June 12, 1934. J. PRICE 1,962,909

HEAT EXCHANGER

Filed April 29, 1932 2 Sheets-Sheet 1

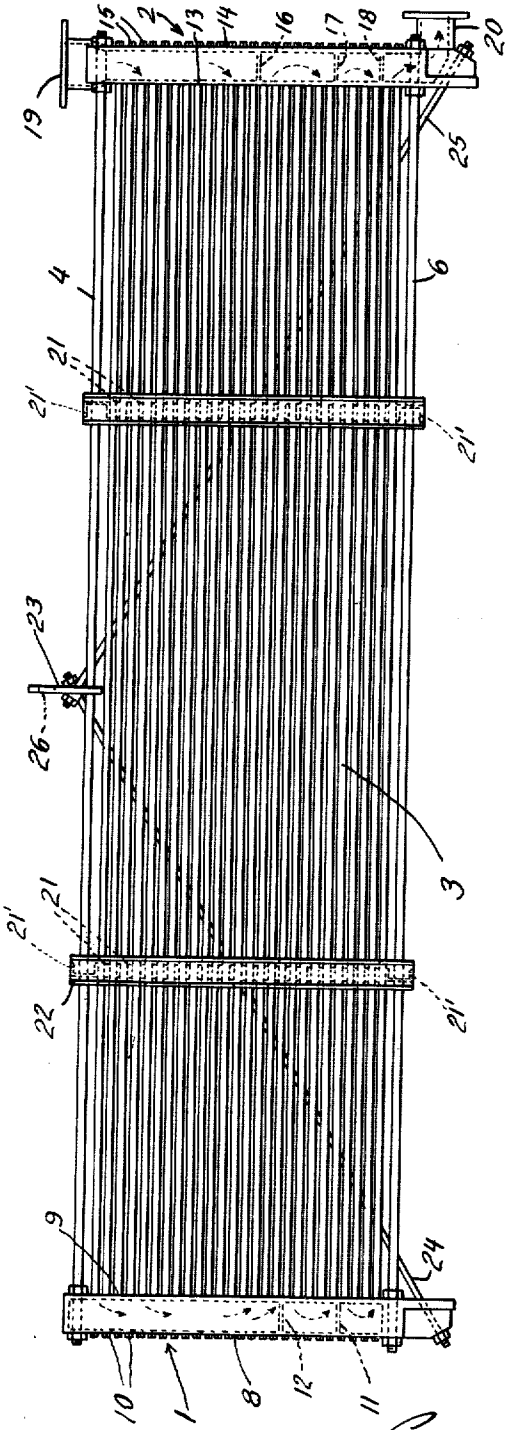


Fig. 1.

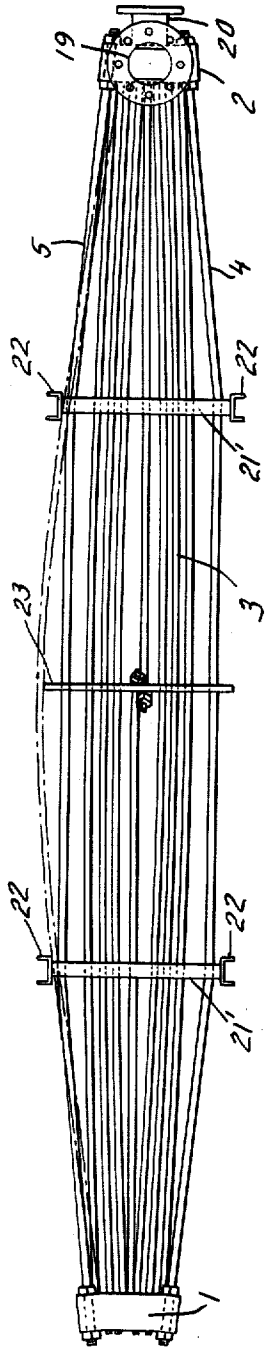


Fig. 2.

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June 12, 1934. J. PRICE 1,962,909

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Filed April 29, 1932 2 Sheets-Sheet 2

Fig. 3.

