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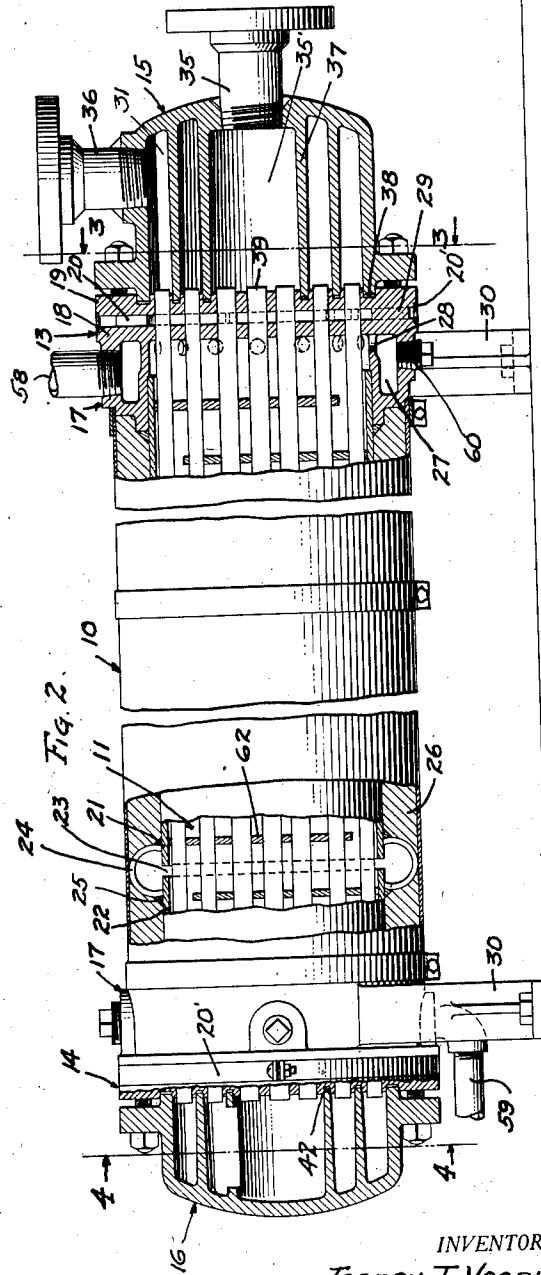
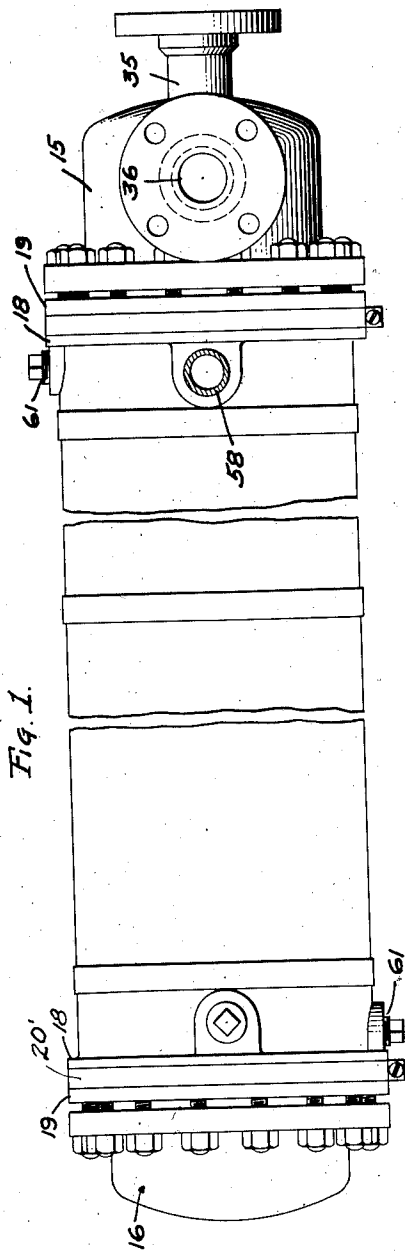
J. T. VORHEIS

