Nov. 8, 1932. R. C. JONES 1,886,403

HEAT EXCHANGER

Filed Feb. 15, 1930 2 Sheets-Sheet 1

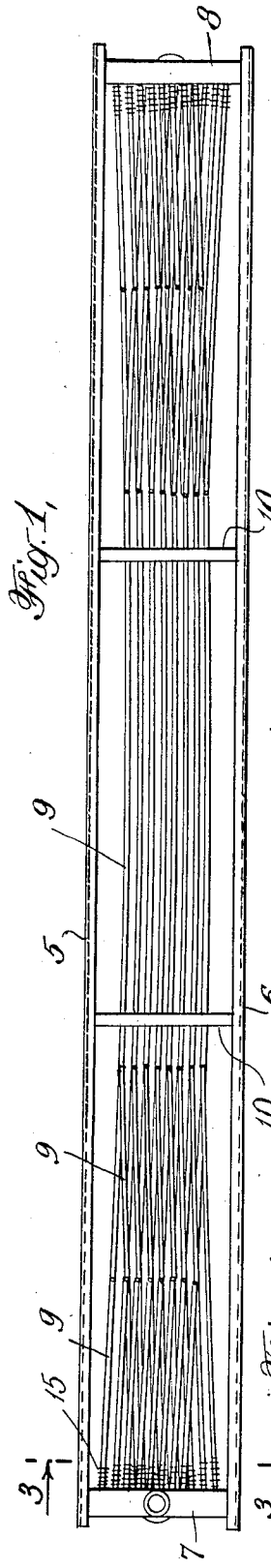


Fig. 1.

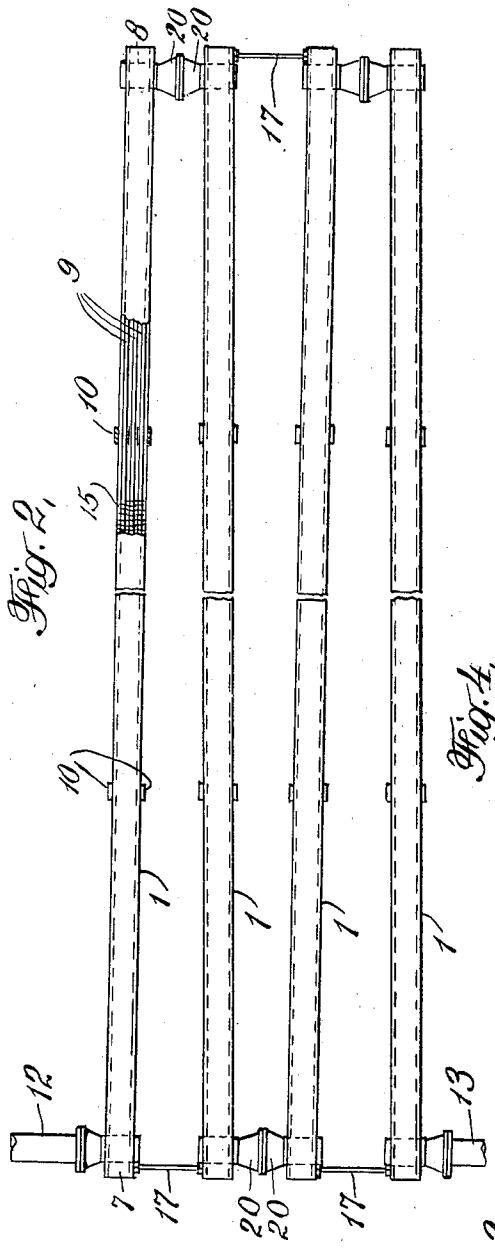


Fig. 2.

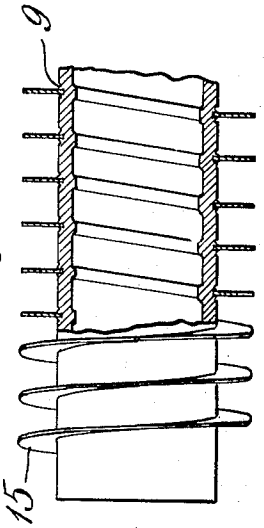


Fig. 4.