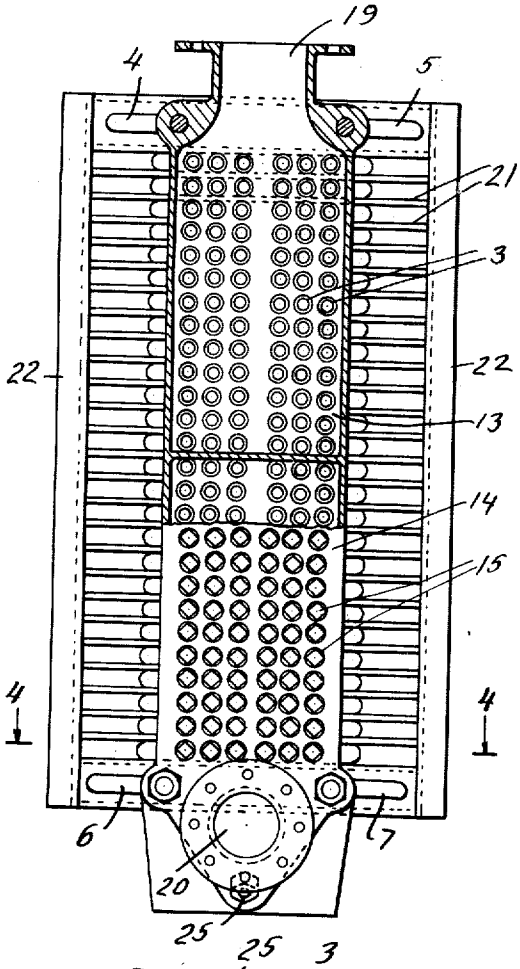


Fig. 4.

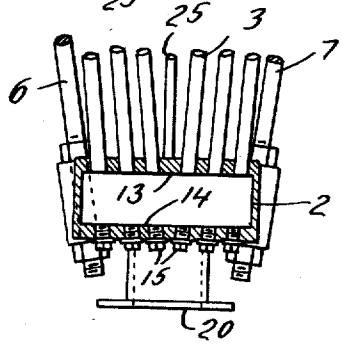


Fig. 5.

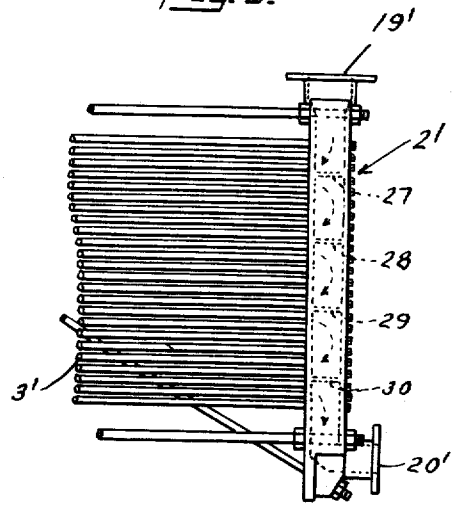
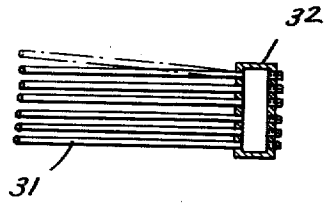


Fig. 6.



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UNITED STATES PATENT OFFICE

1,962,909

HEAT EXCHANGER

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Application April 29, 1932, Serial No. 608,196

9 Claims. (Cl. 257—248)

This invention relates to heat exchangers and more particularly to that type of heat exchanger which comprises a pair of headers interconnected by a plurality of tubes that constitute the heat exchanger elements.

My invention is particularly adapted for use with a medium carrying scale-forming impurities. Accordingly, one embodiment of my invention involves the use of a plurality of flexible tubes disposed between a pair of headers in such manner that the tubes are inherently self-scaling. The arrangement is such that when there is a change in the temperature of the tubes, the resulting elongation or shortening of the tubes does not produce any relative movement of the headers to which the tubes are connected and as a consequence there is a lateral distortion of the tubes of sufficient magnitude to exfoliate such scale as may have formed on the tubes. In heat exchangers of this type, it is desirable to employ a relatively large number of tubes and means for maintaining the tubes in proper spaced relation to each other to provide for efficient heat transfer between the outer tube surfaces and the medium brought into contact with these surfaces. One object of my invention is to provide efficient means for maintaining this desired relationship between the several tubes and a further object of the invention is to provide improved headers especially suitable for use with a large number of flexible tubes. It will be understood however, that the improved headers may be employed with tubes of other types.

