

Nov. 4, 1969

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3,476,038

SUCTION PUMP VORTEX CONTROL

Filed Dec. 20, 1967

2 Sheets-Sheet 1

Fig. 1.

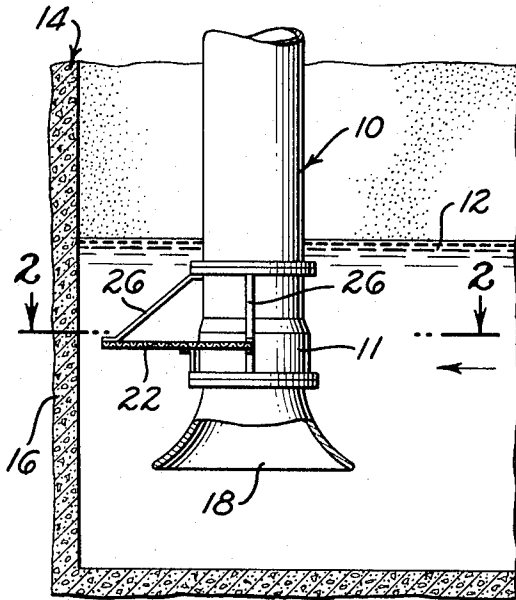


Fig. 2.

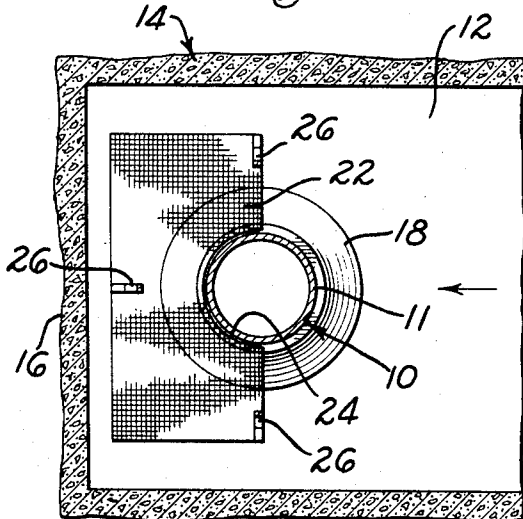


Fig. 3.

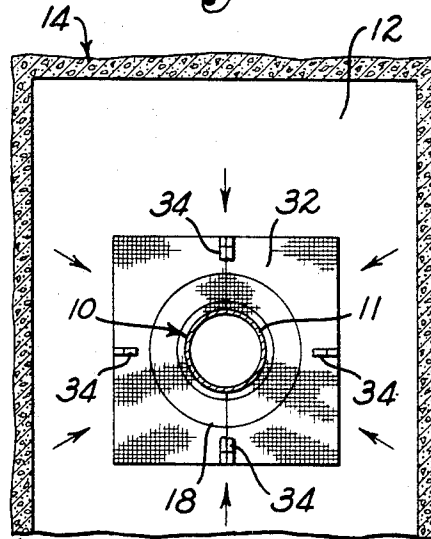


Fig. 4.

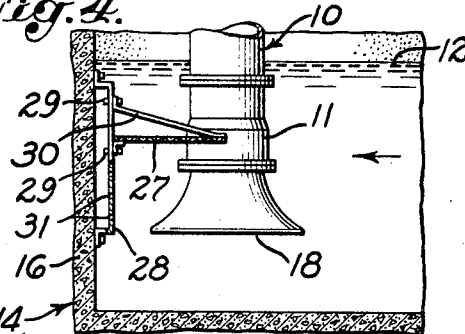
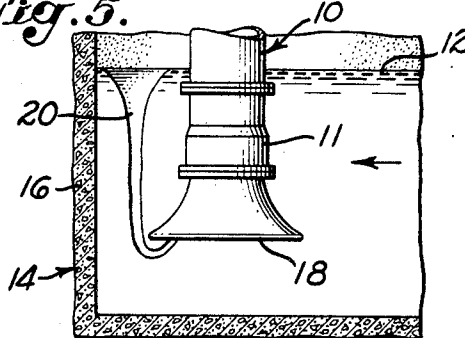


Fig. 5.



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Fig. 6.