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OIL HEATER

Filed July 23, 1932

2 Sheets-Sheet 1



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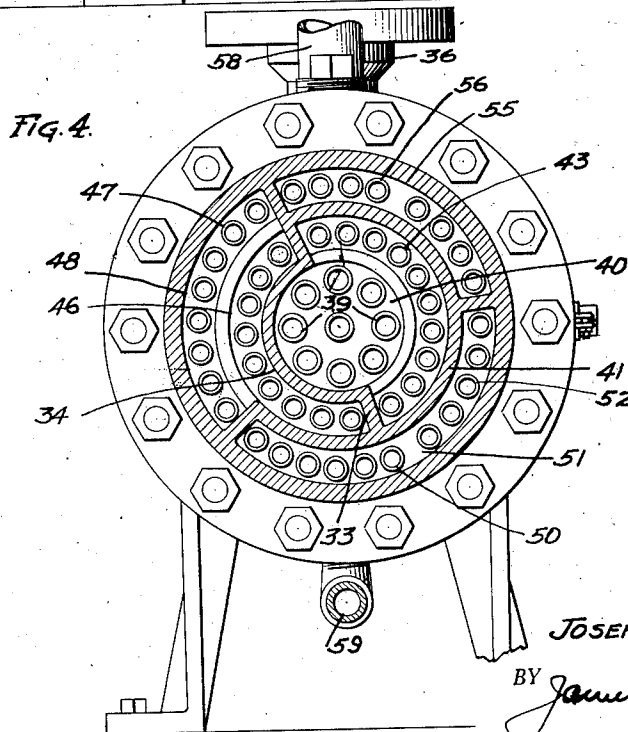
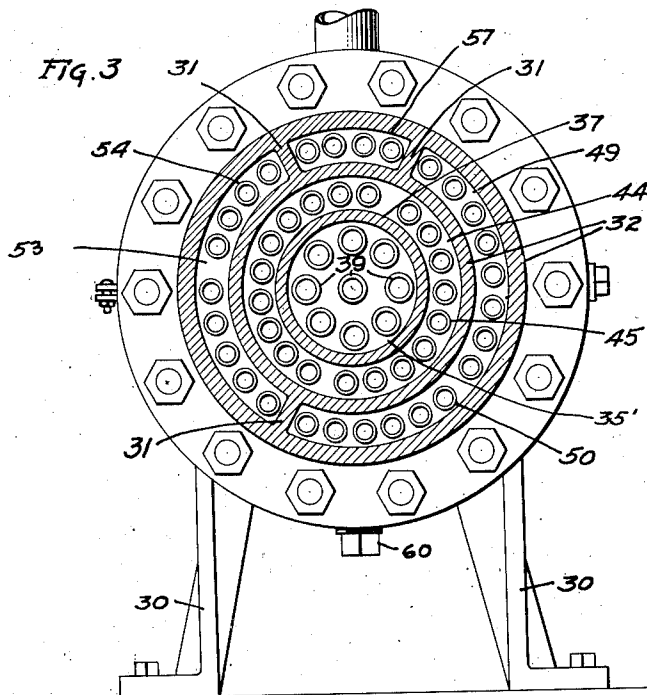
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UNITED STATES PATENT OFFICE

1,948,550

OIL HEATER

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Application July 23, 1932. Serial No. 624,305

12 Claims. (Cl. 257-240)

This invention relates to fluid treating apparatus and particularly pertains to a heat exchanger.

In the treatment of various fluids it is necessary to bring about an exchange of heat whereby a desired fluid may be raised in temperature, or if occasion may be required whereby it is lowered in temperature. Such apparatus is used in connection with heating of oil for use in oil burner systems, and in that particular installation it is desirable that the viscosity of the oil shall be lowered and its temperature raised in an apparatus of relatively small compass and compact design, and through which the oil may flow with minimum obstruction and a maximum heating action. It is the principal object of the present invention, therefore, to provide a heat exchanger in which a heating fluid and a fluid to be heated pass through adjacent conduits and through the walls of which a heat exchange action can take place, said conduits being so assembled and housed as to make a compact device, and so as to accommodate the liquid expanding under the action of heat and permitting expansion of the various parts of the heat exchanger device by use of a simple and compact structure.

