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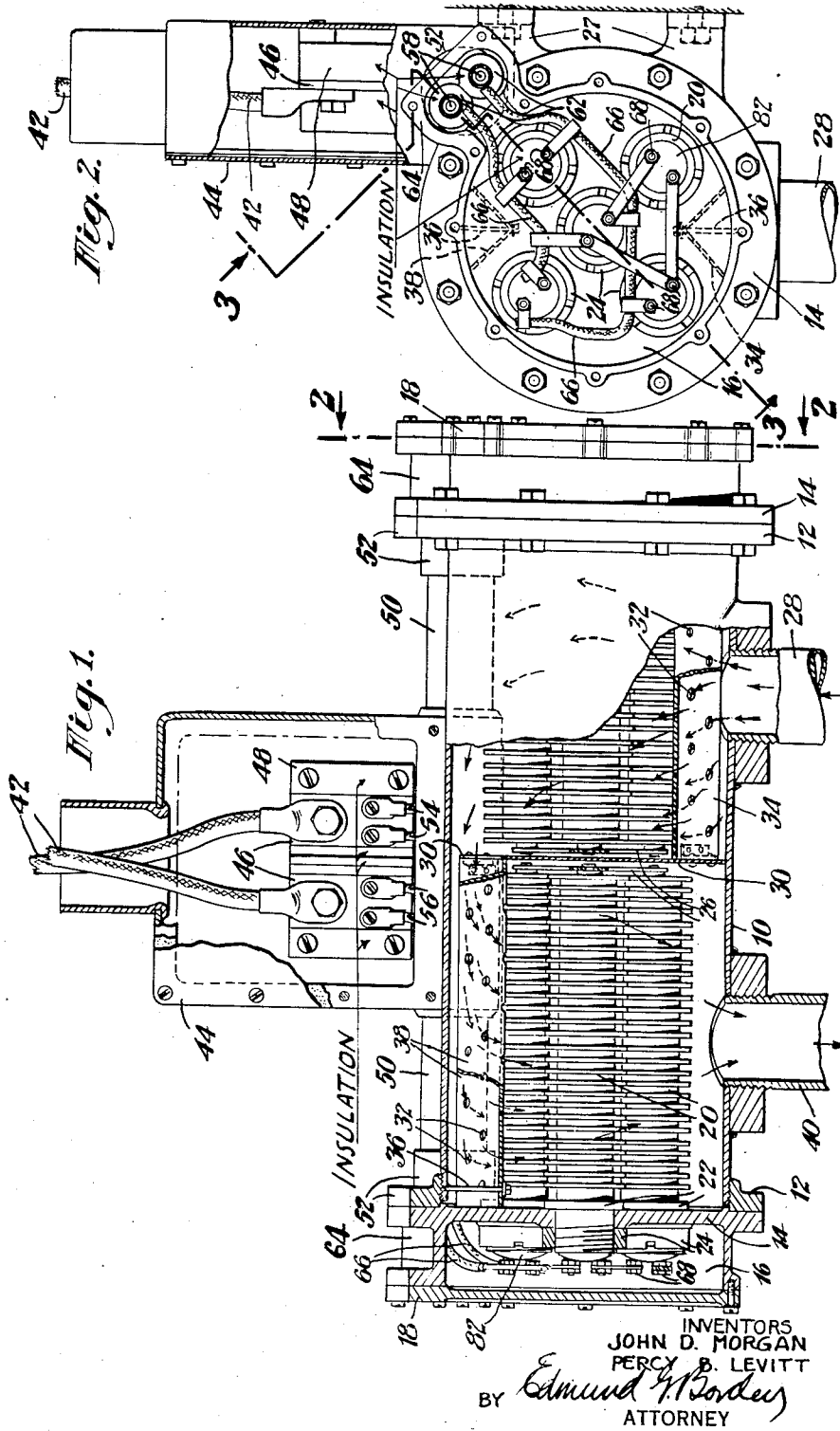
J. D. MORGAN ET AL

