

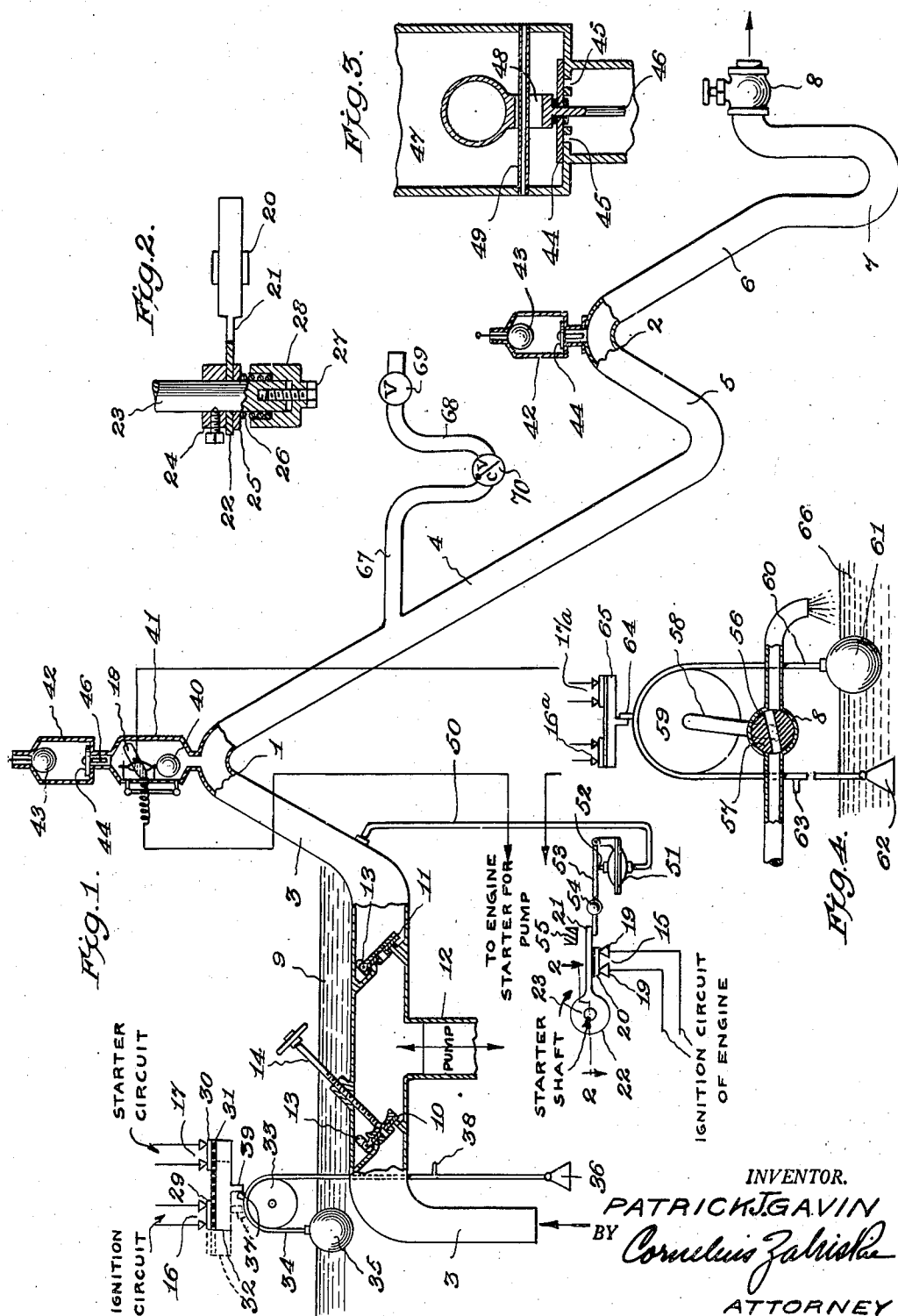
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COMBINED PUMPING AND SIPHONING SYSTEM FOR LIQUIDS

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COMBINED PUMPING AND SIPHONING
SYSTEM FOR LIQUIDS

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15 Claims. (Cl. 103-1)

This invention is a system for conveying liquids from a body of liquid of relatively high surface level to a lower level, through a conduit which extends upwardly and downwardly, as across hill and valley.