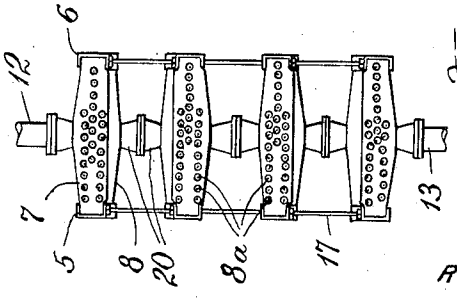


Fig. 5.

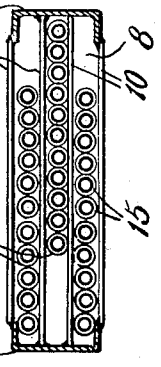


Fig. 3.

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Filed Feb. 15, 1930 2 Sheets-Sheet 2

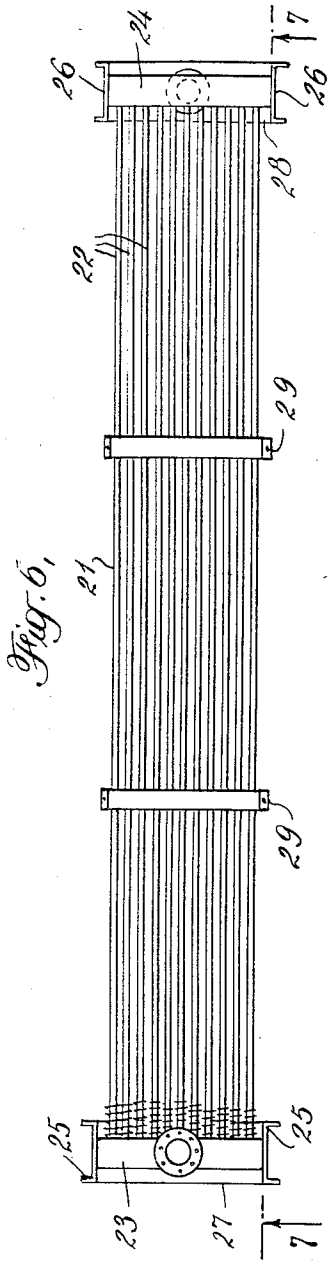


Fig. 6.

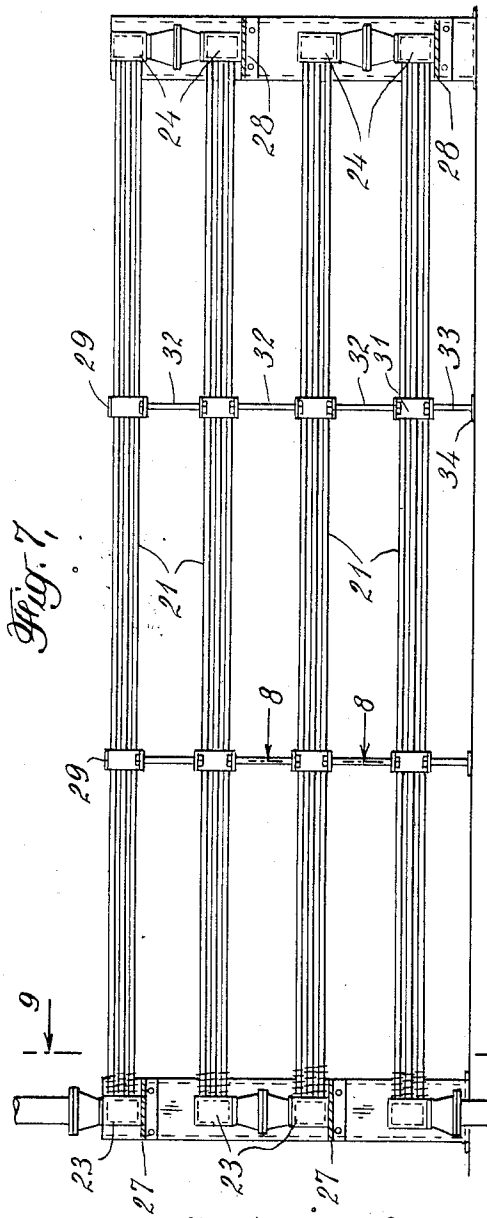


Fig. 7.