It is the further object of the present invention to provide a heat exchanger structure having a tube sheet of peculiar design whereby the leakage of any tube joint in the tube sheet may be readily detected and whereby the commingling of heating fluid and the fluid being heated cannot take place.

The present invention contemplates provision of a shell within which a multipass flow of liquid an fluid may take place, the successive passes progressively increasing, or decreasing, in capacity, and the apparatus being provided with expansion joints whereby the various elements may expand and contract without possibility of leakage.

The invention is illustrated by way of example in the accompanying drawings in which:—

Figure 1 is a view in plan showing the heat exchanger with which my invention is concerned, and with parts broken away for the sake of convenience.

Fig. 2 is a view in central longitudinal section through the device showing the details of construction with which the present invention is concerned.

Fig. 3 is a view in transverse section on the line 3—3 of Fig. 2.

Fig. 4 is a view in transverse section on the

line 4—4 of Fig. 2 and showing the passes of the heat exchanger.

Referring more particularly to the drawings, 10 indicates a cylindrical tubular shell of a heat exchanger within which a tube nest 11 is positioned. This tube nest comprises a plurality of tubes which extend longitudinally within the shell and are provided at their opposite ends with tube heads 13 and 14. A dome 15 of a construction to be hereinafter described closes the tube nest at one end and a dome 16 in conjunction with the head 14 closes the tube nest at the opposite end. The tube heads 13 and 14 rigidly engage and hold the opposite ends of the tubes.

The tube heads 13 and 14 each comprise an annular manifold structure 17 which encircles the end of the shell. The heads each are formed with two tube sheets 18 and 19 disposed parallel to each other and spaced apart to form an intermediate spacing compartment 20. The tube heads are rigidly connected to the shell as by welding. It is therefore, obvious that in order to accommodate expansion and contraction of the metal of the tube nest it is necessary to provide some compensating means. This in the present instance is embodied in the shell construction where it will be seen that the shell 10 comprises at least two wall sections 21 and 22. The sections are longitudinally aligned and separated at their contiguous ends as indicated at 23 in Fig. 2. The annular passageway which would occur at the point of separation is sealed by an expansion ring 24. This expansion member is made preferably in the form of a tubular ring. The wall forming the inner circumference of the ring is cut away to provide a circumferentially extending opening in the ring, which opening is of greater width than the space 23 between the contiguous faces of the shell lengths. The contiguous edges of the shell and the ring are suitably secured together as by welding as indicated at 25 in Fig. 2, although it is to be understood that an annular flexible section might be formed by other means and if desired may be rolled in the shell itself. The shell and expansion joint are covered with a suitable heat insulating material indicated at 26, and then in turn enclosed by sheet metal covering, thus making it possible for longitudinal expansion and contraction of the shell and the tubes to be taken care of by the flexure of the expansion member 24 and the relative movement afforded by the shell parts along the line of severance 23 of the shell. The opposite ends of sections 21 and 22 of the shell structure 10 are provided with the tube heads 13 and

14 to which the ends of the shell sections 21 and 22 are secured. The tube heads are cylindrical, having a circumferentially extending manifold passageway 27 communicating with the ends of the shell through lateral openings 28. The ends of the tube heads are provided with the integrally formed tube sheets 18 and 19, respectively. The tube sheets 19 are spaced from the first named sheets 18 by spacing ribs 29 cast between the sheets and occurring at intervals around the circumference thereof. In this manner the spacing compartment 20 occurs between contiguous faces of the sheets at each end of the tube nest and makes it possible for the tubes to be expanded into both sheets 18 and 19 at each of their ends and for a space 20 to occur between the tube sheets so that in the event there is any leakage around the tubes either permitting fluid to leak out from the shell or for fluid to leak from the domes, it is possible for this leakage to be detected and taken care of until repairs can be made, without shutting down the equipment. The space 20 between the sheets 18 and 19 is normally covered by a band 20' extending around the tube head.