The object of the invention is to provide for the conveying of liquid through such a conduit by means of pump generated pressures or according to siphon principles, and to so constitute such system that it will automatically change from a pump system to a siphon system and vice versa, as conditions warrant.

The invention is adapted for various uses, among which may be mentioned, the cross country transportation of crude oil from a higher elevation to a lower elevation, where intervening hills and valleys require, under present-day systems, the use of a pump at all times as a motivating device to insure the flow of the liquid.

According to the present invention, a pump is employed to fill the system with the liquid to be transported from the higher level and means is provided for thereafter automatically shutting off the pump to permit the system to function according to siphon principles. In the event that the liquid column in the siphon is broken from any cause, the system is constituted to automatically reinitiate operation of the pump in order to reestablish the continuity of the liquid column throughout the length of the system until such time as conditions, conducive to proper operation under siphon principles, are reestablished.

An important feature of the present invention resides in the incorporation in the system of means for evacuating air therefrom, so that such air will not be trapped in a manner to interfere with siphon operation. This means consists in positioning at one or more high points of the system an air relief device which, as liquid is pumped into the system, will permit of the exit of the air from the system. This means is so constituted that it will permit the exit of the air, but will preclude the intake of air at these points. By this means, the air from the system may be evacuated and a continuous column of liquid produced through the operation of the pump, to condition the system for proper siphon operation.

In the operation of pumping liquids, it is found in practice that more or less air or gas may be entrained with the liquid and this air tends to accumulate at the high points of the system where it eventually becomes trapped in sufficient amounts to break the liquid column and inter-

fere with siphon operation. The invention provides means whereby this air may be evacuated without breaking the column of liquid or interfering with the siphon operation.

5 It is frequently desired in the operation of a pump or siphon to lower the level of the pool from which the liquid is drawn, to a predetermined extent and then stop transfer of the liquid. The present invention provides simple and efficient means for automatically shutting off the system when this occurs and automatically starting up the system again, after the original elevation has been reestablished.

Various specific forms of apparatus may be employed in carrying out this invention, but in one of its preferred embodiments, it comprises at least one siphon element which includes a feed leg and a discharge leg, the latter of which extends to a lower elevation than the liquid level in the pool into which the feed leg dips. These two legs collectively form a complete siphon. According to this invention, the discharge leg may be connected to the feed leg of a second siphon, the discharge leg of which extends to a still lower elevation and the discharge leg of this second siphon may be connected to still a third siphon and so on. In any event the feed leg of the first siphon is connected to a pump with inlet and outlet valves at opposite sides of the pump connection, so that through the operation of the pump, the liquid may be drawn from the pool of highest elevation (hereinafter referred to as the feeder pool) and discharged by the pump through the discharge valve into the inlet leg of the first siphon. Through the operations of the pump, the siphon, or succession of siphons of the system, may be charged in the manner described until the system is completely filled.

To insure a complete filling of the system by this operation, the outlet end of the system may be valved, if desired, but I prefer to make the outlet of the system of less cross sectional area than the capacity of the pump, so as to set up, during the filling of the system by pump operation, sufficient back pressure to insure complete filling of the system. During this operation the air relief means to which I have referred automatically functions to clear the system of air and thus permit of such complete filling. When the system is thus filled, the pump may be shut off, preferably automatically as stated, to permit the system to thereafter function according to siphon principles. If, for any reason, the siphon column is interrupted or it be desired to reestablish pumping operations, the pump may be started

again either automatically or otherwise so that the system thereupon becomes a pumping system until subsequently changed again to a siphon system as hereinafter more fully described.