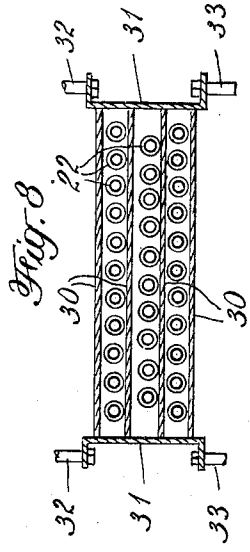


Fig. 8

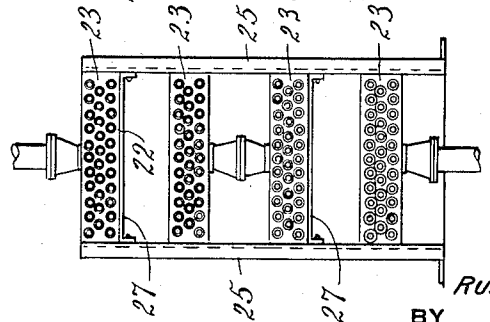


Fig. 9.

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UNITED STATES PATENT OFFICE

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HEAT EXCHANGER

Application filed February 15, 1930. Serial No. 428,597.

This invention relates to heat exchangers, and particularly to heat exchangers intended primarily for the oil refining industry.

In many of the regions where oil refining is carried on, water is not obtainable in sufficient quantities to enable the successful employment of any of the ordinary types of heat exchangers. Also, in certain of these localities, though there may be enough of it, the water is impregnated with scale-forming or corrosive impurities which render it unfit for use in ordinary heat exchangers—particularly the shell-and-tube type—without prior distillation or precipitation. Such measures, however, are obviously expensive where large quantities of heat must be absorbed or dissipated, as in many oil refining operations. It is the object of the present invention to provide a heat exchanger with which it is not necessary to use cooling water for most cooling work, but which can, when it is necessary to use water, be satisfactorily employed with water which is corrosive, scale-forming, or otherwise unsuitable for use in ordinary heat exchangers.

The invention will be described in conjunction with the accompanying drawings, but is limited in its embodiments only by the scope of the subjoined claims. In these drawings;

Fig. 1 is a plan detail of one of the units of the heat exchanger;

Fig. 2 is a side elevation of a number of these units assembled into a heat exchange apparatus;

Fig. 3 is a section on line 3—3 of Fig. 1;

Fig. 4 is a detail of one of the tubes of the exchanger;

Fig. 5 is an end view of the apparatus as shown in Fig. 2;

Fig. 6 is a plan view of a modified form of heat exchanger unit;

Fig. 7 is a view similar to Fig. 2 showing a side elevation of an assembled stack of these units;

Fig. 8 is a vertical section taken on line 8—8 of Fig. 7; and

Fig. 9 is a vertical section taken on line 9—9 of Fig. 7.

The structure illustrated in Figs. 1 to 4 inclusive comprises four identical units indicated generally by reference numeral 1. Each unit comprises a pair of channel-iron side members 5 and 6, between which are secured a pair of headers 7 and 8, one at each end. Extending between the two headers of each unit there is a nest of metal heat exchanging tubes, indicated as a whole by reference numeral 9. The tubes 9 are provided with radially projecting, helically wound metal fins 15, made and combined with the tube in a manner to be hereinafter particularized. The tubes of each unit are here shown as disposed in three superimposed layers, as will appear from the cross-sectional view, Fig. 3, and the ends of the tubes are inserted into and seated in the cast-iron headers 7 and 8, in accordance with any of the well-known methods. Plugs 8*a* shown in Fig. 5 are tapped into holes in the outer faces of the headers in alignment with the ends of the tubes so as to facilitate the securing of the tubes to the headers.