2,373,084

ELECTRIC OIL HEATING APPARATUS

Filed Nov. 25, 1942

2 Sheets-Sheet 1



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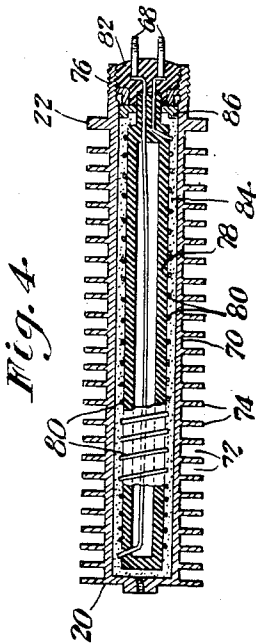
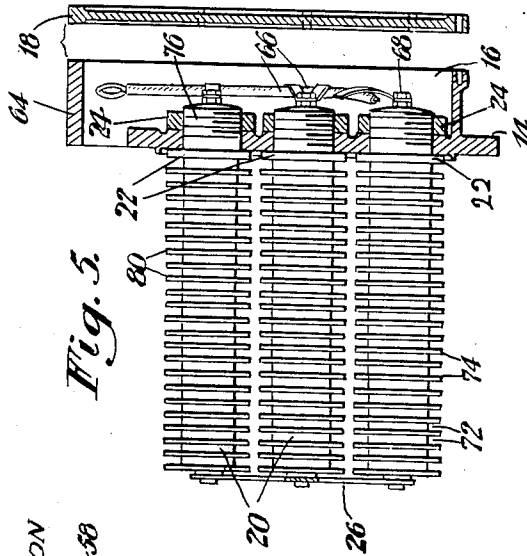
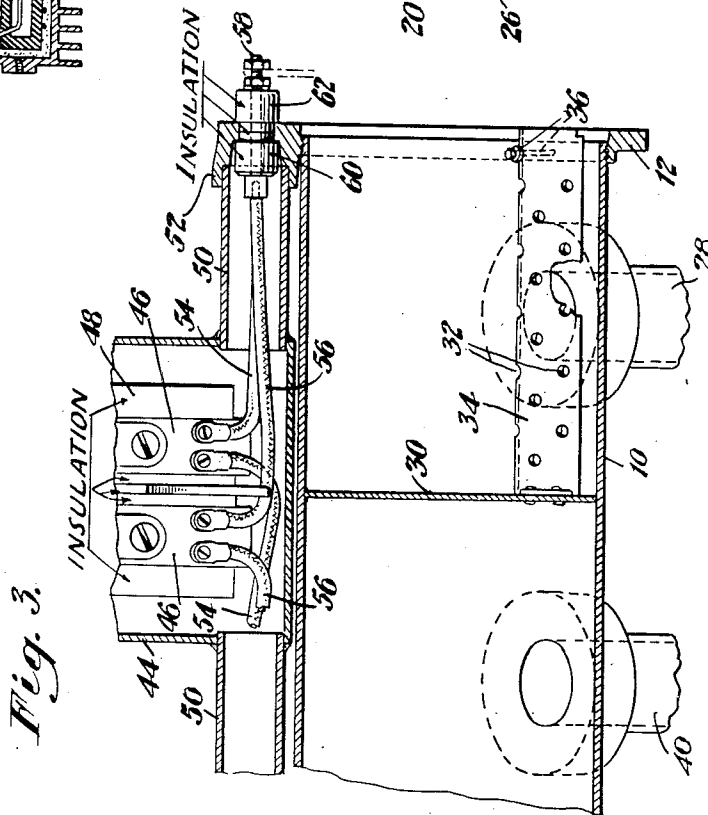
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ELECTRIC OIL HEATING APPARATUS

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2 Sheets-Sheet 2



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2,373,084

ELECTRIC OIL HEATING APPARATUS

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Application November 25, 1942, Serial No. 466,862

7 Claims. (Cl. 219—39)

This invention relates to improvements in electric oil heating apparatus and method of heating motor crank case oils in a purification operation.

In the use of naval patrol vessels equipped with internal combustion motors, it has been common practice to change oil, and clean the motors after very short periods of use. This disadvantage has been overcome by purifying the crank case oil while the motors are in operation. The oil is conducted in a closed circuit from the motor, through purifying apparatus, into an oil storage tank, and back to the motor. Some naval patrol vessels of course are provided with two or more motors, and the invention includes the separate or combined handling of the crank case oil from all of the internal combustion engines of a vessel. Furthermore, the invention contemplates the handling of the crank case oil from Diesel motors or gasoline motors.

In the purification of crank case oils in a cycle of the type referred to above, it has been found that the purification can be made much more effective by heating the crank case oil to a substantially higher temperature than the temperature at which it is withdrawn from the motor crank case. Heating also prevents stoppage of screens and filters by the oil becoming cold and viscous. However, naval patrol vessels powered by internal combustion engines have no conveniently effective heating means available except electricity.

