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HYDRAULIC RAM PUMP

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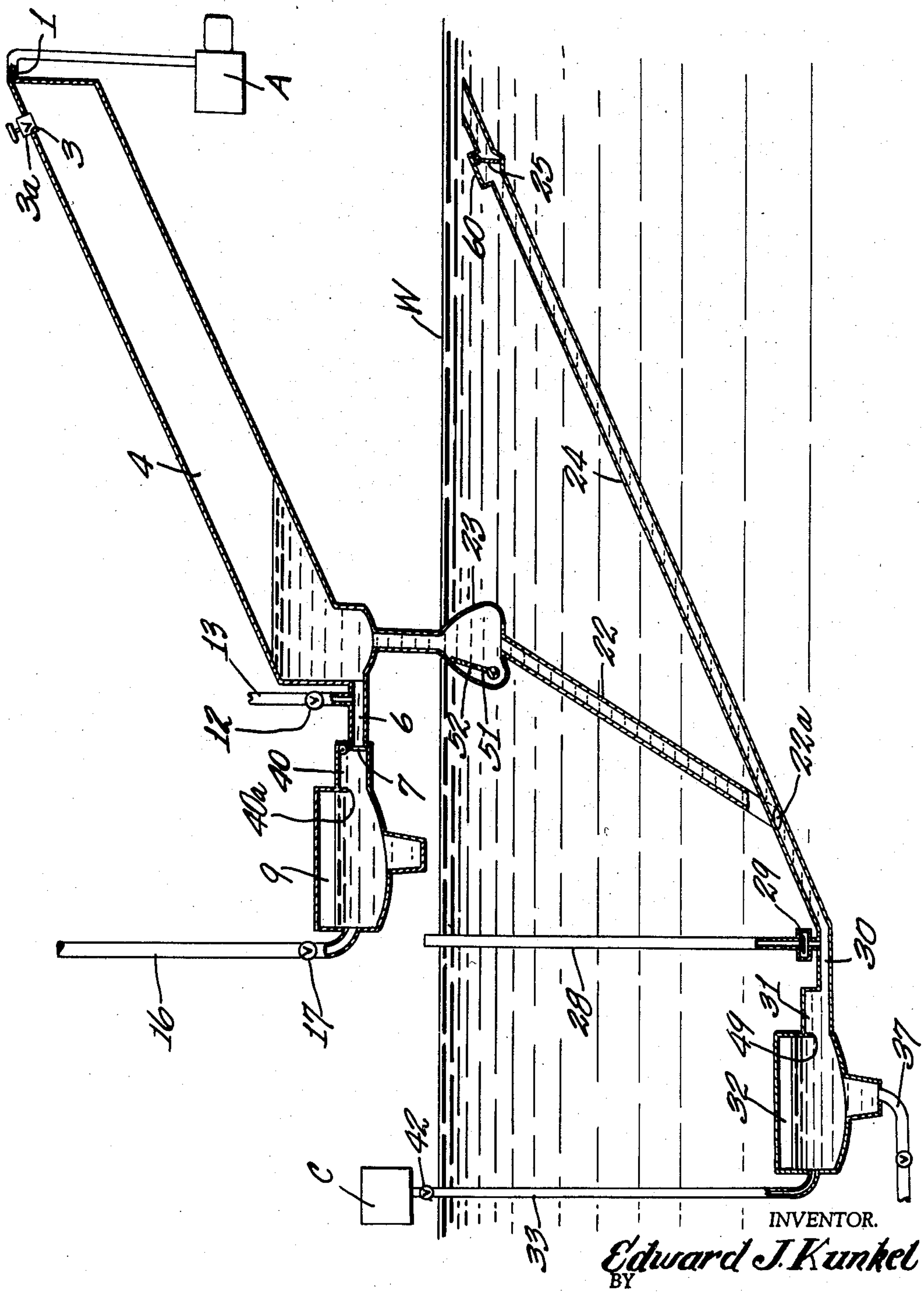

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HYDRAULIC RAM PUMP

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This invention relates to a pump, more particularly a ram pump. My invention provides economy in pump operations and movement of liquid containing fine solid matter without undue damage to the working parts of the pump, and the principal object of this invention is to provide new and improved pumps of this character.

Whereas the common water ram is actuated by the starting or stopping of a waste flow which is diverted into a chamber of compressed air and locked in by a check valve, the compressed air forcing the water in the ram to a higher level, my improved ram pump is not actuated by the wasting of water, but rather by the changing of air pressure on the surface of an upright water column, which is done by producing a vacuum on the top of the column, the changing pressure causing an up and down movement of the water column.

The downward movement of the water in the tube containing the water column is limited by a buoyant flap valve disposed within the tube. When the water is at rest the flap valve remains open, but a downward movement through the tube closes the flap valve, thus trapping water above the valve.