A further object of my invention is to provide efficient means associated with the headers for facilitating the handling of the heat exchanger apparatus. I have reference to improved lifting mechanism which may be directly associated with the headers and which may also be associated with tie rods or the like interconnecting the headers. The headers of my invention are preferably provided with integral tube sheets and with one or more partitions in each header arranged so as to divide the tube bundle into a plurality of passes. The partitions may be so disposed as to divide the tube bundle into passes each having the same number of tubes or, where desired, the partitions may be disposed so that at least one of the passes is composed of a larger number of tubes than at least one other pass. Furthermore, the partitions may be arranged so that the number of tubes per pass varies progressively as the fluid advances through the tube bundle. I prefer to make the header partitions integral with the tube sheets.

The improved headers are preferably of substantially greater height than width, and where flexible tubes are provided between the headers I prefer to employ means for restricting lateral displacement or bowing of the tubes to a plurality of parallel planes extending at substantially right angles to the major axes of the headers.

My improved heat exchanger is especially adapted for submerging duty. For example, the apparatus may be submerged in a liquid, and a hot fluid may be passed through the heat exchanger tubes.

The various objects and advantages of my invention will be more apparent upon considering the following detailed description of certain illustrative embodiments thereof shown in the accompanying drawings in which;

Figure 1 is a side elevation of one embodiment of my improved heat exchanger;

Fig. 2 is a plan view of the apparatus shown in Fig. 1;

Fig. 3 is an enlarged end elevation of the apparatus shown in Fig. 1, parts being cut away to show details of construction;

Fig. 4 is a fragmentary section view taken on line 4—4 of Fig. 3;

Fig. 5 is a side elevation of a portion of another embodiment of my invention and

Fig. 6 is a transverse section view of still another embodiment of my invention.

The heat exchanger of Figs. 1 to 4 inclusive comprises a pair of headers 1 and 2 interconnected by a bundle of tubes 3 and also interconnected by two pairs of tie rods 4 and 5, 6 and 7.

The header 1 is illustrated as being in the form of a casting having a rear wall 8 and a front wall 9. The front wall 9 constitutes a tube sheet integral with the remaining portions of the header and it will be understood that the adjacent ends of the tubes 3 are expanded or otherwise secured in this tube sheet. The rear wall 8 of the header 1 is provided with a plurality of openings in alignment with the tubes, these openings being normally closed by screw-threaded plugs 10. It will be understood that these plugs may be removed whenever it is necessary to clean the inner surfaces of the tubes.

Partitions 11 and 12 divide the chamber within the header 1 into a plurality of compartments which convey fluid from one group of tubes to another.

The header 2 is likewise provided with an integral tube sheet 13 and a front wall 14 having openings therein normally closed by screw-threaded plugs 15. The tubes of the tube bundle

are expanded or otherwise secured in the tube sheet 13 and partitions 16, 17 and 18 divide the header chamber into a plurality of compartments. The header 2 is provided with a fluid inlet 19 at the top thereof and an outlet 20 at the base of the header. Partitions 16, 17 and 18 in the header 2 and partitions 11 and 12 in the header 1 are so arranged as to divide the tube bundle into six passes. In other words, fluid entering the header 2 through the inlet 19 traverses the length of the tubes six times before it is discharged through the outlet 20, as indicated by the arrows in the headers. It will be noted that the header partitions are so disposed that the number of tubes in each pass decreases as the fluid progresses through the apparatus.

The tubes 3 interconnecting the headers are preferably flexible to the extent that they are easily distorted by temperature changes which produce expansion and contraction of the metal of the tubes. It will be understood that the apparatus is intended to be submerged in a fluid, or in any event, the tubes are intended to be in heat exchanging relation with a medium coming into contact with the external surfaces thereof.

