May 24, 1932. M. E. STALEY 1,859,939

ELECTRIC FLUID HEATER

Filed Dec. 3, 1928 2 Sheets-Sheet 1

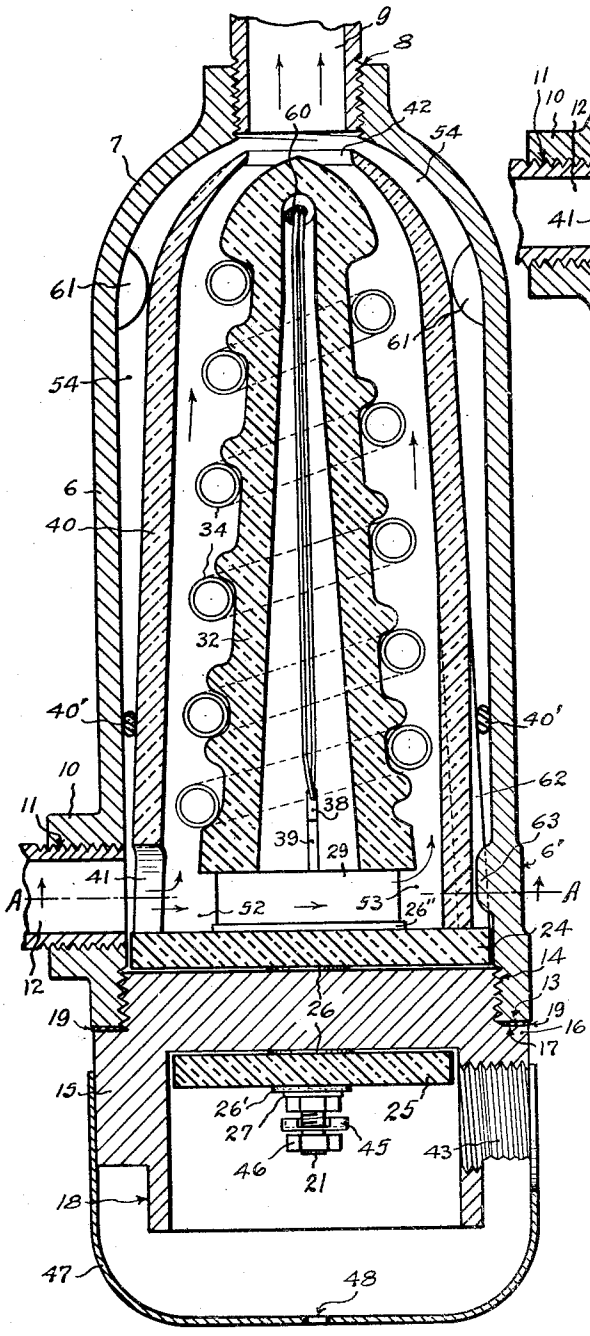

Fig. 1

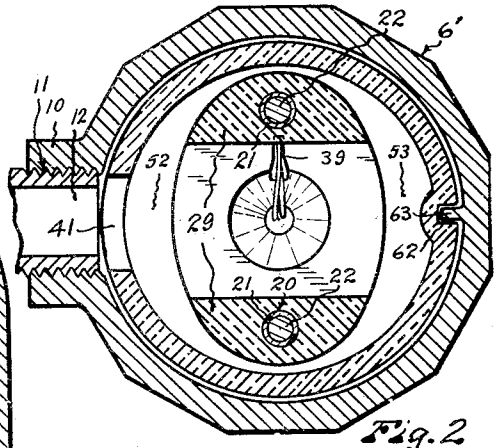

Fig. 2

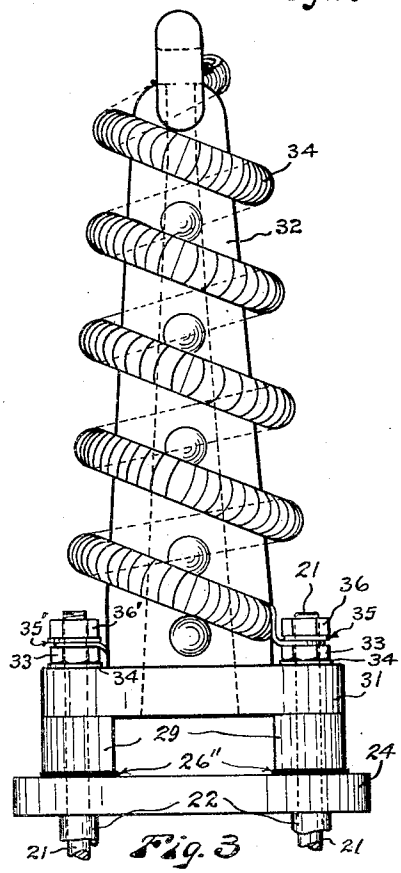

Fig. 3

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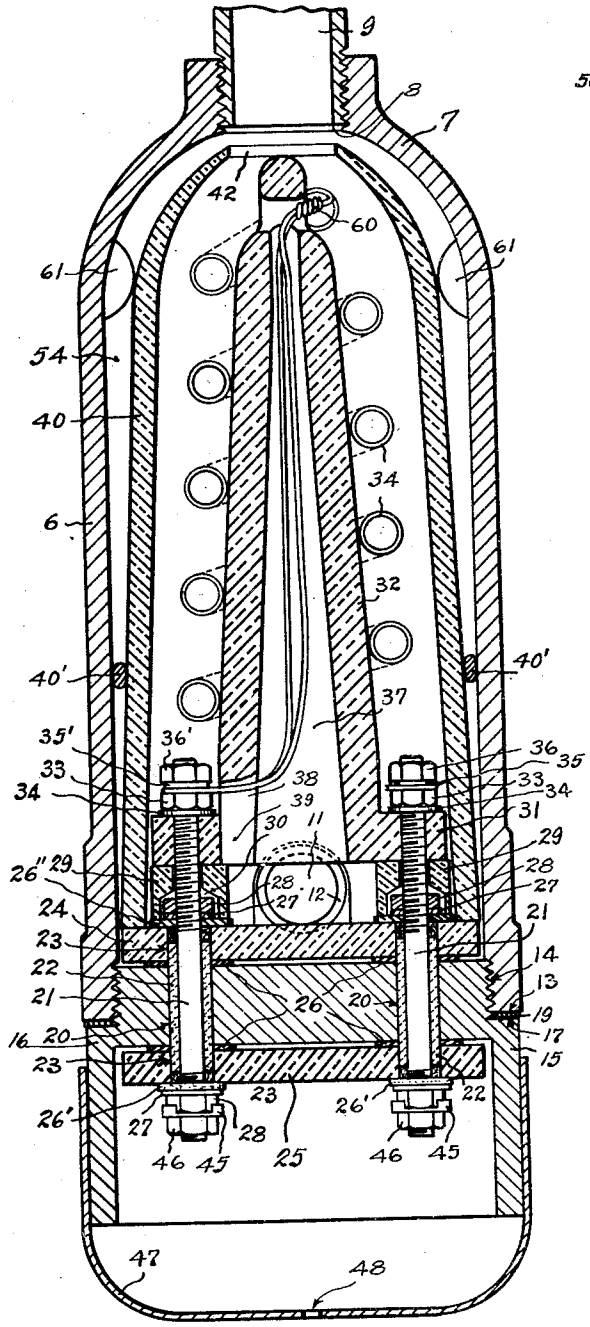
