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Vietz

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[54] **IMMERSION-HEATER DIP TUBE**

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Nov. 6, 1970 Germany .... P 20 54 642.3

[52] **U.S. Cl.** .... **126/360 A**, 126/350 R

[51] **Int. Cl.** **F24h 1/24**

[58] **Field of Search**.... 126/360 A, 350 R; 159/16 A

[56] **References Cited**

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FOREIGN PATENTS OR APPLICATIONS

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[57] **ABSTRACT**

A heater comprises two concentric vertical tubes having a flame projecting down in the inner tube with the lower end of at least one of the tubes immersed in a tank of liquid, as a salt solution or an acid solution to be evaporated, condensed, and recirculated in the annulus between the tubes. Helical spiral vanes are formed in the annulus for delaying and spinning a thin, consistent film of the liquid over the contiguous surfaces of the tubes for producing considerably decreased operating temperatures of the tubes resulting in greatly decreased corrosion of and deposit formation on the heater.

14 Claims, 2 Drawing Figures

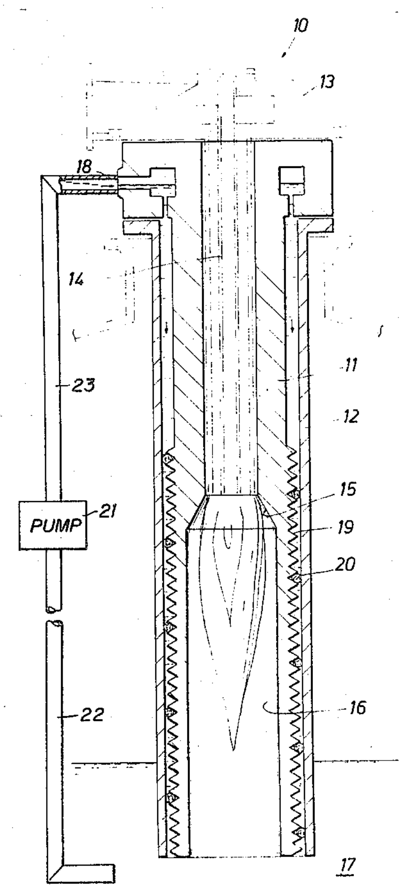

FIG. 2.