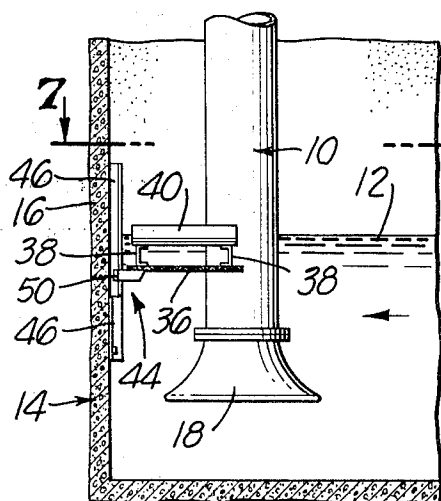


Fig. 9.

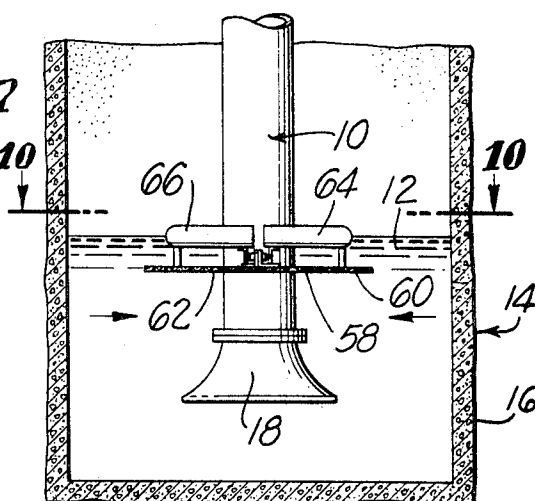


Fig. 7.

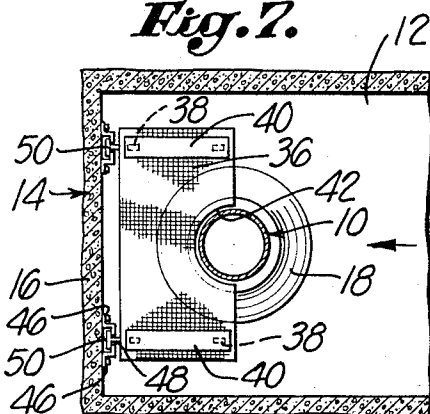


Fig. 10.

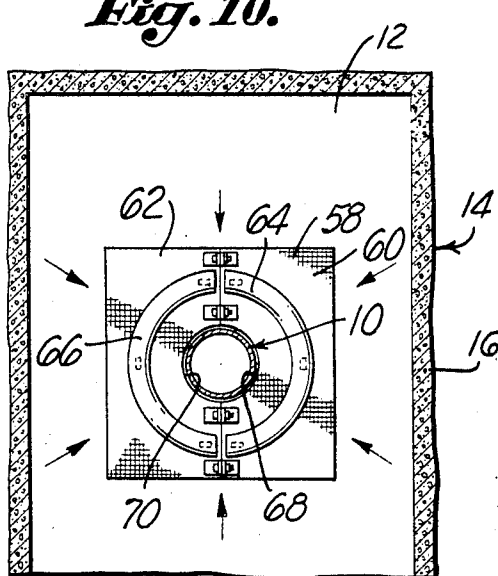
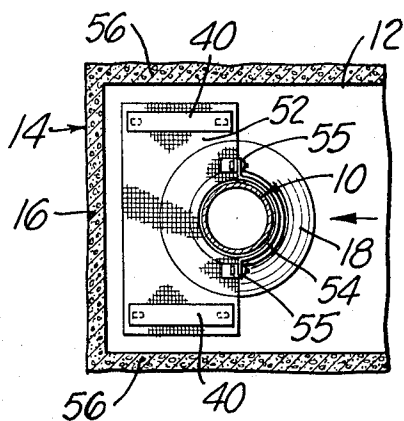


Fig. 8.

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SUCTION PUMP VORTEX CONTROL

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U.S. Cl. 103—220

8 Claims

ABSTRACT OF THE DISCLOSURE

A screen or perforated plate member mounted horizontally exteriorly of the pipe column of a liquid suction pump. The screen is mounted above the suction bellmouth of the pipe column and beneath the surface of the liquid and may be attached to the pipe column or to the walls of the structure confining the liquid, or may be supported within the liquid by a float member.

This invention relates to apparatus for a liquid suction pump and more particularly to an anti-vortex screen for preventing the formation of air-entraining vortices about the pipe column within the liquid. The anti-vortex screen disclosed herein is intended to be used with any and all of the various types of suction pumps, such as propeller and mixed flow pumps, vertical turbine pumps, and the like, and all such pump assemblies are intended to be within the scope of this invention.