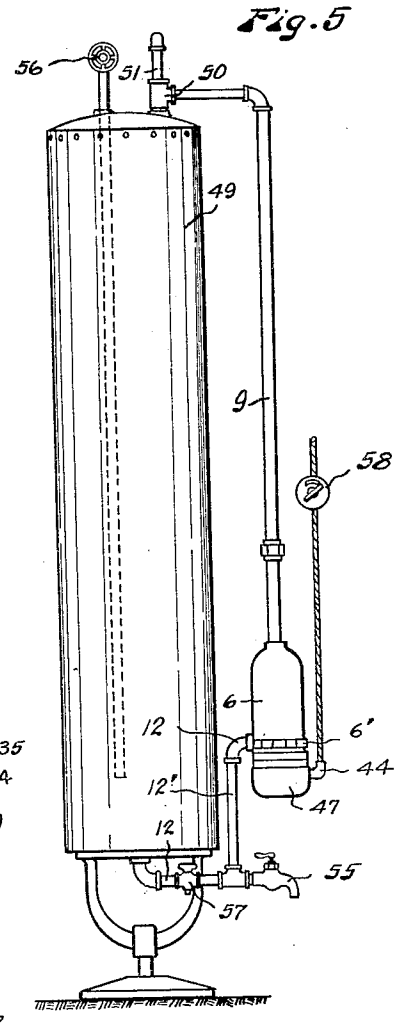


Fig. 4

Fig. 5



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UNITED STATES PATENT OFFICE

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ELECTRIC FLUID HEATER

Application filed December 3, 1928. Serial No. 323,271.

