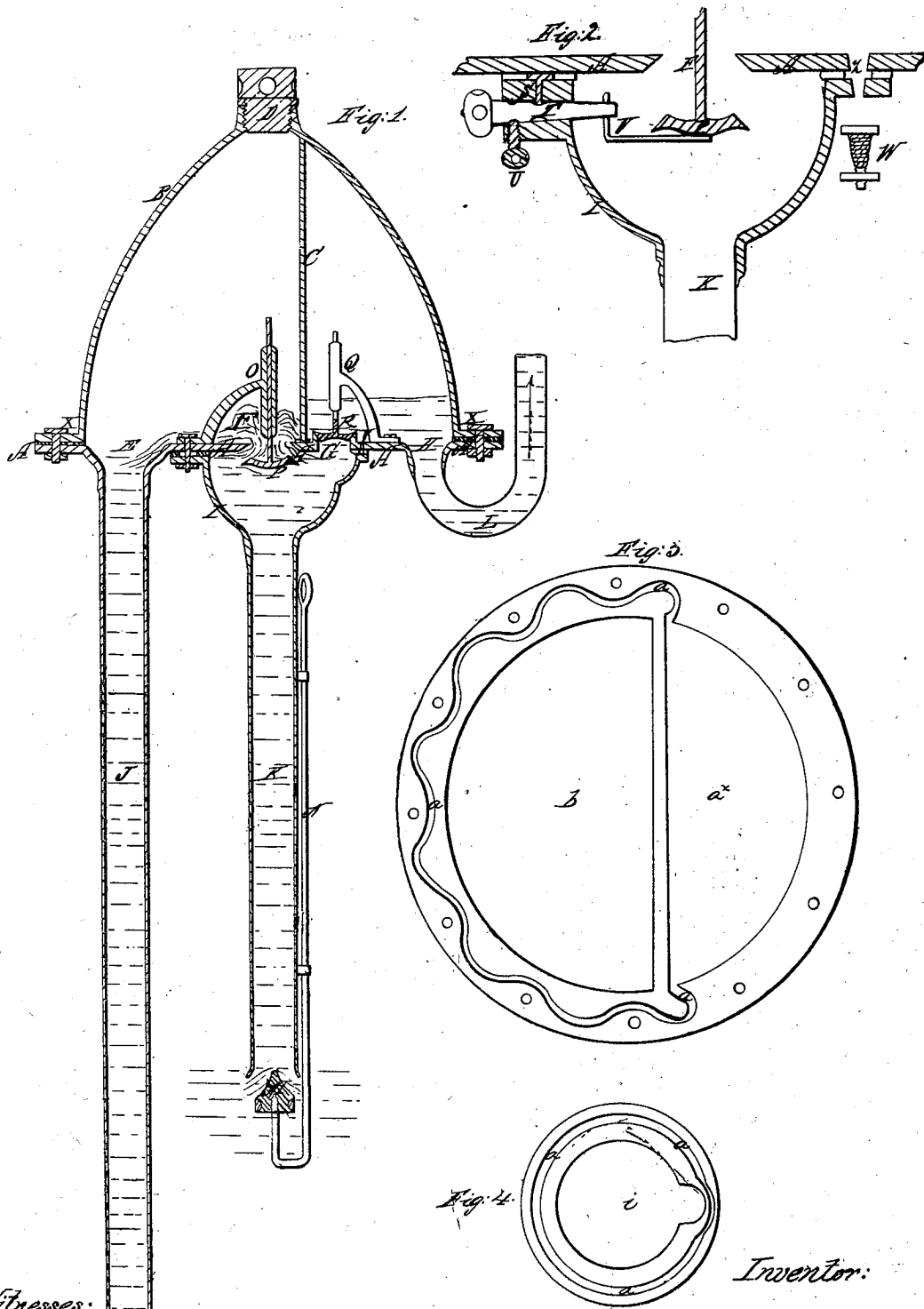


E. W. ELLSWORTH.  
WATER RAM.

No. 4,296.

Patented Dec 6, 1845.



Witnesses:  
Elijah S. ...  
Elizabeth Ellsworth.

Inventor:

Erastus W. Ellsworth

# UNITED STATES PATENT OFFICE.

ERASTUS W. ELLSWORTH, OF SOUTH WINDSOR, CONNECTICUT.

## WATER-RAM.

Specification of Letters Patent No. 4,296, dated December 6, 1845.

*To all whom it may concern:*

Be it known that I, ERASTUS WOLCOTT ELLSWORTH, of South Windsor, in the county of Hartford and State of Connecticut, have invented an Improved Mode of Elevating Water; and I do hereby declare that the following is a full and exact description.

My invention consists in a peculiar manner of working the water-ram of Montgolfier, in combination with the siphon, by the use of a chamber of rarefied air; also in the use of water packing for excluding the external air from the siphon, and in the fixtures herein described for setting in motion and regulating the action of the ram.

To enable others, skilled in the art, to make and use my invention I will proceed to describe its construction and operation.

In the accompanying drawings Fig. 1, is a section of the whole machine (with the exception of the regulator) where it, is a circular plate, through which are four circular openings, E, F, G, H. To the upper surface of this plate is secured by a flange, bolts, and packing, the hollow dome B. In this dome is an air-tight partition C, which comes down to the plate A, where it bears upon packing, like the flange of the dome. This partition passes between the holes F, and G. To the under surface of it, is secured in the same manner as the dome, the cup I which communicates freely with apertures F, and G. This cup forms the head of the ram and the apertures F, and G, the seats of the valves—the escape or waste valve opening at F, downward into the cup I, and the retaining or lifting valve, opening at G, upward into the smaller cavity of the dome which acts as the air-vessel of the ram. These valves have stems rising from their centers which pass through the tubular guides O, Q. From I proceeds the pipe K, which constitutes both the body or trunk of the ram, and the shorter leg of a siphon. The machine thus embodies the hydraulic ram of Montgolfier, the several parts of which are as follows: K, the trunk of the ram, I, the head, P, the escape valve, R, the lifting valve, C, the air-vessel H, L, the discharging pipe; these parts are designed to operate precisely as in Montgolfier's machine and therefore need no further explanation.

From the orifice E, proceeds the pipe J,

the longer leg of a siphon of which K, is the shorter, as before said.

M, is a piston or plug fitted loosely to the bore of the pipe K, and attached to the re-curved rod N, passing through loops on the pipe K, by which it can be drawn up a short distance into, or thrust down entirely out of K.

D, is a screw-plug faced with a collar of packing, through which water may be poured into the larger cavity of the dome, and consequently into both legs of the siphon.

The operation of the machine is as follows: M, is drawn up into K, and J, and K, are filled, and the larger cavity of the dome half, or two-thirds filled with water, through D. D, is then replaced. As soon as D, is replaced the air in the larger cavity of the dome will be rarefied by the weight of the column of water in J, more or less, in proportion to the perpendicular height of the column. Let M, by means of N, be thrust down out of K; this will open the valve P, (if it be shut) and the ram will commence operating, owing to the preponderance of the column of water in J, over that in K.

The use of the body of rarefied air in B (which is a prominent and novel feature in my invention) is analogous to that of the compressed air in the air-vessel C. The water in K, has a reciprocating movement which makes the current through the valves intermittent, and the water enters the two cavities of the dome by pulses, and not in a constant stream. But for the same reasons that it is desirable that the water should pass through the discharging pipe H, L, in a steady current it is also desirable that the escape-water should flow down the longer leg of the syphon in a steady current—namely, that water passes through a pipe, (especially if it be of considerable length) much faster and with far less resistance from friction and inertia, when flowing with a uniform velocity than when checked and impelled intermittently. Moreover as above stated, the water in K, reciprocates; a movement upward is followed by a recoil downward; now without the interposition of the chamber of rarefied air this movement must be communicated to the water in J, from

that in K, or the ram cannot operate. The column in J, must advance and recoil just as far and as often as in K. But this peculiar movement is of no use in J, nay, is exceedingly injurious, for if J, be many rods, or even feet, in length, said movement will consume the effective power of the machine so completely as to stop it.

It is obvious that an equilibrium never can be restored between the chamber of rarefied air and the water in K, inasmuch as the column J, acts as a steady exhausting power, and will always remove the water from the chamber above it at a uniform rate which will be the mean of that at which it enters the chamber from the escape-valve of the ram. Finally—the air inclosed in B, differs from that inclosed in C, only as a spring under tension differs from a spring under pressure, and both bodies of air, by their elasticity are made to convert an intermittent flow of water into a uniform and constant stream.

A peculiarity in my method of packing this machine, and the fixture by which I regulate the action of the ram (both of which I claim as my invention) remain to be described. The packing which I place beneath the flanges of the dome and cup, I make of leather or any other suitable material. It is represented at Figs. 3, and 4. That part of it in Fig. 3 which lies between the vacuum chamber of the dome, and the external air, and the whole of Fig. 4, are divided through their thickness by a channel, which channels are both supplied with water under pressure from the air vessel of the ram. In Fig. 3, the communication between this channel and the air vessel is obvious; with the channel in the packing of the cup it is made through the hole Y, as shown at Fig. 1. The bolts of I, pass through the channel in the packing and are wound with thread conically, and fitted into conical holes as shown at W, Z, Fig. 2.

My regulator (not represented in Fig. 1, as a section of it would be at right angles with the section of said figure) is shown on an enlarged scale in Fig. 2, the lettering of which corresponds to that of Fig. 1. Under the flange of the cup I, is a square block of metal through which passes a horizontal axle T, ground into its place like a common stop-cock. This axle carries, within the cup, a small crank V, which acts as a cam beneath the valve P, permitting it to drop to a greater or less distance from its seat, F. Around that part of the axle which is within the block are cut two grooves, one of which receives the water-packing from the channel above, through the hole S, and the other takes a screw U, from beneath, which clamps the axle in any required position. The advantages of this regulator are that by turning the axle T, at any time when the ma-

chine is in operation, the amount of water which it expends and also which it elevates may be regulated with precision according to any increase or diminution of the supply at the lower end of K, or to the quantity required to be delivered through the pipe H, L. By it P, may also be completely closed, so as to stop the action of the machine entirely.

In order to supply the air vessel of the ram with air, and also to remove from the vacuum chamber any surplus air which may be liberated from the water in passing through it, as much of the plate A, lying under said chamber as the flanges of B, and I, will permit is sunk below the general level of said plate, which drains off the water quickly from the vicinity of F. Consequently after said chamber becomes completely filled with rarefied air, each recoil of the ram draws a small portion of it down through F, which lodges under G, and is forced into the air-vessel of the ram by the next blow.

This apparatus I contemplate applying in all situations where it is desired to elevate water by water-power, and also to springs and wells, wherever the operation of a siphon is practicable. I consider it in some points superior to the common hydraulic ram, inasmuch as the working apparatus, instead of being placed at the foot of the head of water which furnishes the moving power, is located above it, where it can never be immersed in back-water, and is conveniently situated for repair or regulation.

I consider it much superior in efficiency to other methods hitherto proposed for discharging liquids from the curve of the siphon, and as having unquestionable and very great advantages over the combination of the siphon and the water-ram devised by Hachette, inasmuch as I use the best form of the water-ram—that invented by Montgolfier, in which the escape and lifting valves act alternately, and are not connected with each other as in Hachette's machine—also in using a chamber of rarefied air in the manner herein described, for allowing the escape-water of the ram to pass down the longer leg of the siphon in a continuous stream, (instead of permitting it to receive the oscillating movement of the ram) whereby the loss of power from inertia and the friction of the water in the pipe is greatly diminished—also in having fixtures for filling, starting, stopping, and regulating the action of the engine, that can be reached and controlled near the head of the ram, which conveniences are either wanting in Hachette's machine or are situated unhandily at the extremities of the siphon.

What I claim as of my invention and desire to secure by Letters-Patent consists in—

A peculiar manner of working the water-

ram, in combination with the siphon, by the use of a chamber of rarefied air, for the purpose of causing the escape-water to flow down the longer leg of the siphon in a continuous stream; also in the use of channels in the packing of the joints, supplied with water from the air-vessel of the ram, for the purpose of excluding completely, and

with certainty, the external air from the siphon; also in the fixtures herein described for setting in motion and regulating the quantity of water consumed by the ram. 10

ERASTUS W. ELLSWORTH.

In presence of—

JESSE CHARLTON,

ERASTUS ELLSWORTH.

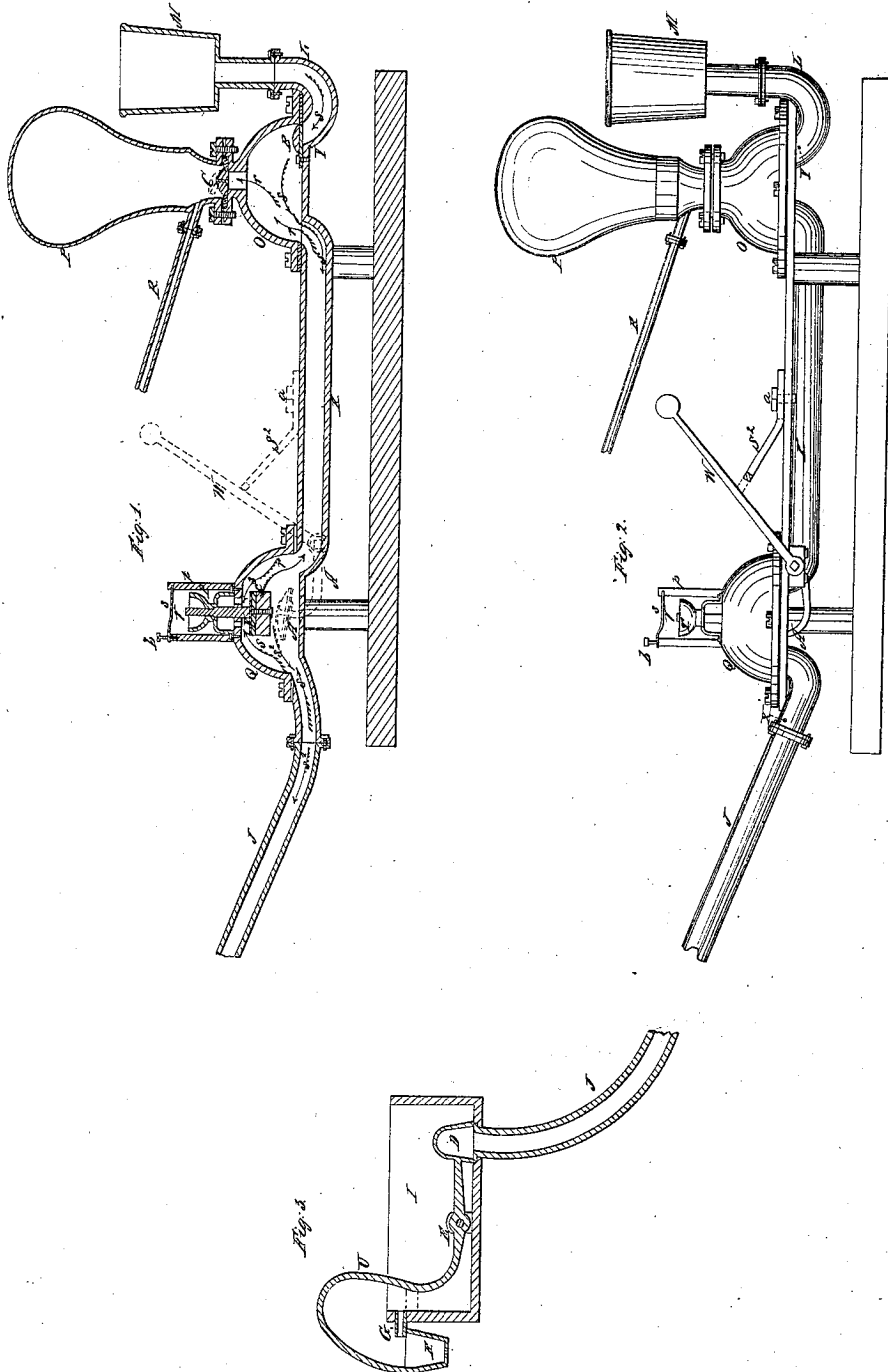


B. S. Benson,

Hydraulic Ram,

N<sup>o</sup> 4,328.

Patented Dec. 26, 1845.



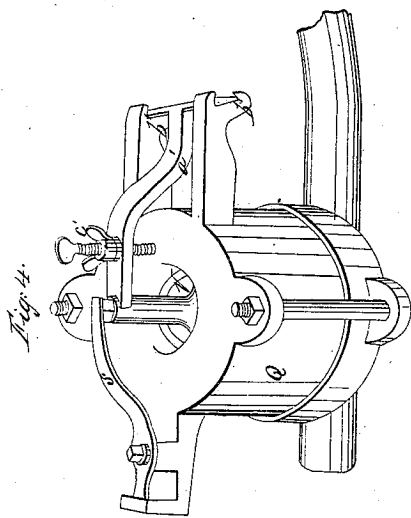
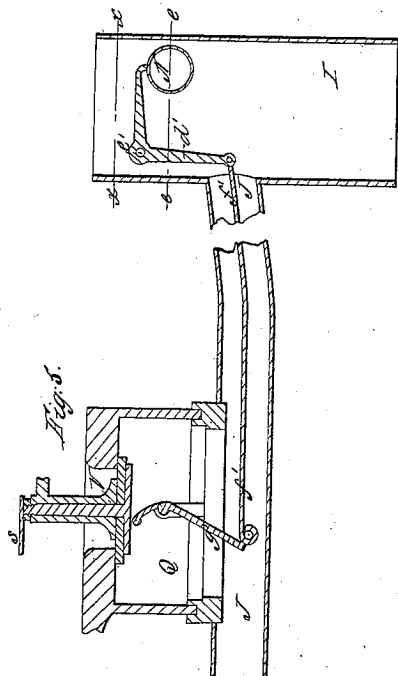
Sheet 2-2 Sheets

B. S. BENSON,

Hydraulic Ram,

Patented Dec. 26, 1845.

No. 4,328.



# UNITED STATES PATENT OFFICE.

BENJN. S. BENSON, OF HARFORD COUNTY, MARYLAND.

## HYDRAULIC RAM.

Specification of Letters Patent No. 4,328, dated December 26, 1845; Antedated August 5, 1845.

*To all whom it may concern:*

Be it known that I, BENJAMIN S. BENSON, of Harford county, State of Maryland, have invented a new and useful Machine for raising Spring-Water by the Momentum of a Descending Fluid in Contact Therewith; which is described as follows, reference being had to the annexed drawings of the same, making part of this specification.

Figure 1 is a vertical longitudinal section. Fig. 2 is a side elevation of the machine. Fig. 3 is a longitudinal section of the reservoir I.

My improvement consists in the raising of spring water from a lower to a higher level by the motive power of river, or branch water, taken from a lower level than that to which the spring water is to be elevated. Branch or river water has been used as a motive power to elevate spring water by other machinery than the water ram. The operation of the water ram heretofore has been to raise a portion of the same water that operated as a motive power in the machine. Under some circumstances it is considered an advantage to throw up more of the water afforded by a spring or springs at command than could be done by using a portion of the spring water as a motive power; consequently it would be advantageous to use branch or other water that might be at command. Under such circumstances the water ram is used with greater advantage for raising water than any other known apparatus, on account of its great simplicity and economy of motive power. The advantage of using the branch water in combination with the spring water as a motive power for raising a portion of the spring water has not before been had.

Description of the machine by which this effect is produced: I is a reservoir containing the water or propelling fluid placed above the level of the discharge valve V; J is a pipe leading from the bottom of the reservoir I to the water chamber Q; K is a second or additional pipe leading from the water chamber Q to a second water chamber O for containing the fresh water to be raised; L is a third pipe leading from the chamber O to the reservoir M containing the fresh or pure water to be raised, conveyed by said pipe L from said reservoir to said water chamber. The chamber O may be made of a semi-globular, or other convenient, form. The chamber Q may be made of

the same or other form; V is a puppet valve, or waste valve, for letting off the waste water at the proper time; and for shutting off the escape of the water as the water flows from the reservoir I through pipe J when it receives an impetus as it passes by said valve V and rams or drives the column of spring water in pipe K against a continuation of the column of water and forces it through chamber O into chamber P. P is an air chamber placed over the second chamber O for containing air to act on the water as a spring in the usual manner.

C is a valve in the bottom of or at the base of the air vessel C for holding the water that is forced into the air vessel.

R is the discharge pipe for conveying and discharging the fresh water.

B is a valve in the second chamber O aforesaid over the mouth of the pipe L for preventing the return of the spring water through said pipe L into the reservoir M.

Y is a small perforation in pipe L to admit air.

D is a valve attached to the end of a vibrating lever U that vibrates on a fulcrum E; and F is a bucket perforated in the bottom with a small aperture for the gradual escape of the water and G is a pipe for conducting the water to the bucket.

Operation: The pipes J and K being filled with river or other water from reservoir I which presses on the valves V and B and closes them; the valve V is then opened by the operator which causes the water to flow freely from the reservoirs I and M through the pipes J, K and L in the direction of the arrows and through the valve V to the waste conduit. The accelerated velocity of the water in passing through the puppet valve V producing increased momentum closes it; and then causes the column of water flowing from the reservoir I to have a pressure, by its impetus or momentum, on the column of fresh water in the pipe K, forcing it to take the direction indicated by the arrows *r* and to rise and pass the valve C, into the air chamber P, and then through the discharge pipe R. The elasticity of the air in the vessel P causes the water to flow in the pipes J and K in the direction of the arrows S and S<sup>2</sup> and to close the valve C which causes a partial vacuum in the chambers O and Q which relieves the valves B and V of pressure—the said vacuum and spring over the valve V causing it to open. The water

then flows from the reservoirs I and M in the manner before described; and in this manner the action of the machine is continued.

5 The operation of the apparatus for preventing the branch water in reservoir I descending below the level of the pipe G is described as follows: When the water has run out of the bucket F through the small  
10 aperture in the bottom of the same which it will do when it ceases to flow through the pipe G by the descent of the water in the reservoir the valve D will then preponderate and close the opening over the mouth  
15 of the pipe J and shut off the flow of the water through pipe J and cause the action of the machine to stop. The water continues to flow into the reservoir I until it again rises to the level of the pipe G, it  
20 then flows through said pipe G into the bucket F and fills it as aforesaid causing the end of the lever U to which the bucket is attached to preponderate and the lever U to vibrate and the valve D to open and the  
25 machine to resume its operation as aforesaid. By this arrangement the valve D is always kept surrounded by water which prevents the entrance of the air into pipe  
30 J and the consequent entire stoppage of the machine.

The machine being once started by opening the valves and a proper supply of water being kept up will need no personal attention as long as the machine remains in  
35 order. The spring *s* is placed above the stem of the valve *v*. It is let into a post *p* at one end; and at the other end it moves over a screw bolt *b* inserted into another

post for preventing it rising too high—the said spring having an oblong opening in it  
40 for that purpose. The spring *s* however may be arranged in any convenient manner.

The action of the spring *s* is as follows: When the velocity of the water in passing by said valve raises it the stem is forced  
45 upward against the spring which is partly contracted thereby. Then when the pressure on the valve is relieved by the partial vacuum created in chamber Q as aforesaid, the pressure of the atmosphere, aided by  
50 said spring will cause the valve to descend and open.

What I claim as my invention and desire to secure by Letters Patent is—

1. Raising spring water to a higher level  
55 than its source by the momentum of a running stream of river, or other water in contact therewith, in a double ram constructed as aforesaid, or other ram, constructed and  
60 combined substantially in the manner set forth, by which analogous results are produced—the two rams being united by an additional pipe K in which the spring and  
65 river water come in contact as above set forth.

2. I also claim the combination and arrangement of the lever U, bucket F, and valve D with the reservoir I as described  
70 for keeping up the action of the machine.

3. I likewise claim the arrangement of the spring *s* for insuring the opening of the valve V as described.

BENJAMIN S. BENSON.

Witnesses:

WM. P. ELLIOT,  
ALBERT E. H. JOHNSON.

J. C. Strode,  
Hydraulic Engine,

N<sup>o</sup> 5037.

Patented Mar. 27, 1847.

Fig. 3

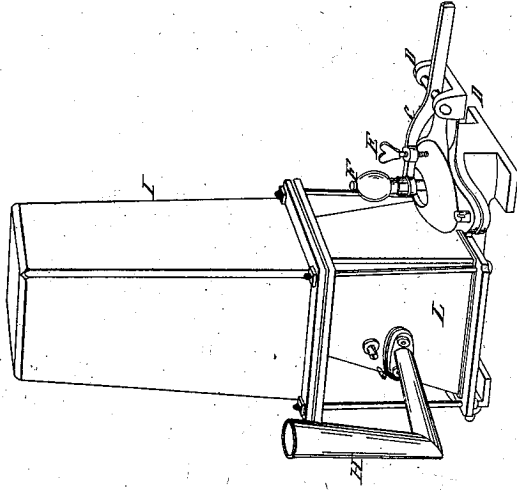


Fig. 2

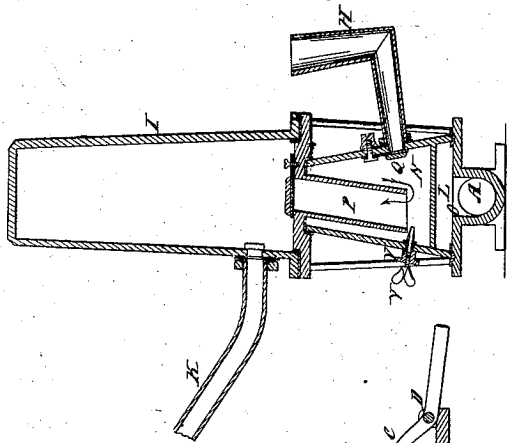
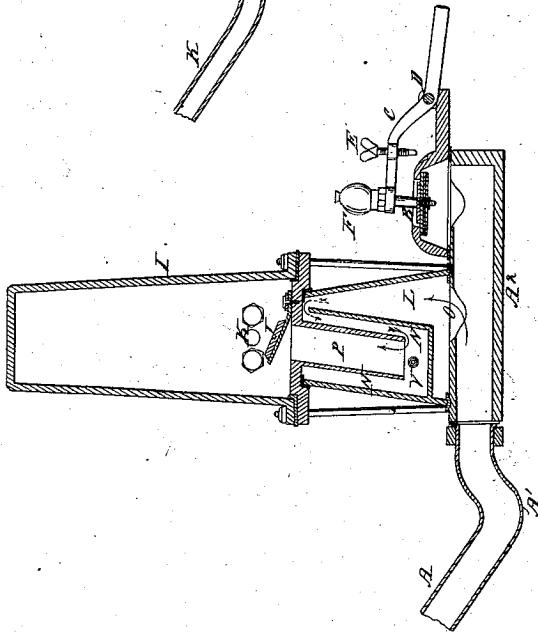


Fig. 1



# UNITED STATES PATENT OFFICE.

JOSEPH C. STRODE, OF EAST BRADFORD TOWNSHIP, CHESTER COUNTY, PENNSYLVANIA.

## HYDRAULIC RAM.

Specification of Letters Patent No. 5,037, dated March 27, 1847.

*To all whom it may concern:*

Be it known that I, JOSEPH C. STRODE, of East Bradford township, in the county of Chester and State of Pennsylvania, have invented new and useful Improvements in Machines for Raising Water, called "Strode's Pneumato Hydraulic Engine," which is described as follows, reference being had to the annexed drawings of the same, making part of this specification.

The nature of my invention and improvement consists in making use of a column of condensed air between the propelling fluid and the fluid that is to be raised—said air being condensed in a pyramidal shaped chamber by means of the momentum of a descending column of water—said chamber having a communication by a small opening at its top with another chamber into which the spring water, or fluid to be raised, is introduced called the spring water chamber, and upon which the condensed air in the first named chamber is made to act, causing said fluid to rise through a tube placed in the spring water chamber (open at its lower end and closed alternately at its upper end by means of a valve) into a large air vessel or receiver of the usual form and construction being conducted thence to its place of destination by pipes or hose in the usual manner.

Figure 1 is a longitudinal section. Fig. 2 is a transverse section. Fig. 3 is a perspective view.

Similar letters in the several figures refer to corresponding parts.

A is the main pipe for conducting the propelling water from the head or reservoir to the pyramidal air chamber. This pipe descends below the level of that portion of it which connects with the air chamber just before it reaches the said chamber and then ascends in a curved line to it forming a curved bend in the pipe as at A' for the purpose of preventing the air received at the valve B during the time in which the vacuum is produced in the air and water chamber as hereafter described, from filling the pipe A; as the air will not descend at said bend in the tube so that the surplus of said air after having filled the condensing chamber L may be carried off by the current of water, through the valve B. The pipe A is enlarged below the air chamber L as at A<sup>2</sup>, and has an opening O into the air chamber

L, through which the water passes when the valve B is closed.

B is a valve attached to a curved vibrating lever C turning on gudgeons D in boxes as its fulcrum having a set screw E for regulating the descent of the valve and a counter balance F for adjusting the valve. When this valve B is down as shown in Fig. 3 the water from the head flows through the opening which it closes. When it is up as shown in Fig. 1, the water rises into the pyramidal chamber L through the opening O and condenses the air therein.

