July 25, 1967 F. Q. SAUNDERS 3,332,478

WATER HEATING APPARATUS

Filed Aug. 15, 1966 2 Sheets-Sheet 1

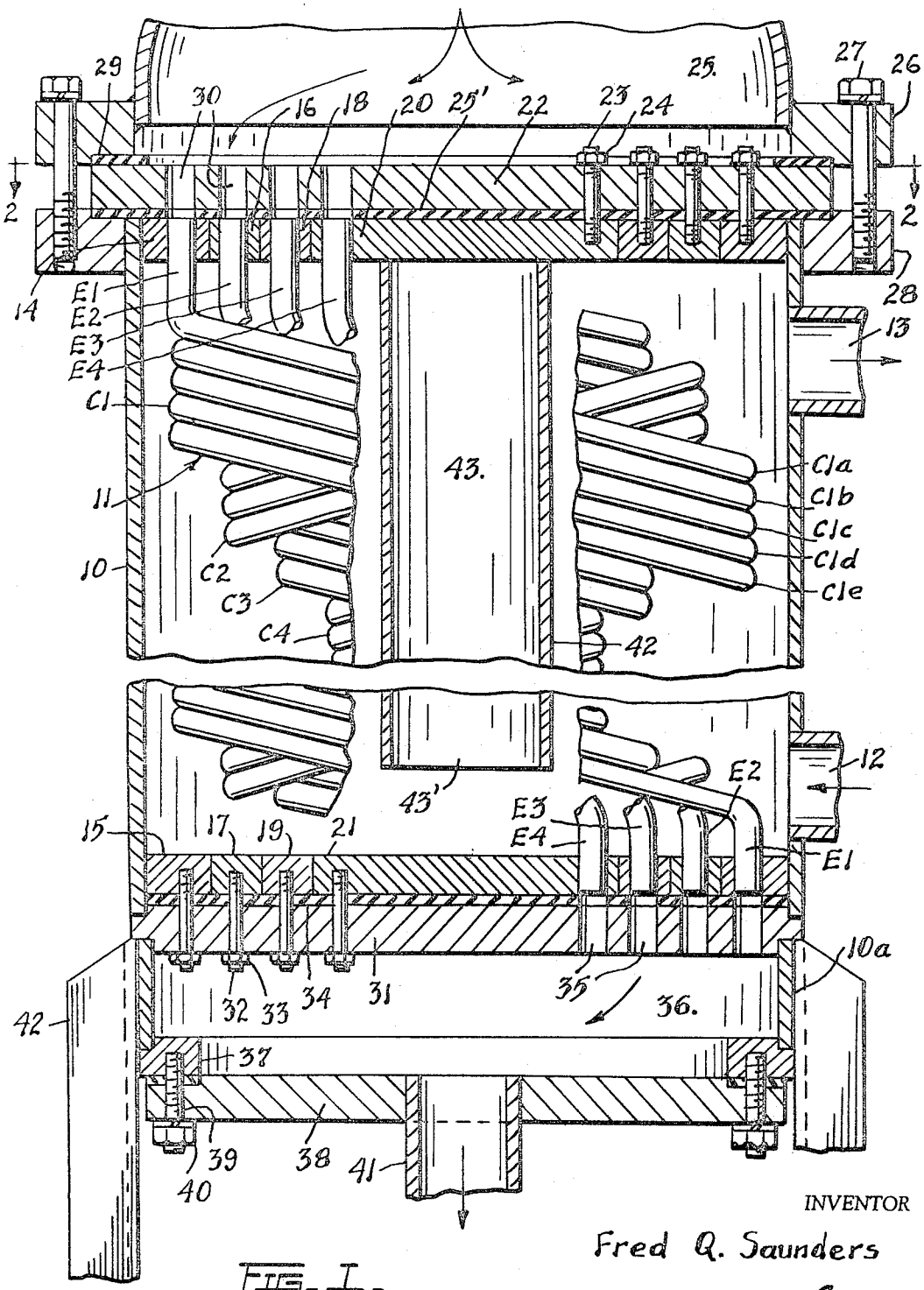


FIG. 1.