My invention relates to improvements in electric fluid heaters of the outside circulation type wherein the heat from the electrical element is imparted directly to the fluid; and to the method of installing and operating the same with particular reference to the use of the invention for heating water.

Electric water heaters of various kinds have been devised in repeated attempts to profit by the faster and more efficient operation resulting from the heating of water by direct contact with the electrical element, but heretofore these attempts have met with meager success in practice because of various inherent electrical and hydraulic defects which are eliminated in my invention, as hereinafter explained.

The chief object of my invention is to provide a simple, compact reliable device of the kind described that is cheap to manufacture, easy to install and economical to operate.

Another object is to provide a water heater that may be used readily in combination with a storage tank, faucet or the like to provide a good supply of hot water quickly after current thereto is turned on.

A further object is to provide a fluid heater adapted to be supported by the connecting piping, wherein the heating element of the same may be easily removed for cleaning or renewal without disturbing said piping.

A still further and important object is to provide means in such heaters whereby the flow of liquid through the same, together with the method of installation and operation are effective in preventing the deposit of sediment which may render the heater inoperative, and to provide means for completely enclosing and insulating the terminal posts near the bottom of the housing to safeguard them against being shortcircuited by deposits of sediment.

An additional object is to provide substantial and adequate electrical insulation for the terminals of the heater, with particular reference to the means of insulating said terminals against the short circuiting tendency of sedimentary deposits.

A final object is to provide means for reducing the electrolytic action in a heater of the kind described, by employing an insulating lining for the heater housing and by constructing the housing of a material that electrolytically is relatively inactive.

Other objects and advantages will be apparent from the following detailed description of a preferred form of the invention clearly illustrated in the accompanying drawings, in which:

Figure 1 is a vertical mid-section of a water heater embodying the invention.

Fig. 2 is a sectional view of the same taken at A—A of Fig. 1.

Fig. 3 is an elevation of the removable heating element and certain insulating parts used to mount and support the same.

Fig. 4 is a view in vertical mid-section, taken through the vertical axes of the terminals.

Fig. 5 is an elevation of a typical installation showing the preferred method of installing the heater in combination with a hot water storage tank.

Like reference numerals are used to indicate like parts throughout the drawings, in which a tubular housing member 6, preferably made of commercially pure die cast aluminum, is closed at one end with a spherically shaped head 7 in which a threaded opening 8 is provided for the reception of the threaded end of discharge pipe 9, which also serves as one of the supports for the heater. A boss 10 extending radially from the housing adjacent the lower end thereof has a threaded opening 11 for the reception of threaded inlet piping 12 which also serves as a support for the heater.

The open end of housing 6, may be provided with a true surface 13 and interior threads 14 which are adapted to receive a threaded base member 15, also preferably a commercially pure aluminum die casting. The base has a shoulder 16 with a true surface 17 so that a water tight joint may be made by using two ordinary wrenches, not shown, one of which would engage the flats of the raised twelve sided portion 6′ of housing 6, and the other would be used on the flat parallel side 18 at the lower extremity of the base, the two wrenches being so operated as

to co-act in screwing said base into said housing thereby tightening surfaces 13 and 17 against a suitable annular gasket 19.

Spaced openings 20 are provided through base 15 to receive terminal screws 21 which are insulated from the base preferably by means of mica sleeves 22, the ends of which project either side of the metal base into corresponding openings 23 in a base liner 24 and terminal block 25, both preferably of porcelain.