Inasmuch as the tubes 9 are of considerable length, combined supports and chafing bars 10 are provided at intermediate points between the headers. These members comprise, preferably, flat steel strips extending transversely between the channel irons, and attached thereto. Each end of each section or unit is connected through a flanged pipe coupling 20, integral with the headers, to the next successive unit, and the uppermost and lowermost units are connected to a lead-in 12 and a lead-out 13, respectively. As shown in Fig. 2, the units are spaced vertically at an angle to each other by means of separators 17 and sloping faces on the couplings 20, to permit the condensate or other liquid in the tubes to drain by gravity.

The heat exchanger may be simply stacked out in the open air, or it may, if desired, be encased in an ordinary cooling-tower, the draft being aided when necessary by a blower or the like. In many of the operations incident to oil refining and the treatment of casing head gas, high temperatures are employed, and while such temperatures are favorable to air cooling, it is essential that

the apparatus be designed to withstand or take care of a large heat expansion factor.

To this end, the tubes of the units of the present invention are made with a slight initial camber or permanent lateral bow, which increases as the tubes expand lengthwise under the heat of the fluid in them.

This bending or buckling and straightening of the bowed tubes following changes of temperature, however, would soon render a heat exchanger of the ordinary finned tube type inoperative and especially one in which the fins are attached to the tubes by soldering or brazing, as the contraction and expansion of the tubes, multiplied by bending, would soon strip the fins off the tubes. The tubes employed in accordance with the present invention are not, however, affected by this bending. These tubes are made by rolling or pressing a helical groove in the periphery of the tube, winding a continuous ribbon of metal edgewise into the groove in such a manner as to upset the lower edge of the ribbon against the bottom of the groove, and then crimping the metal of the tube against the side of the ribbon to thus hold it in the groove in the tube. A method and machine for making such tubes is described in greater detail in the co-pending application of Edward A. Dewald, Serial No. 286,638 filed June 19, 1928.

Referring now to the modified form of heat exchanger illustrated in Figs. 6 to 9 inclusive, the units are in general similar to the units 1, that is, they consist of a plurality of long thin-walled tubes 22 which are secured at their ends in headers 23 and 24. The tubes 22 are provided with heat radiating fins which are constructed and secured to the tubes in the same manner as described previously in connection with the fins 15 and tubes 9.

The heat exchanger units 21 differ from units 1 in that the headers 23 and 24 are not provided with side members such as the side members 5 and 6 shown in Fig. 1 for the purpose of spacing the headers rigidly apart. On the other hand, when the units 21 are assembled as shown in Fig. 7 to form a heat exchanger, suitable supports are provided for carrying the headers 23 and 24. As shown in Fig. 7, these supports consist of a pair of vertical channel bars 25 at the left hand end of the heat exchanger, and a similar pair of channels 26 at the right hand end. Horizontal shelves 27 extend between channels 25 at the proper elevations to support the headers 23. Likewise shelves 28 are supported between channels 26 for the purpose of carrying headers 24.

In view of the omission of the side members 5 and 6, tubes 22 are not given an initial camber or bow, but assume their natural approximately straight condition. As the tubes are of extreme length as compared with their diameter, there is some tendency for them to sag and to prevent too great sagging the supports indicated generally by numeral 29 are provided. These supports are made in sections as illustrated in Fig. 8, and bolted together so that each of the units is complete in itself and any number can be arranged in a stack as shown in Fig. 7, depending upon the size of heat exchanger required.

As illustrated in Fig. 8, each sectional support comprises four horizontal bars 30, the two intermediate bars passing between the layers of tubes 22. These bars are joined together at their ends by a narrow section of channel 31 to the back of which they are welded. The channel sections 31 are supported one upon the other by vertical spacing sleeves 32 through which suitable bolts are passed. At the bottom the bolts which pass through sleeves 33 are tapped into transverse spacing bars 34 which rest upon the ground or foundation on which the heat exchanger stands.

