July 1, 1930. C. F. HAMMOND 1,769,833

APPARATUS FOR LIFTING OR CIRCULATING LIQUIDS

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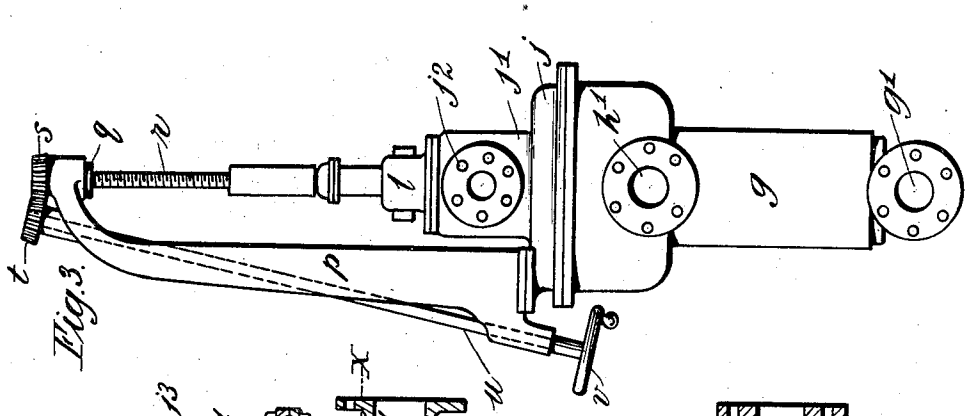


Fig. 3.

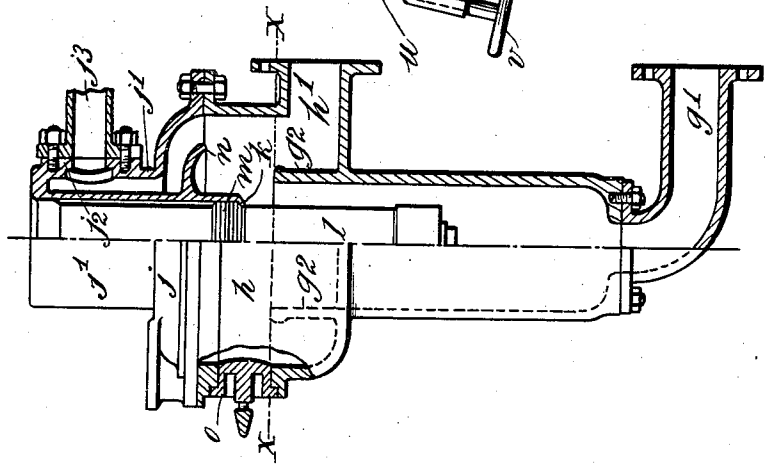


Fig. 2.

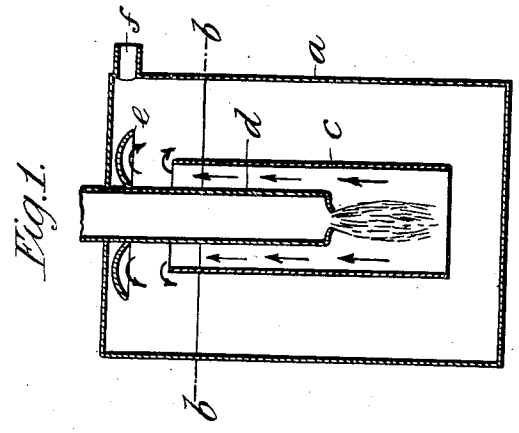


Fig. 1.

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Fig. 4.

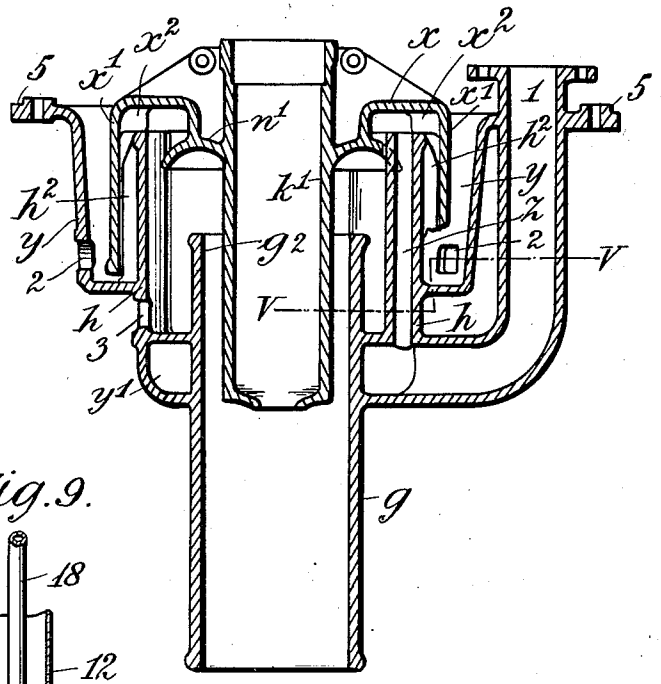


Fig. 9.