Water is prevented from seeping through openings 20 preferably by applying liberal quantities of suitable heat and moisture resisting gasket cement to the ends of insulating sleeves 22. Gasket washers 26, 26′ and 26″, coated liberally with the aforesaid cement, are next placed in position over terminals 21, and then washers 27 of the same metal as the terminals are placed over gasket washers 26′ and 26″ and the whole terminal assembly fixedly secured in position by tightening nuts 28 on the threaded ends of terminal screws 21. This construction provides a double seal at each terminal, one of which is within the heater chamber in combination with base liner 24, and the other is outside this chamber in combination with terminal block 25. It is evident that the seals at both these points must be broken before water can seep through.

Spacer blocks 29, preferably of porcelain, recessed at 30 to receive nuts 28, are placed over terminals 21 which project sufficiently to pass through lugs 31 of a refractory core 32, also preferably of porcelain, which is thus fixedly attached in spaced relation to base liner 24 by tightening nuts 33, washers 34 being used to prevent abrasion of the porcelain. It will be noted that gasket washers 26″ are so shaped and sized as to extend beyond the edges of spacer blocks 29, thus providing a cushion seat that compensates for the small irregularities of the porcelain members thus separated, and also assist in forming a water tight joint at these points when nuts 33 are tightened.

The heating element 34 consists of a coiled resistance wire of suitable material which is wrapped spirally about core 32 as illustrated clearly in Fig. 3, of the drawings. The lower end of the spiral is both mechanically secured and electrically connected to one of the terminals 21 by means of washer 35 and nut 36, while the upper end of the coil is connected near the top of the core by a twisted and brazed joint 60, with a suitable auxiliary or reinforcing wire and this reinforcing wire together with an uncoiled length of the resistance wire extend downward through an axial cavity 37 in the core 32 and outwardly through an opening 38 and make contact with the other terminal by means of washer 35′ and nut 36′. A narrow radial slot 39 is provided in combination with opening 38 to facilitate the assembling operation. The additional wire from the joint 60 to the terminal post 21 constitutes means for increasing the conductivity of the conductor section within the core so that if water circulation through this portion of the core is stopped this section of the wire will not be burned out.

An insulating lining 40 preferably of porcelain, is positioned within housing 6 by means of a rubber band 40′, with openings in the side at 41 and in the top at 42 for the entrance and egress respectively of the water. The band 40′ also serves as a seal to prevent water circulation between the exterior of liner 40 and the housing. Housing liner 40 in combination with base liner 24 serve to electrically insulate the heating element from the metal housing and base, and also serve to conserve the heat generated within the heater by virtue of the low heat conductivity of the insulating material. By means of these liners any tendency for current to leak from the heating element to the metal container is greatly reduced, and in case the heater wire should break, the free ends are effectively prevented from coming into contact with said container thus reducing the possibility of excessive and dangerous currents. Lugs 61 near the top of the housing further assist in holding the lining 40 straight and a slot 62 in the bottom of the lining which fits over a key lug 63 in the housing compels the correct positioning of the lining rotatively.

Any tendency for electrolytic action between heating element 34 and housing 6 or base 15 is practically eliminated by using alternating current derived preferably from the secondary coil of a transformer, not shown, the mid point of said coil being grounded on the piping supplying water to the heater; and by making the housing and base of commercially pure aluminum.

A threaded opening 43 provided in the skirt of base member 15 is adapted to receive the threaded end of a conduit 44 through which the electrical conductors are drawn. After said conductors are connected to terminal screws 21 by means of cupped washers 45 and nuts 46, the installation is completed by pressing into place a thin metal terminal space cover 47 which fits snugly over base member 15. A hole 48 is provided in the bottom of cover 47 for drainage purposes and to facilitate its removal from base 15.

The installation is preferably made in combination with a storage tank 49, inlet pipe 12, and discharge piping 9, which may connect with the tank by means of a T 50, which, in turn, connects with the hot water draw off pipe 51, Fig. 5. Discharge piping 9 is preferably of larger diameter than inlet piping 12 to allow for the expansion of the water as its temperature is raised in passing through the heater. This method of instal-

lation facilitates the circulation of the water through the heater and at the same time minimizes the deposit of sediment therein, which sediment if allowed to collect may render the heater inoperative due to incrustation of heating element 34 and subsequent burn out of the same due to the abnormal rise in temperature when not in contact with the water.