Features of the invention, other than those adverted to, will be apparent from the hereinafter detailed description and appended claims, when read in conjunction with the accompanying drawing.

The accompanying drawing illustrates one practical embodiment of the invention, but the construction therein shown is to be understood as illustrative, only, and not as defining the limits of the invention.

Figure 1 is a diagrammatic view showing partly in section and partly in elevation the preferred form of system of the present invention.

Figure 2 is a detailed section on the line 2—2 of Figure 1.

Figure 3 is a detailed fragmental section of one of the two air relief devices shown in Figure 1.

Figure 4 is a schematic perspective, partly in section, showing a device whereby the transportation of liquid through the system may be controlled by the liquid level of the pool to which the liquid is fed.

In Figure 1 of the drawing, I have shown a system as embodying two siphons 1 and 2 connected in series. The siphon 1 will be referred to as a primary siphon and the siphon 2 as a secondary siphon. The primary siphon has an inlet leg 3 and an outlet leg 4, which latter leg connects to the inlet leg 5 of the secondary siphon. The outlet leg 6 of the secondary siphon is shown as leading to a trap 7, the outlet of which is illustrated as having an outlet valve 8, although this valve may be omitted if desired. The feed leg 3 of the primary siphon dips into and extends well beneath the liquid level of a feeder pool 9 and incorporated in this leg is an inlet valve 10 and an outlet valve 11.

Connected to the feed leg 3, between the valves 10 and 11 is a pump 12. These valves are automatically operable, so that the valve 10 will open during the suction stroke of the pump and close during the compression stroke, while the valve 11 will open during the compression stroke and close during the suction stroke. Through the operation of the pump, liquid may be drawn from the pool 9 past the valve 10 and discharged into the rising portion of the inlet leg 3 through the outlet valve 11.

Valves 10 and 11 are shown as of the pivoted type with the pivots operating in elongated slots 13, so that proper seating of the valves will be assured without binding. Associated with the valve 10 is a threaded post 14, provided at its outer end with a hand wheel and at its inner end with a ball end. Under ordinary conditions, the post is screwed upwardly to permit of the free operation of the valve 10 according to the operations of the pump, but if for any reason it is desired to shut this valve tightly and hold it shut, this may be accomplished by screwing down the post 14 to seat the valve firmly and thus seal the system at this point.

The pump may be conveniently operated by any suitable prime mover, but according to the system as shown, it is adapted to be operated by an internal combustion engine having an appropriate ignition circuit and equipped with an electric starter. The engine, ignition circuit and starter hook-up may be of the conventional type used in automobiles, trucks, etc., and inasmuch as this hook-up is conventional and well under-

stood in the arts, it has not been shown in detail in the drawing, but has been adequately indicated by appropriate legends.

In the ignition circuit are included two switches 15 and 16 and in the starter circuit are included two switches 17 and 18. The switch 15 embodies a pair of spaced apart contacts 19 adapted to be closed by a relatively movable bridge piece 20 carried on but insulated from an arm 21, the hub 22 of which is mounted on the starter shaft 23, to be frictionally connected therewith in any suitable way. A convenient mounting for the hub 22 is shown in Fig. 2. Here a fixed collar 24 is fixed to the starter shaft 23 and the hub 22 is caused to bear against this collar by a friction disk 25, forced against the hub 22 by a spring 26, the tension of which is adapted to be controlled by an adjusting screw 27, operating against a cap 28. The parts are so arranged that when the starter is energized, this shaft will operate in a clockwise direction to engage the bridge piece 20 with the fixed contacts 19 and close the ignition circuit at this point.