The water tube is connected to a submerged diagonal tube, and the column of water in the diagonal tube is supported by a cushion of air. An upward movement of water through the water tube causes the column of water in the diagonal tube to be set in motion. The compressed air cushion absorbs the energy developed by the downwardly moving diagonal column of water and in turn forces the water in the water tube to a higher level so as to discharge such water into a diagonal tube above the ground. Whereas the head in the common water ram is constant, the head in the diagonal tube above the surface must be constantly built up, since it discharges itself during each cycle. If the head in the diagonal tube above the surface is too low to discharge, another cycle of operation will build it up to a height that it will discharge to a predetermined level. It should be noted that the length of the lower or submerged diagonal tube is equal to or or greater than the vertical height of the pump.

The design and operation of my improved ram pump embodies the economy of operation of the common water ram which uses the force of gravity to do work and my improved pump may be used in situations where it is impossible to use the ordinary ram pump. For example, the ordinary ram pump will not work at a level where the waste water cannot drain away and its uses are thus limited.

My improved ram pump may be installed in a stream or reservoir and take water from it, and should be quite useful in supplying irrigation canals, providing cheap water for the culture of rice, and removing excess water in regions where there is a superabundance, such as in the Netherlands. My improved pump may also be used in regions where the water is extremely turbid and is laden with sludge and abrasive silt, without the necessity of constant maintenance and replacement of its moving parts.

Physical facts and calculations point out that in a pump of my improved type, the efficiency increases in a geometric ratio with the pump size, a limiting factor being that as the size increases the solubility of air in water increases also, due to the extremely high air pressures that come in contact with the turbulent water.

As an example, a diagonal tube an inch square and 60 inches long with a pitch of one foot fall or every two linear feet exerts a static pressure of one pound on the bottom of the tube; a ratio of one pound to 60 cubic inches of mass. But, if every dimension is multiplied by 2, the ratio is 2 pounds to 480 cubic inches of mass; if the dimensions are multiplied by 4, the ratio is 4 pounds to 3840 cubic inches of mass; and so on.

In the drawing accompanying this specification and forming a part of this application, there is shown, for purposes of illustration, an embodiment which my invention may, and in this drawing the single figure discloses my improved ram pump in schematic form.

The improved ram pump herein disclosed comprises two tubes **24** and **4**, the tube **24** being the lower one and being submerged below the level of a body of water W, and the tube **4** being the upper one and being disposed above the level of the body of water. Each of the tubes **24** and **4** is disposed at an inclination to the horizontal and may be termed a diagonally disposed tube. Each tube is preferably rectangular in cross-section and the tubes are disposed one above the other and their respective lower ends are connected by an upright conduit **22**.

The tube **4** has an opening **1** at its upper end which is adapted to be connected to means A for establishing a vacuum in the tube **4**. Such means may take the form of a standard motor-driven vacuum pump and therefore need not be described in detail. The tube **4** is also provided with an opening **3**, controlled by a valve **3*a***, for selectively admitting air under atmospheric pressure to the tube.

The tube **24** is substantially uniform in cross-section except at a lower horizontal portion **30**, which latter portion is reduced in cross-section. Near its upper end, the tube **24** is formed with an enlargement **60** in which is disposed a hinged check valve **25**. The enlargement is of sufficient size to permit the valve to swing upwardly to its completely open position and to thus permit water to freely enter the upper end of the tube **24** and flow downwardly therein. The check valve **25** is moved to closed position, against a force normally biasing the valve to open position, by water tending to flow in a direction upwardly of the conduit **24** and therefore acts to automatically prevent upward discharge of the water from the tube **24**.

Two large air compression chambers **9** and **32** are disposed adjacent to and are in communication with respective lower ends of the tubes **4** and **24**. The chambers may be formed by any suitable means and therefore their specific construction need not be described.

An auxiliary air compression chamber **40** communicates with one end of the chamber **9** through an opening **40*a*** and the other end of the auxiliary chamber **40** communicates with the lower end of the tube **4** by means of a small conduit **6**. A conduit **13** establishes communication between conduit **6** and the atmosphere whereby any reduced pressure within the tube **4** or the compression chamber **9** may be relieved at will by proper manipulation of a valve **12** interposed within the conduit **13**.

A water discharge pipe **16** is in communication with the chamber **9** for discharging water therefrom, the discharge from pipe **16** being controlled by a valve **17**. A check valve **7** in the auxiliary compression chamber **40** permits flow of water from tube **4**, through pipe section **6** and to air compression chamber **9**, but prevents a reversal of water flow.