Referring particularly to Fig. 1 of the drawings, it is apparent that the water entering through inlet pipe 12 has two crescent shaped openings 52 and 53 through which to pass as it flows upward through the heater. That portion which flows through opening 53 sweeps across the top of base liner 24 between spacer blocks 29, thus reducing the tendency for the accumulation of sediment in the bottom of the heater. By mounting heater core 32 in spaced relation to base liner 24 it is obvious that a large amount of sediment must collect in the bottom of the heater before it can interfere with its proper operation, and this is retarded by the above mentioned sweeping action of the water.

Another important hydraulic feature of the invention resides in the rotary motion imparted to the water by the spirally disposed heating elements within the relatively small space between heater core 32 and housing liner 40 as it flows upward through the heater after passing through openings 52 and 53 previously mentioned thus providing ample opportunity for the absorption of heat before leaving the heater.

In addition to this it will be noted that the tapered construction of the above mentioned core and liner provides means whereby the velocity of flow is gradually increased as the water expands and ascends upward past heating element 34. This feature has been found to be effective in reducing the amount of sediment deposited by preventing the formation of eddies within the heater and by increasing the velocity of flow whereby a large part of the sediment is carried by the water into tank 49 where it may settle to the bottom.

A space 54 is provided between liner 40 and housing 6 wherein the particles in suspension that are too heavy to be carried by the movement of the water into the storage tank may find lodgement, instead of collecting in the flow space of the heater.

The collection of sediment in the heater is further prevented by so installing it that inlet 11 is well above the bottom of tank 49 thus reducing the tendency of the inflowing water to carry the sediment from the bottom of the tank into the heater because of the vertical run 12′ of piping 12. Much of the sediment collected in the bottom of the tank may be washed therefrom by opening drain faucet 55 with cold water inlet valve 56 either open or closed. With valve 56 open and cock 57 closed the heater may be washed out conveniently by simply opening faucet 55 thus making the full pressure effective in forcing the water downward through outlet piping 9 heater housing 6 and inlet piping 12 and 12′, thus removing a large part of an accumulated sediment.

It is apparent that after closing cock 57 and draining the heater of water it may be readily opened for inspection, cleaning or repairs by removing cover 47, disconnecting the electrical conductors and conduit 44, and unscrewing base member 15 and appended heating element items, which may then be withdrawn as a unit from housing 6 without disturbing the supporting piping. The tapered shape of housing liner 40 facilitates its removal so any sediment that may have collected in space 54 may be cleaned out before reassembling the heater.

With the base element removed heating element 34 may be replaced by simply loosening nuts 36 and 36′ without disturbing any other portion of the heating element assembly.

Experience with a great variety of water heaters has conclusively demonstrated the fact that my invention herein described provides a more effective and economical means of heating liquids by the use of alternating electric current; that it is inexpensive to manufacture; and that it is easy to install, maintain and repair. When installed as herein illustrated and described, a 3500 watt heater will produce sufficient hot water for household purposes within one minute after current is turned on by closing control switch 58.

The terminal posts 21 are completely enclosed and insulated within the lower portion of the housing by the plate 24, spacer blocks 29 and core base 31 together with the several gasket washers used in connection with these parts, so that there is no danger of the terminal posts being short circuited by sediment deposits which may form in the bottom of the heater, in spite of the precautions taken to prevent such sediment deposits.

The core 32 is tapered convergently from bottom to top and has knobs 65 thereon, which cooperate with the taper in assuring the proper positioning of the coil 34 and preventing parts of said coil from creeping up or sagging down, thus reducing the danger of short circuiting between different parts of the coil.

My invention is not necessarily limited to the details of construction as herein illustrated and described, for it is obvious to one skilled in the art that many changes in the design, construction and use of materials may be made to adapt the invention to the various requirements of practice.

Having thus described my invention, what I claim as new and desire to have protected by Letters Patent is:

1. An electric fluid heater of the class described, embodying a conical core of insulating material convergent from bot-

tom to top and free from grooves and indentations, diametrically opposite rows of spaced projections on said core, leaving the remainder of the body of said core smooth and unobstructed, and a heating coil wound spirally on said core and in direct contact with the fluid, said projections and the taper of said core preventing sagging of the coil on the core.

2. An electric fluid heater, embodying a housing having a water inlet and a water outlet, a tapered core disposed axially within said housing, a heating element carried by said core in direct contact with the water to be heated, a lining of solid insulating material within the housing surrounding said element, and a plate of insulating material within the bottom of said housing, said insulating lining and plate serving to reduce electrolytic action in the heater.