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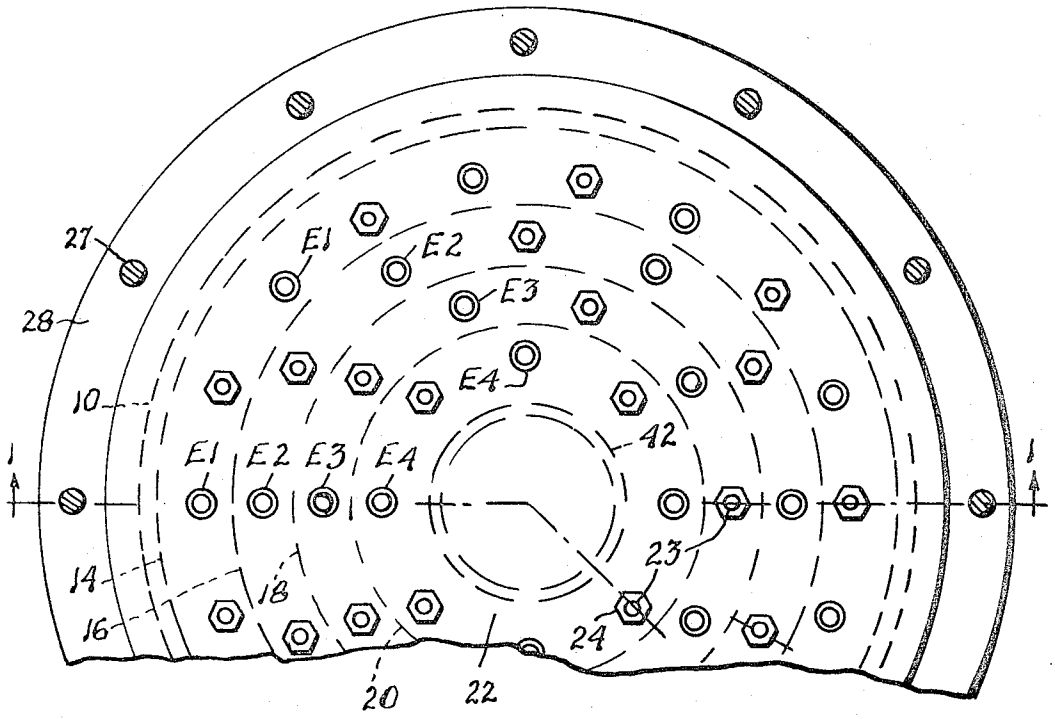


FIG. 2

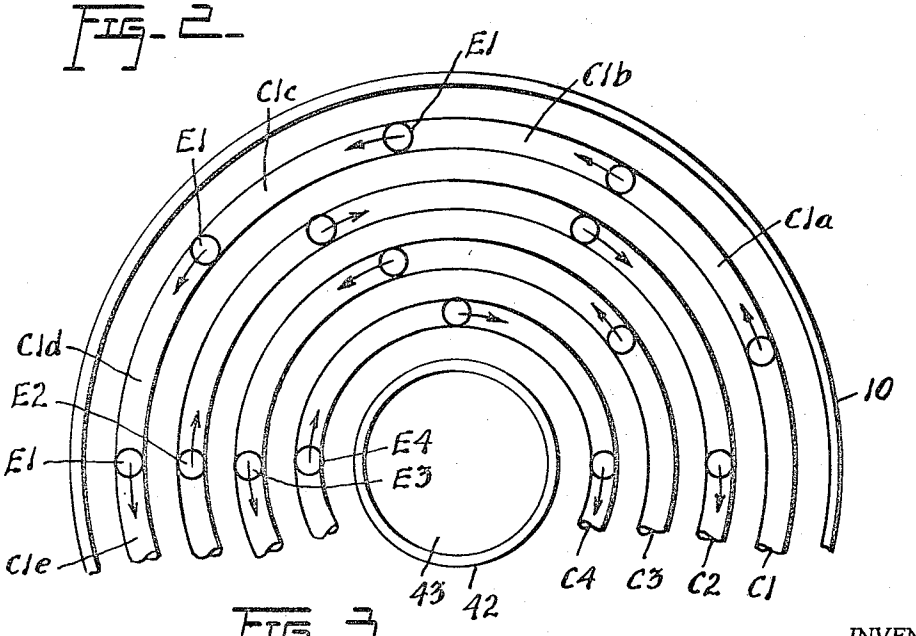


FIG. 3

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WATER HEATING APPARATUS

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Filed Aug. 15, 1966, Ser. No. 572,412
6 Claims. (Cl. 165—76)