Various types of suction pumps are widely and commonly used to remove a liquid, such as water or a fuel, from a confining structure such as a sump or tank. A common problem associated with suction pump operation is the formation of air-entraining vortices having hollow cores through which air is drawn into the suction inlet or suction bellmouth. The suction of the pump creates flow patterns of the confined liquid toward the pipe column of the pump resulting in eddies or swirling of the liquid about the pipe column, eventually causing the formation of the air-entraining vortices. The air reaching the pump because of the vortices upsets the mechanical and hydraulic balance thereby reducing the efficiency and delivery of the pump. Further, the vortices are unstable and give rise to unsteady swirl flows and vibration in the pipe which create problems of corrosion and cavitation in the pump and pipe column. The vibration and unsteady flows produce fluctuating loads on the pump bearings which tend to shorten the bearing life. Additionally, debris floating on the surface of the liquid will be sucked into the pipe column by the vortices with apparent resulting problems of clogging and interference with the apparent resulting problems of clogging and interference with the mechanical operation of the pump.

Much experimentation and testing have been conducted over the past twenty or thirty years to alleviate the problem of the vortices. One solution has been to submerge the suction bellmouth of the pipe column a greater distance beneath the surface of the liquid, since the amount of submergence is inversely proportional to the effective formation of the vortices. However, this solution becomes impractical where the depth of liquid is insufficient or where the liquid is to be completely removed from the confining structure. Other solutions to the problem have been found, usually in the form of radial vanes or partitions beneath the bellmouth. These latter solutions, however, do not solve the problem but merely reduce it since the vortices are not prevented but are diverted, or the liquid whirling action is itself reduced.

I have invented a novel anti-vortex screen which alleviates the above problems by preventing the formation of the air-entraining vortices. A screen or perforated plate

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member is mounted horizontally exteriorly of the pipe column above the bellmouth or suction intake and below the surface of the confined liquid. The screen may be attached to the pipe column or to the walls of the structures confining the liquid, or may be supported within the liquid by a float member. Means may also be provided to vary the position of the screen vertically on its mounting so as to vary the distance of the screen above the suction intake. The screen acts to dissipate or diffuse the eddies or swirls of the liquid about the pipe column so that no air-entraining vortex will be formed. The screen to be operative may be mounted at any location above the bellmouth to within a distance approximately equalling one third of the bell diameter of the suction intake. Although the screen must be submerged at all times to be effective, the screen may thus be effective in a practical sense until all but a small portion of the liquid has been removed from the confining structure. The screen or perforated plate member may be easily and cheaply manufactured and assembled.

It is an object of this invention, therefore, to provide a means for improving the efficiency of a suction pump.

Another object of the invention is to provide such a means which may be easily and cheaply manufactured and assembled.

A further object of the invention is to provide a means for preventing the formation of air-entraining vortices in the operation of a suction pump.

Still another object of the invention is to provide an anti-vortex screen for use with a liquid suction pump including a pipe column, and a suction intake positioned within the liquid, said screen being mounted exteriorly of the pipe column in a substantially horizontal plane above the suction intake and beneath the surface of the liquid.

Yet another object of the invention is to provide such an anti-vortex screen which may be mounted at variable distances above the suction intake of the pump.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings.

In the drawings:

FIG. 1 is a fragmentary side elevational view of a suction pump pipe column submerged within a liquid with my preferred screen member attached thereto;

FIG. 2 is a fragmentary sectional view taken along the line 2—2 in FIG. 1;

FIG. 3 is a view similar to FIG. 2 showing another embodiment of my screen assembly;

FIG. 4 is a view of reduced scale similar to FIG. 1 showing still another embodiment of my screen assembly mounted to a wall of the confining structure;

FIG. 5 is a view of reduced scale similar to FIG. 1 showing a suction pump pipe column in use without my screen assembly attached thereto;

FIG. 6 is a view of reduced scale similar to FIG. 1 showing a variable adjustable mounting of another embodiment of my screen assembly;

FIG. 7 is a fragmentary sectional view taken along the line 7—7 in FIG. 6;

FIG. 8 is a view of reduced scale similar to FIG. 7 showing another variable mounting in a further embodiment of my screen assembly;

FIG. 9 is a fragmentary elevational view of yet another embodiment of my screen assembly suspended from a float member about a suction pump pipe column; and

FIG. 10 is a fragmentary sectional view taken along the line 10—10 in FIG. 9.