Although in this modified form of heat exchanger unit the tubes 22 are not necessarily given an initial bow as in the case of the form shown in Figs. 1 to 3 inclusive, nevertheless the tubes 22 are actually subjected to bowing movement during the usual operation of the apparatus. This is due to the fact that the heating and the cooling of the tubes causes longitudinal expansion and contraction, and although the rigid spacing bars 5 and 6 between the headers are omitted, nevertheless the mere friction of the headers 23 and 24 with their supports 27 and 28 respectively is sufficient to cause a bowing of the long slender tubes 22. If desired, moreover, the same means may be provided for assisting the frictional engagement between headers 23 and 24 and their supports so as to restrain any tendency of relative sliding between them.

It will be noticed that in Fig. 2 the units 1 are sloped slightly so as to provide for natural drainage of the tubes 9 by gravity, while in Fig. 7 the units 21 are arranged in horizontal position parallel to one another. It will be understood that either arrangement may be used with either type of heating unit inasmuch as the velocity at which the liquid is usually circulated through the tubes is ample to sweep the liquid out of the tubes satisfactorily without providing for drainage by gravity. The supporting and spacing bars 10 of Fig. 3 and 30 of Fig. 8 compel the bowing action of the tubes to take place horizontally, and this improves the drainage characteristics of the heat exchanger. In the case of the exchanger unit 1, they also prevent the finned tubes from projecting beyond the boundaries of the protecting side channels 5 and 6 so that the tubes are less liable to be damaged in shipment.

The heat exchanger of the present invention can usually be operated merely with the units stacked out in the open air, or in a cooling casing with a fan. For certain work, however, it is provided with a water-sprinkling pipe overhead, and greater or lesser quantities of water are sprayed on it, with or without the use of circulating air, to obtain the close temperature control required in certain classes of work. The heat exchanger can also be used for all classes of work by employing water alone as the cooling medium. The heat exchanger is particularly adapted for use with water containing scale-forming salts.

The bending and straightening of the tubes following changes of temperature has the effect of preventing scale from forming and of breaking up any scale which may, notwithstanding, form on the tubes. Thus, when water has to be used, the apparatus will not be in any way liable to be put out of operation by the use of hard or corrosive water, when it happens, as is frequently the case, to be the only water available.

It will be understood that whether the tubes of the heat exchanger are given an initial bow as in Fig. 1, or whether they are bowed only during operation of the apparatus as in Fig. 6, the term "bowed" as used in the appended claims is intended to include both forms of heat exchanger unit.

I claim:

1. In a heat exchanger, a unit comprising a pair of headers and tubes between the headers, said headers being connected independently of the tubes, said tubes being bowed and having fins thereon.

2. A heat exchanger, comprising a plurality of stacked units, adjacent units being supported vertically apart to provide for the free circulation of air, each unit including bowed tubes having fins thereon, the bases of the said fins being attached to the tubes only by the metal of the tube.

3. A heat exchanger, comprising a plurality of stacked units, adjacent units being supported vertically apart a distance sufficient to provide for the free circulation of air, each unit including bowed tubes having continuous helical fins thereon.

4. In a heat exchanger, a unit comprising a pair of headers and a plurality of bowed tubes extending between said headers, said tubes having continuous helical fins wound thereon, the bases of said fins being attached to the tubes only by the metal of the tube.

5. In a heat exchanger, a unit comprising a pair of headers, and a plurality of bowed tubes extending between said headers, said tubes having a continuous helical groove in their outer periphery, and a continuous ribbon of heat radiating material wound edgewise on said tube in said groove.

6. In a heat exchanger, a unit comprising a pair of headers, and a plurality of bowed tubes extending between said headers, said tubes having a continuous helical groove in their outer periphery, and a continuous ribbon of material wound edgewise on said tube in said groove so as to upset the lower edge of said ribbon, the metal of the tube surface being crimped over said upset edge.

7. In a heat exchanger, a unit comprising a pair of headers, a plurality of bowed tubes extending between said headers, said tubes having a continuous helical groove in their outer periphery, and a continuous ribbon of heat radiating material wound edgewise on each of said tubes in the helical grooves therein, the metal of the tube surface being crimped against the base of said continuous ribbon.

In testimony whereof I affix my signature.

RUSSELL C. JONES.