ABSTRACT OF THE DISCLOSURE

The disclosure comprises the combination in a heat exchanger of a vertically disposed cylindrical tank provided adjacent its opposite ends with an inlet and an outlet for a liquid to be heated, an upper tube sheet removably mounted at the upper end of the tank, a lower tube sheet permanently secured to the lower end of the tank, a heat exchange coil assembly disposed in the tank and comprising a plurality of coil units nested together in concentric relation, a plurality of pairs of tube rings having the ends of the respective coil units secured therein, said tube rings being arranged in concentric upper and lower sets at the inside of the respective upper and lower tube sheets, means removably and individually attaching said rings to the tube sheets whereby each coil unit with its rings may be removed from the tank independently of the other coil units, and a vertically disposed tubular member provided centrally within said coil assembly and defining a chamber for trapped air, the upper end of said tubular member being secured to the innermost tube ring in the upper set, and the lower end thereof being open and spaced upwardly from the innermost tube ring in the lower set, whereby liquid in the tank may enter said chamber and exert pressure on the air trapped therein.

This application is a continuation-in-part of my copending application Ser. No. 423,517, filed Jan. 5, 1965.

The invention disclosed in the aforementioned application is a water heating apparatus which includes a tank containing a heat exchange coil assembly composed of pairs of concentric coil units mounted so that each pair of coil units may be removed from the tank without disturbing the others. Such mounting is facilitated by locating the ends of the coils in each pair on a common circle and securing the coil ends in an individual tube ring at each end of the coil assembly. The tube rings of the several pairs of coil units are individually secured to tube sheets in the tank, so that each pair of coil units may be removed independently of the others.

The principal object of the present invention is to improve upon the arrangement above outlined so that each individual coil unit rather than pairs of coil units may be removed from the tank independently of the others. This is attained by providing each individual coil unit with a separate tube ring at each end, thus permitting each unit to be removed without disturbing the others. Also, since each coil unit is aligned with its own tube rings, it is not necessary to bend the end portions of the coils to a common circle as in the instance of the paired coil units in the aforementioned application.

Another important object of the present invention is to provide the tank with an improved compression chamber located centrally within the heat exchange coil assembly and adapted to absorb expansion of water when heated, thus affording a cushioning action to minimize or completely eliminate water hammering.

Other objects and features of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings, wherein like characters of reference are used to designate like parts, and wherein:

FIGURE 1 is a fragmentary vertical sectional view of the water heating apparatus of the present invention, this view being taken substantially in the plane of the line 1—1 in FIGURE 2;

FIGURE 2 is a fragmentary cross-sectional view, taken substantially in the plane of the line 2—2 in FIGURE 1; and

FIGURE 3 is a fragmentary diagrammatic view showing the arrangement of the individual coil units.

Referring now to the accompanying drawings in detail, the water heating apparatus of the present invention comprises a vertically elongated cylindrical tank **10** containing a heat exchange coil assembly designated generally by the numeral **11**. The tank **10** has a cold water inlet **12** and a hot water outlet **13** adjacent its respective lower and upper ends, the water within the tank being heated by a suitable heating medium such as hot water or steam passing through the coil assembly **11**.

As in the aforementioned application Ser. No. 423,517, the coil assembly **11** comprises a plurality of concentrically disposed coil units C1, C2, C3, C4, which are nested within each other, each coil unit being made up of a plurality of individual coils which have an overlapping helical lead so that all the individual coils in each unit are interfitted in vertically coplanar relation. As for example, the coil unit C1 is composed of overlapped individual coils C1*a*, C1*b*, C1*c*, C1*d*, C1*e*, et cetera, the end portions of these coils being straight and parallel to the vertical axis of the coil assembly as indicated at E1. Similarly, the end portions of the coils which make up the coil units C2, C3 and C4 are indicated at E2, E3 and E4, respectively. The alternate coil units are preferably wound in relatively opposite directions, as will be noted in FIG. 1.