H is a pipe for conveying the spring water to the spring water chamber. I is the air chamber into which the water is forced. J is the valve for holding it. K is a pipe or hose for conveying the water to its place of destination. The above named parts lettered from A to K inclusive are made and operated in the usual manner.

The improvements are as follows. L is a pyramidal chamber into which air is admitted through the valve B when it descends by the pressure of the external air to supply the partial vacuum created in the pipe A and chambers L and N. This pyramidal chamber has a communication by a small opening M at the top with another chamber N called the spring or pure water chamber; through which opening M the air so condensed is forced and presses on the spring or other water introduced into the same through the pipe H by which pressure the water in said spring water chamber is forced upward through a tube P reaching to near the bottom of said chamber, N, through the valve J into the air chamber I—said valve being represented as open in Fig. 1 and as closed in Fig. 2.

To raise water with this machine open the valve B and let the water flow out, then by closing the valve B the water which is now in motion in the pipe A will pass through the opening O into the pyramidal condensing chamber L and condense the air in the same as before, the condensed air will force the spring water up the tube P which had entered through the valve Q during the continuance of the partial vacuum above spoken of, into the air chamber I and condense the air therein until its density is equal to that in the condensing chambers L and N. below; at this time the spring water will cease to flow into the air cham-

ber I the valve J closes and the air in the chambers I, L and N commences expanding, that in the lower chamber L giving motion to the propelling fluid and driving it backward producing a partial vacuum in the machine and the air in the upper chamber I forcing the spring water to its place of destination. The said partial vacuum in the machine caused by the reaction of the fluid as aforesaid and the pressure of the external atmosphere on the valve B will cause it to open again. The water from the head then flows through this valve with an accelerating movement until it has acquired that degree of velocity as to cause the valve to close. The water having no longer any vent through the valve B passes through the opening O into the pyramidal air chamber L and repeats the operation above mentioned successively. In this manner the operation will continue as long as the machine remains in order and there is a head of water, to propel it.

The valve V is for the purpose of supplying the chamber I with air by admitting said air into the tube P. The said air is admitted during the time that the partial vacuum above mentioned takes place. The air thus introduced into the tube P ascends to the top of the same and is forced into the chamber I at the next stroke of the machine—said valve V' is represented open in Fig. 2 and may be closed, or regulated by screwing in the thumb screw V.

The principal advantages this machine possesses over other machines are, 1st, in case of forcing up pure water by the propelling power of a running stream of water less pure there is no possibility of the impure water mixing with the pure, there being at that time a column of condensed air between the two waters. 2nd, the water being forced into the upper chamber I by the condensation of air in the lower chamber the valve J opens more slowly than when water alone is made the propelling medium and also shuts more slowly thereby preventing the water from escaping back through the valve J after it is forced up, the valve J being nearly closed when the water ceases to flow upward into the chamber L. This advantage upon trial is found to be of considerable importance—enabling

the machine thus operated to force with a given quantity of water several barrels more of water per day than it would otherwise do. 3rd, there being no valve between the condensed air in the lower chamber and the driving water or at the opening O said air is permitted to act a longer time in forcing back said driving water and thereby making a more complete vacuum than in other machines and rendering useless the spring for opening the outlet valve B as used in several machines.

It is not necessary that the spring water chamber N and the air chamber L should be inclosed by the same envelop; but they may form separate chambers and they may be arranged in any convenient way, or manner, most acceptable to the constructor, provided that the capacity of the air chamber does not exceed a due ratio between the propelling power and the water to be raised.

I wish it to be understood that in the construction of these machines I do not wish to confine myself to the form of a hollow frustum of a pyramid, cone, or other form for the several chambers &c.; but I desire the privilege to vary these as I may think proper in form, proportion, and material—provided in all cases that the surplus air be carried off through the valve B. I, however, prefer the forms above described when pure water is to be raised with impure water.

What I claim as my invention and desire to secure by Letters Patent is—

1. Making use of a column of condensed air between the propelling fluid and the fluid to be raised in the manner above described or other mode substantially the same by which analogous results are effected.

2. I claim the particular combination of the pyramidal air chamber L the internal spring water chamber N and the water tube P with the curved conducting pipe A' and valve B and the air chamber I and hinged valve J constructed and arranged in the manner and for the purpose substantially as set forth.

JOSEPH C. STRODE.

Witnesses:

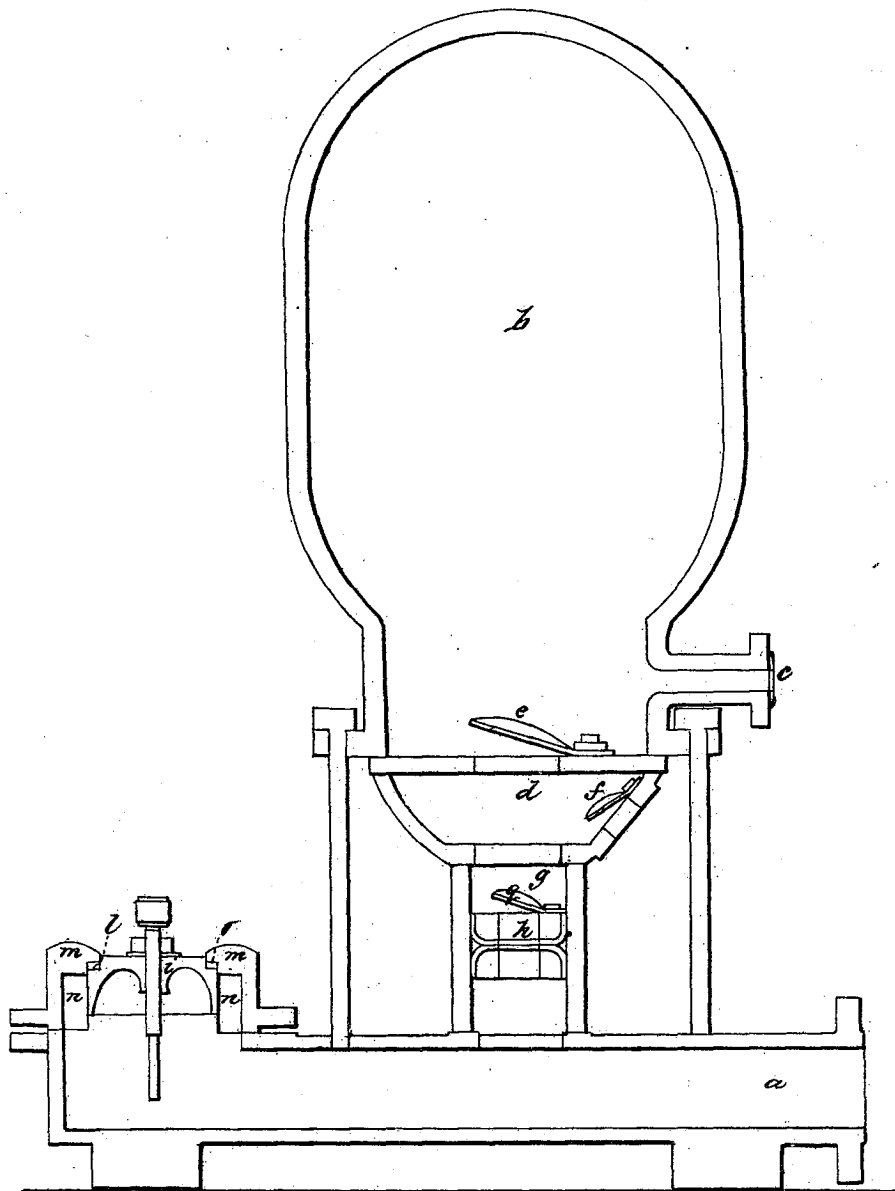
WM. P. ELLIOT,  
ALBERT E. H. JOHNSON.

*H. P. M. Birkenbine,*

*Water Ram.*

*N<sup>o</sup> 5,716.*

*Patented Aug. 15, 1848.*





# UNITED STATES PATENT OFFICE.

H. P. M. BIRKINBINE, OF PHILADELPHIA, PENNSYLVANIA.

## VALVE OF WATER-RAMS.

Specification of Letters Patent No. 5,716, dated August 15, 1848.

*To all whom it may concern:*

Be it known that I, H. P. M. BIRKINBINE, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Water-Rams, and that the following is a full, clear, and exact description of the principle or character which distinguishes them from all other things before known and of the usual manner of making, modifying, and using the same, reference being had to the accompanying drawing, which forms a part of this specification, and in which a vertical section is represented.

The nature of my invention consists in the construction of the valve, so as to form an air cushion therein, and fitting it to its seat with a water cushion, which is renewed at every stroke or pulsation of the ram; and also in forming a valve in the dividing piston, in double acting rams, as will be more clearly set forth in the description of its construction.

The main pipe, *a*, air chamber *b*, and rising main *c* are similar to those now in use; below the air chamber there is a second smaller chamber *d*, separated from it by a valve *e*; a valve *f* also opens into this chamber and admits the pure water to be raised; below said chamber *d* there is a cylinder *g*, in which a piston *h* works up and down; the bottom of this cylinder is open to the main pipe *a*, at the extreme end of which the valve *i* is situated on the upper side, as is the case with many well known rams now in use.

The construction of this valve *i* is novel, and consists of a cup-formed piston, the cup being inverted for the purpose of forming an air chamber. Through the center of this valve a set screw *k* passes, by which the length of the vibration is regulated; the outside of the valve is turned with a rabbet *l* around its upper edge; a similar rabbet is turned in the valve seat *m*, so that when the valve comes up to the seat it incloses a portion of water *o*, which relieves the valve

from the shock and wear of a contact of the metals. The valve works up and down between ribs *n*, and is thus steadied in its place; by this arrangement it will be perceived that the water cushion and the stratum of air within the cup of the valve relieves it of a portion of the shock in closing, as it is evident that without this air cushion the valve will close with its own momentum and that of the column of water combined, which in large machines produces a very great concussion.

In the cylinder *g* a piston *h* works as before remarked. This is formed of metal, and may be packed or not as found desirable, and instead of being made solid as has heretofore been essayed, it is made hollow, or with an opening through the center on which fits a valve *g* that opens upward; this valve is for the escape of air which accumulates beneath the piston, and which would otherwise stop its operation when said air became sufficiently condensed; for this reason all solid pistons have been abandoned, and diaphragms without it would not be available; for if the supply of water above the piston or diaphragm is insufficient, it is prevented from falling; and the machine is then liable to be injured and broken.

Having thus fully described my improvement, what I claim therein as new, and for which I desire to secure Letters Patent, is—

1. The construction of the valve in the manner described, so as to inclose a water cushion between the moving and stationary parts; and also the cup or air chamber within the valve to relieve it from the shocks it is otherwise subject to, as described.

2. I claim the safety valve in a diaphragm, or in this piston *h*, for the purpose, and substantially in the manner set forth, by which the safety and perfect working of the parts is insured.

HENRY P. M. BIRKINBINE.

Witnesses:

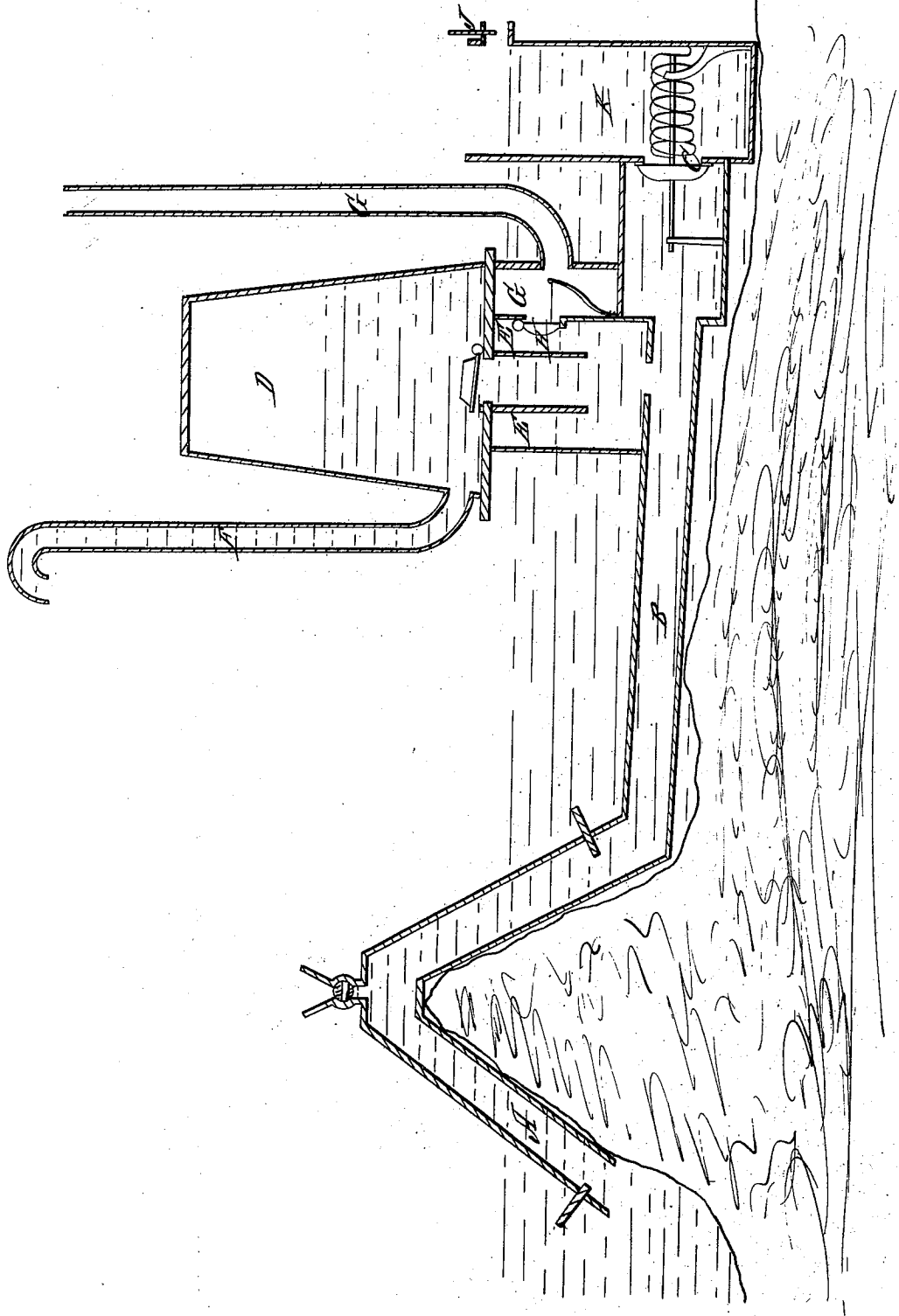
J. J. GREENOUGH,  
D. K. MORSELL,

*D. A. Leighton,*

*Hydraulic Ram.*

*N<sup>o</sup> 5,725.*

*Patented Aug. 22, 1848.*



# UNITED STATES PATENT OFFICE.

DAVID A. LEIGHTON, OF MIDDLEBURGH, NEW YORK.

## HYDRAULIC RAM.

Specification of Letters Patent No. 5,725, dated August 22, 1848.

*To all whom it may concern:*

Be it known that I, DAVID A. LEIGHTON, of Middleburgh, Schoharie county, State of New York, have invented a new and useful improvement in the construction of water-rams to enable said water-rams to operate advantageously when placed under water, which I call "Leighton's air and water chamber for water-rams," a full and complete description of which is in the following specification, with its accompanying drawings, to which reference is made.

Let A B C D E F in the drawing represent a water ram of the usual construction, syphon form, A B representing the main pipe, C outlet valve, D air vessel, E secondary air vessel, F rising main being essentially the ram, delineated and described in Ewbank's *Hydraulics and Mechanics*, 20 Greely's edition, 1848, pages 370, fig. 169.

The improvements which I propose to make consist in the first place of an air chamber and conduit G, G, placed outside and around the orifice of the air valve H, and carried up above the surface of the water in which the working parts of the ram are immersed, in order to secure access of the air to the air valve, without which protection the air valve would be inoperative and the machine subjected to the imperfect action resulting from the absorption of air in the air vessel by the pressure of the fluids. This chamber and conduit need not be in the form represented in the drawings, but (especially in large machines) a continuing chamber of size sufficient to admit access to the air valve H without deranging the other parts of the machine.

At the lower termination of the ram containing, or inclosing and surrounding the outer valve and its spring—which valve I arrange to act horizontally and to be kept on, and drawn to its seat by a spring, (spiral or otherwise)—I erect a chamber K of sufficient height to be elevated above the level of the water in which the ram stands, with an outlet to permit the water as it accumulates from the valve, to pass off at the said level. This outlet has a valve or door to close it J, whenever it may be desirable to do so for the purpose of access to the valve C and its spring, and the removal of the accumulated water to effect that purpose.

I claim—

1. The improvement of the water ram as usually constructed by the addition to the lower or secondary air chamber on the outside of it, surrounding and protecting the external orifice of the air valve; of an air chamber or conduit which shall exclude the access of water to the said valve, whenever the ram shall be immersed in water to a point above the level of said valve, by which improvement I am, for certain purposes enabled to work my machine when immersed in water.

2. I also claim the employment of a water chamber at the termination of the ram, inclosing and securing the outlet valve in the manner set forth in the above specification.

DAVID A. LEIGHTON.

Witnesses:

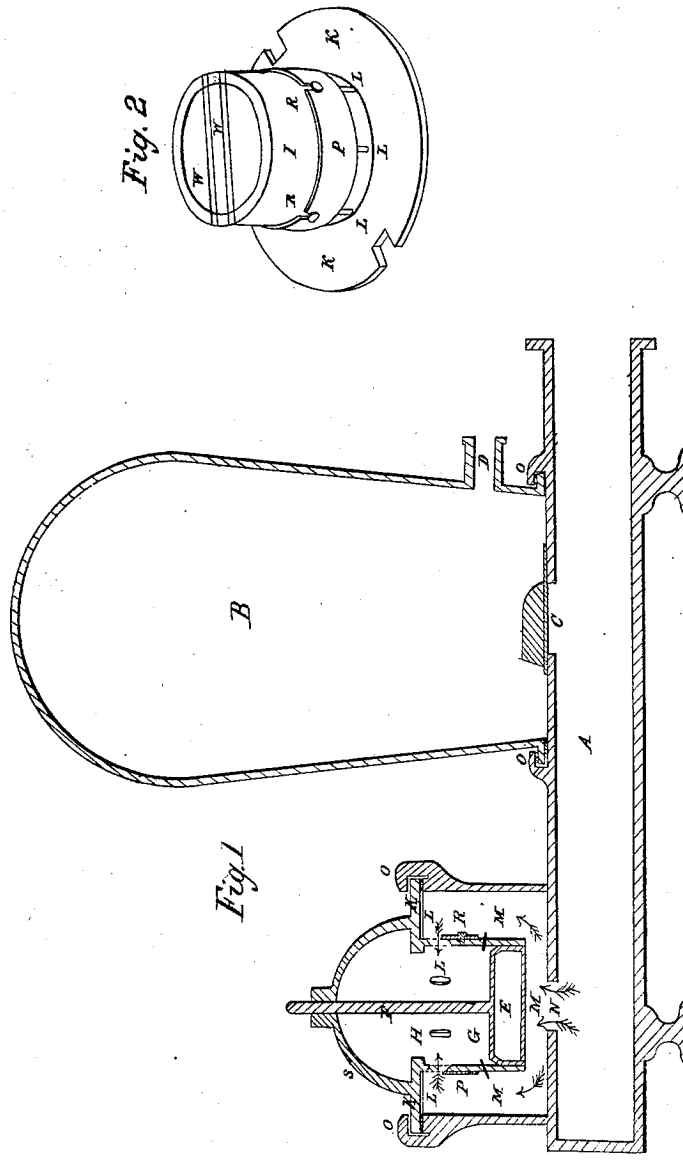
T. G. YOUNGLOVE.

RICHD. VARICK DE WITT.

A. D. SMITH.  
WATER RAM.

No. 6,346.

Patented Apr. 17, 1849.



# UNITED STATES PATENT OFFICE.

ALPHEUS D. SMITH, OF MEREDITH, NEW YORK.

## WATER-RAM.

Specification of Letters Patent No. 6,346, dated April 17, 1849.

*To all whom it may concern:*

Be it known that I, ALPHEUS D. SMITH, of Meredith, in the county of Delaware and State of New York, have invented a new and useful Improvement in the Hydraulic or Water Ram; and I do hereby declare that the following is a clear and exact description of the construction and operation of the same, reference being had to the annexed drawing making a part of this specification.

Figure 1 is a sectional view; and Fig. 2, a view of the impetus valve tube and the governing slide, both in a reversed position.

A is the supply pipe, running underneath the air-chamber and water-chamber, and impetus-valve chamber.

B is the air-chamber, the water entering it at C through an aperture provided with a valve shutting downward.

D is the discharge pipe from the air-chamber.

E is the impetus valve; F the impetus rod; G the impetus valve chamber; I the tube in which the impetus valve moves, constituting the impetus-valve chamber, and forming also the inner walls of the water-chamber M; H the aperture in the top of the impetus valve chamber; K a lip extending around the top of the tube I, solid with it, fastening down over the water-chamber *m*, and extending also within the tube I sufficiently far to form a shoulder which shall prevent the impetus valve E, in its upward motion, leaving the chamber in which it moves; L, L, L, holes through the upper portion of the tube I, for the passage of water from the water-chamber to the impetus valve chamber; *m, m, m*, the water-chamber, surrounding the impetus-valve chamber; *n*, an aperture between the supply pipe, and the water chamber; O, O, O, O, projections over the lip of the tube I, and also over the air-chamber, and its base for the purpose of fastening them firmly; P, a governing slide fitting closely around the tube I, fastened by a screw or screws to the tube, through one or more holes R, which admit the slide to be moved up or down upon the tube; S a semi-circle springing from the top of the tube I or lip K, through which the impetus-rod F, moves; W, W, wires at bottom of tube I.

The nature of my invention consists in the removal, in a great degree of the back-action or the resistance to the backward or down motion of the impetus valve, which in

the water-rams, as heretofore constructed, has hindered the play of the impetus-valve; also in materially lessening the quantity of waste-water, in the working action of the ram.

To enable others, skilled in the art, to make and use my invention, I will describe its construction and operation.

I construct my water-ram, in any of the usual forms, so far as the supply-pipe, the air chamber, the valve belonging to it, (the air-chamber) and the discharge pipe extend. I construct two chambers, an impetus-valve chamber, and a water-chamber, whose relative diameters are generally as 1 to 1½, or as 1 to 2. The impetus valve chamber, I place centrally within the water-chamber, leaving a space between the two equal to one quarter or one half the diameter of the former. The impetus valve chamber I generally make of the same diameter as the supply pipe, and extend it down within the water chamber, until the space between the bottom of it, and the bottom of the valve chamber is equal to one half of its, (the impetus-valve chamber's) diameter; a space large enough to admit sufficient water from below, into the water-chamber. To permit the water from above to pass backward and forward from the one chamber to the other, I make through the tube I (which constitute the impetus valve chamber, and also the inner side of the water chamber,) certain holes, L, L, varying in number and size according to the size and capacity of the ram. These holes are made at, or near the top of such tube, I, and are sufficiently large and numerous to permit the escape and passage of five-sixths of the water entering the ram, if necessary. By means however, of a governing slide, (P) fitting closely around the tube (I); these holes may be partially or wholly closed, and thereby the quantity of water escaping through them may be regulated by, and proportioned to the quantity of the supply. The aperture H, at the top of the impetus valve chamber I construct nearly as large as such chamber, being about one fourth of an inch less in diameter—the extent of the inward projection of the lip K, so that but slight, if any, resistance is offered to the free discharge of the water, which has entered the impetus valve chamber from the water chamber, and consequently but little obstruction is given to the upward motion of the impetus valve.

The impetus valve is solid, and is prevented from falling down or dropping out of the chamber in which it moves, by means of a wire or wires W, W fastened at the bottom of the impetus valve tube and upon which the valve rests when it has reached its further-most downward limit. The wires are represented in the drawing No. 2. The water-chamber is, in size, sufficient to admit the escape of five-sixths of the water or more. The impetus valve, the tube or part forming its chamber, the governing slide, and its fastening screws are constructed of brass,—the water chamber of iron, and cast solid upon that part of the ram, on which the air-chamber, also of iron, rests. When the impetus valve chamber, is properly and centrally placed within the water chamber, it is confined by fastenings or wedges running under the projections O, O.

The combined effect of the whole contrivance of my invention is to give a quicker motion to the impetus valve, both in its upward and downward motion; in the latter, by offering a way, through the water chamber *m*, and the holes L, L for the free passage of the water, and in the former, by removing the resistance occasioned by the water, above the valve, being forced through a small aperture, over the valve and by

enabling a portion of the water to pass back through the holes L, into the water chamber. The play of the valve being thus increased, there is less time, in any given number of its motions, for the water to waste and necessarily less wasted. The increased play of the valve, meeting no resistance in its motion, so as to cause it to lose its force or power, also forces more frequently, and a greater quantity of water into the air chamber.

What I claim as my invention, and desire to secure by Letters Patent, is—

The peculiar combination and arrangement of the parts, by which the impetus valve is made to work in a cylinder, placed for that purpose within a chamber, surrounding it; said cylinder being provided with openings in its sides, which may be enlarged or decreased, above the impetus valve, for the escape of the waste water, until its impetus becomes sufficient to act upon and close the valves, the whole constructed substantially in the manner, and for the purpose, as set forth above in my specification.

ALPHEUS D. SMITH.

Witnesses:

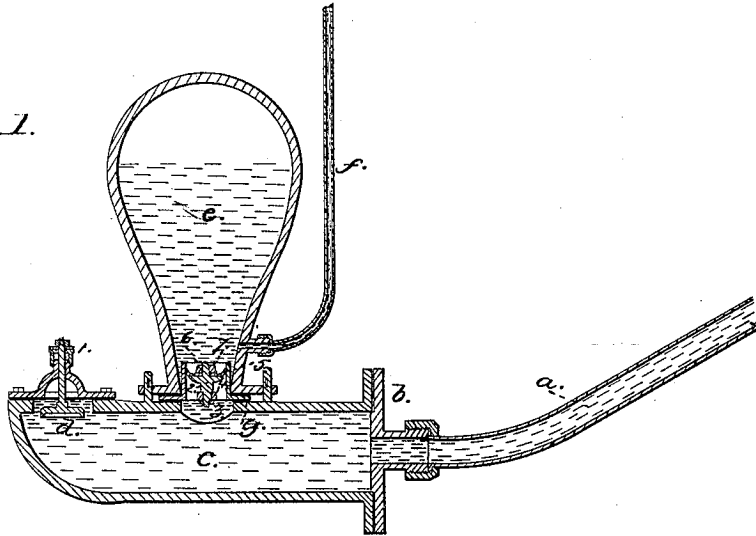
S. A. LAW,  
I. ALBION LAW.

*T. Hanson.*  
*Hydraulic Ram.*

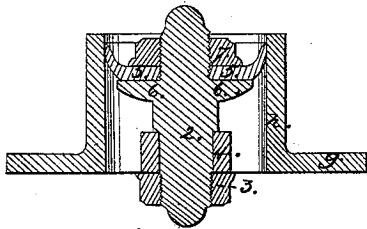
*No 12,549.*

*Patented Mar. 20, 1855*

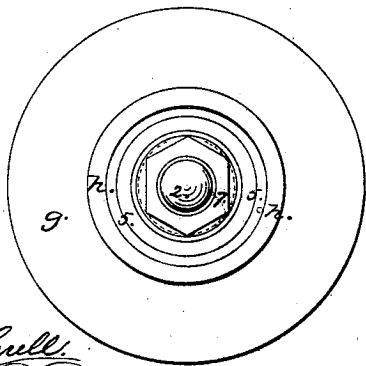
*Fig. 1.*



*Fig. 2.*



*Fig. 3.*



*Witnesses:*

*Samuel W. Snell.*  
*Charles Fenwick.*

*Inventor:*

*Thomas. Hanson.*

# UNITED STATES PATENT OFFICE.

THOMAS HANSON, OF NEW YORK, N. Y.

## VALVE FOR HYDRAULIC RAMS.

Specification of Letters Patent No. 12,549, dated March 20, 1855.

*To all whom it may concern:*

Be it known that I, THOMAS HANSON, of the city, county, and State of New York, have invented a new and useful Improvement in Hydraulic Rams, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1, is a longitudinal vertical section of an hydraulic ram with my improvement. Fig. 2, is an enlarged section of the valve forming the connection between the cylinder and air vessel; and Fig. 3, a plan thereof.

The same letters indicate like parts in all the figures.

