accommodating expansion, the flange 12 of the tube sheet 4 is provided with a thin groove 18 beginning at the inner edge of the flange, which is substantially flush with the outer diameter of the shell, and extending an appreciable distance toward the outer edge of the flange after the fashion shown in the drawings. This groove 18 is of annular configuration and extends around the entire extent of the tube sheet flange 12. By the provision of the groove 18 the body portion 4 of the tube sheet is connected to the shell through the medium of the thinned portion or inwardly projecting relatively annular tongue 19 which is adjacent the groove 18. The groove is formed at such position in the flange 12 that the part 19 will be amply strong to withstand the requirements of service but will at the same time impart a certain flexibility to the flange. For instance, when the expansional and contractual stresses are exerted by the tubes 2 upon the body 4 of the tube sheet the tube sheet will tend to move or bend slightly in the direction of the length of the shell, and this slight movement will be accommodated by flexing of the parts of the flange 12, which flexing is made possible due to the cutting into the flange of the groove 18.

The flange 12 just described may be considered as an annular plate serving to join the tube sheet 4 with the shell 1. As shown in Figs. 1 and 2, this annular plate constituting the flange 12 is associated with the tube sheet by being made integral therewith. In Fig. 3 a modified form of construction is shown in which the flange 12 is made separate from the tube sheet and associated with it by being laid with one of its flat surfaces in contact with a flat surface of the tube sheet, and an integral connection is established between these two parts by a weld 20 extending around the outer periphery of
flange 12. The flange is secured to the steel shell of the apparatus by means of a circle of rivets 21. The flange is provided with the expansion groove 18 and the operation of this modified structure is essentially the same as that of the structure shown in Figures 1 and 2. Because of the riveted joint 21 between the relatively flexible annular tongue 19 and the shell 1, this modified construction is adapted more particularly to high pressure and high temperature conditions than is the structure shown in Figs. 1 and 2 where this connection is effected by means of the weld 13.

The present invention therefore furnishes a heat exchanger which may be readily constructed by ordinary manufacturing methods at a very low cost. The apparatus involves no floating head or other special parts which add to the complexity and cost of the apparatus. The shell of the apparatus together with the tube sheets and tubes is essentially an integral unit. The expansion joint for accommodating differences in expansion and contraction between the parts of the apparatus is incorporated into the tube sheet and is of such nature that it may be formed in the article by simple machining operation. This invention is directed particularly to fuel oil heaters wherein the heat transferring tubes and the shell are of the same material so that relatively small expansional differences are encountered. It will be understood, however, that there are other classes of work including instances in which the tubes and shell are of different material in which the present apparatus may be employed to advantage. The expansion joint of this invention is limited in the amount of expansional difference which it can accommodate, but it is applicable to any apparatus of this general type wherein the expansional differences are of such magnitude that they may be accommodated, by the provision of the present expansion joint at one or both ends of the shell.

I claim:

1. A heat-exchanger, comprising a shell, tubes enclosed by said shell, a tube-support closing one end of said shell, and a head, said tube-support having a portion thereof projecting radially outside the rim of the shell, said projecting portion forming a part of a flat, annular flange, said flange having a body-portion and a portion shaped to fit around the outside of the shell-end, the body portion having an annular groove therein, said groove starting in said body-portion where the end of the shell contacts therewith and extending radially of the flange and lying perpendicular to the tubes, said groove thereby forming the interior, tube-side face of said flange into two parallel lips, one of said lips being attached to said shell around the outside of the end thereof.

2. A heat-exchanger, comprising a shell, tubes enclosed by said shell, a tube-sheet at one end of said shell, and a head, said tube sheet having a portion thereof projecting radially outside the rim of the shell, said projecting portion comprising a flat, annular flange, said flange lying between the head and the shell-end and having a portion thereof fitting around the shell-end, said flange having an annular groove therein, said groove starting in the flange at the point where the shell-end contacts therewith and extending radially of said flange and perpendicular to said tubes, thereby forming the major portion of said flange into two parallel, annular lips extending in a plane perpendicular to the tubes, one of said lips being attached to the outside of said shell at the end thereof.

3. As a new article of manufacture, a flexible connecting device for joining the shell and tube-sheets of heat-exchangers, comprising a flat metal plate, said plate having one of its faces hogged out by two concentric bores, one of said bores forming thereby a circular shoulder on said face near the edge thereof, said shoulder being adapted to fit over the outside of the end of the shell of the heat-exchanger, said shoulder having an annular groove therein extending radially of the plate from the interior face of said shoulder, said groove thereby forming said interior face into two annular, parallel, flexible lips, one of said lips being adapted for attachment to the shell.

In testimony whereof I affix my signature.

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