3. An electric fluid heater, embodying a housing having bottom water inlet and top outlet openings, an electric heating element disposed vertically within said housing, and a lining of solid insulating material surrounding the heating element for reducing electrolytic action in said heater, said lining being larger at the lower end and converging toward the upper end to gradually increase the velocity of flow as the water expands and ascends past the heating element.

4. An electric fluid heater embodying an upright cylindrical housing, having a water outlet at its top end and a water inlet near its bottom end, a core converging from the bottom upward disposed axially within said housing, an electric heating coil wound spirally on said core in direct contact with the water to be heated, and a lining of solid insulating material disposed within the housing and surrounding said core for reducing electrolytic action in said heater, said lining converging from the bottom upwardly to afford a passageway of decreasing area around said core from the bottom to the top of the same.

5. An electric fluid heater embodying an upright cylindrical housing of electrolytically inactive material having a water outlet at its top end and a water inlet near its bottom end, a core disposed axially within said housing, an electric heating coil wound spirally on said core, a plate of insulating material in the bottom of the housing below said core, and a lining of insulating material disposed within the housing with its bottom end in close relation to said insulating plate and surrounding the core, the diameter of the bottom end of said lining being substantially equal to the inside diameter of the housing and the interior walls of said lining converging from the bottom upwardly and said lining having a centrally arranged opening formed at the top end thereof.

6. An electric fluid heater embodying an upright cylindrical housing, having a water outlet at its top end and a water inlet near its bottom end, a core disposed axially within said housing, an electric heating coil wound spirally on said core, and a conical lining of insulating material disposed within said housing and surrounding said core, the bottom of said lining substantially filling said housing and said lining converging toward its upper end forming a sediment space between the walls of the housing and the lining and forming a fluid passageway of decreasing area from bottom to top around said core, said lining terminating at its upper end in a spherical section having a centrally arranged opening.

7. The apparatus as claimed in claim 6 in which said housing is provided with a removable bottom supporting said core and permitting said conical lining to be readily removed regardless of the presence of solid matter between said lining and the housing wall.

8. An electric fluid heater embodying an upright housing, having fluid inlet and outlet means, a tubular core of insulating material mounted axially within said housing, two terminal posts at the base of said core, and an electric heating coil wound spirally on said core, the lower end of said coil being connected with one of said terminal posts and the upper end of said coil extending downwardly inside of said tubular core and being connected with the other terminal post.

9. An electric fluid heater, embodying a housing having fluid inlet and fluid outlet means, a core of insulating material mounted vertically within said housing and having a longitudinal passageway provided therein, an electric heating coil carried on the exterior of said core, two terminal posts at the bottom of said core, the lower end of said coil being connected with one of said terminal posts, and conductor means of greater electrical conductivity than the wire which forms said coil connected with the upper end of said coil and with the other terminal post and extending through said passageway in said core.

10. In an electric fluid heater, a core, an electric heating element wound spirally on said core, a housing enclosing said core, fluid circulation means connected with said housing and means within the housing forming a passageway of restricted area around the core whereby the fluid is brought into direct contact with the heating element and said heating element tends to impart a spiral movement to the water.

11. An electric fluid heater, embodying a cylindrical housing, a core of insulating material mounted axially within said housing, said core having an oval base, spacer means positioned near the ends of said oval base and supporting the core in spaced relation above the bottom of the housing, fluid outlet

means at the top of said housing and means for directing fluid into the side of said housing between said spacer means and between said oval base and the bottom of said housing.

12. An electric fluid heater, embodying a housing, an insulating lining within said housing, a plate of insulating material within the bottom of said housing, a fluid inlet pipe connected with the side of said housing for delivering liquid therein just above said insulating plate, a core of insulating material disposed axially within said housing and surrounded by said lining, means supporting said core in spaced relation above said insulating plate and leaving an unobstructed fluid passageway under the central portion of the core, a heating coil carried by said core and fluid outlet means connected with the top of said housing.