In all hydraulic rams made prior to my invention the connection between the driving cylinder or chamber and the air vessel has been made by means of a clock or other valve closing onto a seat surrounding the aperture and in consequence presenting three serious difficulties. The first is that the valve, when closed, presents a greater area to the pressure in the air vessel than it does to the pressure of the water in the driving chamber below by the extent of the lap on the seat, the consequence of which is that a much greater pressure must be produced in the driving chamber by the driving column of water than there is in the air vessel before the valve will be opened to admit the water to the air vessel; so that the amount of water actually forced in the air vessel is less than could be obtained by the driving column of water if the area of the valve presented to the two opposing pressures was equal, and in consequence the bulk or height of column of water forced up to the reservoir is proportionally reduced. The second is that as the valve moves in, or nearly in the line of the motions of the water when the valve is closed by the preponderance of the pressure above all the water within the air vessel but below the opened valve is forced back into the driving chamber thus causing a dilatation in the air vessel which must be recompressed by the next impulse. And the third is that as the valve is closed suddenly and with violence by the rebound, there is a hammer like action of the valve on the seat, the blows of which follow each other in rapid succession corresponding to the pulsations of the driving column, these rapid and vio-

lent blows of the valve on its seat very soon wears the valve and the seat, thereby inducing leaks which destroy the efficient action of the ram. And besides, particles of sand, gravel, and other hard foreign substances are frequently caught between the packing of the valve and its seat which becomes imbedded in the packing of the valve by the violence of the blows, thereby destroying the action of the ram and requiring it to be taken apart for repair.

The object of my invention is to avoid these difficulties, and to this end my invention consists in combining with the cylinder or driving chamber of a water ram and the air vessel thereof a cylindrical tube or any equivalent thereto, the bore of which for the passage of water is provided with a cup of leather or other equivalent substance, secured and held at or about the center of the said tube, so that when spread out by the preponderance of the pressure in the air vessel above it shall be brought in contact all around with the bore of the tube and thus close the passage to the driving chamber; and when contracted by the preponderance of the pressure in the driving chamber it shall open the said tube for the direct passage of water from the driving chamber to the air vessel.

In the accompanying drawings *a*, represents the drive pipe, from the head of water, connected at *b*, in any suitable or ordinary manner with one end of the driving cylinder or chamber *c*, provided toward the other end and on top with the usual escape valve *d*, the stem of which is provided with an adjusting nut 1.

In the top of the driving cylinder or chamber there is a hole surmounted by the usual air vessel *e*, provided with the pipe *f*, leading to the reservoir. Over the hole and in line with it is placed a short cylindrical tube *h*, secured by a flange *g*, at its lower edge which is embraced between the outer surface of the driving cylinder or chamber and the flange of the air vessel *e*, by which the whole is properly secured together. At the lower end of the tube *h*, there is a bridge 4, to which is secured by a nut 3, a central spindle 2, which is formed with a flat or cup formed collar or flange 6, on which is placed a flexible cup 5, made of leather or other equivalent substance; and this cup is firmly held down by a screw nut 7. The flexible cup if flattened would be of greater



diameter than the bore of the cylindrical tube, so that the edge thereof, when spread, will be brought in contact with the bore of the tube, and close the passage, but when contracted will leave the surface of the tube to permit the passage of water. The leather or other substance of which this cup is formed should be crimped so that when inserted in the tube its outer periphery or edge will present a smooth surface to bear against the bore of the tube.

From the foregoing it will be seen that the leather cup will yield in either direction as the columns preponderate. The moment the pressure in the driving chamber exceeds the pressure in the air vessel the cup will be contracted and permit the water to pass so that the whole impulse will be exerted in forcing water into the air vessel minus the force necessary to bend the cup. And the moment the rebound takes place and the pressure in the driving chamber is reduced below the pressure in the air chamber the cup will be spread and close up the tube without permitting the water in the air vessel from running back into the driving chamber to the injurious extent heretofore experienced. And this latter advantage is due to the fact that the cup in spreading out to close the tube moves at right angles or nearly so to the line of motion of the

water, whilst on the old plan the valve moves in the direction, or nearly so, to the line of motion of the water, thus necessarily causing a dilatation of the air in the vessel to an extent equal to the bulk of water forced back into the driving chamber by the descending valve.

From the very form of the cup and its position in the tube foreign substances can not lodge and remain between the edge of the cup and the bore of the tube; and as the cup in spreading moves nearly at right angles to the line of motion of the water passing through the tube, the shock or hammer like action of the valve is much reduced.

I do not wish to be understood as limiting myself to the special construction herein specified so long as the same ends are attained by equivalent means.

What I claim as my invention and desire to secure by Letters Patent is—

The mode substantially as specified, of forming the connection between the driving chamber and air vessel of water rams by the tube and flexible cup placed within it, substantially as and for the purpose specified.

THOMAS HANSON.

Witnesses:

WM. H. BISHOP,  
ANDREW DE LACY.

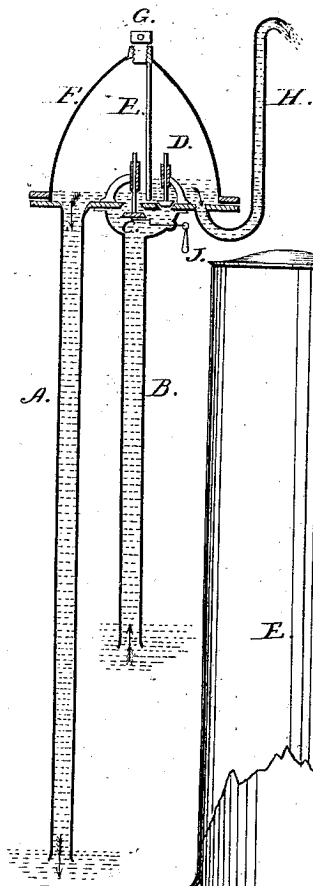
*E. W. Ellsworth,*

*Siphon Ram,*

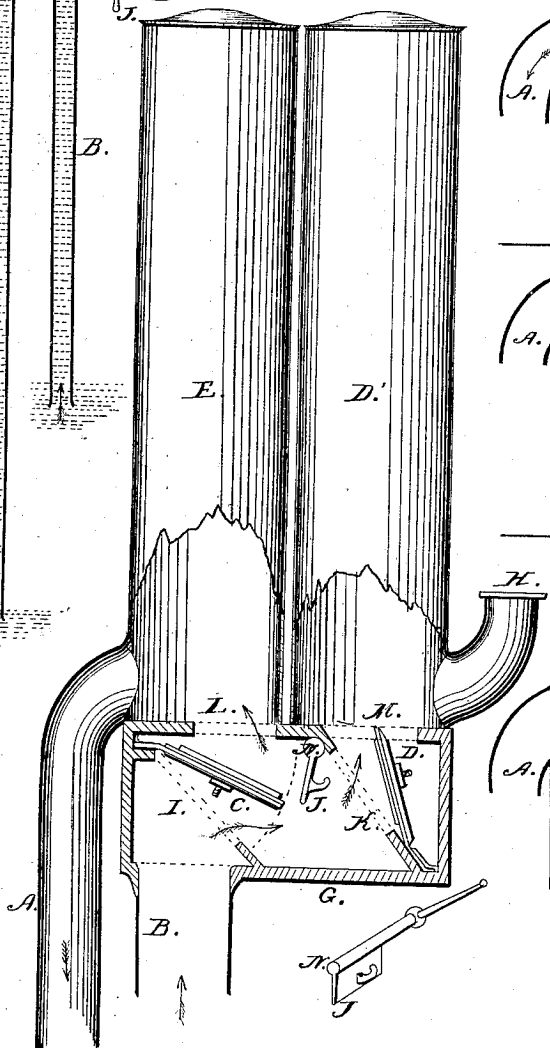
*No. 16, 178,*

*Patented Dec. 9, 1856.*

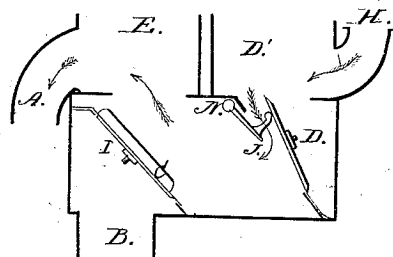
*Fig. 1.*



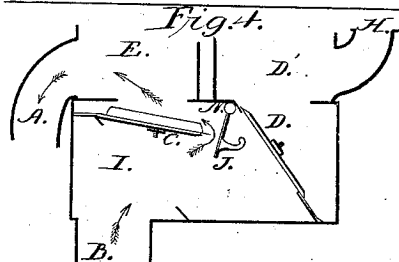
*Fig. 2.*



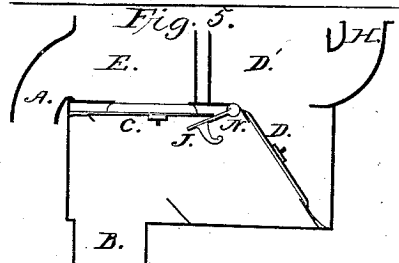
*Fig. 3.*



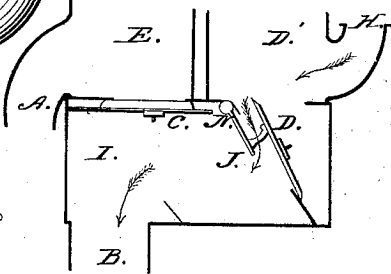
*Fig. 4.*



*Fig. 5.*



*Fig. 6.*



# UNITED STATES PATENT OFFICE.

ERASTUS W. ELLSWORTH, OF EAST WINDSOR HILL, CONNECTICUT.

## ARRANGEMENT OF VALVES, &c., IN SIPHON-RAMS.

Specification of Letters Patent No. 16,178, dated December 9, 1856.

*To all whom it may concern:*

Be it known that I, ERASTUS W. ELLSWORTH, of East Windsor Hill, in the county of Hartford and State of Connecticut, have  
5 invented a new and useful Improvement in Siphon-Rams, applicable also to the common hydraulic ram; and I do hereby declare that the following is a full and exact description thereof, reference being had to  
10 the accompanying drawings and to the letters of reference marked thereon.

The nature of my improvement consists in a new mode of arranging and operating the valves of the water-ram, with a view to  
15 greater durability, more economical action, and greater facility of regulation and repair than have hitherto been attained.

To enable others skilled in the art, to make and use my improvement, I will proceed to describe its construction and operation—first with reference to the siphon-ram for which it is especially intended and adapted. In doing so, it will be necessary  
20 at the outset to refer to a siphon ram for which I obtained Letters-Patent of the United States dated the sixth day of December eighteen hundred and forty five, and numbered four thousand two hundred and ninety six. A sectional sketch of that machine so far as is necessary to exhibit its  
25 mode of action is herewith given in the accompanying drawings—Figure 1—where A, and B, indicate respectively the long and short legs of a siphon which connect at top  
35 with a circular horizontal plate and communicate under the dome F, which is flanged packed and bolted to said plate. In said dome is a perpendicular partition which divides the cavity into two chambers. The  
40 pipe B, and the valves C, D, constitute a water ram, the suction of the water in A, after the pipes have been filled through G, operating the ram and driving a portion of the water which enters at the foot of B, up  
45 and out at H; the two chambers D, and E, of the dome contain air and maintain a continuous flow through the pipes H and A, respectively. The length of stroke of the main valve C, is regulated by a little crank  
50 having a handle outside at J.

My improvements are made with a view to diminish the extent of packed and bolted joints—to render filling the siphon more convenient, to make the valves more durable and more easily regulated—and to render the action of all the working parts visi-

ble, and consequently more readily intelligible. The principles of the above described machine are thereby embodied in a new form, upon which new form I base my  
60 present petition for Letters Patent.

A perpendicular section of my improvement is seen at Fig. 2, where corresponding parts are lettered as in Fig. 1. G, is a parallelepipedal box or chest for containing the  
65 valves, and its cavity is divided by two inclined partitions I and K, through which are valve openings. Through the upper side of the chest also are openings at L, and M, which communicate respectively with  
70 the tubular air chambers E, and D'. The valves C, and D are clack valves, with leather face and hinge, and metal back. The main valve C, is so hung that it may command either of the two openings I, or  
75 L—it is made of a width nearly equal to the horizontal depth of the valve-chest, so that water going the route B, I, L, A, passes mostly around that edge of the valve which is farthest from the hinge. At N, a horizontal  
80 shaft enters the chest through a stuffing box and is expanded, within, into a blade which in form and action resembles an ordinary key in a lock. On one side of this blade is a projection which when the  
85 key is turned to the right opens the valve D; when turned to the left, the blade approaches the edge of valve C.

Now suppose the apparatus to be set up in proper location, and that it be desired to  
90 fill the siphon preparatory to starting. Let H, be connected with a reservoir containing a little water and let the key N—G, be turned into the position indicated in Diagram 3. The water flows in the direction of the  
95 arrows, expelling the air from A. Now let the movement of the key be reversed until it comes to the position represented in Diagram 4. Valve D, closes, and the descent of the water in A acts by suction to elevate  
100 water from the source of supply at the foot of B, into B. The air which was previously in B, is thereby transferred over into A; a repetition of the manipulation with the key will now expel said air, and both legs of  
105 the siphon are then completely filled. The valve C, then commences beating against the opening L, and at each pulsation the momentum of the current in B, acts to drive a stream through D, M, H.

The rapidity of beat, and the volume of water passed by the valves is governed by

the position of N—J. The nearer the blade N—J is set to the edge of the valve C, the more the current which passes the valve is compressed, consequently the shorter the distance said valve drops before it is arrested and thrown up by said current. At the same time N—J never need touch C; and the object of the crank J, in Fig. 1 is thus accomplished without the wear incident to that fixture.

If, while the apparatus is in action, it be desired to stop it, move N—J to the left as shown in Diagram 5. C, is thereby closed, and all motion of water and valves ceases.

When things are in the position last described starting is effected by turning the key (as represented in Diagram 6,) to the right, far enough to raise the valve D, a little for an instant—then letting it drop to its bearing. By this means a current of water is started in the direction H, D, J, B, which is suddenly arrested by the closing of valve D; when the downward momentum acquired by the water in B, produces a transient vacuum under valve C, which, being more perfect than that occasioned by the weight of water in A, causes C, to drop open, and the pulsation of both valves immediately commences.

Thus it will be seen that the key N—J, in its relation to the valves D, C, accomplishes four distinct objects:—1st. It affords the operator a facile method of filling the siphon at the commencement of operations, and of expelling any air that may afterward enter the pipes—and that, without the necessity of plugging either leg of the siphon. 2d. It regulates the beat of the valves, without subjecting them to friction or wear. 3d. It offers a mode of stopping them. 4th. It furnishes a method of starting them.

In constructing the machine for use, I make one of the perpendicular sides of the valve-chest with a plate of glass set in a metal frame which frame is secured to the chest by two or more bolts. A tight joint is

made between the glass and the edges of the chest and partitions by means of india rubber packing, or without packing by using true plate glass, and grinding the edges of the chest to an accurate plane. The ingress of air at the point is further guarded against by a groove or water channel in the packing or (if packing is not used) in the edge of the chest—said channel running around all that part of the joint where the pressure is at any time inward, and communicating freely only with that compartment of the chest—viz, above the valve D,—where the pressure is always outward.

The tubular air vessel D' has the advantage that by exposing only a small surface of water to the compressed air, said air is absorbed very slowly, and the minute bubbles which enter from the siphon when in action are more than sufficient to compensate the loss.

I contemplate operating the machine herein described with the pipes A, B, laid at any angle to suit location, and even simply as a common hydraulic-ram—in this latter case, as A, would be dispensed with, the exhaust chamber E, would be unnecessary, though it would not interfere.

Having, as I believe, fully described all that is essential to an understanding of the methods of constructing and operating my improved ram, what I claim therein as new, and desire to secure by Letters Patent, is—

The combination of either or both the valves of the ram with a governing key; said valves and key being constructed and arranged in the manner herein described, or in any similar manner whereby any or all of the same objects are accomplished, either in a siphon-ram or in a common hydraulic-ram.

ERASTUS W. ELLSWORTH.

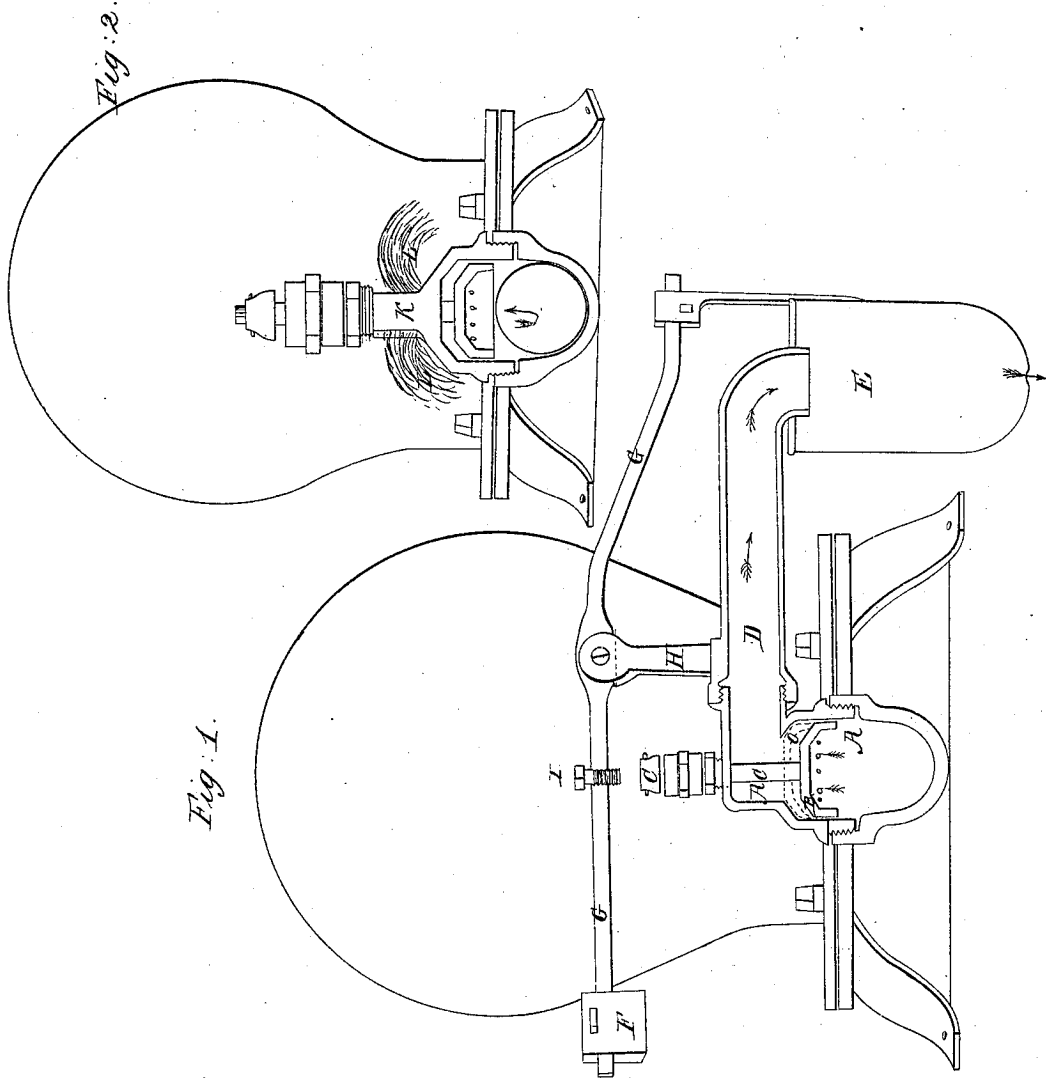
Witnesses:

N. SHIPMAN,  
WM. B. SMITH.

*J. F. Warner,*  
*Hydraulic Ram,*

*N<sup>o</sup> 20,523.*

*Patented June 8, 1858.*



# UNITED STATES PATENT OFFICE.

JOS. F. WARNER, OF PHILADELPHIA, PENNSYLVANIA.

## HYDRAULIC RAM.

Specification of Letters Patent No. 20,523, dated June 8, 1858.

*To all whom it may concern:*

Be it known that I, JOSEPH F. WARNER, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Improvement on the Hydraulic Ram; and I do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being had to the annexed drawings, making a part of this specification, in which—

Figure 1 is a longitudinal elevation of improvement, connected with the figure of a hydraulic ram, Fig. 2 is an end view of a ram, with the ordinary arrangement of open top valve chamber, representing the waste of water.

A A is the valve chamber; B the puppet valve; C C, the valve spindle; D a pipe to convey discharge water to cup E.

F is a weight connected with lever or beam G, by means of a key or set screw. Cup E is also arranged so as to be fastened on the lever or beam G, by means of a key or set screw.

H is a fulcrum to support lever or beam G.

I is a set screw. The dotted lines show the position of spindle when valve is closed.

K, Fig. 2, represents the ordinary open top arrangement of valve chamber; L L, irregular lines showing the waste water from the same.

The nature of my invention consists in arranging that part of the valve chamber above the valve, so as to prevent the water from wasting immediately after passing the valve, by conducting it through a pipe or spout D, to a cup or basin E, by which means said cup is kept full for the purpose of overbalancing weight F, and thereby keeping the set screw I, clear of valve spindle C C, while the ram is in motion; the arrangement of cup E, with an opening in bottom of sufficient size to let the water escape if the ram should stop, and thereby diminish the power of that end of the lever, to which said cup is attached, the weight F as shown, attached to lever G, of sufficient weight when operating in connection with fulcrum H, to bring down the point of set screw I, upon the top of spindle of valve C,

with sufficient force to overcome the weight of driving water, which holds up the valve and forces the valve to fall and the ram to start. The cup E and the weight H are so arranged that both can be shifted upon the beam or lever, and fastened by key or screw so that the cup or basin when full, overbalances the weight F but when it is empty then said weight overbalances the cup.

The arrangement operates thus: While the ram is working instead of wasting the water immediately after passing the valve, as shown at L L, Fig. 2, it is conducted to cup E, by pipe or spout D, from which it is wasted, partly by overflowing, and partly through opening in the bottom of cup, the said cup being thus kept full while the ram is in motion. The set screw I is kept clear of touching or interfering with valve, or ram, so that not a particle of power is lost. As soon as the ram stops from any cause, then the cup ceases to get its supply, and immediately commences to empty, and consequently to get lighter; then the power is changed to weight F, which brings down the leverage upon the top of valve spindle, and forces it to drop, and at once the cup fills again, and then it being the heaviest, raises the lever clear of the valve, and then the ram works freely on as before. The arrows indicate the course of water.

What I claim as my invention, and desire to secure by Letters Patent is—

Using the water after passing the puppet valve by conducting it to a vessel or cup or basin, having a waste opening, or openings in the bottom, and used as a power upon a lever or beam to overbalance another power which is greater when the cup is empty, and least when the cup or basin is full, the conducting pipe D, the closed valve chamber A, the set screw I fixed over the valve, the fulcrum H, and beam or lever G, all the parts as substantially set forth, or used in combination for the purpose of keeping any hydraulic ram to which it may be attached in motion.

JOS. F. WARNER.

Witnesses:

JOHN E. JONES,  
GEORGE I. PIPER.

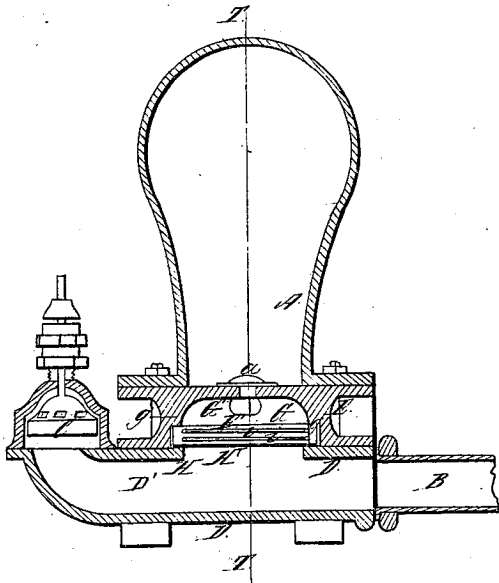
*H. W. Stetson.*

*Water Ram.*

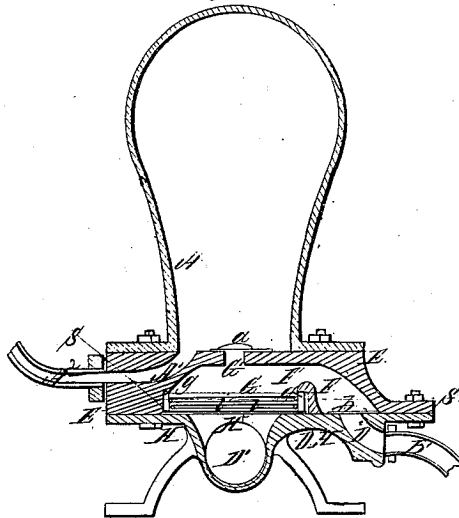
*N<sup>o</sup> 100,084.*

*Patented Feb. 22, 1870.*

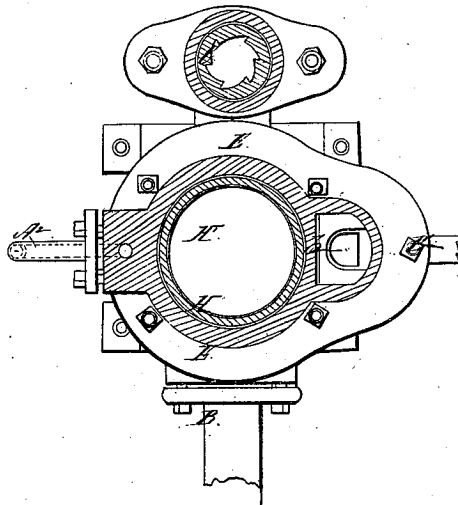
*Fig. 1.*



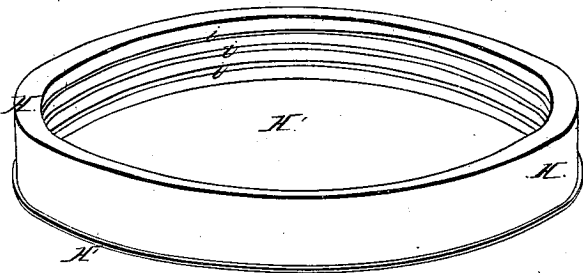
*Fig. 2.*



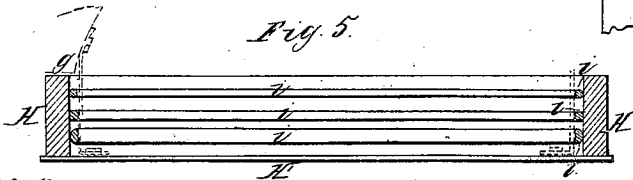
*Fig. 3.*



*Fig. 4.*



*Fig. 5.*



*Witnesses:*  
*S. Hooper*  
*Rufus Blake*

*Inventor:*  
*Kimball W. Stetson*

# United States Patent Office.

KIMBALL W. STETSON, OF KINGSTON, MASSACHUSETTS.

Letters Patent No. 100,084, dated February 22, 1870; antedated February 18, 1870.

## IMPROVEMENT IN WATER-RAMS.

The Schedule referred to in these Letters Patent and making part of the same.

To all whom it may concern:

Be it known that I, KIMBALL W. STETSON, of Kingston, in the county of Plymouth, and State of Massachusetts, have invented certain new and useful Improvements in Means for Raising and Forcing Liquids; and I hereby declare the following to be a full and exact description thereof, reference being had to the accompanying drawings which form a part of this specification, in which—

Figure 1 is a vertical longitudinal section;

Figure 2 is a cross-section on the line T T in fig. 1;

Figure 3 is a horizontal section on the line S S in fig. 2;

Figure 4 is a perspective view of the diaphragm detached on a larger scale; and

Figure 5 is a central vertical section of the same.

Similar letters of reference indicate like parts in all the figures.

My invention relates to raising and forcing water and other liquids by hydraulic or other pressure, and is particularly adapted for use as applied to a hydraulic ram, in which position it is described in this specification.

The invention consists in the combination of a rigid part with a ring or casing under the edges, which yields by its elasticity, and allows the rigid part to move as the pressure on its faces varies, so as to contract or enlarge the fluid-chambers or spaces on the opposite sides of the compound diaphragm so formed; also, in a certain arrangement of valves, in connection with such compound diaphragm, to control the action of a fluid admitted to one of its sides; also, in the use of rings, or spiral supports in combination with the above, so arranged as to sustain the elastic case without interfering with its action; and, lastly, in the double-chambered hydraulic ram, composed of a suitable diaphragm dividing the fluid cavity, and having valves for controlling the ingress and egress of fluids through connections on one side, and with the ram-valve and driving-pipe on the other side; as more fully set forth below.

To enable others skilled in the art to make and use my invention, I will proceed to describe it by the aid of the drawings and the letters of reference marked thereon.

A is the air-chamber;

B is the driving-pipe; and

C is the choke or stop-valve, which alternately stops and releases the water in the driving-pipe, as is familiar. These parts may be constructed in the same form and operate in the same manner as in any of the varieties of hydraulic rams.

D is a casting of iron, and composes the body of the ram. It is attached to the driving-pipe B and valve C by means of screws in the ordinary manner.

E is another casting of iron, fitting down upon the

casting D, and supporting the air-chamber A. These three castings, A D E, are held securely together by bolts, as represented, and the joints between them are made tight by thin sheets of leather, rubber, lead, or other soft material placed between them.

The casting E has two recesses or chambers, F and G, formed in its lower surface.

These chambers connect together within the casting through the passage F', and also connect with the interior of the air-chamber A through the passage G', which is covered by the self-acting valve *a*.