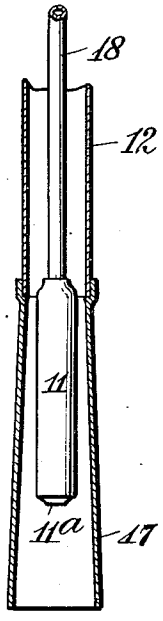
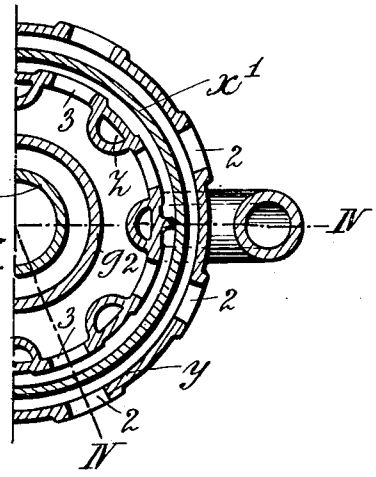


Fig. 5.



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Fig. 6.

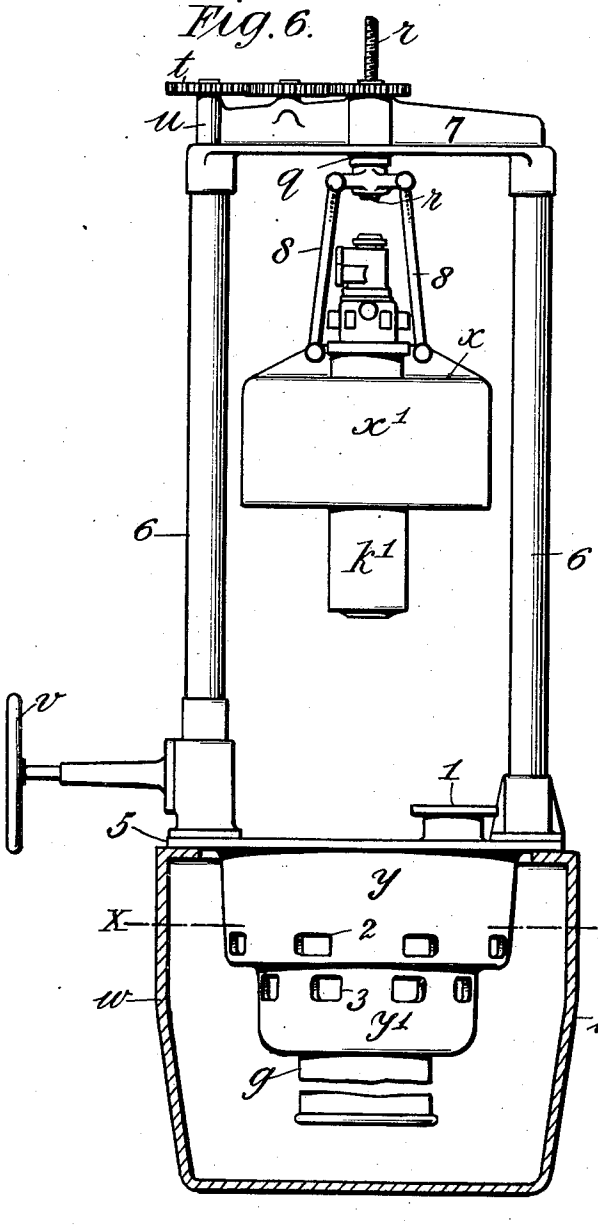


Fig. 7.