Therefore, the primary object of the present invention is to provide a compact and convenient heater for the heating of crank case lubricating oils in a purification cycle.

A further object of the invention is to provide a compact and effective electric heating apparatus for heating crank case oils to be purified.

Another object of the invention is to provide improved method for refining crank case oils.

The improved electric heating apparatus of the present invention comprises an oil heating chamber divided into two heating sections in each of which is mounted a bank of electric heating units arranged so that the oil to be heated passes over the heating units in one compartment of the chamber and then over the heating units in the other compartment of the chamber. The apparatus includes other important features such as means for providing a pressure drop through the heating chamber as well as between the compartments in the chamber, a compact arrangement for the electric heating units and special

means for mounting the heating units in the ends of the heating chamber.

Other objects, features and advantages of the process and apparatus of the present invention will be apparent to those skilled in the art from the following detailed description thereof taken in connection with the accompanying drawings in which:

Fig. 1 is a front view, partly in broken section, of an electric heating apparatus constructed in accordance with the invention.

Fig. 2 is an end view of the heater shown in Fig. 1, with certain parts removed or broken away, taken on the line 2—2 of Fig. 1.

Fig. 3 is a broken longitudinal cross sectional view, taken on the line 3—3 of Fig. 2, of the heating chamber and other portions of the apparatus shown in Fig. 1 with the banks of heating units removed.

Fig. 4 is a longitudinal cross sectional view of one of the heating units employed in the heating apparatus of the present invention.

Fig. 5 is a view, partly in section, showing the arrangement of the heating units and the method of mounting the same.

Referring to Fig. 1 of the drawings, the electric heating apparatus of the present invention comprises in its preferred form a horizontal cylindrical oil heating chamber 10 provided with end flanges 12 to each of which is secured by bolts, as shown, a header 14, the latter of which includes an integral header box 16 provided with a cover plate 18. The headers 14 in the illustrated embodiment of the present invention are used as mountings for banks of electric heating units 20, five of such units being shown as mounted in each header 14 and extending almost to the center of the cylindrical chamber 10. Each of the electric heating units 20 includes a shoulder 22 which bears against the inside of the header 14 and which is held there in fluid-tight manner by a ring nut 24 which is drawn up on the opposite side of the header on a threaded section of the heating unit which extends through the header into the header box 16. The ends of the heating units which extend into the chamber 10, are supported, in spaced relation to each other by a metal spider 26 fastened to the end of each unit 20 by means of screws, as shown. All metal parts of the apparatus are preferably made of brass.

Each of the electric heating units 20 includes a channeled outer shell or casing adapted to uniformly and rapidly heat the oil conducted through the heater. The heater itself which is provided

with mounting brackets 27 on each of the flanges 12, is installed in accordance with the preferred form of the invention, in a cycle provided for purifying the crank case oil from patrol vessel motors. The used crank case oil is withdrawn from the motor and conducted by means of a pump (not shown) to the heating chamber 10 through an inlet pipe 28, the oil being supplied through the line 28 at a moderate pressure of for example about 10 lbs. per square inch. The oil supplied to the chamber 10 through the line 28 passes through relatively small holes 32 in a metal angle distributor 34 mounted over the inlet 28, under the right heater bank and fastened to the partition 30 and to the shell of the chamber 10; to the latter by means of a bolt 36 (Fig. 3). The oil passes through the small holes 32 with a substantial pressure drop and is distributed over the heaters 20, over which it flows upwardly to the top of the chamber and then through a V-shaped opening in the partition 30 into the end of a second perforated metal angle distributor 38 exactly like the distributor 34 and mounted in substantially the same manner as shown in Fig. 1, except that it is above the bank of heating units to the left in the chamber 10. The oil flows through the holes 32 in the distributor 38 with a further substantial pressure drop, and passes downwardly over the heating units 20 to the left of the partition 30. The oil is finally discharged from the chamber 10 through a line 40.