A passage, D<sup>2</sup>, in the casting D, communicates at one end with the pipe B', which is connected with a suitable reservoir for supplying pure water or other liquid desired to be raised.

The other end of this passage D<sup>2</sup> opens into the recess or chamber F, within the casting E, and is covered by the self-acting valve *b*.

The recess G is fitted to receive the annular rubber spring H, the upper face of which rests against a suitable shoulder, *g*, formed in the casting E, as represented, while the lower face presses upon the circular plate H', which rests upon the casting D, and covers a hole therein opening into the passage D<sup>1</sup>, connecting the interior of the driving-pipe B with the valve C, as represented.

The annular rubber spring H and plate H' placed together, as represented, form an elastic and very durable diaphragm which is of great importance. I will now describe them more in detail.

The annular rubber should be formed of the most elastic and durable vulcanized rubber to be procured, and of a little less diameter than the hole in which it is placed. Its depth axially should be slightly greater than the depth of the hole between the shoulder *g* and plate H', so as to press against the shoulder *g* and plate H' sufficiently hard to form a tight joint in both places. The rubber may be cemented to the shoulder *g* and to the plate H', to insure that the joints shall be tight if desired.

The thickness of the rubber radially should be governed by the size of the plate H', and also the depth from which the water is desired to be drawn before it reaches the level of the ram. The larger the plate, as also the deeper the reservoir, the thicker the rubber should be.

Rings *i* are inserted within the annular rubber H, so as to brace it and keep it from collapsing or being forced inward to any great extent, but at the same time to allow it to be compressed and expanded vertically. They are formed of the same outward diameter as the interior of the rubber, and are held in place within the rubber by cement, or they may be made slightly larger than the interior of the rubber, in which case the rubber will cling to them without the cement.

The rings *i* may be made of metal, wood, whale-



bone, rattan, or any material which will keep its shape so as to prevent the rubber from being forced inward, and may be of square, round, or flat section, but I prefer to make them of round brass wire, soldered together in the circular form.

In place of the several separate rings *i*, one continuous wire may be bent spirally around and placed within the annular rubber. Such spiral wire will brace the rubber, and keep it properly distended, and at the same time allow it to expand and contract axially to any necessary extent.

In operating my invention, pure water or other liquid to be raised or forced is supposed to fill the spaces *G' F F'* in the casting *E*. Other water which may be dirty, warm, or otherwise unfit for use or for mingling with the liquid to be raised, but which has a sufficient head, is then passed through the driving-pipe *B*, passage *D'*, and past the valve *C* in the usual manner.

At each closing of the valve *C*, the sudden pressure in the passage *D'* (caused by the inertia of the water in the driving-pipe) against the plate *H'* forces it upward by compressing the rubber *H*, and thereby reduces the space within the cavity *G* above it, and forces a quantity of the water contained within the recess *G* through the passage *G'*, and past the valve *a*, into the air-chamber *A*.

So soon as the momentum of the water in the driving-pipe is overcome, the usual reaction takes place, which relieves the pressure within the passage *D'*, and allows the valve *C* to open by its own weight, in the ordinary manner, when the water in the pipe *B* again flows forward to escape past the valve *C*.

This reduction of pressure allows the expansive force of the rubber *H* to urge down the plate *H'*, and enlarge that portion of the space *G*, which is contained within the rubber.

This enlarged space is thereupon filled by water drawn in past the valve *b* from the pipe *B'* and the connected reservoir.

When the valve *C* again closes, more water is again forced past the valve *a* into the air-chamber *A*, when the rubber, again expanding, fills the space above the diaphragm, as before described.

This operation of filling the space above the yielding part or diaphragm *H H'* with fresh water drawn past the valve *b* by the expansive or downward tendency of the diaphragm, and of emptying past the valve *a* by the pressure caused by the sudden stoppage of the water within the driving-pipe *B*, is repeated indefinitely, thereby drawing water from the reservoir to which the pipe *B'* is attached, and discharging it into the air-chamber *A*, from whence it is conveyed away through the passage *A'* and pipe *A''* to the desired point.

It is obvious that as much water will not be forced into the air-chamber *A* as if there were no diaphragm intervening, for the reason that a part of the power of the water is expended in forcing up the diaphragm.

It is also obvious that the force exerted to press the diaphragm up may again be utilized (or a great part of it) in sucking the water from a lower elevation, so that in reality nearly the whole power of the water, or so much thereof as in ordinary rams, may be utilized in the two operations of drawing and forcing the liquid.

When the water is required to be drawn from a considerable depth, the rubber *H* may not expand sufficiently to bring the plate *H'* entirely down upon the casting *D*, as is the case when it is raised only a little distance; but the rubber will always expand far enough to reduce its expansive force to a degree about equal to the resistance of the water contained in the pipe *B'*, acting upon the area of the plate *H'*, thereby insuring that the expansive power of the rubber will be but slightly, if any, in excess of the press-

ure due to the height from which the water has been already drawn.

A simple sheet of elastic rubber stretched across the recess *G*, between the parts *D* and *E*, may operate successfully for a time as a diaphragm, but the continual combined stretching and bending action will destroy its utility in a short time.

A sheet of leather, rubber, or other flexible material which will not allow the fluids to pass through it, may be placed, as above, between the parts *D* and *E*, and may be strengthened by the addition of a disk or plate near the center, upon which a metal or other spring may press, to form, or assist to form its elastic power; or a diaphragm may be made in the form of a hollow tube, of elastic rubber, attached firmly at one end to a plate, and the other secured to the lower part of the recess *G*, and allowing the plate to stretch the rubber instead of compressing it; but all such forms in which the material is forced to expand or stretch beyond its natural size I do not consider so desirable as the form represented.

I propose to use the rings or supports *i* on either the interior or exterior of the annular rubber—in some cases on one side, and in some cases on the other, but always opposite to that upon which the pressure is greatest.

I also steady the rings *i*, to insure that the rubber *H* shall not swing or move laterally in any direction, by a rigid cylinder or other rigid guides placed upon the plate *H'*, or attached to the casting *E*.

Such guides are shown in red lines in fig. 5. That shown on the right of the figure is attached to the plate alone, and, when used, the casting *E* above the shoulder *g*, must be recessed, so as to allow the guide to rise with the plate.

The guides shown on the left of the figure are attached both to the plate *H'* and to the casting *E*, and slide one within the other like a telescope.

I have represented my diaphragm in a circular form, but any other form may be used with success in which the strip of rubber *H* and shoulder *g* conform to the plate *H'*, so as to leave a portion of the chamber *G* inclosed within the rubber.

It is evident that any means which will alternately compress or force upward the diaphragm *H H'*, and in turn alternately release the same, may be made as effective in sucking and forcing up the liquid as the pressure produced by the sudden stoppage of a current of water, as is the case in the operation of a hydraulic ram.

Having now fully described my invention,

What I claim as new therein, and desire to secure by Letters Patent, is as follows:

1. The elastic ring or casing, of rubber or analogous yielding material, *H*, in combination with the rigid covering part *H'*, and adapted to form therewith a movable side or diaphragm for the fluid-cavity *G* by the direct compression or expansion of the yielding material, substantially as and for the purposes herein set forth.

2. The valves *a* and *b*, arranged to operate in combination with the diaphragm *H H'*, substantially in the manner and for the purpose herein set forth.

3. The rings *i*, in combination with the diaphragm *H H'*, so as to brace and support the elastic material, substantially in the manner set forth.

4. The double-chambered hydraulic ram above described, having the valves *a b* communicating with the chamber *G*, and having the valve *C* and driving-pipe, communicating with the chamber or passage *D'*, and having a suitable diaphragm or yielding partition to separate the chamber *G* and passage *D'*, and arranged for joint operation substantially as and for the purposes herein set forth.

Witnesses: KIMBALL W. STETSON

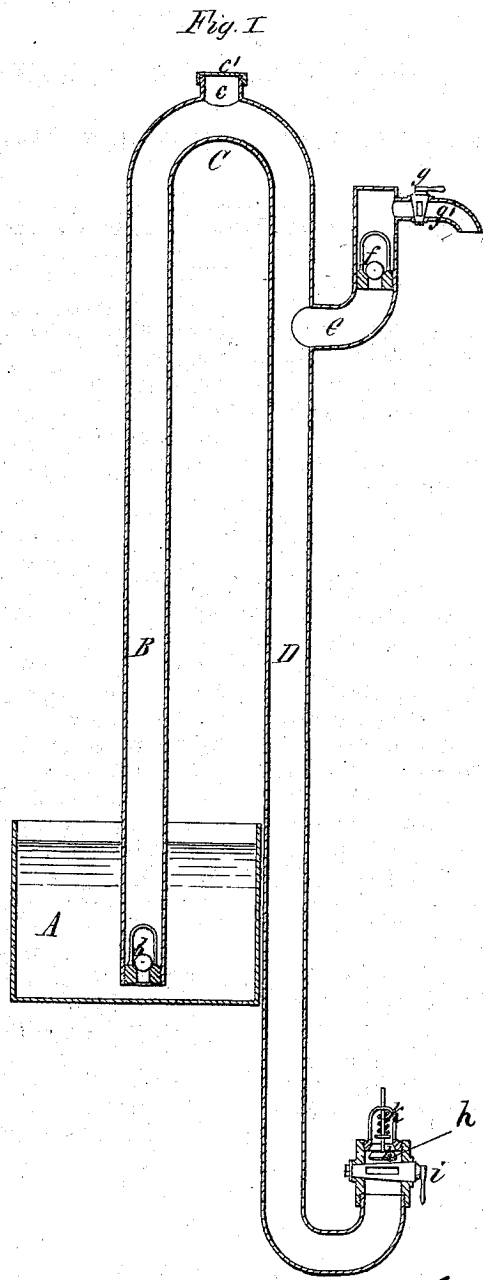
S. HOSFORD,

RUFUS BLAKE.

J. M. BOIS.  
Siphon-Pumps.

No. 136,809.

Patented March 18, 1873.



Edward Wilhelm }  
George J. Metzger } Witnesses.

James M. Bois }  
Inventor

# UNITED STATES PATENT OFFICE.

JAMES M. BOIS, OF SALAMANCA, NEW YORK.

## IMPROVEMENT IN SIPHON-PUMPS.

Specification forming part of Letters Patent No. 136,809, dated March 18, 1873.

*To all whom it may concern:*

Be it known that I, JAMES M. BOIS, of Salamanca, in the county of Cattaraugus and State of New York, have invented certain Improvements in Siphon-Pumps, of which the following is a specification:

This invention relates to an apparatus designed for raising water by siphonic action.

In the accompanying drawing, Figure I is a sectional elevation of my improved siphon-pump.

A represents the reservoir containing the water; B, the short leg of the siphon; C, its crown; and D, the long leg of the siphon. *b* represents the valve or stop-cock arranged in the short leg of the siphon at its lower end. *c* represents an opening provided in the crown of the siphon and closed by a screw-cap, *c'*. *e* represents the discharge-pipe arranged near the crown of the siphon in the leg D. It is provided with a valve, *f*, arranged so as to prevent access of the external air into the said leg. *g* is a faucet arranged in a continuation, *g'*, of the discharge-pipe *e*. *h* is an automatic valve arranged in the long leg D of the siphon at its lower end so as to prevent the outflow of the water when closed. Its spindle works against a spring, *k*, which throws the valve back into its open position. *i* represents a stop-cock arranged in the lower part of the leg D, near the valve *h*, so as to absolutely close the lower end of said leg when desired.

The operation of my apparatus is as follows: The cocks *b i* being turned so as to prevent passage of the water through their respective openings, and the opening *c* being opened, water is filled into the legs of the siphon through the latter, and the air contained in the legs is expelled, partly through the discharge-pipe *e* and partly through the opening *c*. When the water commences to flow out of the discharge-pipe *e* the faucet *g* is closed and the crown of the siphon filled, when the cap *c'* is again applied so as to close the opening *c* air-tight. Upon opening the cocks *b i* and the discharge-faucet *g*, the water is first discharged through the lower end of the leg D until its momentum closes the valve *h*, when the water will raise the valve *f* and discharge through the pipe *e* and faucet *g*, thus relieving the valve *h* of excessive pressure and enabling the spring *k* to return the latter to its open position, when the same operation is repeated. The discharges of water through the pipe *e* follow each other in such rapid succession that a comparatively steady flow of water is obtained.

I claim as my invention—

In combination with a siphon, the valves *b h f*, the cocks *g i*, and duct *e*, when arranged to operate as specified.

JAMES M. BOIS.

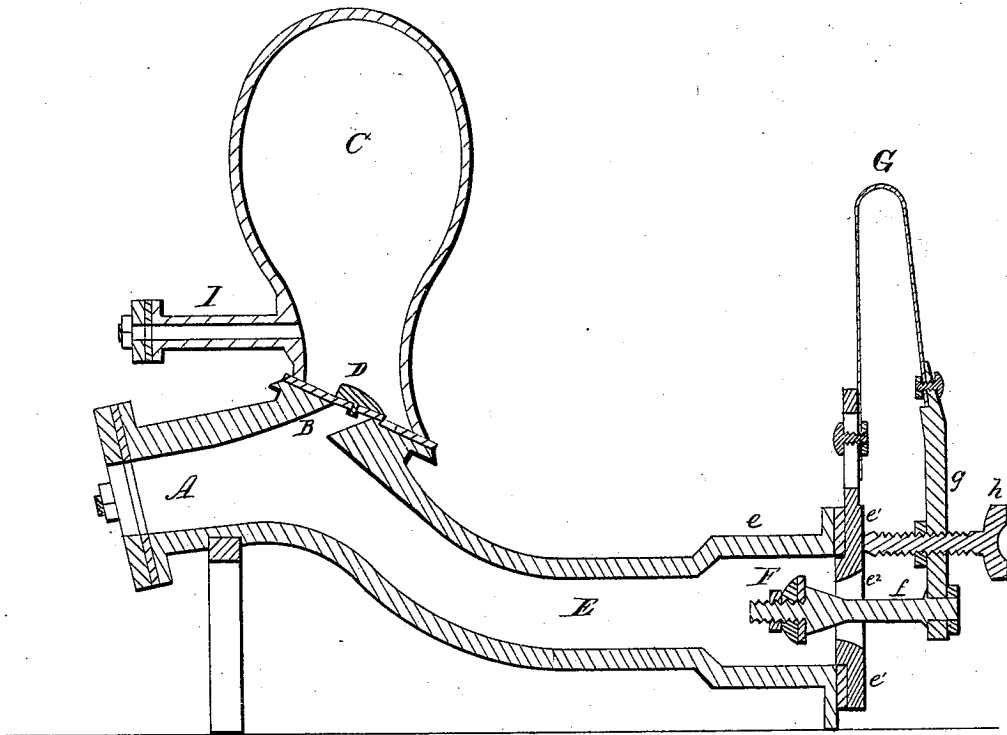
Witnesses:

EDWARD WILHELM,  
GEORGE J. METZGER.

I. B. MILLINGTON.  
HYDRAULIC RAMS.

No. 177,144.

Patented May 9, 1876.



WITNESSES-

*Phil. W. Hale,*  
*Wm. Seal & Hale.*

INVENTOR-

*I. B. Millington*  
*By Edward Kennard & Co.*  
*Attorneys*

# UNITED STATES PATENT OFFICE.

ISAAC B. MILLINGTON, OF SAFE HARBOR, PENNSYLVANIA.

## IMPROVEMENT IN HYDRAULIC RAMS.

Specification forming part of Letters Patent No. 177,144, dated May 9, 1876; application filed February 21, 1876.

*To all whom it may concern :*

Be it known that I, ISAAC B. MILLINGTON, of Safe Harbor, in the county of Lancaster and State of Pennsylvania, have invented certain new and useful Improvements in Hydraulic Rams; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon, which form a part of this specification.

My improvement in hydraulic rams consists in providing the terminus of the ram-tube with a horizontally-acting spring-valve, so arranged as to receive the full head of water flowing through said tube, and in providing the air-chamber with an inclined flap-valve, which easily yields to the pressure occasioned in the tube by the closing of said spring-valve.

The object of these improvements is to reduce water-friction to the minimum, and thus utilize the greatest possible degree of the force of the flow of water in the tube, in order to supply a strong head at a greater elevation than has hitherto been practicable by self-acting apparatus.

I will particularly describe my improvements with reference to the accompanying drawing, which is an outline central vertical section of a hydraulic ram constructed according to my invention.

A is the ram tube or cylinder, having two branches, the shortest of which, B, terminates in the inclined bottom of the air-chamber C, and is closed by the inclined flap-valve D. The other and longest branch, E, curves downward, and extends a short distance beyond the air-chamber, terminating in a slight enlargement, *e*, which is open at end, and has both an inward and outward flange, *e'*, around its edge. Within this enlargement *e* is a valve-head, F, arranged directly in front of the opening, and concentric with the branch E. From the center of this valve-head F a spindle, *f*, extends outward through the opening *e'*, and is attached to a plate, *g*, which to its upper end has attached a bent spring, G, the

other end of which is secured to an upward projection of flange *e*. Through the plate *g* passes a thumb-screw, *h*, which impinges against flange *e*. I is the nozzle of the air-chamber, from which a pipe leads upward to the point where water is to be delivered. The driving-pipe, leading from a more or less elevated source of water-supply to the ram, connects at the front.

It will not be necessary for me to explain the operation of a hydraulic ram, as that is very generally understood.

The spring-valve F stands normally open, and is kept so by spring G, the extent of its opening being regulated by thumb-screw *h*. It will be seen from the position of this valve that the full head of water flowing through the tube strikes it, and receives no previous check to destroy the force of its impact. I make the tension of spring G such as to simply open the valve, and to allow it to close suddenly when the full force of the water strikes it. It will also be seen, from the position of the flap-valve D, that said valve will be easily and quickly opened by the increased pressure of water in the tube, resulting from the closing of the valve F, and that the force of the impact will not be dissipated in overcoming friction, but be almost entirely utilized in forcing water into the air-chamber and pipe J. It will also be seen that as soon as the escape of water through valve D has relieved said valve of upward pressure it will quickly and certainly fall to its seat, thus securing the proper action of the air-chamber in providing a continuous flow through pipe J. I usually provide the valves with leather or rubber seats.

Having now described my invention in such manner as to enable those who are acquainted with the class of apparatus to which it belongs to construct and use hydraulic rams with my improvements, I claim—

1. In a hydraulic ram, the horizontally-acting spring-valve F, substantially as described.

2. In a hydraulic ram, the air-chamber closed by inclined flap-valve D, substantially as set forth.

3. The ram-tube A, having branch B opening into air-chamber C, and guarded by in-

clined flap-valve D, in combination with branch E, the outlet of which is provided with horizontally-acting valve F, as shown.

4. The combination, with a hydraulic-ram tube, of the spring-valve, consisting of head F, spindle *f*, and bent spring G.

5. The combination of valve-head F, spindle *f*, plate *g*, bent spring G, and regulating-screw *h*.

In testimony that I claim the foregoing as my own invention I affix hereto my signature in presence of two witnesses.

ISAAC B. MILLINGTON.

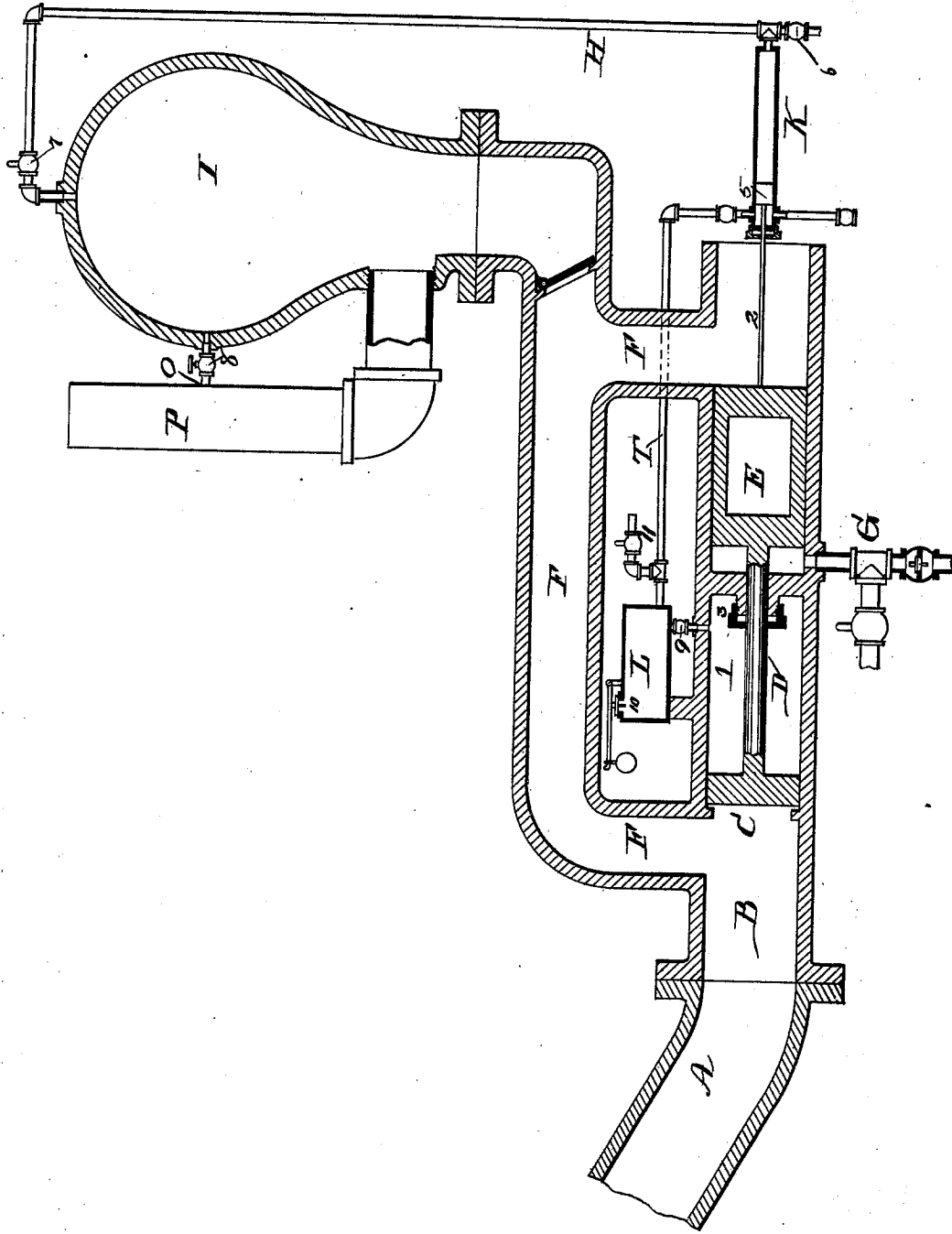
Witnesses:

GEO. M. FRANKLIN,  
JAS. H. BESTOR.

G. YELLOTT.  
Hydraulic-Ram.

No. 214,979.

Patented April 29, 1879.



WITNESSES

*T. H. Robertson*  
*T. C. Brecht*

INVENTOR

*George Yellott*  
*by G. H. W. S. Howe*  
*Attorney*

# UNITED STATES PATENT OFFICE.

GEORGE YELLOTT, OF TOWSONTOWN, MARYLAND.

## IMPROVEMENT IN HYDRAULIC RAMS.

Specification forming part of Letters Patent No. **214,979**, dated April 29, 1879; application filed January 24, 1879.

*To all whom it may concern:*

Be it known that I, GEORGE YELLOTT, of Towsontown, in Baltimore county and State of Maryland, have invented a new and Improved Hydraulic Ram, by the action of which water in large quantities for operating machinery, supplying towns and cities, and for other useful purposes, can be raised to a great elevation; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the annexed drawings, making a part of this specification, by which the whole machine is correctly represented, with an interior view of the pipes, cylinders, pistons, valves, and other appendages and parts connected and put together as when in operation.

The nature of my invention consists in dispensing with the use of the valve which opens and closes the orifice of discharge in the ram-pipe, and by so doing puts in motion and then suddenly stops the flow of water through said pipe in the ordinary hydraulic ram now in use, but which valve, by suddenly closing against a non-elastic and solid substance, causes a shock and jar to the machine proportionate to the momentum of the moving column of water, and substituting for said valve a piston moving against condensed air in a cylinder, the water in the ram-pipe being put in motion and stopped by the action of said piston in opening and closing the channel of escape without any jar or concussion caused by the collision of solid bodies coming in contact suddenly and with great force, which, in a large ram of the ordinary construction, would rupture the pipe and destroy the machine, by reason of which it has been found impossible to use these hydraulic motors for elevating water in large quantities.

To enable others skilled in the art to make and use my invention, I will proceed to describe its construction and operation.

In the accompanying drawings, A represents a section of the ram-pipe conducting the water from the source of supply, which pipe, at its lower end, is attached to and opens into a cylinder, B, which cylinder is divided into two parts, (designated, respectively, by figures 1 and 2.) In that part of cylinder B which is designated by figure 1 is a piston, C, accurately fitted, so

as to prevent the escape of air, and connected by a rod, D, which passes through a stuffing-box, figure 3, with another piston, E, in that part of said cylinder designated by figure 2. This part of said cylinder is open at its end, and its length is about double that of the other part of said cylinder, (designated by figure 1.)

The piston E is hollow, and is cylindrical in shape, with both ends closed, so as to present the exterior appearance of a solid body. It is of sufficient length to fill one-half of that portion of the cylinder designated by figure 2, in which it slides with the rims of its two ends accurately fitted, so as to prevent the passage of air.

F represents a pipe of less diameter than the pipe A, being, at one end, attached to and opening into that portion of the cylinder B immediately in front of the piston C. The other end of the pipe F is attached to and opens into that portion of the cylinder B designated by figure 2, immediately behind the piston E. G is a pipe opening into the part of the cylinder B designated by figure 2, in front of the piston E, and with a valve opening inward and another valve opening outward, so that either air or water can be drawn in and expelled when the piston E is in motion.

K is a small cylinder, with a piston and rod (designated by figure 5) working in said small cylinder by being connected with the piston E. H is a small pipe, by which air being admitted into the small cylinder K by the valve opening inward, and designated by figure 6, is driven through the valve designated by figure 7 into the air-chamber I, which air-chamber communicates with the pipe F by a valve, as represented in the drawings.

In order that there may be always a proper condensation of air in that portion of the cylinder B designated by figure 1, a receiver, L, is attached to said portion of the cylinder, and communicates therewith by a valve, 9, which opens into said cylinder. This receiver is connected by a pipe, T, with the small cylinder K. To the top of this receiver is attached a weighted valve opening outward, and designated by figure 10. This valve is so weighted that when the air in the cylinder is of the desired condensation it rises and lets the air forced into the receiver through the pipe T es-



cape; but if there has been an escape of air from the cylinder, then, when the piston C is at the extreme end of the cylinder, the air therein will exert a less pressure on the valve, figure 9, than will the weight on the loaded valve, figure 10, and air will be forced into the cylinder and supply the deficiency.

The small pipe, figure 11, can be conveniently attached to the receiver-pipe T and closed by a cap screwed on the end after the air in the cylinder has been condensed.

In order to operate this ram I condense the air in that portion of the cylinder B designated by figure 1, by pumping air through the small pipe designated by figure 11, which pipe has a valve opening inward and through the receiver and valve 9. This small pipe should then be closed by a cap screwed on its end.

The air in the cylinder is condensed until it is more than sufficient to overcome by its elasticity the weight and friction of the pistons in the cylinder and the static pressure of the water in the pipe A when the water is at rest in said pipe, which static pressure is dependent upon the height of the fall of water perpendicularly from the source of supply. The air being condensed, as aforesaid, and the two pistons being so placed that the piston E leaves the orifice at the end of the pipe F open, the water passes through the pipe F with a velocity due to the height of the fall, and escapes freely from the end of the cylinder B designated by figure 2.

The column of water in the pipe A is thus put in motion and acquires a momentum due to the weight of the whole number of cubic feet of water in the pipe A multiplied by the velocity of the moving column. This momentum can be easily and correctly estimated, and the mode of calculation should be perfectly understood when a ram is to be constructed, as it has an important bearing upon the strength of materials to be used in its construction.

If the height of the fall of water is ten feet, the water freely escaping through the pipe F will have a velocity in its passage through that pipe of twenty-five feet per second. If the pipe A is of a cubic capacity sufficient to pass four times as much water as the pipe F, the velocity of the water in A will be a little more than six feet per second. If A contains one hundred cubic feet of water the weight of the whole column will be more than six thousand pounds, and the whole column moving through A with a velocity of six feet per second, the momentum will be thirty-six thousand pounds. If the piston C presents a surface of one hundred square inches, and the air in the cylinder has been condensed to two atmospheres, or thirty pounds to the square inch, the resistance at first offered by the piston to the momentum of the moving column of water in A will only be three thousand pounds; but this will be continually increased by the additional condensation of the air as the piston is driven back in the cylinder.

It is thus seen that the momentum of the water in a large ram is immense, and in constructing the machine can be increased at pleasure by simply lengthening the ram-pipe, the height of the fall of water remaining the same.