The present invention provides an individual tube ring at each end of each coil unit, the straight end portions of all the coils which make up the coil unit being secured in apertures formed in such a tube ring. Thus for example, the ends E1 of the coils C1*a*, C1*b*, C1*c*, etc. of the coil unit C1 are fastened in a tube ring **14** at the upper end and a tube ring **15** at the lower end of the coil unit. Similarly, the coil ends of the unit C2 are fastened in tube rings **16**, **17**; ends of the unit C3 in rings **18**, **19**; and ends of the unit C4 in rings **20**, **21**. The rings **14**, **16**, **18**, **20** and **15**, **17**, **19**, **21** in the respective upper and lower sets are concentrically disposed, and the innermost rings **20** and **21** are preferably in the form of circular plates or discs.

The upper tube rings **14**, **16**, **18**, **20** are secured individually to the underside of a tube sheet **22**, this being attained by providing each ring with a plurality of upwardly projecting screw-threaded studs **23** which extend through apertures formed in the tube sheet **22** and are equipped with suitable nuts **24**, a suitable gasket **25'** being interposed between the rings and the tube sheet, as shown. The tube sheet **22** is clamped between the upper end of the tank **10** and a dome-shaped header **25** at the top of the tank, the header having a marginal flange or rim **26** to receive a set of clamping screws **27** which extend into screw-threaded apertures formed in a similar flange or rim **28** secured to the upper end of the tank.

An annular gasket 29 is interposed between the flange 26 of the header and the tube sheet 22 to prevent leakage, it being understood that the header 25 is adapted to receive a suitable heating medium such as hot water or steam, and that the tube sheet 22 is provided with openings 30 in register with the coil ends E1, E2, E3, E4, so that the heating medium may flow from the header downwardly through the coil assembly 11.

The lower tube rings 15, 17, 19, 21 are individually secured to the top of a tube sheet 31 by the studs and nuts 32, 33, a gasket 34 being interposed between the rings and the tube as shown. The tube sheet 31 is secured, as by welding, to the lower end of the tank 10 and is formed with openings 35 in register with the lower coil ends E1, E2, E3, E4, so that the heating medium after passing through the coil assembly 11 may flow into a header 36 constituted by an extension 10*a* at the lower end of the tank. The tank extension 10*a* is also secured by welding to the tube sheet 31 and is equipped with an internal flange 37 having a removable bottom plate 38 secured thereto by a set of studs and nuts 39, 40, as will be clearly apparent. The bottom plate 38 is provided with an outlet 41 for discharging the heating medium from the header 36. As will be noted, the entire apparatus may be supported by a set of suitable legs 42 secured, as by welding, to the tank extension 10*a*.

Inasmuch as the individual coil units C1, C2, C3, C4 are provided with their own individual tube rings which are individually fastened to the tube sheets 22 and 31, it will be apparent that any one of the coil units may be removed from the tank without disturbing the others. For example, if the coil unit C2 is to be removed, the header 25 is separated from the tank by removal of the bolts or screws 27, and the bottom plate 38 is separated by removal of the nuts 40. The nuts 24 are then removed from all the studs 23, thus permitting the upper tube sheet 22 to be lifted off. The nuts 33 are then removed but only from those of the studs 32 which hold the lower tube ring 17 in place, whereupon the entire coil unit C2 may be slid upwardly from between the coil units C1 and C3 and removed from the tank without disturbing the adjacent coil units. Of course, in removing the coil unit C2, the associated tube rings 16, 17 are removed simultaneously therewith.

A tubular member 42 is provided centrally in the tank to serve as a baffle, the member 42 defining therewithin a compression chamber 43 for absorbing expansion of water when heated and also to cushion or eliminate water hammers. The tubular member 42 defining the chamber 43 has its upper end secured, as by welding, to the underside of the top tube ring 20, the member 42 extending vertically centrally through the innermost coil unit C4 of the coil assembly and being open at its lower end 43′ which terminates a short distance above the lower tube ring 21. Air trapped in the chamber 43, being subjected to expansion and contraction resulting from relatively small changes in pressures, effectively compensates for thermal expansion and contraction of water in the tank 10, and also absorbs pressure shock waves or water hammers reaching the interior of the tank.