Referring now to the drawings, FIGS. 1 through 10

show a typical pipe column 10 of any form of a suction pump, such as a propeller, mixed flow or vertical turbine pump or the like (not shown), partially submerged within a liquid 12 confined within a support structure 14 which may be a sump or tank or the like. In many assemblies the pipe column 10 includes a discharge bowl 11 (FIGS. 1 through 5) formed as part of the pipe column 10 which may suitably house the pump (not shown), such as a vertical turbine pump, positioning the pump directly above the suction intake or suction bellmouth (indicated by 18) of the pipe column 10. The pump may, of course, be positioned further downstream along the pipe column 10 away from the suction intake 18 and outside the confining structure 14. FIGS. 6 through 10 illustrate such a situation where the pump (not shown) is located downstream and the pipe column 10 would not necessarily include the discharge bowl 11. The pipe column 10 is positioned adjacent a side or end 16 of the confining structure 14 in FIGS. 1, 2, and 4 through 8, while in FIGS. 3, 9 and 10 the pipe column 10 is positioned away from the walls of the support structure 14. Since the pipe column is fixed relative to the support structure 14 in both instances, the intake end 18 of the pipe column 10 will be spaced a fixed predetermined distance above the bottom of the structure 14. The confined liquid 12, such as water or a fuel, is drawn by the suction pump into the suction intake or suction bellmouth 18 of the pipe column 10 and thence upwardly through the discharge bowl 11, if included, and pipe column 10 to its ultimate destination away from the confining structure 14.

The suction produced by the pump draws the liquid 12 toward the pump pipe column 10 and bellmouth 18 as indicated by the flow arrows in the drawings. As the liquid reaches the pipe column 10, eddies or swirls form about the pipe column above the suction bellmouth 18. Severe swirl of the liquid 12 will eventually produce air-entraining vortices as indicated by 20 in FIG. 5. Air and floating debris are drawn through the hollow core of the vortex 20 through the suction intake 18 and into the pipe column 10 producing the problems of corrosion and cavitation and bearing wear as well as upsetting the mechanical and hydraulic balance and efficiency of the pump as discussed previously. To prevent the formation of the vortices 20, I position a screen or plate member horizontally within the liquid 12 above the bellmouth 18.

More particularly, and referring now to FIGS. 1 and 2, a screen or perforated plate member 22 is shown mounted horizontally within the liquid 12 above the bellmouth 18 of the pipe column 10. Where used throughout herein, the term "screen" is intended to include any and all of the various types and forms of screens or perforated plate members. The screen or perforated plate member 22 may be formed of any suitable material and preferably is constructed of heavy-gage expanded metal with a welded reinforcing frame and may, for example, have a standard finish of hot dip galvanizing.

The screen 22 is preferably positioned within the structure 14 in the general area where vortices would most probably be formed. Where the pipe column 10 is positioned relatively adjacent a wall 16 of the structure 14, the severe swirling or eddying of the liquid 12 is most likely to occur behind the pipe column 10 from the path of flow of the liquid 12, producing air-entraining vortices between the pipe column 10 and the wall 16. The screen or plate member 22 therefore is shown as generally rectangular positioned closely adjacent the pipe column 10 as by an arcuate cut-out portion 24 (FIG. 2) and extends generally outwardly therefrom and toward the near wall 16 to include an area within the structure 14 where the vortices 20 would most probably be formed in this situation. The size and shape of the screen 22 therefore depend upon the anticipated location of the formation of the vortices which will in turn depend upon the positioning of the pipe column 10 in relation to the structure 14. Different locations of the pipe column 10 in the

structure 14 will result in different flow paths of the liquid 12 with varying patterns of swirl of the liquid 12 about the pipe column 10.

The screen or perforated plate member 22 is suitably mounted in a horizontal plane adjacent the pipe column 10, since experimental tests have shown that the screen 22 has the greatest effect of preventing the formation of vortices when horizontal. As shown by FIG. 1, the screen 22 may be attached to the pipe column 10, for example to the discharge bowl 11, as by galvanized mounting brackets 26 which are welded or bolted to the screen 22 and the discharge bowl 11.

The screen may also be attached to the structure 14 as indicated by a screen 27 and mounting brace 28 in FIG. 4. As exemplary of an attachment to the near wall 16 in FIG. 4 the mounting brace 28 is suitably attached to the wall 16 and mounting brackets 30 which may be bolted or welded to the screen 27 are mounted to the brace 28. The screen 27 may also be directly attached to the brace 28 as shown. Alternatively, the screen 27 may be variably and adjustably mounted to the brace 28 by bolts 29 which are received by vertically spaced holes 31 in the brace 28 enabling the screen 27 to be positioned at various distances above the suction intake 18 or the bottom of the structure 14. The brace 28 may be bolted to the wall 16 or otherwise suitably attached. The screen 22 or 27 may therefore be shipped unassembled to the site for easy attachment to the pipe column 10 or structure 14 or may be attached to the pipe column 10 upon assembly of the suction pump apparatus.