It is desirable to maintain the tubes properly spaced from each other to thereby facilitate the transfer of heat between the tubes and the medium surrounding the same. To accomplish this purpose, I have provided spacing means in the form of bars 21 extending between adjacent rows of tubes in a direction at right angles to the major axes of the headers. These bars are interconnected at their ends by structural members 22 welded or otherwise secured thereto. If desired, several sets of spacer bars may be employed and it will be noted that in Figs. 1 and 2, I have illustrated two sets of spacers. These spacers prevent lateral displacement of the tubes except in a direction parallel with the spacers.

The heat exchanger tubes may be initially bowed, as illustrated in Figs. 2, 3 and 4, or they may be initially straight, as illustrated in Fig. 6, and it will be understood that in either case, an increase in the temperature of the tubes will produce sufficient lateral distortion or bowing of the tubes to crack off such scale as may have accumulated on the external surfaces thereof. This action takes place largely because of the fact that the headers are maintained in fixed relative position by the tie rods 4, 5, 6 and 7.

The heat exchanger apparatus may be provided with improved means for lifting the same whereby the transportation and installation of the apparatus is greatly facilitated. I have illustrated a lifting member 23 disposed midway between the headers and above the tube bundle, this lifting member being in the form of a metal plate welded or otherwise secured to the tie rods 4 and 5. An additional pair of tie rods 24 and 25 serve to interconnect the plate 23 with the base of each of the headers. These rods 24 and 25 are attached to the lifting plate 23 near the center thereof and the lifting plate 23 is provided with an opening 26 to facilitate the attachment of the lifting apparatus to the lifting plate.

The tie members 4, 5, 6 and 7 interconnecting the headers 1 and 2 are preferably interconnected at one or more points between the headers. In the embodiment of the invention illustrated in Figs. 1 and 2 this is accomplished by providing channel bars 21' secured at their ends to the structural members 22 and having holes therein through which the tie rods extend. In this manner the tie rods 4 and 5 are interconnected by the channel bars 21' associated therewith and these two tie rods are also connected with the tie rods 6 and 7 by virtue of the fact that the upper pair of channel bars 21' are connected to the lower pair of channel bars 21' by the vertical structural members 22.

The two pairs of tie rods 4 and 5, and 6 and 7 are preferably bowed outwardly or laterally displaced as best illustrated in Fig. 2. This arrangement of the tie rods is advantageous for it serves to protect the heat exchanger tubes from accidental injury during shipping or during their installation. The sections may be stood up on end or laid flat and stacked up on one another without injuring the tubes and the sections may be shipped without crating.

The embodiment of my invention illustrated in Fig. 5 is similar to that illustrated in Figs. 1 to 4 inclusive except for the arrangement of the partitions in the headers. The header 2', shown in Fig. 5, is provided with four partitions 27, 28, 29 and 30 so disposed within the header chamber as to divide the tube bundle 3' into a plurality of passes, each consisting of the same number of tubes. The header 2' is provided with an inlet 19' and an outlet 20' similar in all respects to the inlet and outlet of the header 2 in Figs. 1 to 4 inclusive.

As indicated above, the heat exchanger of Fig. 6 is similar to that illustrated in Figs. 1 to 5 inclusive except for the fact that the tubes 31 are initially straight. When the tubes expand upon being heated, they bow laterally, as indicated in dotted lines in Fig. 6, it being understood that the header 32 is connected to another header (not shown) of the heat exchanger by the tie rods or the like which prevent relative movement of the headers.

The headers of my invention are preferably, though not necessarily, in the form of castings in which event the tube sheets and header partitions may be integral parts of the castings. The apparatus may be easily assembled and installed, and because of the effective arrangement and configuration of the several parts of the apparatus, it may be maintained in efficient operating condition with a minimum of effort.

It is to be understood that my invention is not limited to the particular embodiments illustrated and described in detail but includes such modifications thereof as fall within the scope of the appended claims.

For example, while I prefer to make the headers in such a manner that the tube sheets, header partitions and the side walls of the headers all constitute parts of an integral casting yet it is to be understood that certain features of my invention may be used to advantage where the construction of the headers is considerably modified. In some instances one or both of the headers may comprise a casting including the tube sheet, the side walls and the partitions, and a separate screw plug plate may be bolted or otherwise secured to this casting to complete the header structure. On the other hand it is feasible to provide headers having independent tube sheets, all other portions of each header being parts of a single casting. Furthermore the number of passes can be varied as desired and the number of tubes per pass may be determined in accordance with the contemplated conditions of operation. Where an odd number of passes are provided the fluid inlet connection communicates with one of the headers and the fluid outlet communicates with the opposite header. Such

changes may be made without departing from the spirit of my invention as defined by the appended claims.