The switches 16 and 17 each embody spaced apart stationary contacts adapted to be bridged by bridge pieces 29 and 30, respectively. These two bridge pieces are both mounted on a strip of insulation 31, supported on a slide 32 adapted for rectilinear movement from the full line to the dotted line positions of Fig. 1, and vice versa. When in the dotted line position, both the ignition circuit and the starter circuit will be open at the switches 16 and 17 for only one contact of each of these switches will engage with the bridge pieces, whereas, when the slide is in the full line position, the contacts of both switches will be bridged and the circuits will be completed.

Beneath the slide 32 a sprocket wheel 33 is mounted to rotate and over this wheel extends a sprocket chain 34. To one end of the chain is secured a float 35 and to the other end a weight 36. On the chain are two slide operating fingers 37 and 38 and on the slide in the path of the fingers 37 and 38 is an abutment 39.

The parts are so constituted that, when the liquid level of the pool 9 substantially reaches the desired maximum, the float 35 will elevate to permit the finger 37 to move the slide to the right and close both the ignition and starter circuits. As the level of the pool recedes, the float will descend, so that, when the minimum level is reached, the finger 38 will engage with the abutment 39 and move the slide to the left to break both of these circuits. When the circuits are completed, the engine starter will be operated and the engine will function to operate the pump. When the circuits are broken, the engine will be rendered inoperative and the pump will stop. It will of course be understood that the starter and engine hook up, being of the conventional kind, embodies the usual switches for automatically shutting off the starter after the engine has been placed in operation, as is common. By the means described, the pump is automatically controlled by the liquid level in the pool 9.

The switch 18 is shown as a conventional form of mercury switch included in the energizing circuit of the engine starter. The pivot of the mercury switch is connected to one leg of the circuit while the other leg of the circuit has a pig-tail connection to one end of the switch. This switch is controlled by a float 40 operable within an entrained air casing 41. When the liquid level in this casing falls below the predetermined

minimum, the weight of the float will tip the mercury switch 18 to close the starter circuit and when the liquid level in this casing rises to a predetermined level the float will tilt the mercury switch in the opposite direction and break the circuit.

The entrained air casing is shown as having communication with the highest point in the primary siphon, i. e., at the apex of the siphon where the feed leg joins the discharge leg. A similar casing may be associated with the apex of the secondary siphon, but I have not shown it at this point as the system will function without it, provided there is associated with the apex of each siphon an air relief casing 42. I have illustrated the air relief casing 42 of the primary siphon as communicating with the upper end of the entrained air casing 41, while the air relief casing of the secondary siphon is shown as communicating directly with the apex of this latter siphon.

Each air relief casing is provided with upper and lower seats. With the upper seat cooperates a float valve 43 adapted to seal the outlet at the top of the casing when the liquid level therein rises sufficiently to accomplish this result. The lower valve 44 is adapted to seat in the inlet at the bottom of the casing and is preferably in the form of a rubber disk adapted to normally seal an annular series of perforations 45 against which this disk is adapted to seat. The disk may be provided simply with a guiding stem 46, as shown in Figure 1, but I may extend this stem upwardly, as shown in Figure 3, and form at its top a small float 47. In this case, the stem below the float is slotted as at 48 and a pin 49 passes through the slot to limit the operations of the valve 44.

Connected to the inlet leg 3 of the primary siphon is a pipe 50 which leads to a pressure regulator 51. This regulator may be of the well known diaphragm type wherein the diaphragm has a stem 52 acting against an arm 53 provided with a regulating weight 54. The pressure required to pivotally move the arm 53 may be controlled by adjustment of the weight 54 longitudinally of the arm. The outer end of the arm 53 is positioned beneath and is adapted to actuate the outer end of the arm 21 when the pressure in the system reaches a predetermined maximum. When this occurs, the ignition circuit is broken. The part indicated 55 in Figure 1 is a stop to limit the upward movement of the arm 21.