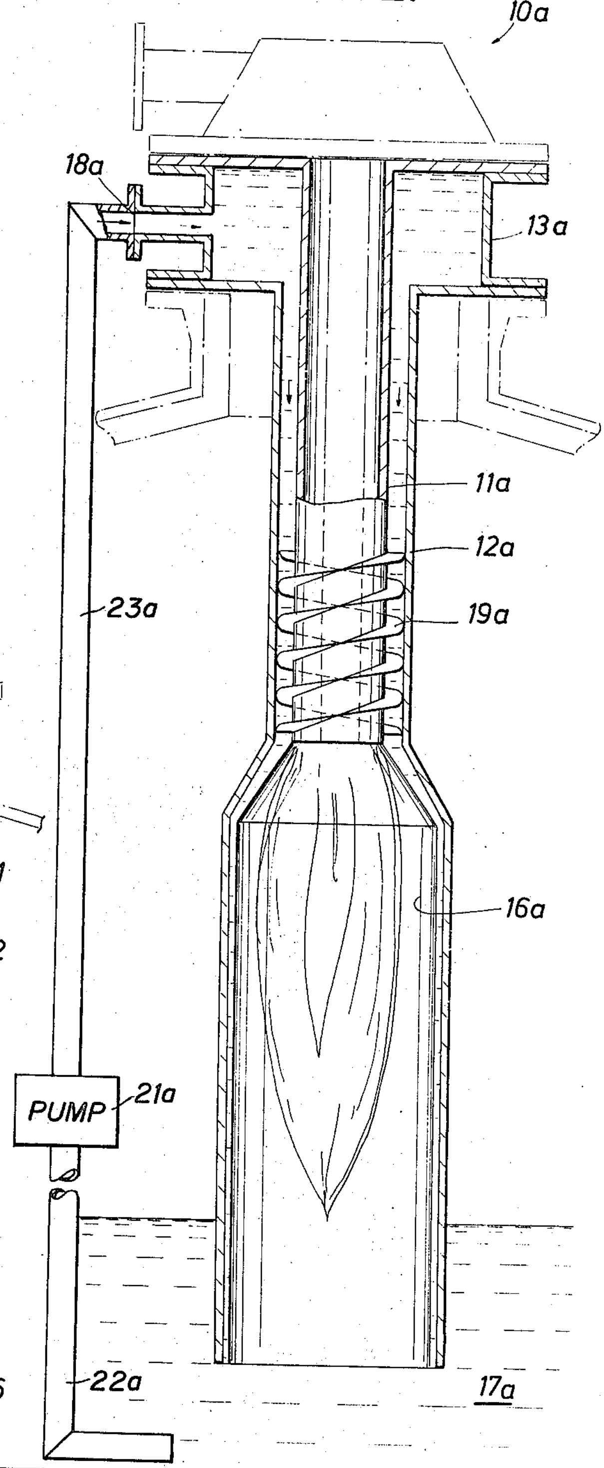
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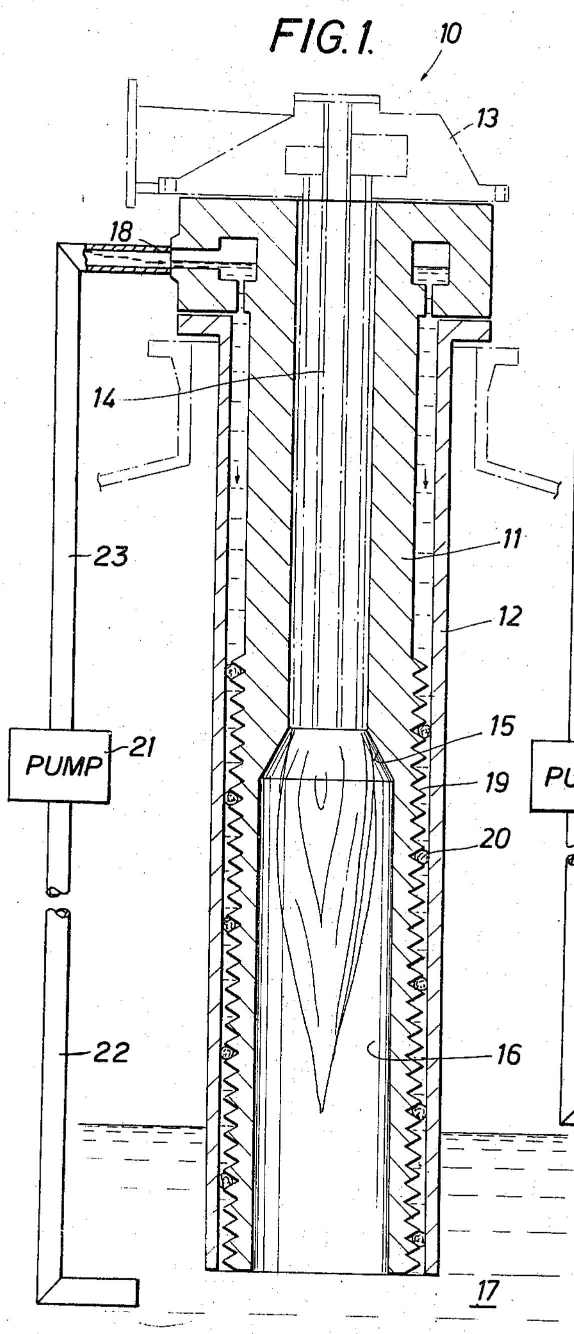
FIG. 1.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IMMERSION-HEATER DIP TUBE

DESCRIPTION OF THE PRIOR ART

The present invention relates to an immersion-heater dip tube for immersion-heater installations which burn a fuel and air mixture for evaporating salt solutions or more particularly acid solutions.

It is common to use immersion-heater installations to evaporate and concentrate dilute aqueous salt or acid solutions. Basically, such installations include a furnace chamber partly filled with the liquid to be evaporated and communicating with a flue or vapor outlet for the flue gas. At least one immersion-heater dip tube protrudes into the liquid so that the hot fuel gases are discharged into the liquid at the tube outer opening where the heat is released and finally passes up through a flue or vapor outlet.