One important function of the angle members 34 and 38 is to provide pressure reducing means to cause a pressure drop in the oil entering the first bank and between the banks of heaters. They also act to distribute the oil substantially uniformly over the heating units of each bank because the oil is forced through the small holes in the members 34 and 38 with a pressure drop. The oil taken from the motor or motors usually has a temperature of only about 140° F. and sometimes only about 130° F., and the heating apparatus of the present invention is provided to bring the temperature up to about 200° F., at which temperature the oil is conducted through a centrifuge for the removal of sludge, small metal particles, and other impurities. The oil discharged from the centrifuge is conducted through a filter and then to the motor oil storage tank for the motor or motors. From the storage tank the oil usually flows by gravity back to the motor or motors to keep them supplied with clean purified oil. The filter used may be a simple felt-type filter or one containing an adsorbent clay such as fuller's earth or other refining clay.

Electricity for the heating units 20 is supplied to the heating apparatus through lead wires 42 which terminate in a water-tight conduit junction box 44. The lead wires 42 are attached respectively to metal connector plates 46 mounted on an insulation block or base 48 set in the box 44. The junction box 44 is mounted to the back and mostly above the heater shell 10 and connected up with fluid-tight connections to the header boxes 16 by means of two conduit nipples 50 which terminate respectively in suitably prepared lateral openings in integral projections 52 on the rim of each of the flanges 12. The nipples 50 may be welded, brazed or otherwise secured in the positions shown in Figs. 1 and 3. Current is distributed from the plates 46 to connectors in the header boxes 16 through wires 54 and 56, respectively, which terminate in soldering lugs on the end of stud connectors 58, each of which are insulated from the metal of the projection

52 by means of substantially cylindrical insulator bushings 60 and 62. The assembly of the lugged studs 58 and the bushings 60 and 62 is illustrated in Fig. 3, in which suitable nuts and washers are used. The insulator bushings 62 at each end of the heater, extend substantially beyond the face of the flange 12 and into a housing 64 which comprises an integral part of the header box 16 into which it opens as shown in Figs. 2 and 5. The cover plates 18 also have integral projections which cover the housings 64.

Electric current is distributed to the heating units 20 from connector studs 58 through distributor lead wires 66 in each of the header boxes 16. The five heaters 20, the heads of which extend into each header box 16, are supplied with current in parallel from the wires 66 by means of connector bars as shown which are attached to connector studs 68 extending from the head of each heating unit. The connector bars are fastened to the studs 68 by means of nuts, as shown. The heating units 20 are mounted in the headers 14 with the nuts 24 in such a manner that they are fluid-tight and the cover plate 18 is fluid-tight with respect to the housing 16, so that it is impossible for any oil or water or other fluid to get into the housing 16. The bushings 60 and 62 also preferably form a fluid-tight joint between the respective conduit nipples 50 and the housings 64 and header boxes 16.

Each of the heating units 20 preferably comprises a solid metal casing 70, in this instance preferably brass (Fig. 4). This metal case or shell is preferably made from a solid piece of stock by boring out the cavity for the electric resistance heating element and machining the outside by means of a suitable chasing tool to produce a number of narrow annular channels 72 separated by relatively thick walls or fins 74. By using a suitable tool, any number of the channels may be made in a single operation, and either before or after the boring step. The walls 74 which separate the narrow annular channels are preferably much thicker than that of the usual fins found in heat exchange apparatus. In a specific instance, the heater case for a 1000 watt heater was made from rolled brass stock of 1 1/4 inch diameter, the overall length of the case being 7 1/2 inches. It had the full diameter of 1 1/4 inches for the fins and a cavity 3/8 of an inch in diameter. The finned section included 50 fins occupying a distance of about 6 1/4 inches. The channels between the fins were about 0.062 inch wide, and rounded at the base, and about 0.10 inch wide at the periphery, so that the fins themselves were substantially thicker at the base than at their periphery, for effective heat transfer. The fins were about 3/8 of an inch wide, and spaced at approximately 0.125 inch. The heating apparatus shown in the drawings, and containing ten of these 1000 watt heating units, was found to be suitable for heating about 150 gallons of lubricating oil per hour from a temperature of about 130° F. to a temperature of 200° F.

The casing of the heating unit 20 includes an end section 76 which is threaded both internally and externally, the opposite end being cut and tapped for mounting on the spider 26. The electric resistance heating element in each of the units 20 includes a hollow cylindrical zircon core 78 and a resistance wire 80 wrapped therearound in spaced convolutions throughout the length of the finned section of the heater. The terminals of the resistance wire extend from the end of the

core and into a hard plastic insulation head 82 in which they are attached to the studs 68. The resistance wire 80 may be chromium, nickel-chromium alloy or aluminum-cobalt-iron alloy.