Referring now to FIG. 3, the pipe column 10 is shown positioned away from the walls of the support structure 14. In this or any other such location (FIGS. 9 and 10) relatively away from the walls of the structure 14, the liquid 12 is drawn toward the pipe column 10 from all or many directions rather than from the one general direction as in FIGS. 1, 2, and 4 through 8, as indicated by the respective flow lines. Air-entraining vortices may therefore be formed at any location about the pipe column 10 when it is positioned as in FIG. 3. A screen or perforated plate member 32, therefore, is shown completely surrounding the pipe column 10 so as to be positioned in the structure 14 at all possible locations for the formation of the vortices. The screen or plate member 32 preferably is attached to the pipe column 10 as by galvanized metal brackets 34. The screen 32 again preferably is heavy-gage expanded metal with the standard finish of hot dip galvanizing; however, again, other forms of screen or perforated plate members and other types of materials may be employed and are intended to be within the scope of the invention.

FIGS. 6 through 10 show other embodiments of anti-vortex screens which are supported within the liquid 12 by floats or other similar means. In FIGS. 6 and 7, the pipe column 10 is positioned adjacent the wall 16 of the support structure 14 and a similarly constructed screen or perforated plate member 36 is mounted between the pipe column 10 and wall 16 as in the embodiment in FIG. 1. The screen 36 is attached, as by brackets 38, to twin floats 40 which have sufficient buoyancy to support the screen 36 as shown. The screen 36 includes an arcuate cut-out portion 42 (FIG. 7) enabling it to be positioned closely adjacent the pipe column 10. To enable the screen 36 to move with a change in the level of the liquid 12, a variable mounting means 44 is provided for adjustably attaching the screen 36 to the wall 16. The mounting means 44 may include two sets of twin mounting braces 46. The braces 46 are suitably attached to the wall 16 and the two braces in each set are spaced apart to provide a vertical slot 48 to receive a flanged tongue member 50. The tongue members 50 are attached one at each end of the screen 36 and slide vertically between the corresponding twin braces 46 permitting the screen 36 to move vertically as the floats 40 follow the liquid level. In this manner the screen 36 will remain in the liquid 12 suffi-

ciently above the suction intake 18 for best vortex preventive results until the liquid level recedes nearly to the level of the suction intake.

In FIG. 8, another embodiment of a screen or perforated plate member 52 is shown slidably mounted about the pipe column 10. The screen 52 is again supported by floats 40 and is positioned adjacent the pipe column 10 where an arcuate rib member 54 extends about the outer half of the pipe column 10. The rib member 54 is bolted or otherwise suitably attached to the screen 52 as shown at 55 and permits the screen to slide vertically along the pipe column 10 as the floats 40 follow to the liquid level. Where the screen 52 is large enough to be positioned adjacent the side walls 56 of the structure 14, the side walls 56 will prevent rotation of the screen 52 from its preferred position between the pipe column 10 and end wall 16 as shown.

Referring now to FIGS. 9 and 10, a screen or perforated plate member 58 is shown mounted about a pipe column 10 which is positioned away from the walls of the structure 14 as in the embodiment in FIG. 3. The screen 58 preferably is formed from two half-sections 60 and 62 each supported from arcuate float members 64 and 66, respectively. The screen 58 is assembled in the structure 14, after the pipe column 10 is positioned, by suitably attaching the half-sections 60 and 62 together, as by bolting, about the pipe column 10. In this manner the screen 58 may be transported and stored separately from the pump and pipe column 10. Each half-section 60 and 62 includes an arcuate cut-out portion 68 and 70, respectively, to allow the screen 58 to be positioned closely adjacent the pipe column 10. As in the embodiments in FIGS. 6, 7, and 8, the screen 58 will slide vertically as the float members 64 and 66 follow the liquid level in the structure 14.