It is also evident that there is no possibility for the fluid within the shell to commingle with the fluid within the tubes as a result of leakage between a tube and a tube sheet.

The tube heads 13 and 14 are here shown as provided with supporting legs 30 by which the device can be supported in a horizontal position. It will, of course, be understood that these might be used as brackets so that the heat exchanger could be held in a vertical position or otherwise. The dome 15 adjacent the tube head 13 is formed with radial baffle plates or partitions 31, and arcuate baffle plates 32. The dome 16 at the opposite end of the shell is provided with radial baffle plates 33, and arcuate baffle plates 34. The dome 15 is of relatively greater length than the dome 16 so as to accommodate the induction pipe 35, and the eduction pipe 36. As here indicated, the induction pipe 35 is disposed concentric with the longitudinal axis of the heat exchanger structure.

It is usual in a structure of this sort to treat and heat a viscous liquid. It has been found desirable to accelerate the velocity flow of this liquid as its heating progresses and as its viscosity decreases, and for that reason the combined sectional area of the tubes in the different passes decreases as the flow of liquid progresses through them. This decrease continues until the liquid in the last passes is traveling with sufficient velocity to give it considerable turbulence, and it will be recognized that the more disturbed the flow of the liquid becomes the more thorough will be the contact of the liquid with the walls of the tubes within which it is confined, and the more efficient will be the heat exchange relationship between the medium on the outside of the tubes and the medium within the tubes. It will be understood, of course, that in the event the device should be used as a cooler the direction of flow of the liquids will be reversed, and that added advantages will be obtained as the cooling liquid moves toward the center of the exchanger and into the passes of larger area.

In order to reduce expansion strains the present exchanger is designed to introduce a relatively cold viscous liquid into the center of the tube bundle where the coldest tubes will be at the greatest distance from the shell wall which attains the temperature of the heating medium and which tubes will be surrounded by the tubes

of other passes of liquid progressively being heated. The induction pipe 35 for the liquid is shown as communicating with a central passageway 35' which is defined by a cylindrical wall 37 concentric with the longitudinal center of the heat exchanger. This wall abuts against a packing 38 interposed between its edge and the outer surface of the tube sheet 19, and defining an area circumscribing the center group of heat exchanger tubes 39. This central group of tubes comprises tubes of a predetermined diameter and number, having sufficient sectional area to accommodate the cold viscous liquid introduced into the heat exchanger. Upon reaching the opposite end of the heat exchanger, the tubes will discharge the liquid into the dome 16 and directly into an eccentric compartment 40 bounded on one side by an arcuate wall section 34 and upon the other side by arcuate wall section 41 described by a relatively greater radius. The wall section is interrupted at its opposite ends by radial partition walls 33. The arcuate partition 34 abuts against a packing 42 interposed between its edge and the tube sheet 19 which forms a part of the tube sheet unit 14. In this manner the tubes 39 may communicate with a row of tubes 43 which make a return pass. These tubes are of greater number than the tubes 39, but have a lesser sectional area so that the velocity flow of the viscous liquid will be increased. The tubes 43 communicate at their opposite end with the arcuate compartment 44, and from there the fluid passes into tubes 45 leading to the opposite end of the shell and there communicating with an arcuate compartment 46, which is in communication with tubes 47 providing a return pass through arcuate compartment 48 to arcuate compartment 49 in the dome 15. The fluid then enters tubes 50 and flows the length of the shell into arcuate compartment 51 in dome 16 and then returning to dome 15 through tubes 52 leading into compartment 53 of dome 15. A reverse flow then follows through tubes 54 to the arcuate compartment 55 of dome 16. A final pass is then made through tubes 56 to arcuate compartment 57 in dome 15, and which compartment is in communication with the eduction connection 36.