Conventional immersion-heater dip tubes have an upper section extending at least partially beyond the furnace chamber of the immersion-heater installation and serve as an intake for the gaseous or liquid fuel, e.g., natural gas, lighting gas, coke oven gas, or fuel oil, or similar fuels, and air. In different design of the immersion-heater, fuel and air may be introduced either separately into the upper section or intake of the immersion-heater dip tube and mixed there, or they may be introduced as a combustible mixture. The immersion-heater dip tube upper section or intake communicates downwardly with a combustion unit or section, which usually has an enlarged cross-section The fuel and air mixture applied via the intake is ignited in the combustion chamber section and burns with an open flame. It is known to be useful to build the combustion chamber long enough to permit only the hot fuel gases, but not the flame itself, to touch the urface of the liquid to be evaporated. Otherwise a larger quantity of liquid droplets will be entrained by the fuel gases and pass an aerosol into the flue.

A very difficult problem encountered in immersion-heater installations of the above described design is the formation of a deposit on and corrosion of the combustion chamber section lower end extending into the liquid. Salt solutions very often leave a deposit, particularly on the hot combustion chamber walls, thus narrowing the free cross-section of the combustion chamber normally available for the flue gases and necessitating the heater to be closed down. The concentration of dilute acid solutions such as phosphoric or sulfuric acid requires additional efficient corrosion-inhibiting measures regarding the immersion-heater dip tube. It is therefore customary to manufacture all or at least the most severely stressed parts of an immersion-heater dip tube from materials that are sufficiently temperature-resistant and acid-resistant, as for example, graphite, ferro-silicon, and the like. Owing to the high cost of these materials it is also common to use a cheaper material, e.g., grey cast iron which is only temperature-resistant for the inner wall of the combustion chamber section and protect this immersion-heater dip tube inner part with a jacket tube made of, for example, ferro-silicon, which is corrosion-resistant but less resistant to thermal and mechanical stresses. It is further known to insert thermal insulating material between the two tubes.

German Offenlegungsschrift 1,519,685 discloses an immersion-heater dip tube, with the jacket tube being fitted at a radial distance from the internal combustion tube, leaving a space between the combustion tube and the jacket tube, into which inert gas is injected and maintained at a pressure suficent to prevent the acid solution from penetrating therein. In this conventional installation the jacket tube, having a higher resistance to corrosion, is thermally relieved by the annular space filled with inert gas. But even with this type of heater neither the combustion tube nor the jacket tube can be prevented from corroding after a relatively short running time, so that both have to be exchanged or at least overhauled and reconditioned.

OBJECTS OF THE INVENTION

Accordingly, a primary object of this invention is to provide a heater that is not susceptible to corrosion and thus has a longer life.

Another primary object of this invention is to form the walls of an immersion-heater dip tube of an inexpensive material as glass or a synthetic material and to maintain the walls cool by evaporation of the liquid there-between.

Yet another object of this invention is to provide an immersion-heater dip tube with concentric tubular walls with a liquid circulating around the walls for cooling thereof.

A further object of this invention is to provide an immersion-heater dip tube which spreads a thin film of liquid to be concentrated over a greater portion of the walls of the heater for achieving greater evaporation.

A still futher object of this invention is to provide an immersion-heater dip tube that is easy to operate, is of simple configuration, and is formed of economical inexpensive materials.

Other objects and various advantages of the disclosed immersion-heater dip tube will be apparent from the following detailed description, together with the accompanying drawing, submitted for purposes of illustration only, and not intended to define the scope of the invention, reference being had for that purpose to the subjoined claims.

BRIEF DESCRIPTION OF THE DRAWING

The drawing diagrammatically illustrates by way of example not by way of limitation, two forms of the invention wherein like reference numerals have been employed to indicate similar parts.

FIG. 1 is a schematic elevation of the immersion-heater dip tube with parts in section; and

FIG. 2 is a modification of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The invention disclosed herein, the scope of which being defined in the appended claims is not limited in its application to the details of construction and arrangement of parts shown and described, since the invention is capable of other embodiments and of being practiced or carried out in various other ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

The present invention achieves the above objects by providing an immersion-heater dip tube for an immersion-heater installation heated with a fuel-air mixture, for use in evaporating salt solutions or more particularly acid solutions. This heater comprises at least one intake means for the fuel and/or air mixture, an ignition device for the fuel gas, a combustion chamber having an open end protruding vertically downwardly and at least one tube extending below the level of a liquid to be evaporated by the immersion-heater, and a protecting shield or second tube which is spaced from the first tube but which is fixed relative thereto and concentric therewith. One feature of this immersion-heater dip tube is that at least one of the tubes is covered with a continuously renewed, relatively thin, consistent film of the liquid to be evaporated.