As will be apparent from the drawings, the radial spacing between the adjacent coil units C1, C2, C3 and C4 is uniform, and also is the same as the radial spacing of the innermost coil unit C4 from the outer surface of the tubular member 42. Moreover, it is also the same as the radial spacing of the outermost coil unit C1 from the inner surface of the tank side wall. The purpose of these equal spacings is to assure a uniform flow of water around or between all the coil units, as the water flows from the inlet 12 to the outlet 13.

While in the foregoing there has been described and shown the preferred embodiment of the invention, various modifications may become apparent to those skilled in the art to which the invention relates. Accordingly, it

is not desired to limit the invention to this disclosure, and various modifications and equivalents may be resorted to, falling within the spirit and scope of the appended claims.

What is claimed as new is:

1. In a heat exchanger, the combination of a cylindrical tank provided adjacent its opposite ends with an inlet and an outlet for a liquid to be heated, a pair of tube sheets provided at the opposite ends of said tank, at least one of said tube sheets being removable, a heat exchange coil assembly disposed in the tank and comprising a plurality of coil units nested together in concentric relation, a plurality of pairs of tube rings having the ends of only one of the coil units secured therein, and means removably and individually attaching said rings to said tube sheets, whereby each coil unit with its rings may be removed from the tank independently of the other coil units.

2. The device as defined in claim 1 wherein each of said coil units comprises a plurality of individual coils with overlapping leads.

3. The device as defined in claim 1 together with a header for a heating medium removably mounted at one end of said tank, said removable tube sheet being clamped between said one end of the tank and said header.

4. In a heat exchanger, the combination of a cylindrical tank provided adjacent its opposite ends with an inlet and an outlet for a liquid to be heated, a pair of tube sheets provided at the opposite ends of said tank, at least one of said tube sheets being removable, a heat exchange coil assembly disposed in the tank and comprising a plurality of coil units nested together in concentric relation, a plurality of pairs of tube rings having the ends of the respective coil units secured therein, and means removably and individually attaching said rings to said tube sheets, whereby each coil unit with its rings may be removed from the tank independently of the other coil units, the other of said tube sheets being permanently secured to said tank, together with a tank extension secured to said permanet tube sheet and defining a header for a heating medium exteriorly of the permanent tube sheet, said header having a removable cover plate whereby access to the permanet tube sheet may be had.

5. In a heat exchanger, the combination of a cylindrical tank provided adjacent its opposite ends with an inlet and an outlet for a liquid to be heated, a pair of tube sheets provided at the opposite ends of said tank, at least one of said tube sheets being removable, a heat exchange coil assembly disposed in the tank and comprising a plurality of coil units nested together in concentric relation, a plurality of pairs of tube rings having the ends of the respective coil units secured therein, and means removably and individually attaching said rings to said tube sheets, whereby each coil unit with its rings may be removed from the tank independently of the other coil units, together with an air compression chamber provided in said tank centrally within said coil assembly.

6. In a heat exchanger, the combination of a vertically disposed cylindrical tank provided adjacent its opposite ends with an inlet and an outlet for a liquid to be heated, an upper tube sheet removably mounted at the upper end of the tank, a lower tube sheet permanently secured to the lower end of the tank, a heat exchange coil assembly disposed in the tank and comprising a plurality of coil units nested together in concentric relation, a plurality of pairs of tube rings having the ends of the respective coil units secured therein, said tube rings being arranged in concentric upper and lower sets at the inside of the respective upper and lower tube sheets, means removably and individually attaching said rings to the tube sheets whereby each coil unit with its rings may be removed from the tank independently of the other coil units, and a vertically disposed tubular member provided centrally within said coil assembly and defining a chamber for trapped air, the upper end of said tubular member being secured to the innermost tube ring in the upper set, and the lower end

thereof being open and spaced upwardly from the innermost tube ring in the lower set, whereby liquid in the tank may enter said chamber and exert pressure on the air trapped therein.

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