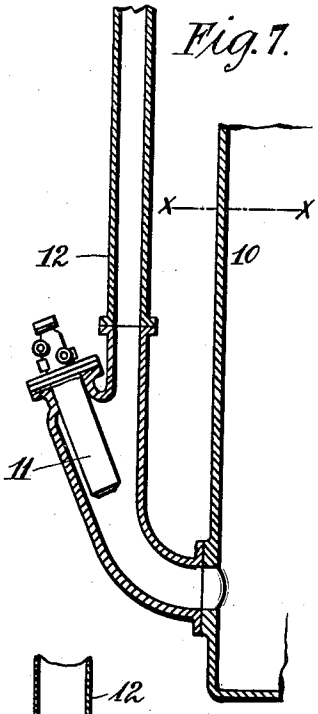
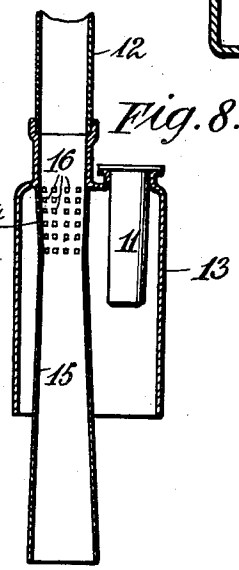


Fig. 8.



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Patented July 1, 1930

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UNITED STATES PATENT OFFICE

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APPARATUS FOR LIFTING OR CIRCULATING LIQUIDS

Application filed September 4, 1926, Serial No. 133,683, and in Great Britain September 5, 1925.

This invention relates to improvements in apparatus for lifting or circulating water or other liquid. The object of this invention is to provide simple pieces of apparatus adapted on the one hand for the direct application of flame to the liquid, in order to obtain the most efficient heating thereof, and on the other hand, for the direct application of the gases of combustion to a portion of the body of such liquid for the purposes of effecting a lift of such portion either for circulation purposes or for raising purposes.

The liquid to be lifted or circulated may be water or a material which like water, is normally liquid, or it may be a material which is normally solid and liquefies only upon the application of heat. Lead, zinc, and other metals or alloys are examples of the latter materials, and, for some purposes, a mass of molten lead kept in active circulation can be used very advantageously for carrying out treatments or operations in industrial processes. When water is circulated or lifted, the body of water lifted or in rapid circulation may be employed for the heating of rooms, buildings and so on, or the circulation may be promoted within a boiler and constitute part of a system of steam generation, as will be readily understood.

According to this invention a portion of a body of liquid is suitably enclosed by an enclosure having an inlet and outlet and a submerged burner extends into the enclosure, whereby the flame from the burner directly heats the enclosed portion of liquid, and the products of combustion escaping into such portion, lighten it, so that it is lifted in accordance with the principle of an air lift pump. When the gases of combustion are employed for raising liquids to a height, they ascend a rising pipe and escape with the liquid. When such gases, however, are employed for circulation purposes, they are separated and drawn off from the circulatory system within the apparatus.

In order to enable the invention to be readily understood, reference is made to the accompanying drawings illustrating several different constructions and arrangements by way of example, in which drawings:—

Figure 1 is a more or less diagrammatic representation of a very simple application of a submerged burner for effecting heating and circulation of a body of liquid.

Figure 2 is a sectional elevation of a more elaborate piece of apparatus adapted for heating and circulating a liquid, more particularly a heavy liquid such as molten lead.

Figure 3 is an elevation, to a smaller scale, of the apparatus, illustrated in Figure 2 as seen when fitted with mechanical means for raising and lowering the burner.

Figure 4 is an irregular vertical section on the line IV—IV of Figure 5, of a modified construction adapted for being lowered into a bath, pot or crucible for heating and circulating the liquid mass therein.

Figure 5 is a horizontal section on the line V—V of Figure 4.

Figure 6 is an elevation, to a smaller scale of the apparatus illustrated in Figures 4 and 5 as seen when applied to a pot or crucible and fitted with mechanical means for raising and lowering the burner and top or cover part of the apparatus.

Figures 7, 8 and 9 are diagrammatic sectional views showing three different applications of the invention to water-raising means.

Referring to Figure 1, *a* is a container in which the liquid level stands at the line *b*—*b* and *c* is an open ended cylinder suitably supported within the container and enclosing a portion of the body of liquid. Within the container there is suspended a burner tube *d*, which extends downwards into the cylinder *c* so that its nozzle is submerged at a suitable depth below the level *b*—*b*. Around the burner tube *d* there may be provided an annular cowl or deflector *e* situated above the upper end of the cylinder *c* when the burner is in working position. A flue pipe connection *f* is provided at or near the top of the container *a*.