This is a fact never to be lost sight of by those engaged in the construction of this ram, and it is deemed important to make it clearly appear. This momentum is directed against the head of the piston C, and driving back the two pistons connected by the rod D the piston E slides over and instantly closes the orifice of discharge of the pipe F, thus suddenly checking the moving column of water in F, which is then driven into the air-chamber I, when the entire momentum of the water in the pipe A is concentrated on the head of the piston C, and the two pistons are driven back until the air in that portion of the cylinder B designated by figure 1 acquires an enormous pressure, while at the same time water enters by atmospheric pressure through the pipe G and fills the space, which would otherwise be left vacant by the piston E when driven to the end of the cylinder B. There is also a supply of air driven by the small piston figure 5 through the pipe H into the air-chamber I, and replaces the particles of air absorbed and carried off by incorporation with the water by compression.

To guard against an excessive quantity of air being forced into the air-chamber, the one end of a very small pipe, O, opened and closed by a cock, figure 8, is inserted into the air-chamber at a point below which the water should never fall when the ram is in operation. The other end of the pipe O is inserted in the ascending pipe P, and after the ram is put in operation the cock figure 8 is opened, and water passes out and is discharged up the pipe P, unless the water falls below the point of insertion of the pipe O into the air-chamber, when air passes through the pipe O by the preponderating pressure, and is carried out in bubbles through the pipe P.

As the velocity of the water in the pipe A is diminished the condensed air in that portion of the cylinder B designated by figure 1 reacts, and, driving the water back by means of the piston C, causes it to enter the air-chamber I through the pipe F with a pressure equal to the sum of the two opposing forces—namely, the pressure of the condensed air in the cylinder and the remaining momentum of the moving column of water in the pipe A.

When the motion of the water in the pipe A has entirely ceased the water will no longer act by its momentum, but will act by static pressure alone, which, if the fall, as has been supposed, is ten feet, would be one-third of an atmosphere; and as the air in that portion of the cylinder B designated by figure 1 was originally condensed so as to be more than sufficient to overcome this static pressure, together with the weight and friction of the pistons in the cylinder B, the two pistons C and

E will be impelled forward by the air so condensed until the orifice in the end of the pipe F will be opened, when the water in the pipes F and A will be put in motion again and with a like result.

If the initial condensation of the air in that portion of the cylinder B designated by figure 1 has been made sufficient for the purpose, all waste-water which has entered through the pipe G can be utilized by a proper connection with the said pipe G, as the water, acting alternately by static pressure and by momentum, becomes weaker and stronger as it changes its mode of action; and when acting by momentum as a solid body of equal weight its power is only limited by the length and diameter of the ram-pipe and the strength of the materials, so that if a greater condensation of the air in the cylinder is desired for a given purpose it is only necessary to lengthen the ram-pipe and such additional condensation is obtained, while the static pressure when the water is at rest in the ram-pipe will remain unaltered.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a hydraulic ram, a piston or pistons, or other solid body or bodies, resting against condensed air or other elastic fluid in a cylinder or other confined space, and by the action of said

piston or pistons, or other solid body or bodies, when driven back by the momentum of the water in the ram-pipe against the said condensed air or other elastic fluid, closing the orifice through which the water, by its motion in escaping, gives velocity and momentum to the water in the ram-pipe, and by the reaction of said condensed air or other elastic fluid on said piston or pistons, or other solid body or bodies, opening said orifice, and thereby putting the water in the ram-pipe, communicating with said orifice by a proper connection therewith, in motion with a renewed velocity after said water has ceased to act by momentum and is acting by static pressure, and driving water into the air-chamber without any shock or concussion endangering the safety of the machine, substantially as herein specified.

2. In combination with an air-vessel and ascending pipe of a hydraulic ram, a small pipe provided with a controlling valve or cock, the said pipe connecting the air-vessel and ascending pipe at a point below the lowest level attained by the water in the air-vessel, substantially as and for the purpose specified.

GEORGE YELLOTT.

Witnesses:

R. C. MASSENBURG,  
THOMAS JONES.

(No Model.)

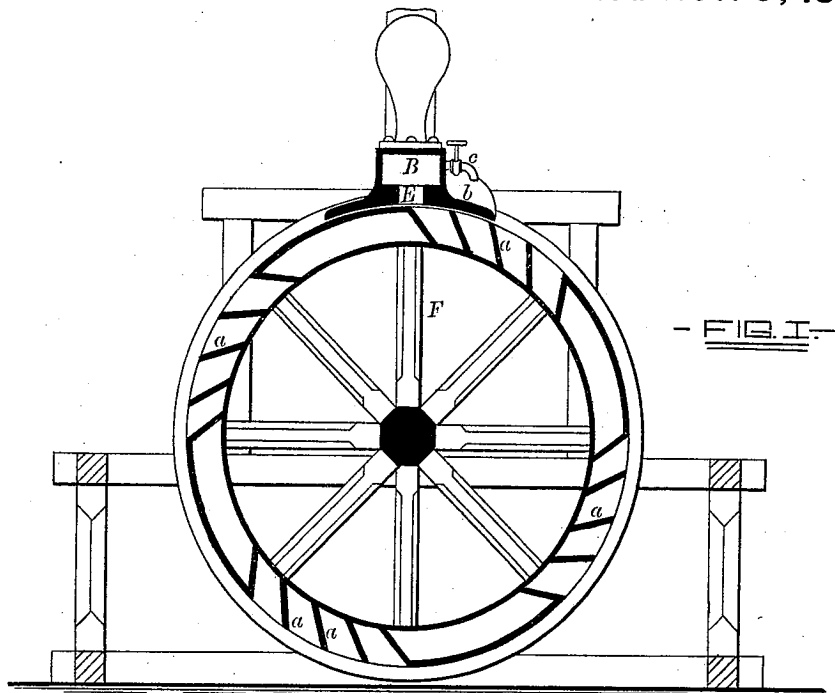
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G. YELLOTT.

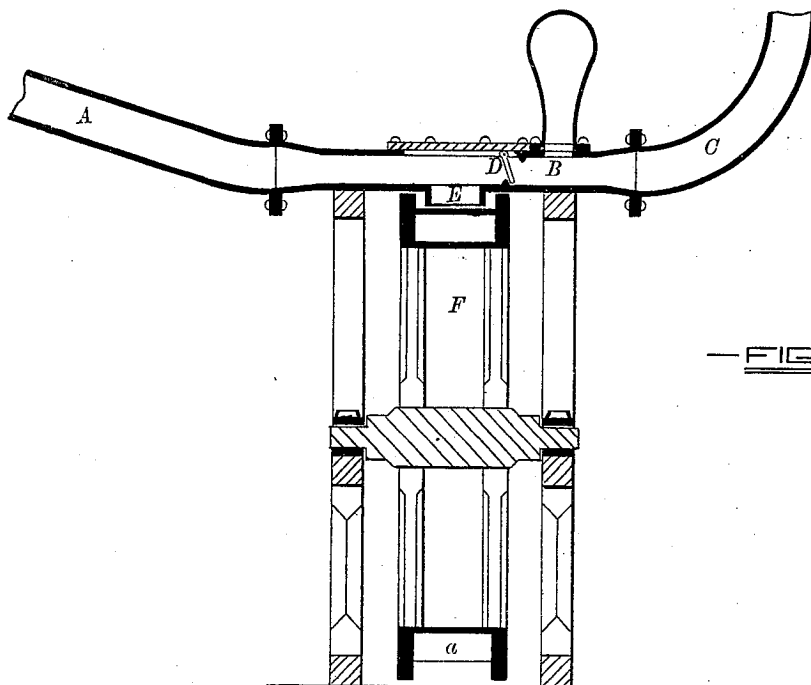
Hydraulic Ram and Water Wheel.

No. 234,368.

Patented Nov. 9, 1880.



- FIG. I. -



- FIG. II. -

- WITNESSES -

*Geo. A. Boyden,*  
*Harry V. Albaugh.*

- INVENTOR -

*George Yellett,*  
*by G. H. J. Howard,*  
*Atty.*

(No Model.)

5 Sheets—Sheet 2.

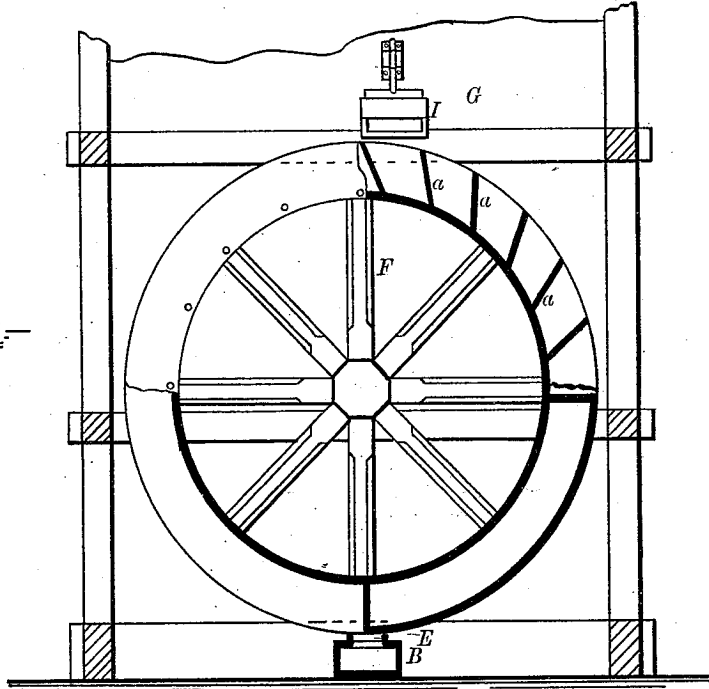
G. YELLOTT.

Hydraulic Ram and Water Wheel.

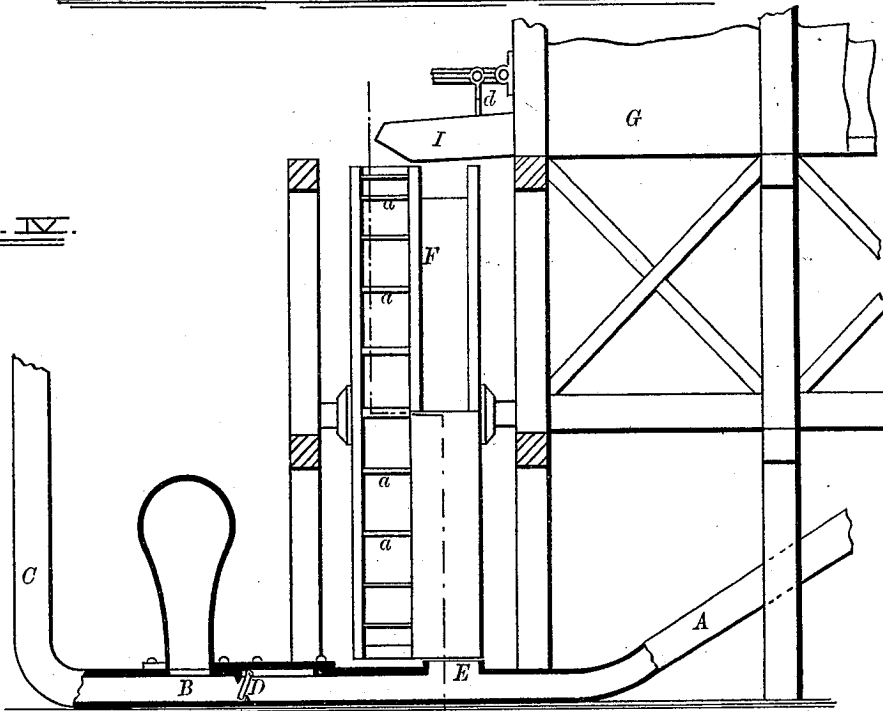
No. 234,368.

Patented Nov. 9, 1880.

— FIG. III. —



— FIG. IV. —



— WITNESSES: —

*Harry A. Albaugh*  
*J. P. Crowl*

— INVENTOR: —

*George Yellott*  
*G. H. M. Howard*  
 Atty.

(No Model.)

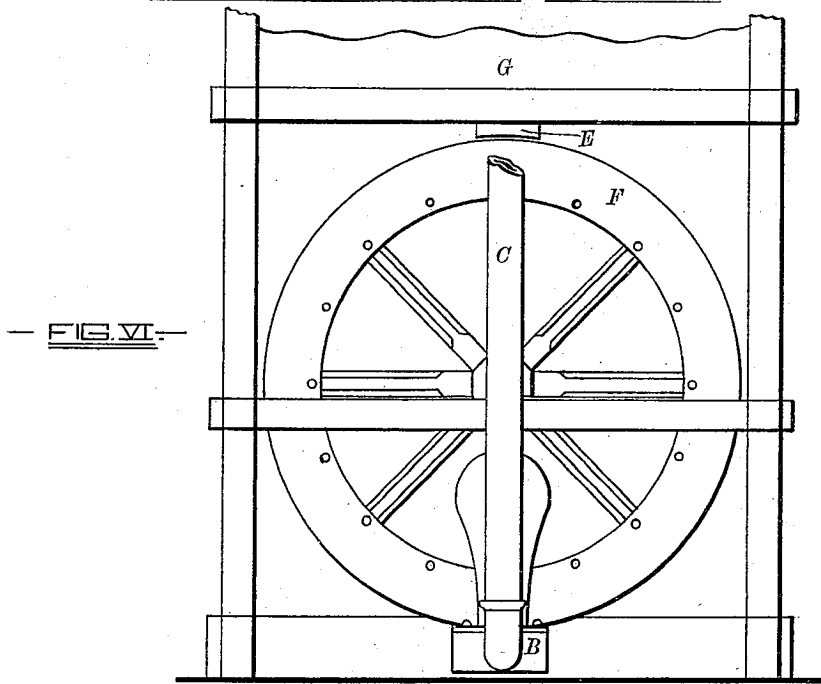
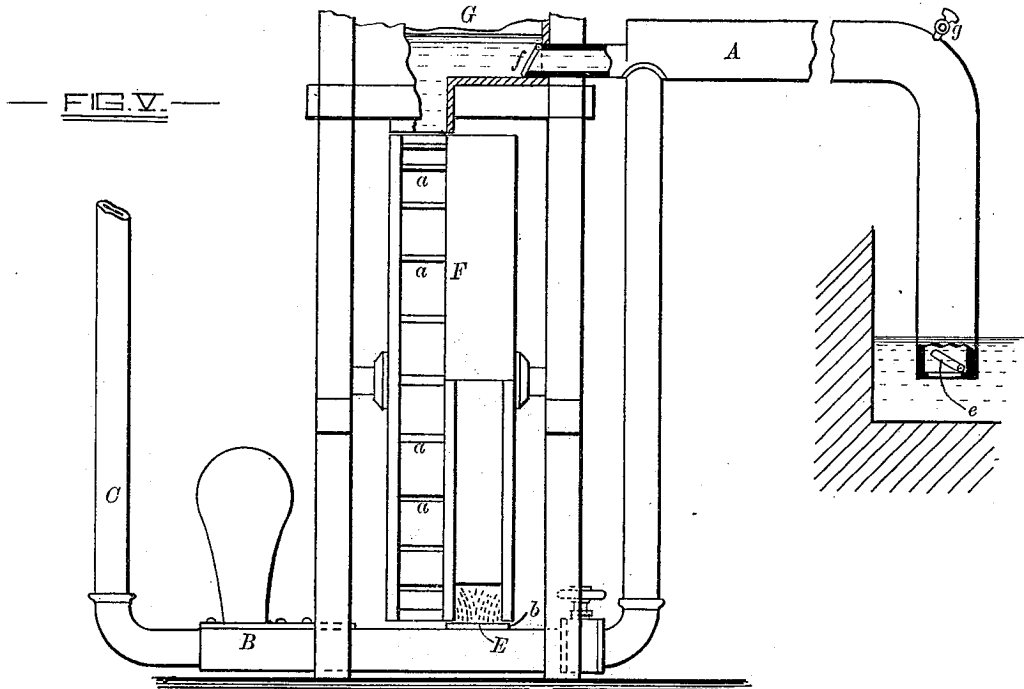
5 Sheets—Sheet 3.

G. YELLOTT.

Hydraulic Ram and Water Wheel.

No. 234,368.

Patented Nov. 9, 1880.



WITNESSES

*Harry V. Albaugh*  
*D. S. Cowl*

INVENTOR

*George Yelott*  
by *Chas. W. Howard*  
*Atty.*

(No Model.)

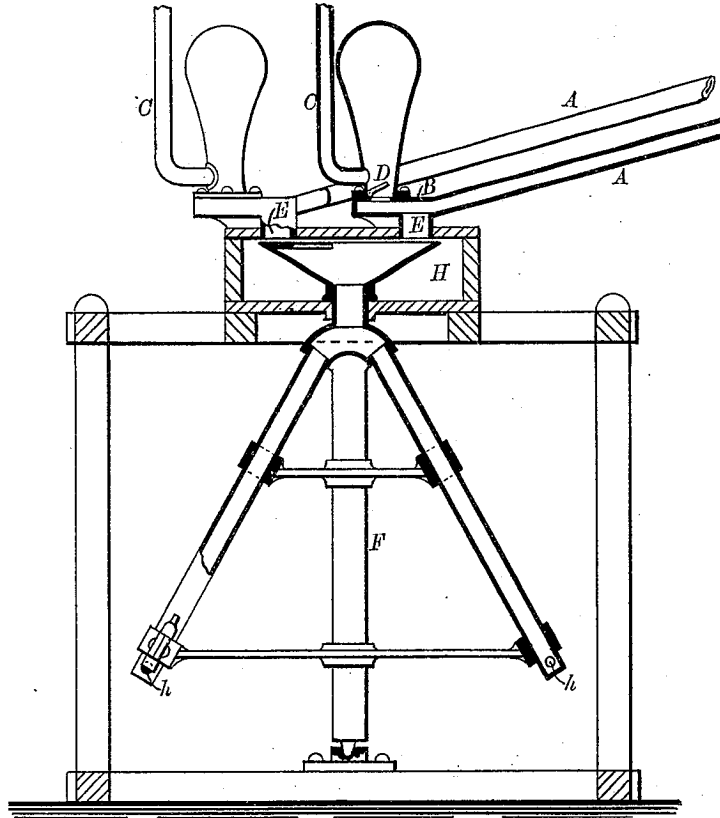
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G. YELLOTT.

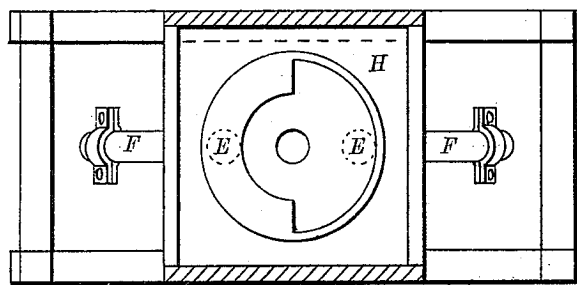
Hydraulic Ram and Water Wheel.

No. 234,368.

Patented Nov. 9, 1880.



— FIG. VI. —



— FIG. VII. —

— WITNESSES —

*Harry K. Albaugh*  
*D. P. Cole*

— INVENTOR —

*George Yellett,*  
*by C. H. M. Howard,*  
*Attys.*

(No Model.)

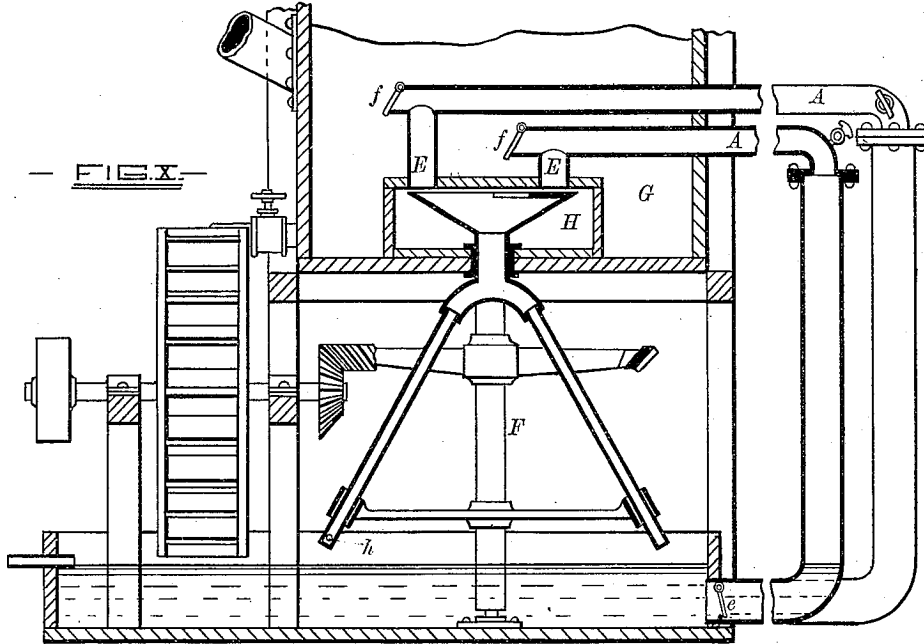
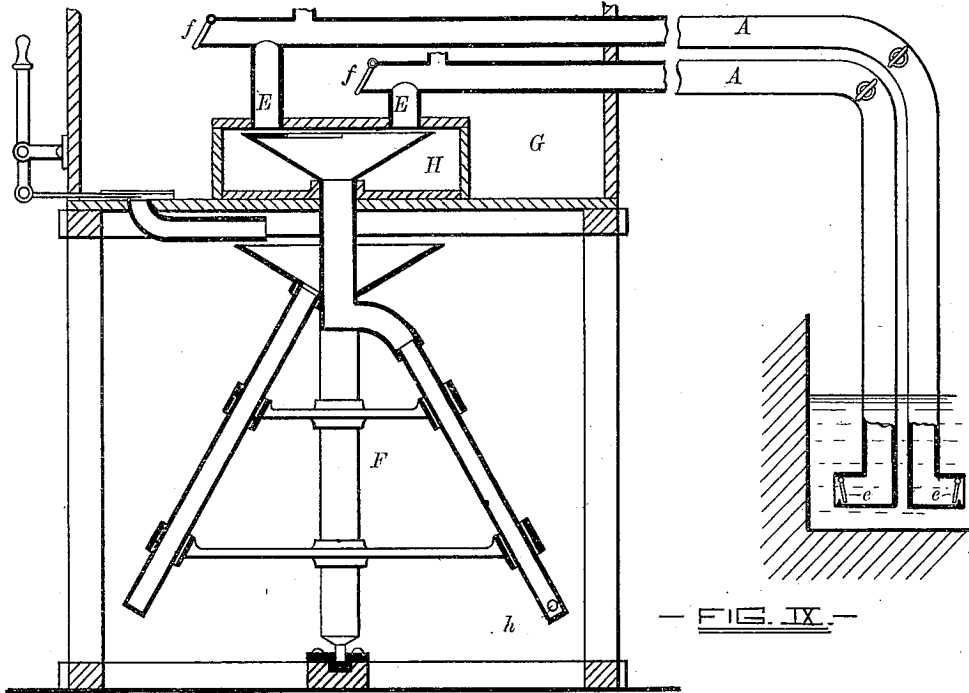
5 Sheets—Sheet 5.

G. YELLOTT.

Hydraulic Ram and Water Wheel.

No. 234,368.

Patented Nov. 9, 1880.



— WITNESSES —

*Harry P. Albaugh.*  
*D. P. Cowl.*

— INVENTOR —

*George Yellott.*  
*by C. H. M. Howard*  
*Atty.*

# UNITED STATES PATENT OFFICE.

GEORGE YELLOTT, OF TOWSON, MARYLAND.

## HYDRAULIC RAM AND WATER-WHEEL.

SPECIFICATION forming part of Letters Patent No. 234,368, dated November 9, 1880.

Application filed June 28, 1880. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE YELLOTT, of Towson, in the county of Baltimore and State of Maryland, have invented certain Improvements in a Combined Hydraulic Ram and Water-Wheel, of which the following is a specification; and I do hereby declare that in the same is contained a full, clear, and exact description of my said invention, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

This invention, briefly stated, consists in substituting for the valve ordinarily employed in hydraulic rams to automatically open and close the orifice of discharge in the drive-pipe a water-wheel, which, in its revolution, alternately opens and closes the said orifice, and is driven or revolved by the intermittent discharge of the water effected, or admitted of, by the revolution of the said wheel, as will hereinafter fully appear.

Prefatory to a description of my improvements it may be proper to say that when water acts by momentum in running through a long pipe its power is not to be estimated or measured by the vertical altitude of the source of supply alone, but by the weight of the moving column multiplied by its velocity in feet per second.

The water being incompressible, it acts the same as a solid body, with this difference, that power would have to be applied to a solid mass to overcome its inertia, while a body of water is easily and instantly put in motion by simply providing a means of escape from the pipe in which it is confined.

In the Montgolfier ram the valve in the drive-pipe which controls the orifice of discharge is forced to its seat, and the said orifice closed suddenly by the momentum of the moving column of water. It is, however, well known that this device can only be used on a very small scale, in consequence of the destructive action of the valve on the surrounding mechanism. For instance, if the drive-pipe was a foot in diameter and two hundred feet long, and the velocity of the column twenty feet per second, the momentum would be about two hundred and forty thousand pounds. This enormous force acting on a valve such as is used in the Montgolfier ram would destroy the

valve, or the metal of the pipe surrounding the valve and against which the valve is driven.

One object of my invention, as hereinafter described, is to obviate this difficulty and render it possible to elevate large bodies of water. The other object of this invention is to utilize the waste water from the ram in effecting the rotation of a wheel capable of doing useful work.

In the further description of my said invention which follows, reference is made to the accompanying drawings, forming a part hereof, in which—

Figures I and II are sectional elevations, as seen from different points, of a ram combined with an overshot water-wheel constructed in accordance with my improvements.

The remaining figures of the drawings illustrate modifications in the construction of the apparatus, as hereinafter described.

Similar letters of reference indicate similar parts in all the views.

Referring to Figs. I and II, A is the drive-pipe, extending from the source of the water-supply to the ram-chamber B. C is the water-delivery pipe, leading from the ram-chamber to a point to which the water is to be elevated. D is a valve situated in the ram-chamber, which is opened by the flow of water.

The ram-chamber B is provided with a supplemental discharge-orifice, E, which, under circumstances hereinafter described, admits of the passage of the whole or a portion of the water delivered to the ram-chamber to an overshot water-wheel, F, located directly below the said chamber. The water-wheel F is of peculiar construction—that is to say, sections of its periphery are fitted with buckets *a*, whereby the wheel is revolved, while the remaining sections present a smooth convex surface to the under side of the ram-chamber, which is provided with a concave plate, *b*. The width of the plate *b* should be less than the distance between the flanges of the water-wheel, in order that the curved plate may not entirely close the spaces between the flanges. If this were not the case, the passage of water to the buckets would be impeded by the compression of air in the same.

The number of the bucketed and smooth-surfaced sections which follow each other in



alternation are dependent on the size and circumference of the wheel; but there should never be less than three of each kind, so that when the buckets in one section are being filled those in another section are being emptied.

The operation of this apparatus is as follows: When a bucketed section of the water-wheel is under the orifice E, the whole or a portion of the water delivered to the ram-chamber passes to the buckets of the wheel and revolves it; but upon a smooth section being carried to underneath the chamber in the revolution of the wheel the discharge through the orifice E is stopped, and the water is made to pass directly to the air-vessel, and thence to the delivery-pipe C, which conducts it to a reservoir, or to some place from which it may be used.

By means of this construction no portion of the water flowing through the drive-pipe is wasted, as is the case in the Montgolfier ram, but is conducted alternately to the air-vessel or delivery-pipe and to the water-wheel. The momentum of the wheel is sufficient to effect its movement while the smooth sections of its rim are passing the orifice E.

To put a large and heavy wheel in motion when it is standing with a smooth section under the orifice E, a cock, *c*, is used to fill the buckets below the end of the plate *b*.

A modified construction of the invention is illustrated in Figs. III and IV, which represent sectional views of the apparatus as seen from different points. In this modification two wheels are used, one having buckets distributed over its entire circumference, and the other without buckets, but provided with a series of smooth projecting surfaces similar to those described in connection with the wheel illustrated in Figs. I and II. The two wheels are secured to the same shaft, and consequently revolve together. The object of this modification is to utilize a stream of water of any kind to assist in securing for use water from a spring of limited capacity. With this view I conduct the water which is not suitable for drinking purposes to a penstock, G, and thence, by means of a spout, I, having a suitable gate, *d*, to the bucketed wheel. The spring-water is led through the drive-pipe A to the ram-chamber B, the supplemental aperture of which is beneath the other wheel and controlled by the smooth projections on the same. This modification may be advantageously used in cases where a water-wheel is already in operation, as a powerful ram is obtained without diminishing the power of the wheel.

The construction of the apparatus illustrated in Figs. V and VI differs only from that shown in Figs. III and IV in that the entire body of water used is derived from the same source by means of a siphonic pipe. In this design the penstock is fed by a portion of the water passing through the drive-pipe.

To properly effect the result desired in this

design the short leg of the siphon is furnished with a valve, *e*, and the portion of the drive-pipe entering the penstock with a valve, *f*, which latter valve must be kept below the water-line in the penstock to prevent leakage of air.

In charging the siphonic drive-pipe the valve *f* is opened and the air in the said pipe allowed to escape through a valve, *g*.