13. An electric fluid heater, embodying a cylindrical housing having a bottom, a fluid inlet pipe connected with the side of said housing substantially tangent to the plane of said bottom, a core of insulating material disposed axially within said housing having a longitudinal passageway provided therein, an oval shaped base formed on said core, means interposed between the ends of said base and the bottom of said housing for supporting said base in spaced relation above said housing bottom and leaving an unobstructed passageway underneath the central portion of said base, the major axis of said base being arranged at right angles to the axis of the inlet pipe, said oval shaped base leaving crescent shaped fluid passageways on opposite sides between the edges of the base and the sides of the housing, a heating coil on said core, and fluid outlet means at the top of said housing.

14. An electric fluid heater, embodying a cylindrical housing having a spherical upper end provided with a fluid outlet, a removable base arranged to be screwed into the bottom of said housing, spaced apart terminal posts extending upwardly through said base, an insulating plate resting on the top of said base, nuts on the bottom ends of said terminal posts, insulating blocks resting on said insulating plate, an upright hollow core having a base supported on said blocks, whereby an open space is left under said coil base between said blocks, said terminal posts extending up through said core base, all parts of said terminals between the bottom of said housing and the top of said core base being completely enclosed and insulated, nuts on the top ends of said posts, a horizontal fluid inlet pipe connected with the side of said housing in alignment with said open space, a heating coil wound spirally on said core, the lower end of said coil being connected with one of said terminal posts, conductor means extending lengthwise within said core and connecting the upper end of said coil with the other terminal post and a lining disposed within said housing and surrounding said core, and convergent from the bottom end upwardly.

15. An electric fluid heater, embodying a cylindrical housing having a spherical upper end provided with a fluid outlet, a removable base arranged to be screwed into the bottom of said housing, spaced apart terminal posts extending upwardly through said base, sleeves on said posts insulating the same from said base, a plate of insulating material beneath said base, another plate of insulating material on the upper side of said base, gaskets between said insulating plates and said base, means sealing the ends of said tubes within said insulating plates, nuts on the bottom ends of said terminal posts, insulating blocks resting on said upper insulating plate, an upright hollow core having a base resting on said blocks, whereby an open space is left under said core base between said blocks, said terminal posts, extending upwardly through said base, a horizontal fluid inlet pipe connected with the side of said housing in alignment with said space, a heating coil wound spirally on said core, the lower end of said coil being connected with one of said terminal posts, conductor means extending lengthwise in said core and connecting the upper end of said coil with the other terminal post, a lining disposed within said housing and surrounding said core and convergent from bottom to top, and means for preventing circulation of liquid between said lining and said housing.

16. An electric fluid heater embodying a tubular housing open at the bottom end, a removable base for closing said open bottom end, a fluid outlet conduit at the top of said housing, fluid inlet means entering the side of said housing near the bottom end, an electric heating element extending axially within said housing, a lining arranged to fit within said housing and surround said heating element and having an opening on one side near its bottom end arranged to register with said fluid inlet conduit and means for compelling the correct positioning of said lining rotatively within said housing.

17. In a direct current electric fluid heater, an upright housing provided with fluid circulation means, a heating element within said housing and disposed directly within the fluid which circulates in said housing, terminal screws extending upwardly through the bottom of said housing and connected with the heating element electrically and supporting said heating element in spaced relation above the bottom of said housing, and insulating means completely enclosing said terminal screws between the bottom of the housing and the base of the electric heater for preventing the grounding and short

circuiting of said terminal screws by sedimentary deposits.

18. The combination with a hot fluid storage tank, of a direct contact electric fluid heater having its lower extremity disposed a substantial distance above the bottom end of said storage tank, a pipe connecting the upper end of the heater with the upper end of the tank, and an ascending pipe connecting the bottom end of said tank with the lower end of said heater to permit liquid to flow from the storage tank to the heater but to retard the passage of sediment to the heater.

19. The combination of a hot fluid storage tank, a direct contact electric fluid heater having its lower extremity disposed a substantial distance above the bottom end of said storage tank, an ascending fluid inlet pipe connecting the bottom end of said tank with the lower end of said heater to retard the passage of sediment to the heater, and an ascending discharge pipe connecting the upper end of the heater with the upper end of said tank and having a larger diameter than said inlet pipe to facilitate the circulation of the heated fluid through the heater.

The foregoing specification signed at Seattle, Wash., this 24 day of Sept., 1928.

MILES E. STALEY.