The operation is as follows:—The burner *d*, which is supplied with any suitable fuel, and with air under pressure, is ignited and lowered into the position shown in Figure 1. The pressure of the air supply, and possibly also the fuel supply, must be sufficient for maintaining combustion when submergence of the burner nozzle is effected to the desired

depth. The flame of the burner heats by direct contact the liquid enclosed in the cylinder and the products of combustion escape upwardly within the said cylinder. Circulation is then promoted in accordance with the air lift principle, for the gases within the column of liquid lighten the latter so that it is caused to rise within the cylinder *c* in accordance with the weight of this column as compared with the weight of the column outside the cylinder *c*. This rising of the column is also assisted by the heat concentrated within the cylinder *c*. Consequently, the column rising within the cylinder *c* overflows the upper edge thereof, the overflow joining the remainder of the mass in the container and there being a free and constant influx at the lower end of the cylinder *c* to take the place of the liquid displaced and delivered at the top thereof. Any liquid carried up to the deflector *e* is cast down by the latter on to the mass beneath.

If the liquid in the container *a* is water and steam is generated, such steam may be drawn off at *f* with the products of combustion, and be made use of, as for heating purposes. Or the body of liquid itself may be drawn off and passed through heaters and returned to the container. Finally, if the liquid is a molten metal or alloy, suitable use may be made of it for the purpose of directly or indirectly heating some other body or medium.

The apparatus seen in Figure 2 is a circulator which is adapted to be connected to a container, such as tank or pot, for heating and circulating a liquid body contained therein. This circulator comprises a cylindrical body *g* having an enlarged upper portion *h*, the bottom of the cylindrical body being fitted with an elbow *g'* for connection with the lower part of the tank or pot. The enlarged upper portion *h* is formed with a radial connection *h'* adapted for connection with a duct leading from an upper part of the tank or pot. The cylindrical wall of the part *g* is continued upwards into the enlarged upper part *h* so as to provide an upstanding wall g^2 and the connection *h'* communicates with the annular space surrounding such wall g^2. The cover *j* of this apparatus is formed with a dome part *j'* within which depends a central tubular part *k* forming a guide and holder for a burner *l* inserted through the part *k* so as to depend well within the cylindrical body part *g*. The body of the burner may be formed with grooves to receive packing rings *m* for making a tight joint between the burner and tubular part *k*. A flat seating j^2 for the bolting on of a flue pipe j^3 is provided at one side of the dome *j'* so that gases of combustion collecting in the dome may be carried off. To prevent splashes or particles of liquid from being carried by the gases into the flue, a deflector *n* is fitted or formed around the tubular part *k*.

The circulator is very advantageous when employed for heating and circulating a body of molten lead. In this case, the normal level of the molten lead may be at the line X—X. For enabling the dross and impurities to be removed from the lead from time to time, the wall of the enlarged part *h* is formed with a hand hole which is closed tightly by a plug *o* or hand-hole cover. This hand-hole being situated at the level X—X, the raking of the surface of the lead, after removal of the plug *o*, can be carried out in an expeditious manner.

Assuming that the circulator is employed for heating and circulating molten metal such as lead or zinc, the elbow *g'* communicates with the bottom or lower part of the bath and the connection *h'* communicates with the upper part of such bath, the normal level of the molten metal being at X—X as aforesaid. The burner *l*, after being ignited is lowered, and submerged beneath the surface of the lead which is heated by direct flame contact. Due to the central heating and to the gases of combustion lightening the column within the cylindrical body *g* and wall g^2, the liquid rises and overflows the rim of the wall g^2 and enters the annular space surrounding such wall, being carried away to the upper part of the bath through the connection *h'*. Liquid at a lower temperature is supplied continuously through the elbow *g'* from the lower part of the bath. The gases of combustion separate from the liquid above the level X—X and pass around the deflector *n* up into the dome *j'*. They may be conducted into any suitable economizer or pre-heater by the flue pipe j^3 which is bolted on at j^2 as above described.

For vertically adjusting and completely lifting or lowering the burner *l*, mechanism such as that illustrated in Figure 3 may be employed. In this example, there is erected on the cover *j* a standard *p* having a bearing at the top for a nut *q* which is permitted to revolve but not to move endwise. A screw *r* works in the nut and serves for the suspension of the burner *l*. Any suitable means may be adopted to prevent revolution of the screw. A bevel wheel *s* connected with the nut *q* meshes with a bevel wheel *t* on a shaft *u* housed within the standard *p*. A handwheel *v* at the lower end of the shaft *u* serves for adjusting the burner *l* through the toothed gear and screw mechanism above described.