Figs. VII and VIII represent two views of another modification of my invention. In this case two drive-pipes are used, and also two ram-chambers with their attachments.

The supplemental discharges enter a casing, H, made strong and air-tight, and intended to be kept filled with water. The water-wheel is of the reactionary type, and consists of a vertical hollow shaft having hollow communicating arms, the upper end of which shaft enters the casing H, and is of funnel shape. The upper edge of the funnel is provided with a semicircular plate, which corresponds in its action with the smooth projecting sections of the wheel first described in cutting off alternately the supplemental discharges of the two rams. The water passes down through the hollow arms of the wheel, and is finally discharged through lateral openings *h*, which are controlled by suitable gates.

When the supplemental discharge-orifice of one drive-pipe is closed the corresponding orifice in the other drive-pipe is open. Consequently the flow of water to the reactionary wheel is continuous, or nearly so.

The centrifugal force of the water leaving the discharge-openings at the ends of the arms accelerates the movement of the water through the wheel. Therefore the water is, as it were, pumped downward.

In Fig. IX the siphon principle is applied to the reactionary wheel shown in Figs. VII and VIII, and one arm of the wheel is supplied with water from a penstock, which enters a funnel situated on the central shaft and below the casing.

In all cases where a reactionary wheel is employed it is designed to apply gearing to the said wheel to accomplish useful work.

In the arrangement of the apparatus as shown in Fig. X a portion of the water taken up by the siphons is from a tank which receives the discharge from the reactionary wheel.

I claim as my invention—

1. In combination with the ram-chamber of a hydraulic ram, a water-wheel adapted in its revolution to alternately open and close the waste-water orifice in the said chamber, and thereby effect the alternate movement of the water from the drive-pipe toward the ram delivery-pipe and to said wheel, whereby in the latter action of the water the said wheel is caused to revolve, substantially as herein specified.

2. In combination with the ram-chamber of a hydraulic ram, a water-wheel having at its periphery a series of bucketed and a series of

plain sections, the said plain sections being adapted as valves to cut off the discharge of waste water from the said chamber, and thereby conduct the body of water from the drive-  
5 pipe of the ram toward the air-vessel of the same, and the said bucketed sections to receive the waste water, and thereby effect the revolution of the said wheel, substantially as herein specified.

10 3. A hydraulic ram the chamber of which

has a circular concave surface, adapted to fit, practically water-tight, the circumference of a water-wheel, the said concave surface having therein an orifice for discharging water from the said chamber to the said wheel, substan- 15  
tially as herein specified.

GEO. YELLOTT.

Witnesses:

HARRY V. ALBAUGH,  
ARMISTEAD R. YELLOTT.

(No Model.)

G. YELLOTT.  
HYDRAULIC RAM.

No. 281,749.

Patented July 24, 1883.

Fig. 1.

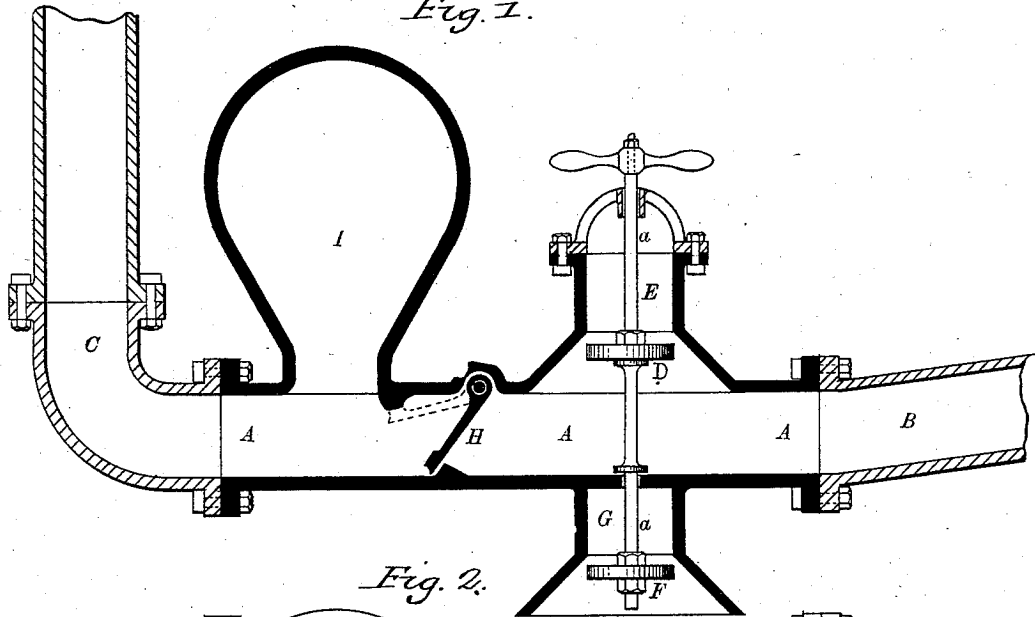


Fig. 2.

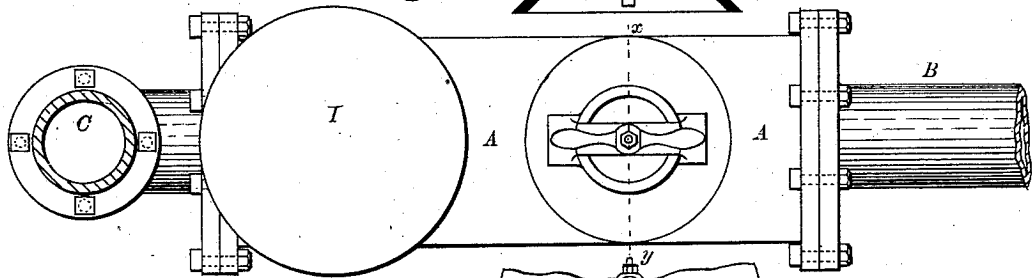
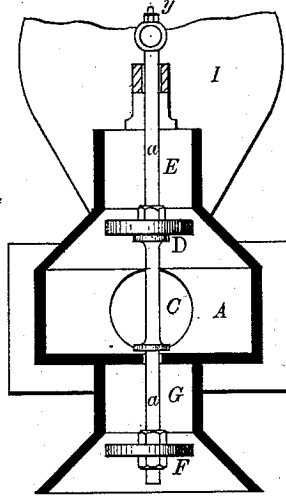


Fig. 3.



- WITNESSES -

*Dani Fisher*  
*Chas B. Cassady*

- INVENTOR -

*George Yellott,*  
*by G. H. W. Howard,*  
*Atty.*

# UNITED STATES PATENT OFFICE.

GEORGE YELLOTT, OF TOWSON, MARYLAND.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 281,749, dated July 24, 1883.

Application filed September 11, 1882. (No model.)

*To all whom it may concern:*

Be it known that I, GEORGE YELLOTT, of Towson, in the county of Baltimore and State of Maryland, have invented certain Improvements in Hydraulic Rams, of which the following is a specification.

To fully understand the nature of my present invention it must be borne in mind that water moving through the drive-pipe of a hydraulic ram and completely filling it acts like a solid body, and that the power of the apparatus is limited only by the length of the pipe, the velocity of the moving body of water, and the strength of the materials.

The capacity of a Montgolfier ram is necessarily limited, in view of the main valve closing with a sudden collision against a solid substance—namely, the material surrounding the valve-opening which constitutes the valve-seat.

In my invention, as hereinafter described, the collision of the valve and seat is prevented; and in view of this a ram can be constructed to work satisfactorily, of any size or capacity, and a large body of water elevated as easily as a small one.

In carrying out my invention I provide the ram-chamber with, preferably, a cylindrical outlet-pipe, and construct a piston-valve to be automatically moved from within the ram-chamber to the said outlet-pipe, its first position allowing of the escape of the water entering the said chamber, and the second preventing this escape and obliging the water to pass the said valve toward the air-vessel and delivery-pipe. To the stem of the piston-valve I secure a second piston, and provide the ram-chamber with a supplemental chamber, into which the second piston enters and compresses air as the first piston ascends and cuts off the waste or outflow of water. By this means the first-named piston is cushioned by compressed air, which, in its expansion, re-establishes the outflow of water—a necessary step to effect a second operation of the ram. In the air-compressing operation a small portion of air escapes at each stroke of the compressing-piston around its stem to the water in the ram-chamber, and passes thence to the air-vessel, thereby obviating the necessity of what is termed a “sniffing-valve.”

In the further description of my invention which follows reference is made to the accompanying drawings, forming a part hereof, and in which—

Figure I is a longitudinal section of the improved ram. Fig. II is a plan of the invention. Fig. III is a transverse section taken on dotted line *xy*, Fig. II.

Similar letters of reference indicate similar parts in all the views.

A is the ram-chamber, and B and C, respectively, the drive and delivery pipes.

D is a piston-valve secured to a stem, *a*, suitably guided, and adapted to slide from the chamber A to an open cylinder, E.

On the lower end of the stem *a* is a similar piston-valve, F, adapted in its upward movement to compress air in the chamber G.

H is the delivery-valve, of ordinary description, and I an air-chamber of common construction.

Supposing the movable parts of the apparatus to be relatively situated as shown in Fig. I, water passing down the drive-pipe B into the ram-chamber A at first escapes around the valve D; but almost immediately the means of escape of water is cut off by the passage of the valve D into the cylinder E. In the movement of the piston-valve D air is compressed by the valve F in the chamber G and all shock or jar of the moving mechanism prevented. After the pressure in the air-vessel is raised sufficiently to overcome further admission of water to the said vessel, the valves D and F assume their first positions by the expansion of the air in the chamber G, and the ram operation is repeated.

It will be understood that a small quantity of compressed air passes around the stem *a* to the chamber A, and thence to the air-vessel, at each stroke of the valves, to maintain the requisite bulk of air in the said vessel.

I do not limit myself to any peculiar shape of the various chambers and valves; but for convenience in construction I prefer, except in the case of the ram-chamber, a cylindrical form.

In addition to the purposes for which a hydraulic ram is generally used—namely, as a stationary device for elevating water—I propose to employ my improved ram as a portable appa-

ratus for extinguishing fires. To admit of this use the device would be provided with wheels or placed on a wheeled truck, whereby it could be transported and connected to a fire-plug.

5 In such use of this invention the water-main, or a link of hose connecting the device to the plug, would constitute the drive-pipe, and the ordinary hose now used as the delivery from the fire-engine could be substituted for the  
10 pipe C shown in the drawings. In cases where there is ample water-supply the ram would prove an efficient fire-engine.

I claim as my invention—

15 1. In a hydraulic ram, the valve around which the water passes in its escape, and which is closed by the movement of the escaping wa-

ter, combined with an air-compressing valve and an air-chamber, the said air-compressing valve operating to form an elastic cushion for the outflow-valve, and thereby preventing 20 shock or jar in the operation of the ram, substantially as specified.

2. In combination with the chamber A, the outlet pipe or cylinder E, and compressed-air chamber G, the valves D and F, connected by 25 the stem *a*, and adapted to operate substantially as specified.

GEO. YELLOTT.

Witnesses:

E. JACK DIGGS,  
H. C. BURKE,  
WM. GALLOWAY.

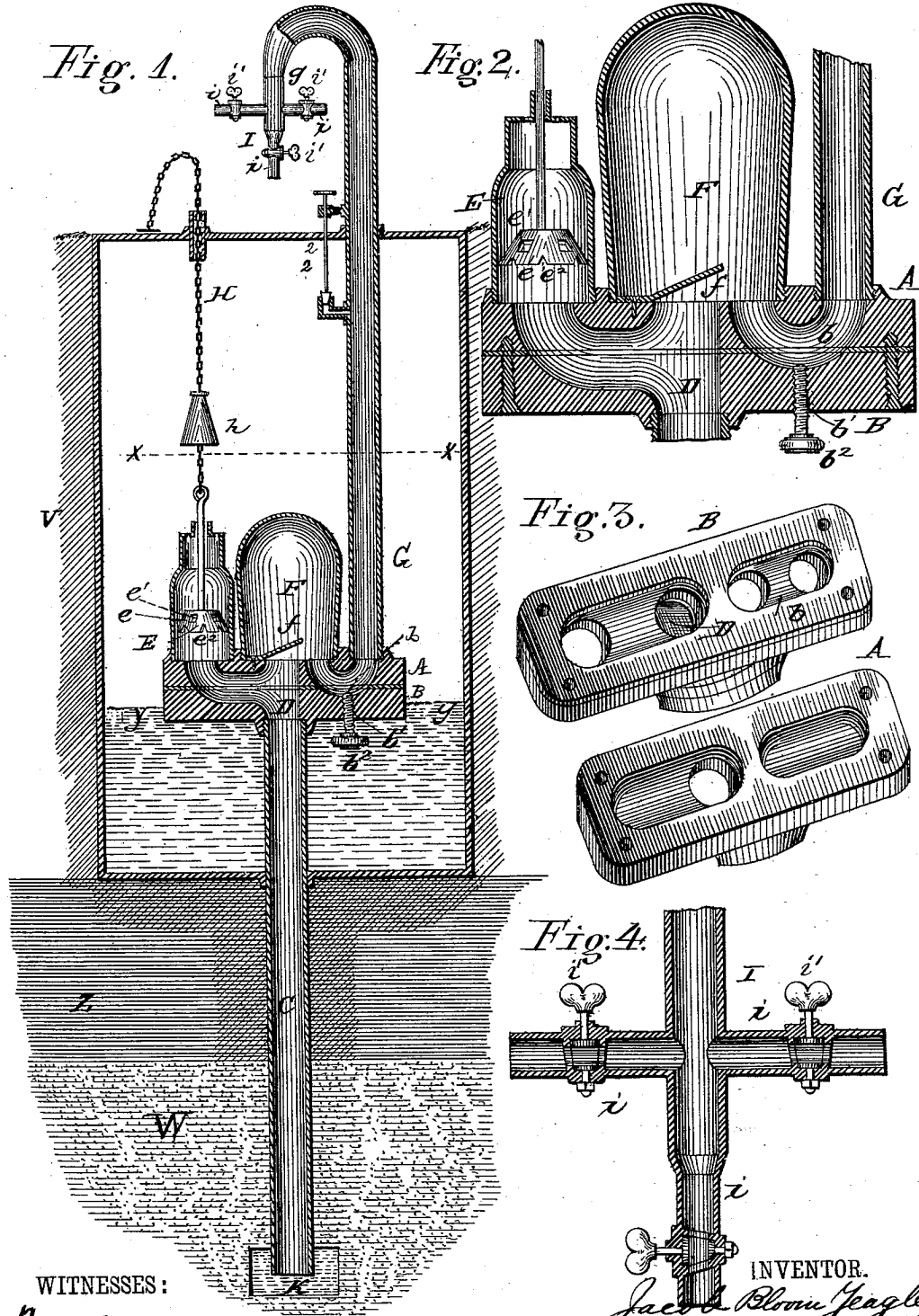
(No Model.)

J. B. YEAGLEY.

HYDRAULIC RAM.

No. 298,262.

Patented May 6, 1884.



WITNESSES:

*Fred. S. Dieterich,*  
*John P. Brooke*

INVENTOR.

*Jacob Blum Yeagley*  
*Dewitt C Allen*  
 ATTORNEY

# UNITED STATES PATENT OFFICE.

JACOB BLOOM YEAGLEY, OF INDIANAPOLIS, INDIANA.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 298,262, dated May 6, 1884.

Application filed October 20, 1883. (No model.)

*To all whom it may concern:*

Be it known that I, JACOB BLOOM YEAGLEY, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful Improvements in Hydraulic Rams or apparatus for raising water from wells having water-bearing strata of different hydrostatic levels; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to certain new and useful improvements in hydraulic rams or apparatus for raising water from wells having water-bearing strata of different hydrostatic levels, and more particularly to improvements upon my former patent, dated September 25, 1883, and numbered 285,774, and relating more especially to improvements in the manner of the construction of some of the parts, and adapting the apparatus for the distribution of water, all as will be hereinafter fully described, and set forth in the claims hereto annexed.

Referring to the accompanying drawings, Figure 1 represents a vertical section through my improved apparatus after it has been placed in the desired stratum; Fig. 2, an enlarged vertical section through my improved apparatus; Fig. 3, an enlarged detached view of the upper and lower parts, which form the efflux fountain-pipe and the connections between the efflux valved chamber, valved air-chamber, and influx and supply pipes; Fig. 4, a detached view of the water-distributor.

Like letters of reference indicate like parts in the several figures.

In the drawings, A and B represent two cast and grooved upper and lower parts or plates connected together by screws or bolts, with a suitable water-tight packing between their meeting faces. These grooved parts or plates have an interior groove, which forms the efflux fountain-pipe D, and also the parts to which the influx fountain-pipe C, efflux valved chamber E, valved air-chamber F, and supply-tube G are connected by any suitable screws or bolts. The parts A and B may be

cast in one piece. Through the bottom of lower part, B, is an opening, *b'*, communicating with the groove *b*, that connects the valved air-chamber F with the supply-tube G. The opening *b'* is closed by a screw or other suitable plug or stop-cock attachment, *b''*; and the object of said opening *b'* is to drain out any sand or sediment that may gather in said groove *b* and valved air-chamber, by simply removing screw-plug, or opening stop-cock *b''*, when the water in supply-pipe G will run out, and at the same time the sand and sediment will be washed out of the groove *b* and valved air-chamber. The valve *e* in efflux-chamber E is shaped like an inverted saucer, with openings or slots *e'* in sides to let water flow through; and on outside edges, below and between each slot *e'*, there is a small half-round opening, *e''*, to wash out the sand or sediment that may accumulate therein. This valve plays freely in the efflux-chamber E, the openings letting through sufficient water to give the required velocity of the water-flow, and consequent required resulting momentum of the water. The wire chain or cord H has a weight, *h*, (like the old-fashioned steelyard weight,) connected to it about five or six inches above its connection with the valve-stem, so that the apparatus is stopped by taking wire chain or cord in hand and, by lifting, close efflux cylinder or chamber by valve *e*, when the water-pressure on bottom of efflux-chamber valve *e* will hold it closed. Then the supply-pipe drainer 2 2 may be opened, if required, to prevent freezing of the water in said supply-pipe. The apparatus is again set in motion by dropping the weight *h* on valve-stem, by means of wire chain or cord H, to push valve down, when the water will instantly begin to flow from the efflux valved chamber E, thus setting the apparatus in automatic operation. The weight *h* is then raised (by means of wire chain or cord) just high enough, so as not to interfere with the valve-stem in its automatic upward and downward motion. The supply-pipe drainer 2 2 is then closed.

I represents a hydraulic distributor, to be screwed on supply-pipe G at the point *g*, and has a number of short tubes, *i*, provided with stop-cocks *i'*; and by means of pipes or hose

connected to said tubes *i* the water can be forced to any desired place by opening that one needed and closing the others.

By connecting any of the hose or pipes with a or to a turbine or any water-motor wheel, there may be run not only light but heavy machinery in proportion to the size of my apparatus.

Construction and operation of my improved apparatus: In Fig. 1 is shown a dug well into the first sand and gravel or any other water-bearing stratum, V, giving a low water-rise and good drainage, the water rising in well to the height Y Y. The influx fountain pipe or tube C is now driven or sunk by boring or drilling through the clay stratum Z, or other stratum or strata impervious to water, into the second or any other water-bearing stratum, W W, giving the required hydrostatic rise in fountain-pipe C above the water-rise in the well employed as a drain of the waste water from the apparatus. The fountain-pipe C may or may not be perforated at its lower end, terminating in cavity K, which cavity may usually be formed by pumping out the finer sand before the apparatus is screwed on pipe C. This pipe C, as also supply-pipe G, efflux valved chamber E, and valved air-chamber F, should then be connected to the connected upper and lower parts, A and B. The water will now flow from pipe C through efflux-opening D by hydrostatic pressure, attempting to reach the hydrostatic equilibrium of the fountain-head water supplying the stratum in which the fountain-pipe C terminates at its lower end. Now, when the water has attained its greatest velocity through pipes CD, in seeking its hydrostatic level, the valve *e* will close the efflux-chamber E instantly, by being carried up by the current, and, by the sudden stoppage of flow, water will be forced into the air-chamber, forcing up the valve *f*, which opens upward. The aperture through the bottom of air-chamber closed by said valve should be perpendicularly over and nearly as large in area as the upper opening of the fountain-pipe C, in order to obtain the greatest possible beneficial results, as shown by my experiments with this apparatus. When the current through pipe or opening D carries up the efflux-valve *e*, closing the efflux chamber or cylinder E, causing a sudden stoppage of flow through said chamber or cylinder, the water, by force of its momentum in fountain-pipe C, has its greatest pressure against and beneath the air-chamber valve *f*, because it is in direct line with the flow of the water in and through the fountain-pipe C, even drawing a portion of the water out of pipe D and efflux valved chamber E, below the efflux-valve *e*, when closing said efflux-chamber, caused by the rapid velocity of the water in fountain-pipe C, entering air-chamber. Thus it will be seen that the efflux-valve *e* does not fall wholly by its own weight or specific gravity, but partly by the suction or partial vacuum formed in pipe

D and efflux-chamber E, below the valve *e*. The flow having thus expended its effective force or momentum against the resistance of the condensed valved air-chamber, the water will again flow through pipe or opening D and efflux-chamber E, when the valve *e* will again close the aperture of the efflux-chamber E when the flow has attained its greatest velocity, which is almost instantly, as the flow is in reality perpendicular, while the reaction, at the same time, cannot cause the water to throw itself back upon the reservoir, because said reservoir is full and curbed beneath pervious and impervious strata. By these successive impulses, caused by the velocity of flow and momentum of the water, as above described, water is forced automatically in a steady stream through the supply-pipe G by the aid of the air-chamber, otherwise, without the air-chamber, the water would issue from supply-pipe G spasmodically at each pulsation of the valve *e* in the efflux-chamber E, which pulsations have but little variations in the same apparatus attached to the same fountain-pipe C.

X X represent a suppositional height to which the water rises from the cavity K. Any two water-bearing strata, whether first and second, first and third, second and third, or first and fourth, second and fourth, or any other combination of water-bearing strata (separated by a stratum or strata impervious to water) giving the greatest difference of hydrostatic levels, are employed. A difference as low as two and one-half feet will automatically operate my improved apparatus successfully for ordinary purposes. Where any one of above-specified water-bearing stratum, or any other farther down, gives an Artesian flow sufficiently high above the surface of the ground, then the apparatus may be screwed on Artesian-fountain pipe and the surface of the ground employed to drain off the waste water from the apparatus where water is required to be raised higher than the Artesian-fountain flow.

I have demonstrated, recently, that a difference of hydrostatic levels of from five to fifteen feet can be invariably found in this city and adjacent country between the rise, in a dug well; into first water-bearing stratum and the rise from the second water-bearing stratum, when tubed through the water-rise in the dug well by means of the fountain-pipe C, and wonderful results of power obtained with my improved apparatus by actual public demonstration, as above stated. The geological stratification of the earth's crust is such as to almost invariably find in any locality a difference of hydrostatic levels in the water-bearing strata underlying the earth's surface, as explained above, to operate my improved apparatus.

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

1. In a hydraulic ram or apparatus for rais-



ing water from wells having water-bearing strata of different hydrostatic levels, the combination, with an influx fountain-pipe, C, of the two-part castings A B, having a pipe, D, groove *b*, efflux-valved chamber E, and valved air-chamber F, said parts adapted to connect two water-bearing strata of different hydrostatic levels, substantially as and for the purposes herein shown and described.

2. In a hydraulic ram or apparatus for raising water from wells having water-bearing strata of different hydrostatic levels, the combination, with an influx fountain-pipe, C, of the parts A and B, having a pipe, D, the efflux valved chamber E, valved air-chamber F, and supply-pipe G, adapted to communicate with air-chamber, and all arranged to connect two water-bearing strata of different hydrostatic levels, substantially as and for the purposes herein shown and described.

3. In a hydraulic ram or apparatus for raising water from wells having water-bearing strata of different hydrostatic levels, the combination, with an efflux-chamber, E, an air-chamber adapted to connect pipes C D, and the supply-pipe G, of the parts A and B, provided with groove *b*, opening *b'*, and plug or stop-cock attachment *b''*, substantially as and for the purposes herein shown and described.

4. In a hydraulic ram or apparatus for raising water from wells having water-bearing strata of different hydrostatic levels, the combination, with a valved air-chamber and influx and efflux pipes, of the efflux-chamber E, having an inverted saucer-shaped valve, *e*, having the two series of openings *e e'*, substantially as and for the purposes herein shown and described.

5. In a hydraulic ram or apparatus for raising water from wells having water-bearing strata of different hydrostatic levels, the combination, with a valved air-chamber and influx and efflux pipes, of the efflux-chamber E, having a valve, *e*, and connecting rope or chain, H, having a weight, *h*, substantially as and for the purposes herein shown and described.

6. In a hydraulic ram or apparatus for raising water from wells having water-bearing strata of different hydrostatic levels, the combination of an influx fountain-pipe, an efflux fountain-pipe, said two pipes adapted to connect two (2) water-bearing strata of different hydrostatic levels, intermediate valved air-chamber, efflux valved chamber, supply-pipe, and drainer 2 2, and a water-distributor having a series of pipes controlled by stop-cocks, substantially as and for the purposes herein shown and described.

7. The combination of an Artesian-fountain pipe, an efflux fountain-pipe with an efflux valved chamber, intermediate valved air-chamber adapted to connect efflux fountain-pipe and Artesian-fountain-pipe, and the supply-pipe G and parts A and B, provided with groove *b* and plug or stop-cock attachment *b''*, substantially as and for the purposes herein specified.

In testimony whereof I affix my signature in presence of two witnesses.

JACOB BLOOM YEAGLEY.

Witnesses:

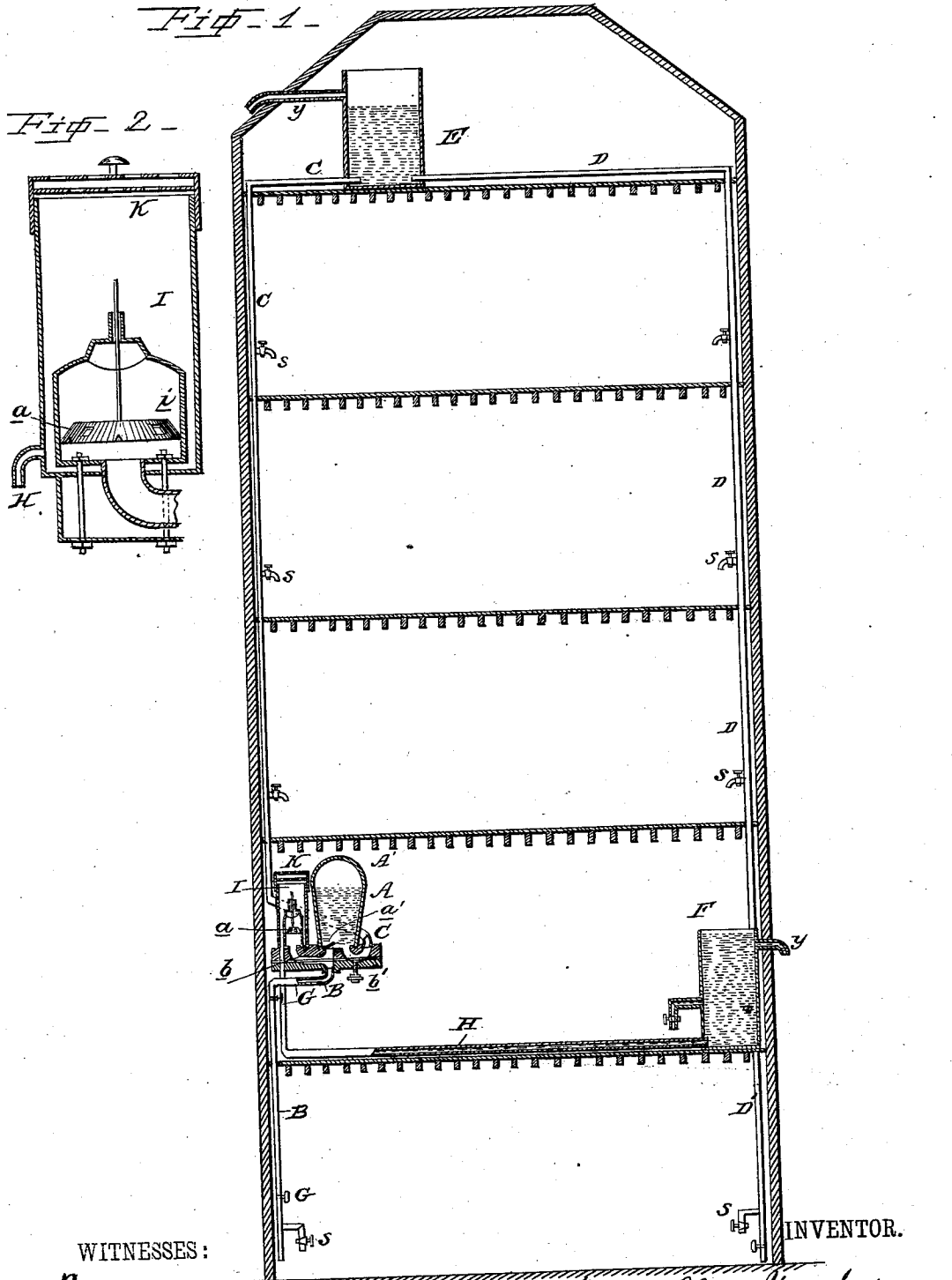
THOMAS ATKINSON,  
C. C. GLASS.