In making up the heating unit 20, the resistance wire 80 and the core 78 are coated with a zircon wash made of 50% milled grain zircon and 50% of natural grain zircon bonded with a mixture of 6% P_2O_5 and 2% chromic acid. This coating is hardened onto the wire and the core by heating the element to a temperature of about 600° F. in an oven. The core and resistance wire unit is mounted in the casing 70 by packing it in the cavity therein in spaced relation from the shell, the space being filled with fine zircon sand 84 which is a good dielectric and has a high heat conductivity. The layer of sand 84 completely surrounds the core and resistance wire and may be very densely packed by vibrating the casing as the sand is introduced around the core. The packed-in sand is held in place under the head 82 by means of a gasket member 86.

While the heating units 20 have been shown as cylindrical, they may have any other desired cross-section such as elliptical, tear-drop, triangular, rectangular, etc. In any of these shapes, however, the channels and dividing walls are preferably arranged so that relatively narrow deep channels are provided in planes at approximately right angles to the longitudinal axes of the units so that the oil passed thereover will be heated rapidly and uniformly. In the case of the heating units of circular cross-section as illustrated, the oil flows through channels on each side of each heater unit. In the arrangement as shown more particularly in Fig. 1, the banks of heaters are mounted so that the heating units extend substantially horizontally while the oil on both sides flows across the bank or in the same direction as the channels in the heater unit casing walls.

Regardless of the cross-sectional shape of the electric heating units mounted in each bank, they are preferably arranged so that the oil passed over each bank has little or no chance of avoiding the influence of the narrow channels or fins. Note for example that the five heating units mounted in the right compartment of the particular heater described, are arranged so that the two lower heating units 20 in conjunction with the middle unit 20, substantially screen the whole area over the distributor 34 (Fig. 2), and that the two upper heating units in conjunction with the middle unit substantially screen the distributor 38 in the left hand section of the heater. The size of the heating units 20, that is, the outside dimension of the fins, is such that three heaters substantially equal the internal diameter of the cylindrical chamber 10. Note that Fig. 5 shows the close mounting of the three heating units 20 which are in line with the housing 64. If desired, end plates substantially fitting the inside of the chamber 10 and the distributors 34 and 38, may replace the spiders 26. Other arrangements may be made with a larger number of heating units to accomplish substantially the same results, so that the oil introduced below or above the banks of heaters is substantially screened through the channels of the heating units. In fact, the arrangement, with the five heaters as illustrated, has two screens for each bank of heaters, one in the upper portion of the chamber and the other in the lower portion of the chamber 10. The fins of the outside heaters 20 may touch or almost touch the wall of the chamber 10 and the fins of

the middle heating unit 20 with which they are aligned.

While the oil heating apparatus of the present invention has been illustrated as being mounted in a horizontal position, and this position has certain advantages as indicated above, the chamber 10 may nevertheless be mounted in any other desired and necessary position since the angle of mounting has no appreciable influence on the operation of the heating apparatus, as long as a pressure drop is provided at the inlet and between the compartments of chamber 10.

The heating apparatus of the present invention is easy to keep clean and easy to keep in running order, since the bank of heating units on either side can be removed and cleaned as a bank or each individual heating unit 20 can be removed and cleaned separately or replaced if necessary. Furthermore, all of the electrical connections are readily accessible and easily replaced or repaired. The header boxes 15 are always clean and free from oil or water, and the housing 64 is placed at the upper part of the heater so that it is free from any contamination, even when one of the headers 14 is removed from the heater.

The relatively thick closely spaced fins or channel walls of the electric heating units are of considerable importance because the metal of which they are composed is an integral part of the tubular shell of the heater itself and therefore conducts heat rapidly to relatively narrow bodies of oil in the channels. While it is preferred that the fins be of the shapes described and shown, somewhat similar results may be accomplished by cutting a continuous spiral channel in the metal stock of the casing 70 so as to leave a continuous thick tapered spiral fin. This arrangement would of course have substantially the same type of channels as shown in the drawings. While in the present case the electric heating units as well as the whole heating apparatus is preferably made of brass for its particular use in the process cycle described in connection with naval patrol vessels, the apparatus may be made of other metals. For example, where its use is required for air craft, the relatively light metals: aluminum, aluminum alloys, magnesium and magnesium alloys may be used. The electric heater casings 70, however, are preferably made from metals of high heat conductivity such as brass, aluminum, copper or silver.