FIG. 1 illustrates schametically one embodiment of the invention, an immersion-heater dip tube **10** comprising two concentric tubes **11** and **12** having fixed at the top thereof a suitable furnace, such as but not limited to, a gas-air furnace **13** wherein a fuel and air mixture is injected at the top thereof. This fuel-air mixture is injected downwardly in the first or inner tube, the upper portion of which forms an intake conduit **14**, ignition taking place at the mid-portion **15** of the tube where the inside diameter of the tube increases to form a combustion chamber **16**. The second or outer tube **12** is concentric with the first tube **11** and extends in this modification down to the bottom of the first tube, the lower end of both tubes extending down into a container of liquid **17** such as the salt or acid solutions. This liquid to be evaporated is circulated by a suitable hydraulic pump **21** for pumping the liquid **17** from the tank at the bottom up through pipe **22**, the pump **21**, and pipe **23** into the liquid intake **18** at the top portion of the heater and down in the annular space or chamber between the two tubes **11** and **16**. Thus as it passes down the annular chamber, a film of coolant liquid is formed on the contiguous surfaces of the tubes and the liquid is evaporated as it circulated downwardly to raise the density of the remaining liquid below. Helical spiral cooling vanes **19** are formed on the external surface of the inner tube **11** for causing the liquid to spiral and circulate around the inner tube as it returns to the tank at the bottom. In addition to the helical spiral vanes is a helical spiral packing cord **20**, or the like, which is circular in cross-section and likewise encircles the inner tube in a helical spiral configuration, but with increased pitch for causing the fluid to spiral around the inner tube and between the two tubes as it flows around and downwardly. Thus, the annular space or annulus between the two tubes is formed in which the liquid to be evaporated is continuously circulated so that the inner parts of the immersion-heater dip tube or surfaces of the two tubes are continuously covered with a relatively thin film of liquid. With the annulus being open at the lower end of the tubes, the circulating liquid ultimately passes into the liquid container or furnace bottom where it combines with the liquid **17** stored there. The fins **19** and spiral cord **20** all forming a continuous spiral surface which will greatly improve the heat transfer from the walls of the tubes where combustion takes place to the thin film of liquid on the tube surfaces.

FIG. 2 illustrates a second embodiment of the immersion-heater dip tube **10***a* wherein the air-gas mixture is injected from the heater **13***a* which is connected to the tops of the two tubes **11***a* and **12***a*. and passes down internally of the inner tube **11***a*. The inner tube ends where the combustion chamber **16***a* begins. The outer tube **12***a* which is concentric with and spaced radially from the inner tube forms the outer wall of a helical conduit therein the liquid **17***a* from the tank is pumped by a suitable hydraulic pump **21***a* up through pipes **22***a* and **23***a* into the top of the tube at intake **18***a* and passes down this annular space. Helical, radial and spiral vanes, or a continuous spiral surface **19***a* is secured to the outer surface of the inner tube **11***a* in this annular space whereby as the liquid passes down through the annular space it is given a centrifugal whirl so that when the liquid passes down and out of this annular space into the combustion chamber formed by only the outer tube, centrifugal force holds the fluid pressed against the wall in a spiralling condition as it flows down the inner surface of the wall to the liquid **17***a* below. As seen in FIG. **2**, the outer tube forms the wall of the combustion chamber **16***a*. As the liquid flows down the inner surface of the outer tube **12***a* it is evaporated and results in concentration of the liquid in the tank. Thus, the annular vanes **19***a* impart a spin to the liquid as it leaves the annular space and is distributed in a thin film over the inside surface of the outer tube.

Further, as long as the liquid film contains water the temperature of the liquid film will not exceed substantially 100° C., irrespective of the temperature of the fuel gases. The walls of this area where combustion takes place are thus kept at a relatively low temperature due to liquid evaporation cooling. At this temperature, corrosion is not accelerated and the risk of deposit formation is small. With such intensive cooling of the tube where combustion takes place, there is not even need for double walls for this area of the immersion-heater dip tube. In the simplest case the hitherto necessary combustion chamber may be deleted and the outer tube act as the fuel gas conduit and combustion chamber. Another advantage offered by this embodiment of the invention is the use of inexpensive materials such as synthetics or silica glass for the manufacture of the jacket or outer tube.