Figures 4 to 6 illustrate a modified construction of circulator which is adapted for being lowered into a pot, bath, or other container *w*, Figure 6. As in the preceding construction, this circulator comprises a cylindrical part *g* connected with an upper enlarged part *h*, the cylindrical part being extended upwardly to provide an upstanding wall g^2 within the part *h*. Instead of a cover bolted down on to the part *h*, as in Figures

2 and 3, the cover x in this modification is formed with a skirt x' so that it is of bell-like formation. Around the wall of the upper part h there is formed an annular well y into which the skirt x' depends when the cover x is lowered until webs or projection x^2 on its inner surface rest upon the top of the cylindrical wall of the part h, as seen in Figure 4. The top portion of the part h, may be provided on the outside with webs or ribs h^2 for centering and guiding the skirt x'. The cover x is formed centrally with a depending tubular burner holder or casing k', and around the latter a cowl or deflector n' is provided for the same purpose as the deflector n in Figure 2. The top portion of the cover x provides a dome-like space for the collection of the gases of combustion, but instead of these being carried away by a flue connected to the cover as described with reference to Figures 2 and 3, an annular flue space y' is formed around the cylindrical part g and just beneath the enlarged upper part h, and vertical flues or ducts z communicate between the dome space of the cover and the annular flue space y'. The flues or ducts z may be formed integrally on the inner side of the upper portion of the wall h, as illustrated. The gases of combustion are carried away from the annular flue y' by means of the uptake 1 which can be connected to any suitable flue pipe. Upper ports 2 are formed in the wall of the well y and lower ports 3 are formed in the lower part of the wall h.

Figure 6 illustrates the application of this circulator to a pot w, the body part being suspended within the pot by lowering it until the flange 5 thereon comes to rest upon the rim of the pot. Columns 6 support a cross beam 7 provided at mid-length with a bearing for a nut q which is revoluble but prevented from moving endwise. A screw r working in the nut q is connected with a bridle 8, and the cover x is suitably suspended from the bridle. A vertical shaft u in one of the columns 6 is suitably geared with the spindle of a hand wheel v at the lower end, and carries a toothed wheel t at its upper end meshing with toothed gearing for revolving the nut q.

The operation is as follows: Let it be assumed that the pot w contains molten lead, the level of which is about at the line X—X, and that the cover x is in the elevated position shown in Figure 6. The burner inserted in the tubular holder k' is ignited and the hand wheel v is operated to lower the cover x to the position seen in Figure 4. The heat of the burner flame applied directly to the molten mass within the cylindrical part g, and the gasification of the column by the products of combustion entering the same, produces, or brings about a rising of the column as already explained so that the molten lead overflows the rim of the wall g^2 and enters the annular space surrounding that wall, the cooler metal from the pot having free entrance at the lower open end of the cylindrical part g. The lead which has overflowed from the column passes from the annular space back into the pot through the lower ports 3. The upper ports 2, being submerged, admit molten lead to the annular well y so that a liquid seal is formed at the lower edge of the skirt x' of the bell-like cover x. This construction affords immediate access to the parts, as the effective seal produced by the lead enables bolts and fastening means to be dispensed with.

In any one of the foregoing constructions, the mixture supplied to the burner can be adjusted so that there is no excess of oxygen and consequently none to spare for combination with the material being treated. Thus, when molten lead or even molten zinc, is employed, no oxides need be produced by the flame and products from the submerged burner. If desired, a thermostatic or pyrometric control of the burner may be provided to prevent excessive heating of the liquid mass.

Figure 7 illustrates one application of the invention to an air-lift pump device. According to this arrangement, 10 is a tank or closed container to which water is suitably admitted and 11 is a burner inserted through a branch of the rising pipe 12 so as to be submerged in the water beneath the level X—X. The burner 11 is supplied from above through a suitable pipe or pipes, not shown, under a suitable pressure. It will be seen, therefore, that the products of combustion aerate or gasify the column in the lower part of the rising pipe 12. The column consequently ascends in the pipe 12 and is discharged at the top.