The system which I have described operates as follows: If it be assumed that the liquid level of the pool 9 rises to a point indicated in Figure 1, the switches 16 and 17 will be closed thus completing the ignition circuit to the pump engine and the starter circuit, whereby the engine will be started and will operate the pump. With the threaded post 14 withdrawn as stated, and the system free from liquid, the pump will function to fill both the primary and secondary siphons with liquid from the pool 9. The outlet of the system at the extreme right in Figure 1 has either less outlet capacity than the capacity of the pump or the valve 8 is closed or partially closed, so that the feed of liquid into the system is greater than its discharge, whereby in due course the system will fill with liquid as the pump proceeds to operate. Since the system was free from water at the beginning of the operation, considerable air will be trapped at the apex to both the primary and secondary siphons, but by virtue of the air relief casings 42, this air will

escape to the atmosphere past the valves 44 and 43, until the system is entirely filled with liquid. As the system fills, the liquid will rise in the air relief casing 42 of the secondary siphon until it actuates the float 43 and seals the outlet of said casing. As the liquid level rises in the entrained air casing 41, air in the apex of the primary siphon will pass off through the air relief casing until a considerable quantity of liquid has flowed into the entrained air casing 41. As the liquid level rises in its casing, the float 41 will tip the mercury switch 18 and break the circuit to the starter, if it has not already been broken, which under ordinary operation will have previously taken place. The liquid will continue to rise in the casing 41 until it passes into and practically fills the air relief casing 42 whereupon the valve 43 will close.

The system is now completely closed at the apex of both siphons, but the pump will still continue to operate until the pressure of the liquid in the system (built up by back pressure at the outlet end) is sufficient to operate the regulator 51 and thus break the ignition circuit at the switch 19, as hereinbefore described. When this occurs the pump will stop and inasmuch as the entire system is filled and both valves 10 and 11 are free to operate, the system will automatically change into a siphon system and liquid will flow according to well known siphon principles, from the pool 9 to the discharge end of the secondary siphon, to be discharged through the valve 8.

As the liquid continues to siphon, entrained air in the liquid may tend to accumulate at the apex of the primary siphon. This air, however, will, as freed from the liquid, bubble up through the entrained air casing to the top thereof and will accumulate at this point below the valve 44. As the siphon operation proceeds, this accumulation of air may in time displace all of the water in the entrained air casing 41 and if this operation were permitted to continue, the siphon would be broken by a resulting airlock therein.

It is to preclude this contingency, that the switch 18 is positioned within the entrained air casing for when the liquid level therein falls sufficiently, this switch will be closed before the system can be airlocked and as soon as this switch is closed, the engine starter will be energized, so that the pump is started up again to restore normal siphon conditions. It will be noted in this respect that the normal operation of the starter will maintain the switch 15 closed except when it is opened by the operation of the pressure regulator 51.

The system will function either as a pumping system or a siphoning system, so long as the level of the pool 9 does not fall below a critical low level, but when it does the float 35 will automatically break the ignition and starter circuits at the switches 16 and 17 and stop the pump. The entire system will be inactive until the liquid level of the pool 9 is reestablished.

If at any time it is desired to shut off the system entirely for any purpose, the threaded post 14 may be screwed down to positively seat the valve 10 and hold it shut until it is again desired to open the system for operation.

There are times when it is desirable to control the operation of the system by the liquid level of the body of liquid to which the system feeds. For example, if the outlet end of the system is adapted to feed the liquid to a tank or pool, it may be desirable to automatically shut off the

system after the liquid level in the tank or pool has reached a predetermined maximum and to automatically turn on the system again when the liquid level in the tank or pool drops to a predetermined extent.