In describing the method of using the heater of the present invention in the refining of used crank case oils while in service, it was mentioned that a pump was used to force the oil into the heater through the line 23. However, a suitable pressure drop through the sections of the heater may be secured by attaching the pump to the outlet 40 and drawing the oil through the heater. Various other modifications may be made in the procedure and in the structure of the heating apparatus of the present invention without departing from the invention itself. Such modifications and changes are to be understood as coming within the scope of the invention as defined by the appended claims.

Having described the invention in its preferred form and illustrated the same in connection with certain specific examples, what is claimed as new is:

1. An electric oil heating apparatus, comprising a cylindrical chamber of substantially greater length than diameter having a header at each end and a partition wall dividing the chamber into two substantially equal compartments. a

bank of electric heating units mounted in each of said headers and extending into and substantially filling each compartment, a header box at each end of the chamber into which each of the electric heating units also extends, means for supplying electric current to said header boxes and to the electric heating units extending thereinto, means for supplying oil to one of said compartments, for conducting the oil through an opening in the partition in said chamber into the other compartment and for discharging the heated oil from the last-mentioned compartment, and a pressure reducing distributor mounted in each compartment and adapted to cause a pressure drop in the oil flowing from one compartment to the other and in the oil flowing into the inlet compartment of the chamber.

2. An electric oil heating apparatus, comprising a cylindrical chamber of substantially greater length than diameter having a header at each end and a partition wall dividing the chamber into two substantially equal compartments, a bank of electric heating units mounted in each of said headers and extending into and substantially filling each compartment, a header box at each end of the chamber into which each of the electric heating units also extends, each of said units having a metal casing the outer surface of which is composed of deep narrow channels, means for supplying electric current to said header boxes and to the electric heating units extending thereinto, means for supplying oil to one of said compartments, for conducting the oil through an opening in the partition in said chamber into the other compartment and for discharging the heated oil from the last-mentioned compartment, and a pressure reducing distributor mounted in each compartment and adapted to cause a pressure drop in the oil flowing from one compartment to the other and in the oil flowing into the inlet compartment of the chamber.

3. An electric heating apparatus, comprising a tubular chamber of substantially greater length than width having a header at each end and a partition wall dividing the chamber into two substantially equal compartments, a bank of relatively long narrow electric heating units mounted in each of said headers and extending into and substantially filling each compartment, a header box at each end of the chamber into which the connector head of each of the electric heating units extends, means for supplying electric current to said header boxes and to the connector heads of the electric heating units extending thereinto, means for supplying a fluid to be heated to one of said compartments, for conducting it therefrom into the other compartment and for discharging the heated fluid from the last-

mentioned compartment, and a distributor mounted in each compartment and adapted to cause substantially uniform distribution of the fluid over the bank of electric heating units therein.

4. An electric heating apparatus as defined by claim 3 in which said means for supplying electric current to said header boxes comprises a fluid-tight junction box from which electric lead lines extend through conduit nipples to connectors mounted in said header boxes.

5. An electric oil heating apparatus, comprising a tubular chamber of greater length than width, having a bank of relatively long narrow electric heating units mounted in and substantially filling said chamber, each of said units being provided with a metal shell having a thick tubular wall containing a large number of closely spaced deep channels which extend at substantially right angles to the longitudinal axis of the shell, means for supplying and discharging oil from said chamber arranged to cause the oil to flow transversely through said bank of heating units and thereby flow through and be heated in said channels.

6. An electric heating apparatus, comprising a tubular chamber of greater length than width, having a bank of cylinder-shaped electric heating units extending into said chamber, each of said units including a metal shell having a thick cylindrical wall containing a large number of closely spaced deep annular channels separated by thick metal walls and which extend at substantially right angles to the longitudinal axis of the shell, means for supplying and discharging a fluid from said chamber arranged to cause the fluid to flow through said bank of heating units transversely to the axis of said shell and thereby flow through and be heated in said channels.

7. An electric oil heating apparatus comprising an oil heating chamber in which the oil is heated by a bank of relatively long narrow electric heating units mounted in the chamber and through which the oil to be heated is conducted, each of said units having a thick metal wall surrounding an electric resistance heating element, said wall containing externally closely spaced deep annular channels along substantially its entire external surface, said channels running substantially transversely to the length of the heating unit, an oil inlet for the chamber, and a plurality of said electric heating units mounted over said inlet in closely spaced arrangement in such a manner that the oil entering the chamber is forced through the channels of said plurality of heating units.

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