The modification in Figure 8 is suitable for being lowered beneath the surface of water in an open well, and in this case the burner 11 is enclosed in a hood or bell 13. The burner is suitably supplied with combustible mixture, or with fuel and air, under a suitable pressure. The lower end of the pipe 12 is connected with a tubular fitting which passes through the hood 13 and is of vena contracta form, the upper portion 14 contracting downwardly within the hood and the lower portion 15 expanding or flaring downwardly and extending down beyond the bottom edge of the hood 13. The portion 14 is formed just beneath the top of the hood with openings or perforations 16. When the burner 11 is ignited, the products of combustion within the hood escape through the openings or perforations 16 into the column and aerate or gasify it. As soon as ascending movement is obtained in the rising pipe 12, there is a reduction of pressure at the vena contracta due to the velocity of the

liquid at the constriction, and consequently there is a strong inducement for the gases of combustion to pass into the column for the further aeration of the liquid therein and the consequent production of the air lift action already explained.

According to the modification in Figure 9, the burner 11 is suspended within a tubular part 17 fitted to the lower end of the rising pipe 12, the lower end of the part 17 being of greater diameter than the upper part which is connected to the rising pipe 12. The burner 11 comprises a long tubular combustion chamber formed with a nozzle 11ª and fed with combustible mixture which passes down the supply and mixing pipe 18 at high velocity. The tubular part 17 and burner 11 after ignition being suspended at a suitable depth below the surface of the liquid to be raised, the products of combustion aerate the column within the part 17 and rising pipe 12 so that an ascending movement of the liquid to a suitable delivery is obtained.

I claim:—

1. An air-lift elevator comprising a lift tube, a burner holder for suspending a burner within said tube and with the nozzle of such burner submerged beneath the normal level of liquid within such tube, and an annular deflector around such burner holder at a level above the open upper end of said lift tube, substantially as set forth.

2. An air lift elevator, comprising a cover device, a lift tube suspended from said device, a burner holder depending from said cover into and concentrically with said tube, exhaust flue means in association with said cover, a sealed enclosure around the head of said lift tube, said enclosure being provided with deliveries for the liquid overflowing from the head of said lift tube, substantially as set forth.

3. Apparatus for elevating liquids according to the air-lift principle, comprising a container for a body of liquid, a tube having its lower end communicating with such container, a submerged flame burner supported within said tube, an enclosed chamber at a higher level than the upper end of said tube, and an outlet for products of combustion from said chamber.

4. Liquid circulatory system in which liquid is elevated according to the air-lift principle, comprising a closed container for a body of liquid, an air-lift tube communicating at its upper and lower ends with upper and lower levels in said container, a burner submerged within said tube so as to impart its heat and deliver its products of combustion to a lower portion of the liquid column in said tube, collector means for collecting the products of combustion separating away from the liquid delivered at the upper end of such tube, and outlet means on said chamber for said products.

5. Liquid circulatory system in which liquid is elevated in one part of the circuit by an elevator operating according to the air-lift principle, comprising a closed container for liquid to be circulated, an air-lift tube, upper and lower connections between said tube and upper and lower levels of said container, an annular trough surrounding the upper end of said tube, a cover device depending into and sealed by liquid in said trough, means for discharging combustion gases from said cover device, and a submersible burner submerged in the lower part of the liquid column in said tube.

6. Apparatus for elevating liquids according to the air-lift principle, comprising an air lift tube adapted for separating a column of liquid from a body of such liquid, a continuous combustion burner comprising a submersible flame nozzle, and burner-supporting means adapted for supporting the burner with its nozzle submerged in said liquid and the flame thereof heating the liquid by direct contact therewith so that products of combustion issuing from said nozzle heat and gasify said column for producing air-lift action therein.

7. Apparatus for elevating liquids comprising a container for a body of liquid, an air lift tube adapted for separating a column of liquid from a body of such liquid and with its lower end communicating with such container, a continuous combustion burner comprising a submersible flame nozzle, and burner-supporting means adapted for supporting the burner with its nozzle submerged in the lower portion of the column of liquid in said tube and the flame thereof heating the liquid by direct contact therewith so that the products of combustion continuously issuing from said nozzle heat and gasify said column for producing air lift action therein.

8. An appartus for circulating liquid according to the air lift principle, comprising an air lift tube forming a defined column in part of a liquid circuit, a continuous combustion burner comprising a submersible flame nozzle, and burner-supporting means adapted for supporting the burner with its nozzle submerged in said liquid and the flame thereof heating the liquid by direct contact therewith so that products of combustion issuing from said nozzle heat and gasify said column for producing air-lift action therein.

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