(No Model.)

J. B. YEAGLEY.  
HYDRAULIC RAM.

No. 298,263.

Patented May 6, 1884.



# UNITED STATES PATENT OFFICE.

JACOB BLOOM YEAGLEY, OF INDIANAPOLIS, INDIANA.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 298,263, dated May 6, 1884.

Application filed January 12, 1884. (No model.)

*To all whom it may concern:*

5 Be it known that I, JACOB BLOOM YEAGLEY, a citizen of the United States of America, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful improvements in an automatic apparatus for raising water to a higher level in pipes connected with water-works mains than the hydrostatic-pressure level of water-works; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

15 This invention relates to certain new and useful improvements in apparatus for raising water automatically in pipes connected to and communicating with water-works pipes or mains to a higher level than the hydrostatic-pressure level of water-works, and more particularly to improvements on my former patent dated September 25, 1883, and numbered 285,774, as also on my former application now pending, filed in the United States Patent Office October 20, 1883, and relating more especially to improvements of some of the parts, and in the adaptation for the raising and distribution of water in buildings having water-works-pipes connection, the water-works pressure being insufficient ordinarily to raise water in pipes to the upper stories of the highest class of buildings in many of our larger cities, except, probably, in cases of emergency, when the fire-bell is sounded, calling out the fire-department to extinguish a fire, or for some other extraordinary emergency, when the full water-works-pressure power is applied, where the Holly water-works system is employed, while the reservoir system would raise water only about as high as the surface-water in the reservoir.

45 The object of my invention in the application of my apparatus is to raise water automatically into the upper stories or on the roofs of the highest buildings under a very low or ordinary water-works pressure under either of above-named systems, being no greater, for instance, than ten (10) or fifteen (15) pounds on the square inch, raising water 50 under such pressure in pipes in buildings about

twenty (20) and thirty (30) feet high, respectively, while it is much less where buildings stand on still greater ground elevations, while with my apparatus, under the same conditions, water can be raised in pipes automatically to any required height ordinarily practical, the amount of water thus raised being governed, first, by the pressure in the pipe leading to my apparatus of given size; second, by the size of the apparatus and corresponding size of the pipe leading to the water-works main with a given pressure, and, third, the height to which the water is required to be raised under a given pressure with a given apparatus. The pressure or force of my apparatus may be increased or decreased under the same water-works pressure simply by adjusting it higher or lower on the pipe leading to the main, and under a high water-works pressure my apparatus works very rapidly, and an extraordinary pressure-power of several thousand pounds on the square inch may be obtained, provided the apparatus and pipes leading from it are made strong enough to resist such a pressure, and water under such a pressure could be raised not only hundreds but thousands of feet high. The cause of this is clearly to be seen in the construction and mechanical operations of the apparatus under such a hydrostatic pressure, which may be regarded as a vertical one (the pipe being free from short turns)—as, for instance, if the water-works pressure is sufficient to raise and maintain water in a pipe about one hundred and fifty (150) feet high, equal to about seventy-five (75) pounds pressure on the square inch, the water would issue from the bottom of the pipe with a velocity of more than ninety-six (96) feet per second, provided the pipe is kept constantly full, which is the case under a constant uniform pressure above stated; and since the momentum or quantity of motion is the weight of the moving mass multiplied by its velocity, and since the initial velocity in such a case is also its maximum or final velocity, because it is a well-known principle that the velocity of a stream flowing from an orifice is the same, theoretically, as that acquired by a heavy body falling freely from a height equal to the dis-

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tance from the surface of the liquid to the orifice, or, in other words, equal to the head of the liquid, the head being the vertical distance from the center of the orifice to the surface of the liquid, hence from these facts it is readily seen what power and velocity may be obtained from and under such conditions when hydro-mechanically applied, as in my apparatus, which will be hereinafter more fully described in its operations.

Referring to the accompanying drawings, Figure 1 represents a vertical section through a house or other building, showing my improvements as applied to the water-works pipe; Fig. 2, an enlarged vertical sectional view of the waste-water receiver inclosing efflux-cylinder and check-valve.

The apparatus A is constructed similarly to my former patent and pending application before referred to, having an efflux-cylinder, *i*, provided with a check-valve, *a*, and air-chamber A', provided with valve *a'*, said chambers being connected by a short cross-pipe, *b*, connected to the pipe B at right angles externally, but communicating internally, so that the intersecting orifice is formed to comply with the "contraction of the fluid-vein" to increase the velocity; also, a plug, *b'*, for closing drain-opening in bottom of supply-pipe C. C represents the supply-pipe leading from apparatus to the tank E.

D represents pipe leading from tank E to any desired room or rooms or apartments of the building or buildings to be supplied.

F represents a tank supplied from efflux-cylinder waste-water receiver I through pipe H.

K represents a double perforated top or cover of the waste-water receiver, with openings alternating, or not coinciding with each other, and so arranged as to prevent water from being thrown through from the efflux-cylinder, and yet to admit air freely through the openings or perforations.

D' is supply-pipe leading from tank F down to the first floor, or any apartments below tank, where water may be required.

SS are stop-cocks to draw water from supply-pipes C and D.

Y Y represent overflow-pipes of tanks E and F, leading to other water-saving receivers, if desired, or may be drained off on or in the ground; or the apparatus may be stopped working when the tanks are full by closing either of the stop-cocks G.

The apparatus should be adjusted on the water-works pipe B, so as to dispense with elbows or short turns in the pipe leading to the apparatus, which is easily done by placing the side of the apparatus against the wall of the building, instead of its end, as shown in the drawings, which is so drawn simply to show more clearly all the parts of the apparatus. This will then also avoid the turning of the pipe C at the apparatus leading to the tank E, and thus give the apparatus much more power.

The apparatus being placed in the desired position—for instance, ten (10) or fifteen (15) feet or more below the statical water-works pressure—and the tanks and the pipes arranged as may be desired, bearing in mind that the tank F must be placed at least its own height lower than the apparatus A, so as to have a free flow of the waste water into it through pipe H. For ordinary purposes, even in large buildings where much water is needed, the ordinary-sized water-pipes are used above the apparatus, and the apparatus need be no larger than an ordinary gas-meter, weighing only from fifty to sixty pounds, while the pipes leading to the apparatus must always correspond with the size of the apparatus employed. The supply-pipe running from the apparatus to the tank E may also be used to supply water to the different rooms or apartments through the stop-cocks SS, as well as to supply the tank. All having been arranged ready for operation, the stop-cock G below the apparatus A is opened. The water will enter the apparatus with a force theoretically conditioned on the principles above explained, making allowance, however, for changes of flow in the apparatus when in operation. The efflux check-valve *a* within the efflux-cylinder *i* is instantly carried upward by the pressure and current of the water, and instantly closing the efflux-cylinder orifice. The water, having by this time been put in rapid motion, and having no means of escape, forces open the air-chamber valve *a'*, (which opens upward,) caused by the momentum of the current in the pipe, the air-chamber valve being in line with the current, while at the same time a part of the water in the short connecting cross-pipe *b*, communicating with the efflux-cylinder, is drawn out, as well as the water in the efflux-cylinder, below the check-valve by force of the rapid and strong flow over the area of the intersecting orifice of the short cross-pipe *b* into the air-chamber A', thus forming a partial void or vacuum in the short cross-pipe *b* and efflux-cylinder under the check-valve, the water having been carried into the air-chamber, the sudden condensation of the air in the air-chamber by the momentum of the stream aiding in its operations, thus reducing the pressure in the efflux-cylinder below the external atmospheric pressure, which forces down the check-valve, its dropping or opening not depending on its weight, no matter how great the statical pressure of the water may be. The efflux-valve is thus then made to drop instantly, and opening not by its weight only, but is forced down by external atmospheric pressure or "suction," as above explained. The efflux-cylinder orifice being thus opened, and the water or current having expended its effective force into the air-chamber, the air-chamber valve is made to close by the pressure above it, when the water again rushes to the efflux-cylinder orifice, but is again instantly refused egress by the check-valve closing the orifice,

the maximum pressure being again directed upon the air-chamber valve, because it is in the direct line of the current, moving with great velocity and consequent powerful momentum, especially under a high head or pressure, again causing the water in the short cross-pipe and efflux-cylinder to be dragged or drawn out by the rapidly-flowing current over the intersecting orifice of the cross-pipe and sudden condensation of the air in the air-chamber, thus again causing a void or vacuum, as above explained, causing the efflux check-valve again to open, as before, and so on automatically, in rapid succession of but little variation in the same apparatus under the same pressure. The greater the pressure, however, the more rapid and powerful will the apparatus work on the principles above explained. It will thus be seen that it is not only a hydraulic device alone, but combines a very important pneumatic principle, without which the apparatus would be inoperative, constituting by the employment of these two very important and valuable forces, governed by the physical force of gravity, really a hydro-pneumatic apparatus. By these successively rapid impulses, varying from one hundred to several hundred pulsations per minute, increasing and decreasing as the pressure varies in the pipe to which the apparatus is attached, (which I have proven by practical demonstration with my new apparatus,) the water is forced out of opening under the air-chamber into the supply-pipe C, and from it in a steady stream, caused by the atmospheric condensation in the upper part of the air-chamber. A stop-cock may to good advantage be placed in the supply-pipe a little above the apparatus, as well as below it, and then by opening the drain-plug and efflux-valve fresh air may be had to fill the air-chamber, as well as to wash out the inside of the apparatus, the latter being easily done by taking out the drain-plug and opening the lower stop-cock.

The application of the practical utility of this apparatus is not only for a sure and cheap water-supply for domestic purposes, but is also an excellent and a valuable protection against fire, as the tanks may be large and kept constantly full to successfully meet such an emergency. Again, it must be borne in mind that the waste water from the efflux-cylinder is not a loss or expense to be charged against the apparatus, even though any water-works company

upon whose pipes it may be placed should elect to put a water-meter on the pipe supplying the apparatus. The waste water can be used in the lower parts of the building as advantageously as though it was drawn directly from the water-pipe; and in case of a fire not in the building the apparatus may be instantly stopped, thus preventing an encroachment upon the water-works company of the city, allowing a speedy maximum main pressure in full control of the company by their machinery.

I do not wish to be understood as claiming, broadly, in this case anything shown, described, or claimed in my former patent and pending application before referred to.

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

1. The combination of the water-works pipe B, supply-pipe C, tank E, supply D, tank F, waste-water receiver I, pipe H, and apparatus A, consisting of the efflux-cylinder *i*, valved air-chamber A', and connecting cross-pipe *b*, substantially as and for the purpose herein shown and described.
2. The combination of the water-works supply-pipe B with main connection, supply-pipe C, apparatus A, consisting of the efflux valved cylinder *i*, valved air-chamber A', and connecting cross-pipe *b*, the waste-water receiver I, pipe H, and tank F, substantially as and for the purpose herein shown and described.
3. The combination of the water-works supply-pipe B with main connection, supply-pipe C, intermediate apparatus, A, consisting of the efflux valved cylinder *i*, valved air-chamber A', cross-pipe *b*, and waste-water receiver I, having double perforated top K, with alternating openings, substantially as and for the purpose herein shown and described.
4. The combination of the water-works supply-pipe B, communicating with main pipe, apparatus A, constructed substantially as described, supply-pipe C, tank E, supply-pipe D, tank F, and supply-pipe D', substantially as and for the purpose herein shown and described.

In testimony whereof I affix my signature in presence of two witnesses.

JACOB BLOOM YEAGLEY.

Witnesses:

C. FRIEDGEN,  
N. L. ALLEN.

(No Model.)

3 Sheets—Sheet 1.

A. BAER.  
HYDRAULIC RAM.

No. 337,112.

Patented Mar. 2, 1886.

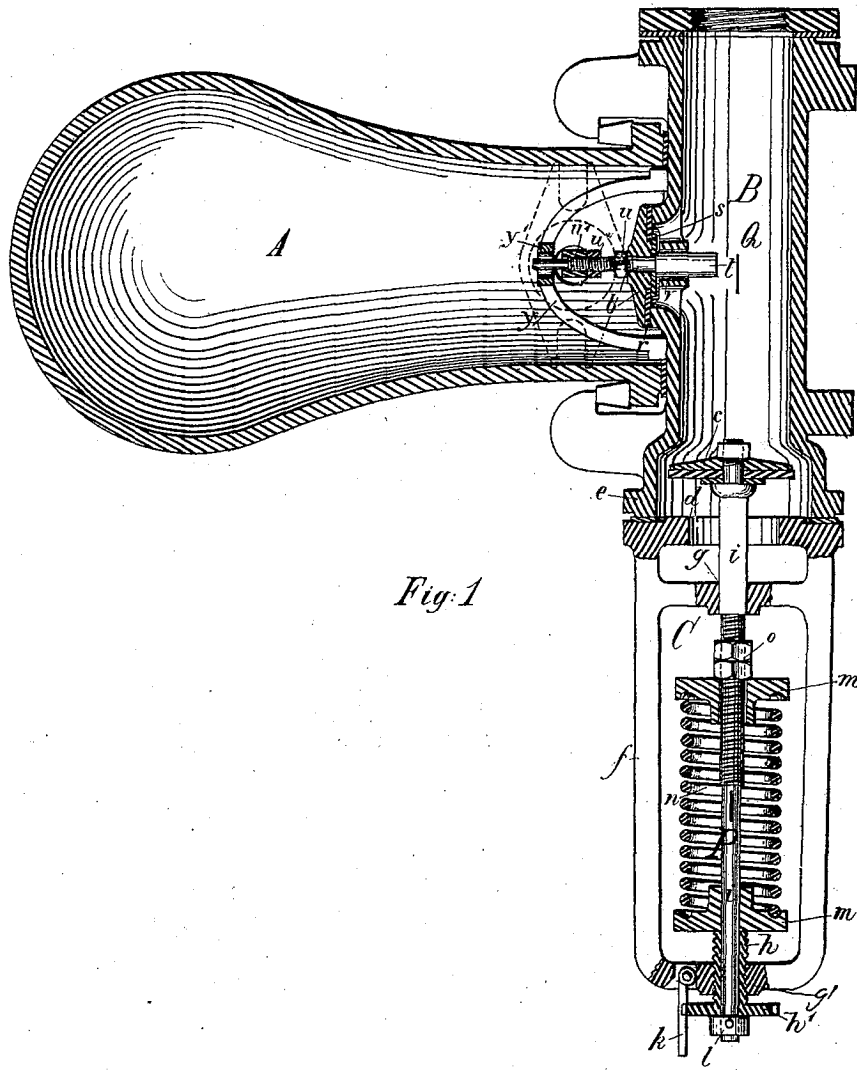


Fig. 1

Witnesses:  
 Maurice Delmar.  
 Arthur L. Morsell.

Adolphus Baer  
 Inventor:  
 By Louis Bagger & Co.  
 Attorneys

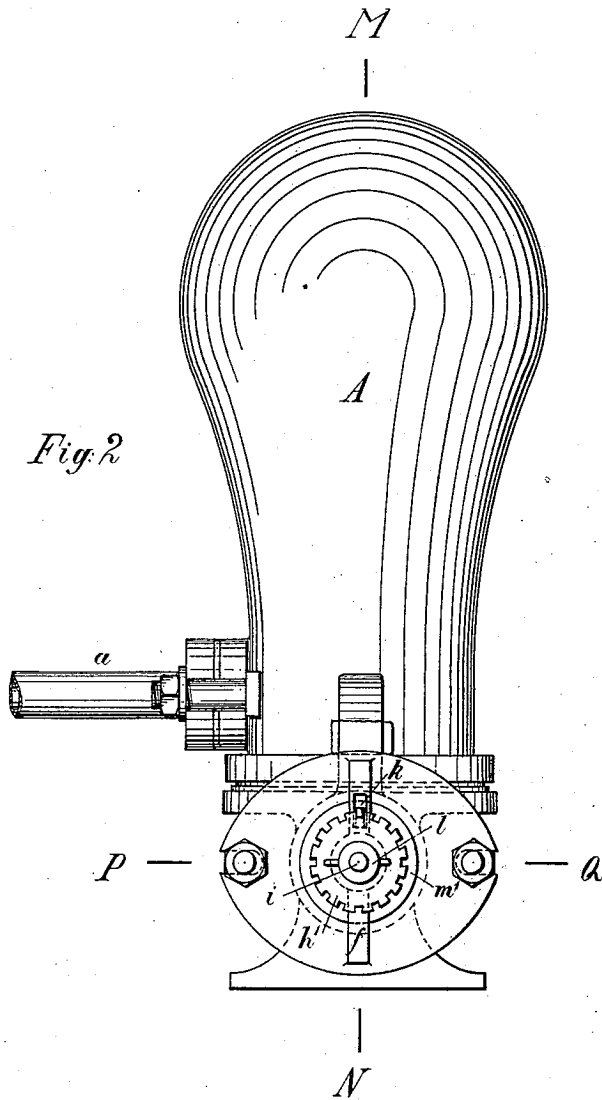
(No Model.)

3 Sheets—Sheet 2.

A. BAER.  
HYDRAULIC RAM.

No. 337,112.

Patented Mar. 2, 1886.



Witnesses:  
Maurice Delmar.  
Arthur L. Morell.

Adolphus Baer,  
Inventor:

By Louis Bragge & Co.  
Attorneys.

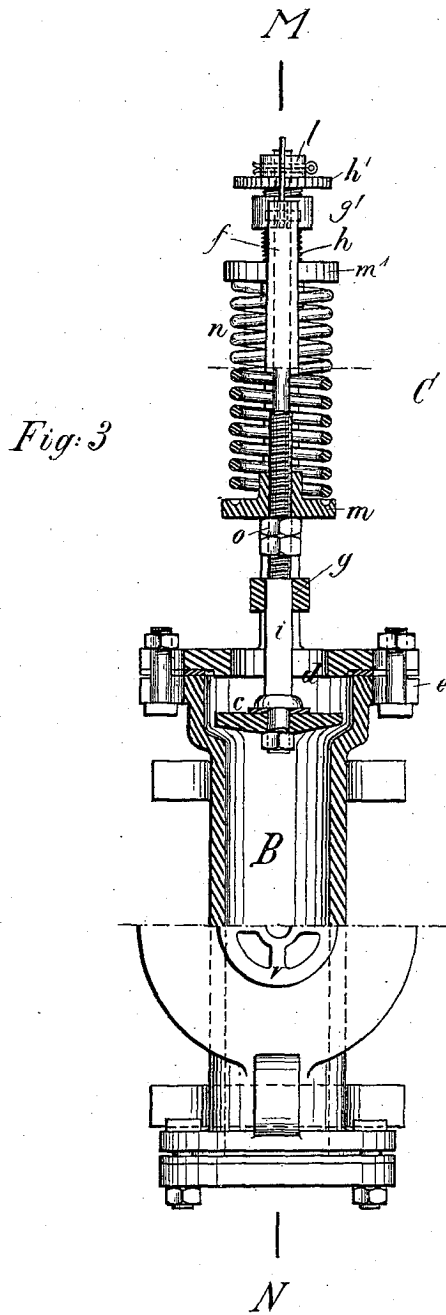
(No Model.)

3 Sheets—Sheet 3.

A. BAER.  
HYDRAULIC RAM.

No. 337,112.

Patented Mar. 2, 1886.



Witnesses:  
Maurice Delmar,  
Arthur L. Morwell.

Adolphus Baer,  
Inventor:  
By Louis Bagger & Co.  
Attorneys.



# UNITED STATES PATENT OFFICE.

ADOLPHUS BAER, OF ZURICH, SWITZERLAND.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 337,112, dated March 2, 1886.

Application filed December 12, 1885. Serial No. 185,493. (No model.)

*To all whom it may concern:*

Be it known that I, ADOLPHUS BAER, a citizen of the Republic of Switzerland, residing at Zurich, in Switzerland, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification, reference being had to the accompanying drawings, which form a part of the specification, and in which—

10 Figure 1 is a longitudinal vertical sectional view of my improved hydraulic ram, taken on lines M N, Figs. 2 and 3. Fig. 2 is an end view of the same; and Fig. 3 is a top view of the ram, showing the air-chamber removed and showing portions taken in section on line P Q, Fig. 2.

Similar letters of reference indicate corresponding parts in all the figures.

20 My invention has relation to hydraulic rams; and it consists in the improved construction and combination of parts of a ram having means for adjusting the stroke of the discharge and outlet valves, and having means for adjusting the tension of the discharge-valve, as hereinafter more fully described and claimed.

25 In the accompanying drawings, the letter A indicates the air-chamber, which is provided with the outlet pipe *a*, and which is secured by suitable clamps and by a suitable packed joint upon the water-chamber B, into which the feed-pipe enters at one end. A valve-seat, *d*, having an outwardly-projecting guide-frame, C, is suitably clamped upon a flange, *e*, at the discharge end of the water-chamber, and the discharge or stop valve *c* plays upon the inner face of this seat. The guide-frame consists of side pieces, *f*, the end pieces of which are respectively formed with a smooth bearing, *g*, near the valve seat, and with a screw-threaded bearing, *g'*, at the outer end of the frame, and the stem *i* of the discharge-valve slides in the inner bearing, *g*. A screw-threaded sleeve, *h*, projecting inward from a disk, *h'*, having a series of notches in its edge, fits in the screw-threaded bearing *g'*, and has the outer end of the discharge-valve stem sliding in it, and the notches in the edge of the disk are engaged by a pawl or latch, *k*, pivoted at its inner end to the end piece of the guide-frame. The outer end of the valve-stem is formed with a collar, *l*, which bears against the

notched disk, and it will be seen that the inward stroke of the valve and valve-stem will be regulated by adjusting the screw-threaded sleeve and its disk in the female-threaded bearing in the end of the frame, the stem sliding in the inner bearing in the frame and in the sleeve. An outer disk, *m'*, and an inner disk, *m*, slide upon the valve-stem and confine a spiral spring, *n*, which is wrapped around the stem and bears with its ends against the grooved and flanged inner faces of the disks, and the outer disk bears against the inner end of the screw-threaded sleeve, while the inner disk is adjusted upon the valve-stem by means of a nut and its jam-nut *o*, which fit upon the stem, which at that portion is screw-threaded. It will be seen that the tension of the spring which furnishes resistance for the discharge-valve against the flow of water may be regulated by means of the nuts upon the threaded portion of the valve-stem. The upper side of the water-chamber is provided with a valve-seat and aperture having a cross-bar formed with a vertical bearing, *v*, and a valve, *b*, having an elastic disk, *r*, secured to its under side, plays upon this seat, being clamped upon the valve-stem *t* between a disk, *s*, bearing against the elastic disk and held upon the stem by the lower portion of the stem being enlarged, and a nut, *u*, which fits upon a threaded portion of the upper end of the stem. The upper end of the stem slides in a vertical bearing, *y'*, formed at the top of a yoke, *y*, projecting into the air-chamber, and an adjusting-nut, *v'*, and a jam-nut, *v''*, serve to limit the upward stroke of the valve and stem, the adjusting-nut stopping against the bearing in the yoke when the valve is raised, and the jam-nut bearing against the lower end of the adjusting-nut. In this manner it will be seen that the flow of water into the air-chamber, and consequently out through the outlet-pipe, may be regulated, and the resistance of the discharge or stop valve may be regulated, as well as its stroke, regulating the force with which the water will enter the air-chamber and rise in the outlet-pipe, as well as the volume of the same, by regulating the volume of water flowing out of the discharge-aperture before the same is closed and the water repelled and forced through the outlet-valve.

Having thus described my invention, I claim and desire to secure by Letters Patent of the United States—

1. In a hydraulic ram, the combination of a  
5 water-chamber, a valve-seat secured at the discharge end of the chamber and having an outwardly-projecting guide-frame formed with an inner smooth longitudinal bearing and an outer screw-threaded longitudinal bearing, a  
10 discharge or stop valve having a stem passing through the bearings, and having a collar secured at its outer end, a screw-threaded sleeve fitting in the threaded bearing and having a notched disk at its outer end, the stem sliding  
15 in the sleeve with its disk bearing against the outside of the disk, and a latch pivoted to the end of the guide-frame and engaging the notched disk, as and for the purpose shown and set forth.
2. In a hydraulic ram, the combination of a  
20 water-chamber, a valve-seat secured at its discharge end, and having an outwardly-projecting frame provided with a smooth longitudinal inner bearing at one end and a screw-  
25 threaded bearing at its outer end, a screw-threaded sleeve fitting in the threaded bearing and having a disk with a notched edge at its outer end, a pivoted latch engaging the notched edge of the disk, a discharge or stop valve  
30 playing upon the seat and having a stem sliding in the bearing and sleeve, and formed with

a collar at its outer end and with a screw-threaded inner portion, a disk upon the stem bearing against the inner end of the threaded sleeve, a disk fitting upon the inner portion  
35 of the stem, adjusting-nuts bearing against the inner face of the disk and fitting upon the threaded portion of the stem, and a spiral spring wrapped around the stem and held between the disks, as and for the purpose shown  
40 and set forth.

3. In a hydraulic ram, the combination of a water chamber having a valve-seat at its upper side formed with a central bearing, an  
45 air-chamber having an outlet and secured over the valve-seat, a stem sliding with its enlarged lower portion in the bearing of the seat and having a threaded middle portion, a yoke having a bearing in its upper portion for the upper end of the stem, a valve upon the stem  
50 having an elastic disk clamped between a disk upon the shoulder and a nut upon the threaded portion of the stem, and a stop-nut and a jam-nut upon the threaded portion of the stem, as  
55 and for the purpose shown and set forth.

In testimony whereof I hereunto sign my name, in the presence of two subscribing witnesses, this 14th day of November, 1885.

ADOLPHUS BAER.

Witnesses:

EMIL BLUM,  
WILLIAM SCHNEIDER.

(No Model.)

3 Sheets—Sheet 1.

P. LORMANT.  
APPARATUS FOR RAISING WATER.

No. 592,872.

Patented Nov. 2, 1897.

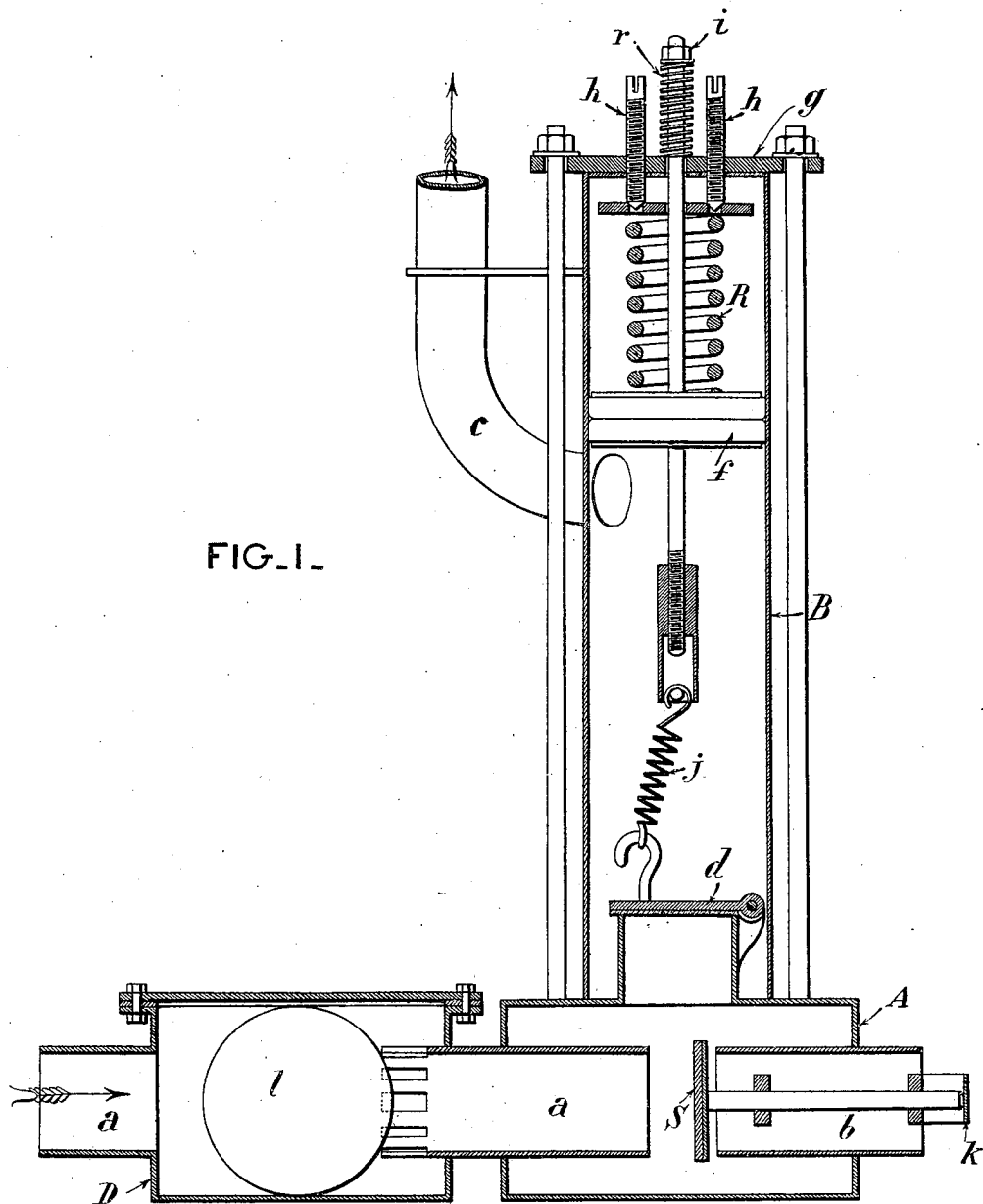


FIG. 1.