The heating medium is introduced into the shell through a threaded connection 58, one of which is disclosed in Fig. 1 of the drawings, as being disposed at each end of the shell and associated with the manifold structure which includes the manifold passageway 27. Condensate may be drained from the shell and the manifold through a drain connection 59 in tube head 14. The drain opening in the opposite head 13 being shown at 60 as plugged. Plugged openings 61 are provided in each of the tube heads 13 and 14 and may be used for various purposes such as accommodating vents, gauge connections, or drains for the heater in different positions.

In operation of the present invention the heat exchanger is assembled as shown in the drawings and a heating medium delivered to the shell through one of the connections 58. If desired baffle plates 62 may be interposed at points along the length of the shell to more thoroughly distribute the heating medium and to cause it to more uniformly and intimately contact with the walls of the tubes. A liquid to be heated may be introduced through the induction pipe 35 and will progressively flow through the various pipes and by-passes of the heat exchanger. During this flow it will be in heat exchange relationship with

the heating medium and will be gradually raised in temperature and increased in turbulence as the liquid flows from pass to pass of the heat exchanger and in successive passes of which the sectional area decreases.

In the event that the temperature of the heating medium has an expansive effect upon the entire heat exchanger, there will be variation in the strains imposed upon the different parts of the heat exchanger, as these parts vary from their normal temperature, and in relation to each other. This variation in expansion will be accommodated by the expansion ring 24 which will permit the shell to become compressed longitudinally in order to accommodate longitudinal expansion of the shell with relation to the tubes. It will be understood that this must be provided due to the fact that the tubes are rigidly secured in the tube sheets at opposite ends of the device. The expansion member 24 will flex as required, permitting the abutting faces of the sections 18 and 19 to move toward and away from each other as expansion and contraction of the assembled structure takes place.

In the event that the tubes become in any way loosened with relation to the tube sheets within which they are fastened it will be evident that there will be no possibility of leakage of the heating medium into the fluid being heated, or vice versa. This is for the reason that space 29 will occur between the tube sheet sections of each of the tube sheet units 13 and 14. The tubes will be expanded into each of these tube sheet units and if there is any leakage around the outer ends of the tubes at the point where they extend through the outer tube sheets it may be readily observed. This leakage will only occur into the space 29, between the tube sheets 18 and 19, which communicates with the atmosphere, or if there is leakage between the inner tube sheet sections this leakage will only permit the heating medium to drain out into the space 29. There will not be any opportunity for the liquids or fluid to commingle and reach the compartments or passageways intended for another fluid however. In this way it is also possible to detect leakage in tube sheets and locate the leaking point.

It will thus be seen that the device here disclosed provides a heat exchanger in which a maximum heat exchange surface is obtained, and through which a fluid to be heated may be rapidly circulated and which structure provides for a compact and rigid assembly of the parts while accommodating expansion due to the temperature variations, and while preventing commingling of the fluids passing through the heat exchanger due to any leakage of either fluid around the tubes.

While I have shown the preferred form of my invention, as now known to me, it will be understood that various changes may be made in combination, construction, and arrangement of parts by those skilled in the art without departing from the spirit of my invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:—

1. A device of the character described comprising a tubular shell, a tube nest extending therethrough, domes at the opposite ends of the tube nest and partition members in said domes whereby a fluid will be caused to flow through groups of the tubes in multipass arrangement and whereby the sectional area of the tubes of successive groups progressively vary.

2. A heat exchanger comprising a tube nest, a shell therefor, domes at the opposite ends of the shell with which the tubes of the tube nest communicate, and partition means in the domes for directing the fluid which passes through the tubes to successively pass along paths of travel concentric with the longitudinal axis of the shell.