In operation, the liquid is pumped up and injected into the liquid intake at the top of the heater from where it flows down the annular space between the two tubes. As the liquid is guided by the radial helical spiral vanes a whirling action is imparted to the liquid as it leaves the guiding vanes where it is whirled around an pressed by centrifugal force against the internal surface of the hot outer tube on its route to the tank of liquid below. Thus, it has been shown that the liquid can be distributed as a thin layer of film over the inner surface of the outer tube in the combustion area by using the guide vanes, the pitch of the guide vanes being formed to provide the proper flow rate of liquid through the annular space and over the cylindrical surface of the outer tube.

Thus, it will be seen that the instant immersion-heater dip tube provides an evaporating heater for condensing liquid in a manner which meets each of the objects set forth above.

While two portions of an immersion-heater dip tube have been disclosed in the accompanying specification and drawing, it will be evident that various other modifications are possible in the arrangement and construction of the disclosed immersion-heater dip tube without departing from the scope of the invention, and it is accordingly desired to comprehend within the purview of the invention such modifications as may be considered to fall within the scope of the appended claims.

I claim:

1. In an immersion-heater dip tube including two concentric, spaced apart, vertical tubes with a heater fixedly connected on the upper ends of the tubes for

projecting heat downwardly internally of the tubes towards the lower ends of the tubes, at least the end of one of said tubes being immersed in a container of liquid to be condensed, the immersion-heater dip tube further comprising,

a. evaporating means for said heater,
b. said evaporating means has means for recirculating said liquid from said container of liquid to the top of said heater and down between said concentric tubes to return to said container, and
c. said evaporating means comprises a continuous spiral surface mounted in an annular portion formed between the two concentric spaced apart vertical tubes and extending downwardly a distance greater than the diameter of said annular portion for increased evaporation of the liquid.

2. An immersion-heater dip tube as recited in claim 1 wherein,

a. said evaporating means comprises means for spreading a thin, continuous, consistent film of said liquid to be evaporated over a surface of said inner tube.

3. An immersion-heater dip tube as recited in claim 1 wherein,

a. said evaporating means comprises liquid means for cooling off both of said concentric tubes.

4. An immersion-heater dip tube as recited in claim 1 wherein,

a. said evaporating means comprises means for substantially covering an upper portion of at least one of said tubes with a liquid film and for wholly covering a lower portion of at least one of said tubes with said liquid film.

5. An immersion-heater dip tube as recited in claim 1 wherein,

a. said evaporating means comprises means for substantially covering an upper portion of the outer tube with a liquid film and for wholly covering a lower portion of the outer tube with said liquid film.

6. An immersion-heater dip tube as recited in claim 1 wherein,

a. said evaporating means has means for substantially covering both the upper external surface of the inner tube and the upper internal surface of the outer tube with liquid films.

7. In an immersion-heater dip tube including two concentric, spaced apart vertical tubes with a heater fixedly connected on the upper ends thereof for projecting a flame downwardly internally of the inner tube towards the lower ends of the tubes, at least one of said tube lower ends being immersed in a container of liquid to be condensed, the immersion-heater dip tube further comprising,

a. external means for recirculating said liquid from said container of liquid to the top of said heater and down between said concentric tubes to return to said container,
b. one of said concentric tubes has spiral means for guiding the liquid in a spiral course between the two tubes at least a portion of the downward travel from the top of the heater to the container, and
c. said spiral means comprises a continuous spiral surface mounted in an annular portion formed between the two concentric spaced apart vertical tubes and extending downwardly a distance greater than the diameter of said annular portion for increased evaporation of the liquid.

8. An immersion-heater dip tube as recited in claim 7 wherein,

a. said one tube is the inner tube.

9. An immersion-heater dip tube as recited in claim 7 wherein,

a. said spiral means comprises helical vanes on the external surface of the inner tube.

10. An immersion-heater dip tube as recited in claim 7 wherein,

a. both of said concentric tubes extend down into the container of liquid.

11. An immersion-heater dip tube as recited in claim 7 wherein,

a. said spiral means comprises helical spiral vanes on the external surface of the upper portion of the inner tube.

12. An immersion-heater dip tube as recited in claim 7 wherein,

a. said spiral liquid guiding means positioned in the upper portion of said tubes imparts a spin to the downward traveling liquid to form a thin film over the lower portion of the outer tube.

13. An immersion-heater dip tube as recited in claim 7 wherein,

a. said spiral means comprises helical spiral vanes on the external surface of the lower portion of the inner tube.

14. An immersion-heater dip tube as recited in claim 10 wherein,

a. said spiral means has a second helical spiral means overlapping said spiral vanes for increasing evaporation of said liquid as it returns to the container.

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