The lower horizontal portion **30** of lower tube **24** communicates with one end of an auxiliary air compression chamber 31, the other end of the latter communicating with the chamber 32 through an opening 49. An upright pipe 33 communicates with the chamber 32 and is connected with a source of compressed air C, a valve 42 controlling flow through the pipe 33. The valve 42 may be opened to supply air under pressure to the chamber 32 when necessary.

An upright pipe 28 is in communication with the lower horizontal portion 30 of the lower tube 24 and a disk check valve 29 in the tube permits a low pressure condition within the portion 30 to unseat the valve 29 and provide for flow of air under atmospheric pressure to the portion 30. The chamber 32 may have a valve-controlled clean-out conduit 37 at its lower end to provide for selective flushing of the chamber of dirt and silt.

The lower tube 24 has a side opening 22*a* for communication with the lower end of the conduit 22. An enlargement 23 is formed in the upper portion of the conduit 22 and a hinged, buoyant valve 51 is disposed within the enlargement. The valve is in the open position shown when the water in the pump is at rest, and is automatically moved to closed horizontal position when water flows downward through the enlargement 23. An aperture 52 in the valve 51 provides a bleeder hole to prevent the buoyant valve from being locked in closed position. The aperture also reduces water hammer in the conduit 22.

In operation, and assuming water has entered the tube 24 and stands in conduit 22 substantially level with the level of the water body W, when pressure is reduced in tube 4, as by operation of the vacuum pump A, water from conduit 22 will rise in tube 4, thus providing for further water flow into tube 24 and conduit 22.

The energy of the water flowing downwardly in tube 24 is absorbed by compression of the air in chambers 31 and 32 and, since the valve 25 prevents upward flow of water in tube 24, the air pressure in chambers 31 and 32 therefore acts on the water in conduit 22 to urge the water upwardly into tube 4.

The operation of vacuum pump A may be in timed relation with operation of other portions of the pump so that air pressure in tube 4 is reduced to draw water into the tube to a predetermined level, whereupon the valve 3*a* is opened to admit air under atmospheric pressure to the tube. Such action causes the level of the water in tube 4 to drop but as the column of water tends to move downwardly, the valve 51 is thereby closed so that the lowering level of water in tube 4 flows into chambers 9 and 40 and compresses air in the upper portions thereof.

When valve 17 is opened, the compressed air in chambers 9 and 40 will expell the water from the chambers so that it may be directed to good use by the conduit 16.

As water is drawn upwardly into tube 4 by reduced air pressure therein, it will be appreciated that water will flow from the body W downwardly into tube 24 so that there is a constant rise and fall of the water column in conduit 22, with the fall being interrupted by closing of the valve 51 to divert the falling water into the chambers 9 and 40.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiment herein described may be variously changed and modified,

without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described, hence it will be appreciated that the herein disclosed embodiment is illustrative only, and that my invention is not limited thereto.

What is claimed is:

1. A ram pump, comprising two elongated tubes, each positioned at an angle to the horizontal and said tubes being disposed one above the other, means for establishing a vacuum in the upper of said tubes, a conduit connecting respective lower ends of said tubes, the upper end of said lower tube being in communication with a head of water, a first check valve in the lower tube permitting flow of water from said head downwardly in said lower tube, said check valve automatically closing to prevent return flow of water, a first air compression chamber means communicating with the lower end of said lower tube, flow of water downwardly in said lower tube acting as a piston to increase air pressure in said chamber means to an amount to reverse the flow of water and thereby close said first check valve, thus water thus trapped in said lower tube being elevated through said conduit by the air pressure in said chamber means to enter the lower end of said upper tube, a second check valve in said conduit and permitting water flow through said conduit and into said upper tube and preventing return flow of water through said conduit when the pressure of air in said chamber means is insufficient to force water through said conduit, a second air compression chamber means in communication with the lower end of said upper tube, air being compressed in said second air compression chamber means by the head of water trapped within said upper tube, a liquid discharge outlet in communication with said second air compression chamber means, and means intermediate and in communication with said second air compression chamber means and the lower end of said upper tube for controlling discharge of water.

2. The structure of claim 1 wherein said lower tube has an enlargement adjacent to its upper end, a hinged check valve within said enlargement and hanging vertically when in closed position, an orifice in the side wall of said lower tube adjacent its lower end to establish communication with said conduit, and said lower tube having a reduction in cross-section adjacent to its lower end.

3. The structure of claim 2 and further including an auxiliary air compression chamber means in communication with said first air compression chamber means and with the lower end of said lower tube and positioned therebetween.

4. The structure of claim 3 and further including a short horizontal tube establishing communication between the lower end of said lower tube and said auxiliary air compression chamber means, an air tube communicating with and for admitting air into said short tube, and a third check valve for controlling flow of air through said air tube.

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