3. A heat exchanger comprising a tube nest, a shell therefor, domes at the opposite ends of the shell with which the tubes of the tube nest communicate, and partition means in the domes for directing the fluid which passes through the tubes to successively pass along paths of travel substantially concentric with the longitudinal axis of the shell, said passes occurring along arcuate lanes on circles substantially concentric with the longitudinal axis of the shell.

4. A heat exchanger comprising a tube nest, a shell therefor, domes at the opposite ends of the shell with which the tubes of the tube nest communicate, and partition means in the domes for directing the fluid which passes through the tubes to successively pass along paths of travel concentric with the longitudinal axis of the shell, said passes occurring along arcuate lanes on circles concentric with the longitudinal axis of the shell and said passes being progressively arranged along concentric circles of progressively changing diameter whereby the tubes will be grouped in their lanes around the longitudinal axis of the shell.

5. In a heat exchanger a tube head and tube sheets incorporating an annular manifold adapted to fit over the end of a shell and being formed with radial openings in its inner wall to permit entry of fluid from the manifold to the shell throughout the circumference thereof, a tube sheet formed integral with the manifold and closing the outer end of the head.

6. In a heat exchanger a tube head and tube sheets incorporating an annular manifold adapted to fit over the end of a shell and being formed with radial openings in its inner wall to permit entry of fluid from the manifold to the shell throughout the circumference thereof, a tube sheet formed integral with the manifold and closing the outer end of the head, and a second tube sheet formed as a part of said head and spaced from the first tube sheet.

7. A tube head for heat exchangers and the like, comprising an annular member adapted to be secured to the end of a heat exchanger shell, said member being formed integral with the tube sheet through which tubes extend and within which the tubes are expanded, and a second tube sheet spaced from the outer face of the first named tube sheet and through which said tubes extend and within which they are expanded.

8. A tube head for heat exchangers and the like, comprising an annular member adapted to be secured to the end of a heat exchanger shell, said member being formed integral with the tube sheet through which tubes extend and within which the tubes are expanded, and a second tube sheet spaced from the outer face of the first named tube sheet and through which said tubes extend and within which they are expanded, and spacing lugs formed between said tube sheets to hold the sheets in fixed spaced relation to each other.

9. In a heat exchanger or the like, a tube head adapted to be secured at the end of a heat exchanger shell, said head including a manifold encircling the end of the heat exchanger shell and communicating therewith, the manifold be-

ing formed with a plurality of inlet and outlet openings through which suitable pipe connections may be optionally made.

10. In a heat exchanger or the like, a tube
5 head adapted to be secured at the end of a heat exchanger shell, said head including a manifold encircling the end of the heat exchanger shell and communicating therewith, the manifold being provided with supporting legs by which the as-
10 sembled heat exchanger is carried.

11. A heat exchanger or the like comprising a shell formed of two longitudinally aligned cylindrical sections, the contiguous edges of which sections are in spaced relation to each other, an
15 annular expanding member substantially semi-circular in section and of sectional diameter greater than the space between the contiguous ends of the shell sections, said expanding member being welded to the circumscribed shell sections throughout their circumference, a fixed
20 tube head at the opposite ends of the composite shell structure, a set of tubes fixed into said tube heads whereby expansion and contraction of

the tubes will produce expansion and contraction of the shell as permitted by the expanding member, a covering of heat insulating material surrounding the shell and its expanding member, an outer metal covering enclosing the shell
80 and its insulation, and fluid circulating domes secured against the outer faces of the tube heads.

12. In a heat exchanger of the class described, a shell, a tube nest therein comprising a plurality of tubes uniformly distributed with relation
85 to the transverse section of the shell and extending longitudinally thereof, tube sheets, one closing each end of the shell and through which the tubes extend, circulating domes, one for each tube sheet and within which the tubes of each
90 tube sheet communicate, and a plurality of concentric partition members within each dome and by which the tubes are separated into concentrically arranged groups, said partition members having lateral openings to cause the fluid in the
95 tube sheets to flow in multi-pass through the concentrically arranged groups of tubes.

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