The screens or perforated plate members 22, 27, 32, 36, 52, and 58 are therefore mounted about a pipe column 10 in the liquid 12 where it is anticipated vortices would be formed. The screens are mounted horizontally within the liquid 12 above the bellmouth 18 of the pipe column 10 and may be attached to the pipe column 10 or to a near wall of the confining structure 14, or may be suitably supported from float members. Experimental tests have indicated that where such a screen is positioned a distance equal to at least one-third of the bellmouth diameter or higher above the suction intake and within the liquid 12, the screen will prevent the formation of air-entraining vortices by diffusing or dissipating the eddies or swirls of the liquid 12 about the pipe column 10. The screen thereby provides an efficient and inexpensive means for alleviating the problems of vortices forming during operation of a suction pump.

Although I have described in some detail various forms of my invention, changes, modifications, and substitutions may be made therein without departing from the spirit of the invention. I therefore intend that my invention be limited in scope only by the terms of the following claim:

1. A vortex inhibiting means for a rotary liquid pump having a pipe column having a downwardly opening inlet submerged in a liquid confined in a container member, comprising in combination:

means for positioning the pipe column inlet a predetermined distance from the bottom of said container member; and

a screen member positioned between the surface of the liquid and the pipe column inlet in a substantially horizontal plane and defining an unimpeded flow zone between said screen member and the surface of the liquid for inhibiting and breaking up air-entraining vortices moving into said unimpeded flow zone toward the pipe column inlet created by said rotary liquid pump.

2. The vortex inhibiting means for the rotary liquid

pump of claim 3 wherein the inlet of the pipe column includes a bell-shaped intake, and further including mounting means for attaching said screen member to the exterior of the pipe column a distance above the inlet equal to at least one third of the diameter of said bell-shaped intake to define a dissipation space in which the inhibited and broken-up vortices are dissipated before the liquid passes through the bell-shaped intake into the pipe column.

3. The vortex inhibiting means for the rotary liquid pump of claim 1 wherein said means for positioning includes means for positioning the inlet adjacent an end wall of the container member, and said screen member extends between the pipe column and said end wall.

4. The vortex inhibiting means for the rotary liquid pump of claim 1 including:

a float member; and

means connecting said screen member to said float member, said screen member being slidably attached to said end wall for vertical movement therewith, whereby said float and said screen member move up and down with the liquid surface level to maintain said unimpeded zone at a substantially constant depth.

5. The vortex inhibiting means for the rotary liquid pump of claim 1 including:

a float member; and

means connecting said screen member to said float member, said screen member being slidably attached to the pipe column for vertical movement therewith, whereby said float member and said screen member move up and down with the liquid surface level to maintain said unimpeded flow zone at a substantially constant depth.

6. The vortex inhibiting means for the rotary liquid pump of claim 1 wherein said screen member includes a screen extending horizontally from the exterior of the pipe column.

7. A vortex inhibiting apparatus for a rotary liquid pump having a pipe column including:

a downwardly opening inlet at a lower end of the pipe column;

means for confining said liquid and having an end portion and a bottom;

means for positioning said inlet beneath the surface of said liquid confined in said end portion and a predetermined distance from said bottom;

a rotary suction pump for moving said liquid through said inlet and up the pipe column;

perforated means for inhibiting and breaking up air-entrained vortices which develop in said liquid as it moves along said confining means through said end portion into said inlet; and

attaching means for positioning said perforated means in a generally horizontal pattern between the surface of said liquid and said inlet to define an unimpeded flow zone between said surface and said perforated means.

8. Apparatus as in claim 7 including an open float member and wherein said attaching means is connected with said float member, whereby said float member and said perforated means move up and down with the liquid surface level to maintain said unimpeded zone at a substantially constant depth.

References Cited

UNITED STATES PATENTS

895,768	8/1908	KoenigKramer et al. ..	103—220
1,441,187	1/1923	Valboe	103—220
1,644,248	10/1927	Goldman	210—242
2,660,312	11/1953	Snyder et al.	103—220

HENRY F. RADUAZO, Primary Examiner

U.S. Cl. X.R.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,476,038

Dated November 4, 1969

Inventor(s) John L. DICMAS

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

- Col. 1: Lines 52-54, delete repetition of "with the apparent resulting problems of clogging and interference", pg. 3, ls. 4-5 of specification.
- Col. 5: Line 57, "ing claims." has been omitted at the end of the line, pg. 13, l. 25 of specification.
- Col. 6: Line 1, "claim 3" should be --claim 1-- (claim 12, l. 1 --claim 11 became claim 1 of patent).
- Col. 6: Line 16, "claim 1" should be --claim 3 (claim 14, l. as amended by Examiner's Amendment--claim 13 is claim of patent).

SIGNED AND
SEALED

JUN 16 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

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Commissioner of Patents