I claim:

1. A heat exchanger having an exposed tube bundle and comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon a single expansion of said tubes, and a single lifting means disposed between said headers and connected thereto and to the aforesaid means.

2. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes and lifting means connected to said headers and to the aforesaid means, said lifting means comprising a transverse member disposed between the headers and connected to the base of each header.

3. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes and lifting means connected to said headers and to the aforesaid means, said lifting means comprising a transverse member disposed between the headers and lifting rods connecting the base of each header with said member.

4. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes, and lifting means connected to said headers and to the aforesaid means, said lifting means comprising a transverse member disposed between the headers and lifting rods connecting the base of each header with said member, said member being located above the tubes.

5. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes and lifting means comprising a transverse member disposed between the headers and above the tubes and means for connecting said member to the base of each of said headers.

6. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, a pair of tie rods interconnecting the tops of the headers, a transverse lifting member disposed between said headers and connected to each of said tie rods, and a pair of lifting rods connecting said transverse member to the base of each header.

7. A heat exchanger comprising a pair of headers, a plurality of tubes interconnecting said headers, a pair of tie rods interconnecting the tops of said headers, a transverse lifting member disposed between said headers and connected at its ends to said tie rods, and a pair of lifting rods connecting the central portion of said member to the base of each header.

8. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting the headers, a plurality of pairs of tie members interconnecting the headers, and means for interconnecting all of said tie members at a point between said headers.

9. A heat exchanger comprising a pair of headers, a tube bundle comprising a plurality of flexible tubes interconnecting the headers, and a plurality of tie members interconnecting the headers, the said tie members having portions thereof laterally displaced with respect to the tube bundle whereby the lateral extremities of said tube bundle are protected.

JOSEPH PRICE.

CERTIFICATE OF CORRECTION.

Patent No. 1,962,909. **June 12, 1934.**

JOSEPH PRICE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 9, claim 1, strike out the words "a single"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of July, A. D. 1934.

Bryan M. Battey

(Seal) **Acting Commissioner of Patents**

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I claim:

1. A heat exchanger having an exposed tube bundle and comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon a single expansion of said tubes, and a single lifting means disposed between said headers and connected thereto and to the aforesaid means.

2. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes and lifting means connected to said headers and to the aforesaid means, said lifting means comprising a transverse member disposed between the headers and connected to the base of each header.

3. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes and lifting means connected to said headers and to the aforesaid means, said lifting means comprising a transverse member disposed between the headers and lifting rods connecting the base of each header with said member.

4. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes, and lifting means connected to said headers and to the aforesaid means, said lifting means comprising a transverse member disposed between the headers and lifting rods connecting the base of each header with said member, said member being located above the tubes.

5. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, means independent of said tubes for preventing separation of said headers upon expansion of said tubes and lifting means comprising a transverse member disposed between the headers and above the tubes and means for connecting said member to the base of each of said headers.

6. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting said headers, a pair of tie rods interconnecting the tops of the headers, a transverse lifting member disposed between said headers and connected to each of said tie rods, and a pair of lifting rods connecting said transverse member to the base of each header.

7. A heat exchanger comprising a pair of headers, a plurality of tubes interconnecting said headers, a pair of tie rods interconnecting the tops of said headers, a transverse lifting member disposed between said headers and connected at its ends to said tie rods, and a pair of lifting rods connecting the central portion of said member to the base of each header.

8. A heat exchanger comprising a pair of headers, a plurality of flexible tubes interconnecting the headers, a plurality of pairs of tie members interconnecting the headers, and means for interconnecting all of said tie members at a point between said headers.

9. A heat exchanger comprising a pair of headers, a tube bundle comprising a plurality of flexible tubes interconnecting the headers, and a plurality of tie members interconnecting the headers, the said tie members having portions thereof laterally displaced with respect to the tube bundle whereby the lateral extremities of said tube bundle are protected.

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