Figure 4 of the drawing shows a device which may be employed in this connection. In utilizing such a device the valve 8 is so controlled that it opens the system when the liquid level rises to the point desired and closes when the liquid level recedes to the point desired. Thus in Figure 4 the valve 8 is shown as a plug valve having a straight-through passage 56 formed in the plug 57 of the valve and adapted, through rotation of the plug, to permit the passage of liquid out of the system. Coaxial with the plug and secured against rotation thereto is a valve stem 58, attached to a sprocket wheel 59 of the same general character as the sprocket wheel 33. Over the sprocket wheel is passed a sprocket chain 60 to one end of which is secured a float 61 and to the other end of which is secured a weight 62 and on the sprocket chain are secured two stops 63 and 64 which correspond to the stops 37 and 38 of Figure 1. These stops are adapted to operate a slide 65 of the same general type as the slide 32 of Figure 1. This slide carries bridge pieces adapted to control switches 16a and 17a which correspond to the switches 16 and 17 of Figure 1. The parts are so proportioned that, when the liquid level 66 rises to the predetermined maximum, the projection 64 will act upon the abutment of the slide 65 to open both the starter circuit and the ignition circuit which are controlled respectively, by the switches 17a and 16a, so as to stop the pump and at the same time the plug valve 57 will have been rotated to shut off the outlet end of the system.

As the liquid level recedes at 66, the stop 63 will in due course engage with the abutment of the slide 65 and close the switches to start the pump and at the same time open the outlet end of the system, so that the liquid level of the body 66 can be reestablished.

In the system as thus far described liquid from the pool 9 is fed from the inlet end of the system through the valve 8 at the outlet end of the system. There may be times, however, where it is desired to tap the system at one or more points intermediate its ends to draw off liquid at these points. To provide for this I have shown, for example, a single branch pipe 67 although, in practice, I may provide branches at more than one point. In any event each branch is preferably provided with an air trap 68 beyond which is an outlet valve 69 and in the air trap of each branch is positioned a check valve 70 which will permit liquid to flow out of the system through the check valve, but will preclude retrograde flow of liquid or air into the system. These branches may be either above or below the level of the pool 9. The check valve 70 will close and remain closed against the inlet of air, while the main outlet valve 8 or the valve 69 in any other lower branch is open and while the system is operating as a siphon system. If the lower valve or valves, however, are closed, it will then be possible to siphon off liquid from the system through the branch valve 69, provided always that the branch line from which the liquid is then drawn off is below the level of the pool 9. If it is above the level of the pool 9 liquid can only be drawn from such a branch outlet when the system is operating as a pumping system.

The foregoing detailed description sets forth

the invention in its preferred practical form, but the invention is to be understood as fully commensurate with the appended claims.

Having thus fully described the invention, what I claim as new and desire to secure by Letters Patent is:

1. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with automatically operable air outlet relief means operable to automatically release air from the apex of the siphon tube, and a pump connected to the inlet leg of the siphon tube below the juncture of said legs to pump liquid through the tube.

2. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, and a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, said air relief means embodying a casing having valved communication with the apex of the siphon tube at its bottom, and a float valve controlled outlet at its top.

3. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, said air relief means embodying a casing having an inlet passage at its bottom communicating with the apex of the siphon tube and an outlet passage at its top communicating with the atmosphere, an inlet valve operable to permit the flow of air and liquid from the siphon tube through said passage into said casing but to preclude flow of either air or liquid in a counter direction, and a float valve operable by the rise of liquid level in said casing for closing said outlet to the atmosphere.

4. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, and entrained air evacuating means interposed between the apex of the siphon tube and the air relief means and permitting free flow of air from the siphon tube to the air relief means.

5. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, entrained air evacuating means interposed between the apex of the siphon tube and the air relief means and permitting free flow of air from the siphon tube to the air relief means, said entrained air evacuating means including a float operated switch, and a pump controlling electric circuit including said switch for starting the pump.

6. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, and en-

trained air evacuating means interposed between the apex of the siphon tube and the air relief means and permitting free flow of air from the siphon tube to the air relief means, said entrained air evacuating means including a float operated switch included in a pump controlling electric circuit for starting the pump when a predetermined amount of air has accumulated in the entrained air evacuating means.

7. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, and entrained air evacuating means interposed between the apex of the siphon tube and the air relief means and permitting free flow of air from the siphon tube to the air relief means, said entrained air evacuating means including a float operated switch included in a pump controlling electric circuit for starting the pump when a predetermined amount of air has accumulated in the entrained air evacuating means, and means governed by the pressure of liquid in the siphon tube for automatically stopping the pump when such pressure reaches a predetermined maximum.

8. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, and a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, and means governed by the pressure of liquid in the siphon tube for automatically stopping the pump when such pressure reaches a predetermined maximum.

9. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, the feed leg of the siphon tube being arranged to dip into a pool of liquid at a higher elevation than the lower end of the discharge leg of the siphon tube, and means governed by the liquid level in said pool for automatically controlling the stopping and starting of the pump.

10. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs and provided at the juncture of said legs with air relief means operable to permit the release of air from the apex of the siphon tube, a pump connected to the inlet leg of the siphon tube to pump liquid through the tube, the feed leg of the siphon tube being provided in advance of the pump with a self-seating inlet valve and beyond the pump with a self seating outlet valve, and a threaded post for forcing the inlet valve to and holding it in closed position when it is desired to seal the feed leg of said tube.

11. A combination pumping and siphoning system comprising; a primary siphon tube having a feed leg adapted to dip into a pool of liquid and

an outlet leg joined to the feed leg at the apex of the primary siphon tube, a secondary siphon tube having a feed leg joined to the lower end of the outlet leg of the primary siphon tube and connecting with the outlet leg of the secondary siphon tube at the apex of the secondary siphon tube, air relief means at the apex of each of said siphon tubes, and a pump connected to the inlet leg of the primary siphon tube.

12. A combination pumping and siphoning system comprising; a primary siphon tube having a feed leg adapted to dip into a pool of liquid and an outlet leg joined to the feed leg at the apex of the primary siphon tube, a secondary siphon tube having a feed leg joined to the lower end of the outlet leg of the primary siphon tube and connecting with the outlet leg of the secondary siphon tube at the apex of the secondary siphon tube, air relief means at the apex of each of said siphon tubes, a pump connected to the inlet leg of the primary siphon tube, and means governed by the pump imposed pressure within the primary siphon tube to stop the operations of the pump.

13. A combination pumping and siphoning system comprising; a primary siphon tube having a feed leg adapted to dip into a pool of liquid and an outlet leg joined to the feed leg at the apex of the primary siphon tube, a secondary siphon tube having a feed leg joined to the lower end of the outlet leg of the primary siphon tube and connecting with the outlet leg of the secondary siphon tube at the apex of the secondary siphon tube, air relief means at the apex of each of said siphon tubes, a pump connected to the inlet leg of the primary siphon tube, means governed by the pump imposed pressure within the primary siphon tube to stop the operations of the pump, and means controlled by the liquid level in said pool for starting the pump when the liquid level in the pool reaches a predetermined elevation and for stopping the pump when said level recedes to a predetermined elevation.

14. A combination pumping and siphoning system comprising; a primary siphon tube having a feed leg adapted to dip into a pool of liquid and an outlet leg joined to the feed leg at the apex of the primary siphon tube, a secondary siphon tube having a feed leg joined to the lower end of the outlet leg of the primary siphon tube and connecting with the outlet leg of the secondary siphon tube at the apex of the secondary siphon tube, air relief means at the apex of each of said siphon tubes, a pump connected to the inlet leg of the primary siphon tube, and a trap connected to the outlet end of the discharge leg of the second siphon tube.

15. A combination pumping and siphoning system comprising; a siphon tube having feed and outlet legs, a pump connected to the feed leg of the siphon tube and adapted to pump liquid from a feed pool into which the feed leg of the siphon tube dips to a discharge pool at the outlet end of the outlet leg of the siphon tube, and means governed by the liquid level of said discharge pool for controlling the operations of the pump.

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