Witnesses:-  
W. C. Pinckney  
C. Holloway

Inventor:-  
Pierre Lormant,  
By J. E. Udowen  
Attorney

(No Model.)

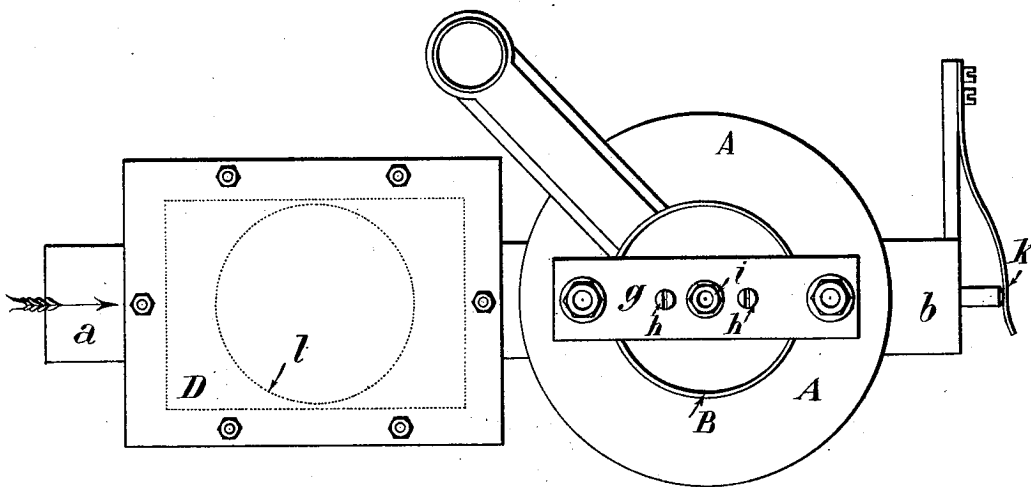
3 Sheets—Sheet 2.

P. LORMANT.  
APPARATUS FOR RAISING WATER.

No. 592,872.

Patented Nov. 2, 1897.

FIG. 2.



Witnesses:-  
W. C. Pinckney  
C. Holloway

Inventor:-  
Pierre Lormant,  
By J. S. M. Bowen  
Attorney



# UNITED STATES PATENT OFFICE.

PIERRE LORMANT, OF PARIS, FRANCE.

## APPARATUS FOR RAISING WATER.

SPECIFICATION forming part of Letters Patent No. 592,872, dated November 2, 1897.

Application filed November 14, 1896. Serial No. 612,098. (No model.) Patented in France October 8, 1896, No. 260,288.

*To all whom it may concern:*

Be it known that I, PIERRE LORMANT, gentleman, residing at 223 Rue de l'Université, Paris, in the Republic of France, do hereby declare the nature of my invention for Improvements in and Connected with Apparatus for Raising Water (for which I have obtained Letters Patent of France, dated October 8, 1896, No. 260,288) and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement.

My invention relates to improvements in and connected with apparatus for raising water, and has for its object to provide apparatus resembling in its action a hydraulic ram, but having the advantage that it utilizes a larger proportion of the energy of the water in the main for the effective elevation of water in the rising main. I obtain this result by equilibrating the column of water in the rising main by its own weight by means of a special device to be described. According to my invention I am also enabled to abruptly stop the flow of the water in the elevator for the purpose of transforming its momentum into a raising force while still maintaining the flow in the feed-main, whereby the pulsations are extremely rapid, loss of water is considerably reduced, and the efficiency of the apparatus considerably increased.

To enable my invention to be fully understood, I will describe it by reference to the accompanying drawings, in which—

Figure 1 is a vertical section of apparatus constructed according to my invention. Fig. 2 is a plan of the same. Fig. 3 is a view similar to Fig. 1 of a slightly-modified construction of my apparatus.

My apparatus comprises a case or box A, into which the water inlet and outlet pipes *a* and *b*, respectively, open, the said pipes being arranged in alinement with one another. The case or box A is surmounted by a vertical cylinder B, in permanent communication with the rising main *c*. Between the cylinder B and the box A there is arranged a flap (or other) valve *d*, which is in connection with a piston *f*, adapted to move in the cylinder B above the outlet from the cylinder into the rising main *c*.

A spring R is placed between the piston *f*

and an upper cross-piece or support *g*, fixed to the cylinder B. Screws *h h* limit the movement of the piston *f*, and a nut *i*, which is supported on a spring *r* and which is screwed upon the end of the piston-rod, enables the initial tension of the spring R to be adjusted. A spring *j*, the tension of which can be regulated, connects the valve *d* to the piston *f*.

It will be obvious that the water in the rising main *c* exerts pressure simultaneously on the lower face of the piston *f* and upon the upper face of the valve *d*. By this means a state of equilibrium is obtained for the column of water which can be regulated so as to give a desired excess of pressure from above downward in such a manner that the valve *d* is kept upon its seat by a small pressure.

The opening of the outlet-pipe *b*, which opens into the box A, is controlled by a valve S, which is normally kept open by a spring *k*.

When the water is fed into the box A with a progressive velocity, a moment arrives when the difference of pressure on the two faces of the valve S in the outlet-pipe *b* causes the said valve to close, the flow of water in the outlet-pipe *b* ceases abruptly, and the momentum of the water raises the valve *d* and the water enters the cylinder B.

When the momentum of the water inclosed in the box A is used up, the valve *d* falls back onto its seat, the valve S opens, and a certain quantity of water escapes through the said pipe. As soon as the water has regained its normal velocity in the box A the valve S again closes, thereby causing a fresh flow of water into the cylinder B, and consequently into the rising main *c*.

It is found that by arranging the apparatus so that the weight of water in the rising main assists in opening the valve *d* an improvement is effected, and that said valve closes as quickly as required when relieved of the shock due to closing valve S. The yielding of spring *j* allows the valve *d* to close without waiting for piston *f* to entirely resume its lower position.

To render the beats or pulsations as frequent as possible, and consequently to diminish the time during which the water flows through the outlet-pipe *b*, (as pure waste,) I arrange a second box D in the water-inlet pipe *a*, and in this box I arrange an elastic

pocket *l*, filled with air. This pocket is preferably of caoutchouc, covered with tanned hemp to avoid deterioration and adherence to the walls of the box. I can, however, make  
 5 this pocket of any other suitable material. With this arrangement, as soon as the flow ceases in the outlet-pipe *b* by reason of the closing of its valve *S* the water which is in the inlet-pipe *a*, instead of having its flow  
 10 abruptly stopped throughout its whole height, continues to flow owing to the presence of the pocket *l*, which by its compressibility provides for the required time a free space for the water in such a manner that as soon as  
 15 the valve *S* is again open the water instantly regains its maximum velocity in the box *A*, because the water in the inlet-pipe *a* has preserved its velocity and because the compressed air in the pocket by its expansion assists the movement of water into box *A*, so  
 20 that the valve *S* is therefore again closed. The closing of valve *S* suddenly checks the flow of water in chamber *A* and operates valve *d*, notwithstanding the continued flow  
 25 into chamber *D*.

In the modified construction of my apparatus shown in Fig. 3 the piston is replaced by a membrane or metallic disk *g*, fixed at the upper end of the cylinder *B'*, of which it forms  
 30 the cover. A cross-bar *l*, fixed to the cylinder *B'*, serves as a fixed nut for a screw *v*, which limits the movement or displacement of the metallic disk *g*, and consequently the distance to which the valve *d'* is raised. This  
 35 valve *d'* is connected to the membrane *g* by means of a spring *u* and of a metal rod *x*, which passes through the membrane, the joint *y* between the rod and membrane being made tight by being formed of two leather or  
 40 india-rubber washers or as a stuffing-box. This section of the membrane which is adapted to be displaced under the pressure of the water is made slightly larger than that of the valve *d'*, in order that the upward pressure  
 45 on the diaphragm due to the water in pipe *C* may exceed the downward pressure on the valve due to the same cause (the water in pipe *C*) approximately as much as the weight of water between the valve and diaphragm,  
 50 which weight rests on the valve but not on the diaphragm.

My apparatus can be used as a substitute for hydraulic rams and can utilize heads of water of too little power to be useful for hydraulic rams. Moreover, as my apparatus  
 55 enables the weight of water in the rising main to be equilibrated, it can be applied to vari-

ous types of hydraulic elevators, to pumps, &c., and my arrangement of compressible air-pocket can be applied to the various known  
 60 types of hydraulic rams.

I claim—

1. In an apparatus for raising water, the combination of a chamber or box *A* having an inlet and a waste-outlet, a valve for the  
 65 latter, a cylinder rising from said box, a valve between the box and cylinder, a piston for said cylinder and connected to the last-mentioned valve, and a rising pipe communicating with the cylinder between the piston and  
 70 valve, whereby the weight of water in the rising pipe aids in opening the valve admitting water to the cylinder, substantially as described.

2. In an apparatus for raising water, the  
 75 combination of a chamber or box *A* having an inlet and a waste-outlet, a valve for the latter, a cylinder rising from said box, a valve between the box and cylinder, a piston for said cylinder and connected to the last-mentioned  
 80 valve, a spring adapted to resist movement of the piston away from the valve, and a rising pipe communicating with the cylinder between the piston and valve, whereby the weight of water in the rising pipe aids in  
 85 opening the valve admitting water to the cylinder, substantially as described.

3. In an apparatus for raising water, the combination of a chamber or box *A* having an inlet and a waste-outlet, a valve for the  
 90 latter, a cylinder rising from said box, a valve between the box and cylinder, a piston for said cylinder and connected through a spring to the last-mentioned valve, and a rising pipe communicating with the cylinder between the  
 95 piston and valve at a point nearer the piston than to the valve, substantially as described.

4. The combination of box *A*, having an inlet and a waste-outlet, a valve for the latter, a cylinder rising from said box, a valve between the box and cylinder, a piston for said  
 100 cylinder, and connecting through a spring to the last-mentioned valve, means for adjusting said spring, a rising pipe communicating with the cylinder between the piston and  
 105 valve, and an adjustable spring above the piston, substantially as described.

In witness whereof I have herunto set my hand in presence of witnesses.

PIERRE LORMANT.

Witnesses:

S. CAURENO,  
 FR. HOFFMANN,  
 H. T. SMITH.

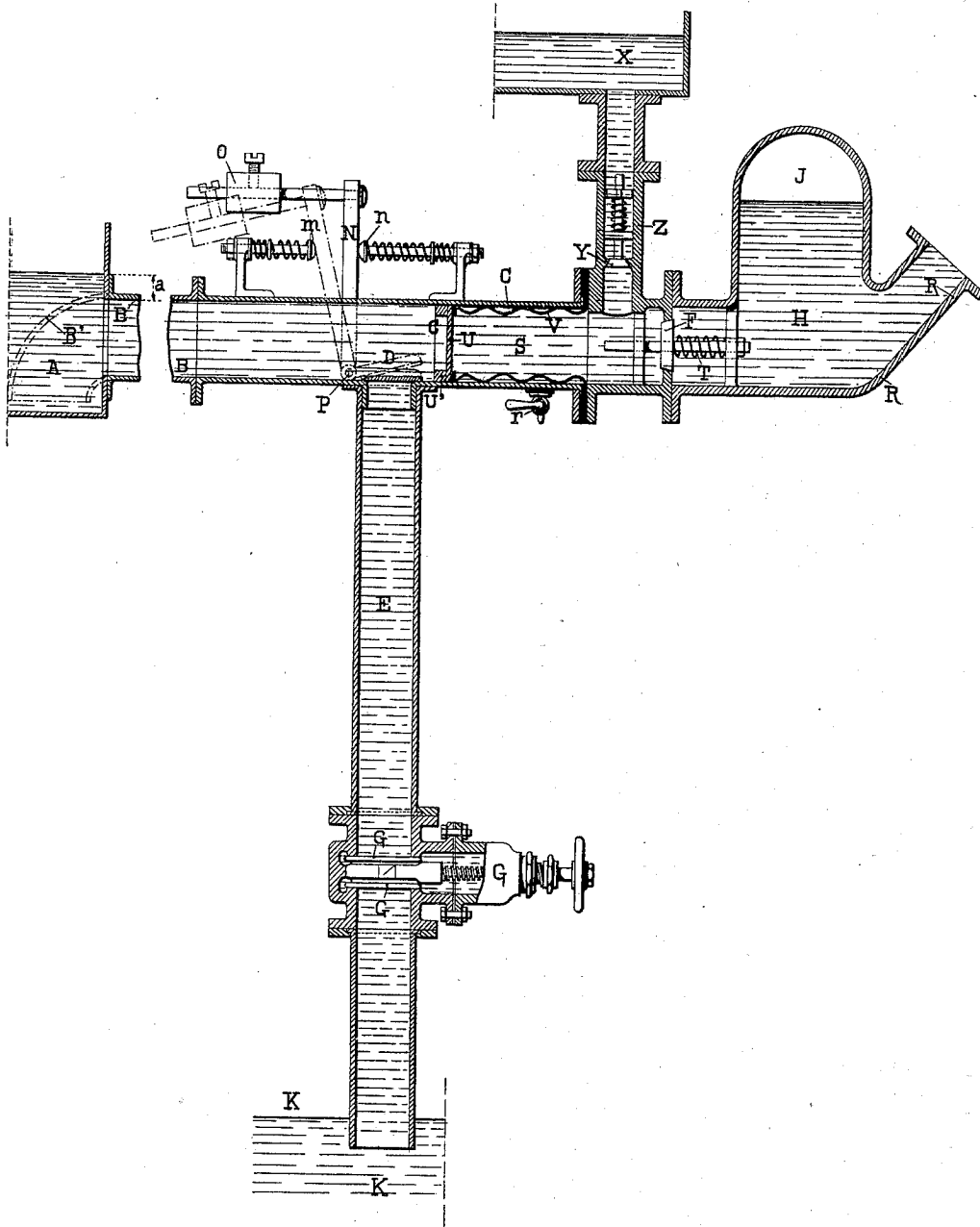
No. 624,921.

Patented May 16, 1899.

J. C. GELLY.  
HYDRAULIC RAM.

(Application filed Sept. 1, 1897.)

(No Model.)



Witnesses:  
Ella L. Giles  
O. W. ...

Inventor:  
Joseph Charles Gelly  
By  
Richard ...  
Attys



# UNITED STATES PATENT OFFICE.

JOSEPH CHARLES GELLY, OF PARIS, FRANCE.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 624,921, dated May 16, 1899.

Application filed September 1, 1897. Serial No. 650,266. (No model.)

*To all whom it may concern:*

Be it known that I, JOSEPH CHARLES GELLY, a citizen of the French Republic, residing at Paris, France, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

The invention has been patented in France, dated July 28, 1897, No. 266,351; in Belgium, dated August 4, 1897, No. 129,844; in Italy, dated August 4, 1897, No. 88/483, Vol. XXXII, No. 138; in Austria, dated August 5, 1897, No. 5,029; in Hungary, dated August 5, 1897, No. 11,364; in Spain, dated August 4, 1897, No. 21,277; in Russia, dated August 6, 1897, No. 2,488, and in Switzerland, dated August 4, 1897, No. 15,079.

My invention relates to a new or improved apparatus by means of which the vis viva or momentum of a mass of water flowing downward from any suitable source, waterfall, or tank may be utilized for forcing, raising, or elevating a portion of said water up to a level higher than the level in the source or tank. The apparatuses of this class, known as "hydraulic rams," as heretofore constructed must generally be located in the lower reach or level of a waterfall and communicate with the upper reach or level through a main or pipe, into which the water circulates with a certain speed imparted to it by the pressure of the head of water, and consequently with a corresponding momentum which is utilized for producing a shock against a valve suitably arranged for elevating a portion of the water up to a certain height above the lower level of the waterfall. Such devices are objectionable because of the following inconveniences: As they must be located in the lower reach of the waterfall or somewhat above the lower level of the same, they are liable at certain moments to be completely submerged and unable to work. Moreover, they can only work under a considerable head of water. Lastly, the water, after having expended its momentum for actuating the ram, escapes directly in the lower reach and cannot be fed into another hydraulic apparatus for producing motive power. With the apparatus constructed according to my invention these inconveniences are avoided. The said apparatus may be located at the upper level of the waterfall and actuated even by a

very small head of water, it only being necessary that the mouth of the inlet-pipe be constantly covered by or immersed in the water of the source, so as to prevent the air from penetrating in the said pipe. For the purpose of imparting to the water in the inlet-pipe the sufficient speed, and consequently the momentum necessary for producing the mechanical effect desired, I provide at a suitable point of the inlet-pipe a device, such as a suction-pipe, acting by depression, so as to cause the flowing of the horizontal column of liquid contained in the inlet-pipe.

In order that my said invention may be readily understood by any person skilled in the art, I will now proceed to describe the same fully with reference to the accompanying drawing.

The accompanying drawing shows my invention in vertical section.

A is a tank or any other receptacle in which the water of the source or waterfall is collected. The tank A communicates through an inlet-pipe B with a chamber C, the under side of which is provided with an opening controlled by a check flap-valve D and a vertical pipe E, leading to the bottom of a well or to the lower reach or level K of the waterfall, and preferably provided at its lower end with a sliding valve or cock G or any other suitable means for opening or closing the said pipe. The front or right end of the chamber C communicates with an air-reservoir H through an opening controlled by a valve F, actuated upon by a helical spring T, and on the air-reservoir H is branched the elevating-pipe R. The axis or shaft P, onto which is keyed or otherwise secured the check flap-valve D, is provided at its outer end with a bell-crank lever or arm N, bearing an adjustable weight O and the swinging movements of which are limited by two spring adjustable buffers *m* and *n*.

In certain cases, (such as for supplying towns with potable water,) where the available quantity of potable or filtered water is comparatively small, it is often necessary to raise this whole quantity. This I may effect by utilizing any dirty or not potable water. In the case where the potable water is to be taken at a level situated above the level of the water in the tank A of the raising apparatus, the

said potable water is collected into a reservoir X, while the motive dirty water is fed into the apparatus from a tank or reservoir, such as A.

5 Inside the chamber C a movable disk or piston U is secured to one end of a bag-like corrugated membrane V, made of india-rubber, leather, thin metal, or any other suitable elastic material. The edges of the other end of  
10 said membrane are attached to the front or right end of the chamber C, so as to form a water-tight collapsible chamber S, communicating with the air-reservoir H through an opening normally closed by the valve F,  
15 pressed by a helical spring T, and with the potable-water reservoir X through a pipe Z, controlled by a downwardly-opening valve Y. Inside the chamber C is fixed an annular stop U', the object of which is to limit the rear-  
20 ward stroke of the disk U, and on the front end of the chamber C is provided a cock  $\gamma$ , enabling to discharge any water which might eventually leak into the space comprised between the membrane V and the wall of the  
25 chamber C in the case where the disk or piston U would not be absolutely water-tight.

The working of this device is as follows: Assuming that the tank A, the inlet-pipe B, and the part of the chamber C situated at the  
30 left of the disk or piston U be filled with motive (not potable) water, and the collapsible chamber S, the air-reservoir H, and the elevating-tube R be filled with potable water which has been fed from the reservoir X  
35 through the pipe Z, when the apparatus is started by opening the sliding valve or cock G and as soon as the check flap-valve D is closed by the pressure of water flowing through the pipes B and E the motive water  
40 circulating in the inlet-pipe B and chamber C crushes or impinges, owing to its momentum, against the disk or piston U, thus causing the chamber S to be collapsed and the potable water therein to be forced into the air-reser-  
45 voir H and elevating-pipe R through the opening of the valve F, which has been opened

while the valve Y remains closed. When the momentum of the water is expended, the spring T closes the valve F, and the greater pressure of the water in the reservoir X, the  
50 level of which is higher than the level of the motive water in the tank A, opens the valve Y and forces back the disk or piston U to the left end of its stroke in close contact with the annular stop U', thus expanding the cham-  
55 ber S and filling it again with potable water, whereafter the same working is repeated.

The membrane V and disk U might be replaced without departing from the nature of my invention by any other suitable device  
60 constituting a movable water-tight partition between the potable and not potable water, and for holding the disk U in a vertical plane a helical spring may be provided into the chamber S.  
65

I do not wish to limit myself to the location of the reservoir for the potable water above the raising apparatus.

Having now particularly described and as-  
70 certained the nature of my said invention and in what manner the same is to be performed, what I claim is—

In combination, the horizontal pipe B, the pipe E leading down therefrom, the valve D controlling the pipe, means for opening the  
75 valve, the disk U movable in the pipe B, the valve F with its spring for closing the valve against the pressure from the flow of water through the pipe, a reservoir connecting with the space between the disk U and the valve  
80 F, and the flexible material for holding the disk U in normal position, said valve and diaphragm being arranged transversely of the horizontal pipe and operating horizontally,  
85 substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

JOSEPH CHARLES GELLY.

Witnesses:

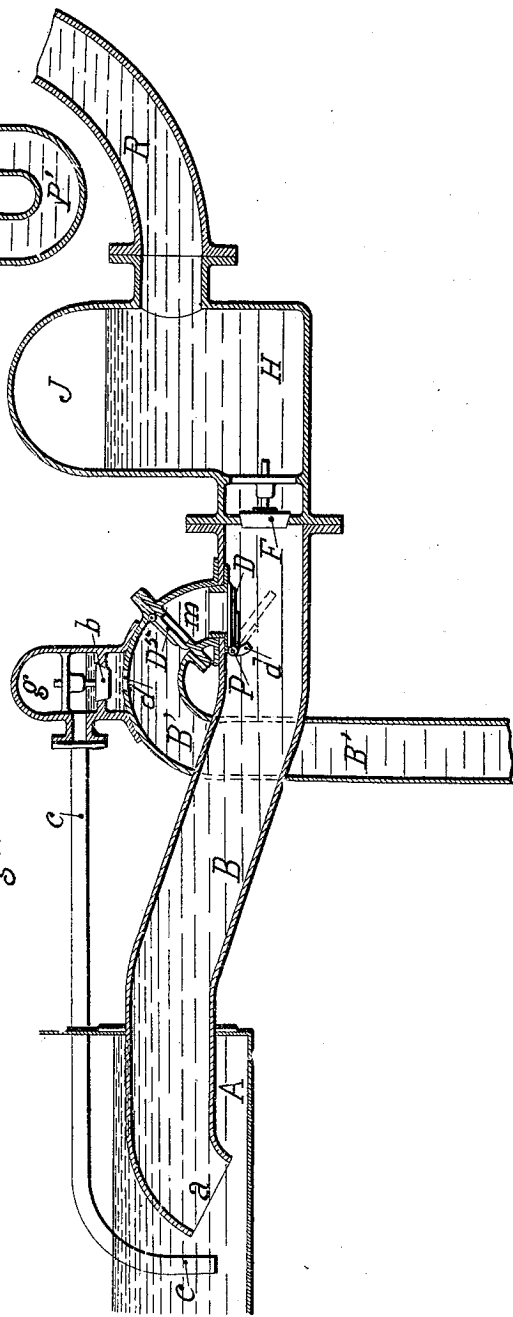
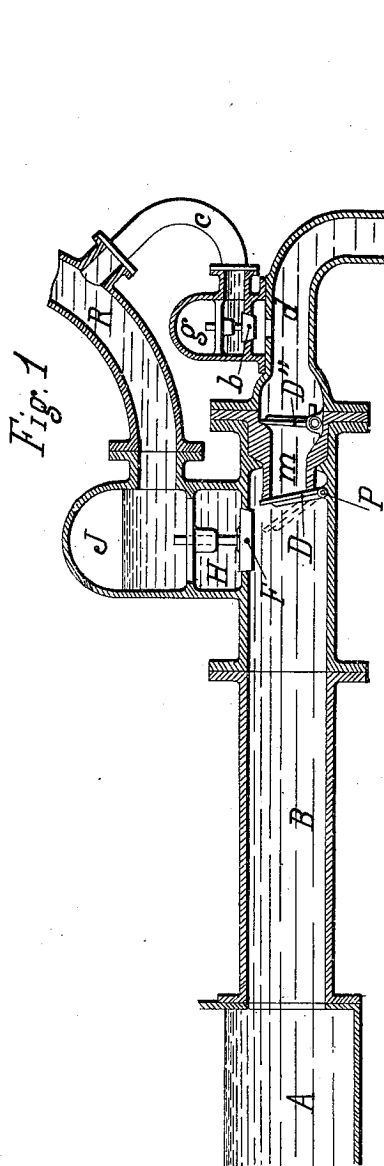
GEORGES DELOM,  
EDWARD P. MACLEAN.

J. C. GELLY.  
HYDRAULIC RAM.

(Application filed Apr. 14, 1898.)

(No Model.)

4 Sheets—Sheet I.



Witnesses:

*H. D. Keeler*  
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Inventor:

*Joseph C. Gelly*  
by *James L. Norris*  
att<sub>y</sub>

J. C. GELLY.  
HYDRAULIC RAM.

(Application filed Apr. 14, 1898.)

(No Model.)

4 Sheets—Sheet 2.

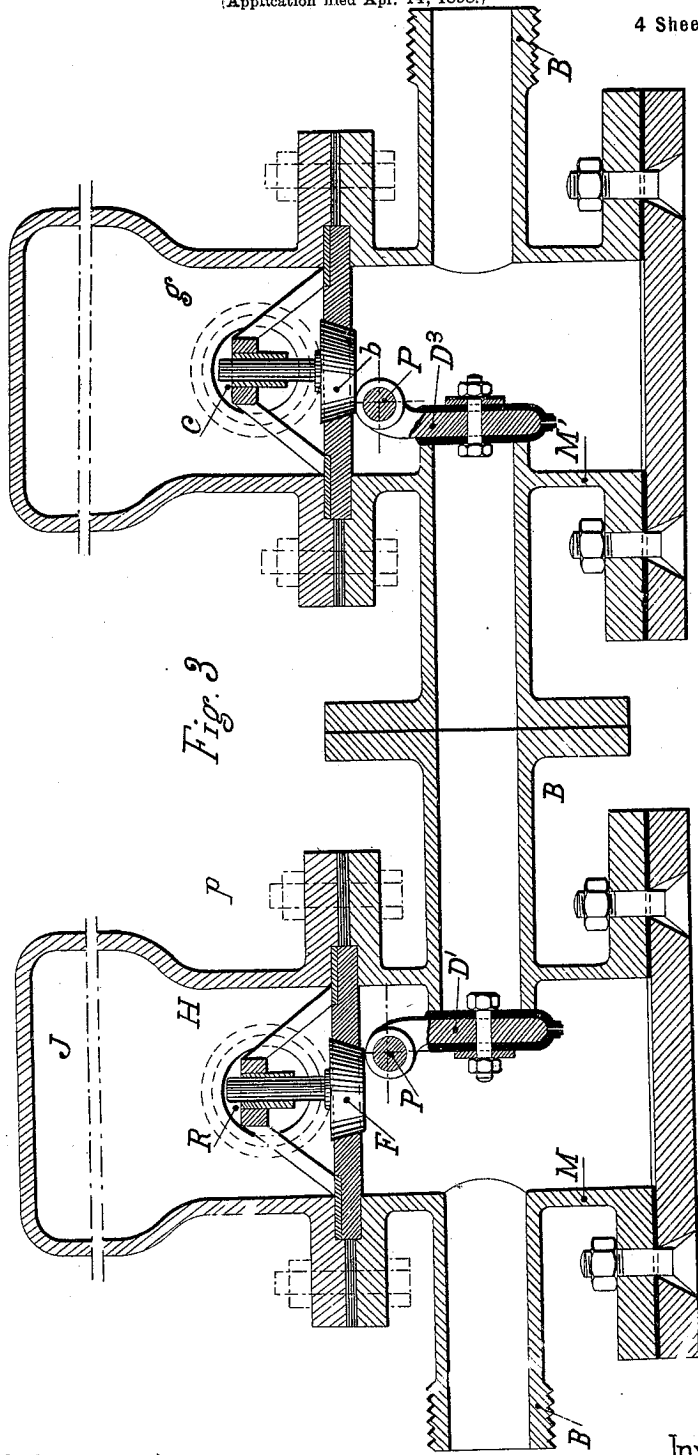


Fig. 3

Witnesses:

*F. D. Keegan*  
*Wm. Lee Nelson*

Inventor:

*Joseph C. Gelly*  
*by Jam. L. Tomig.*

atty

No. 640,125.

Patented Dec. 26, 1899.

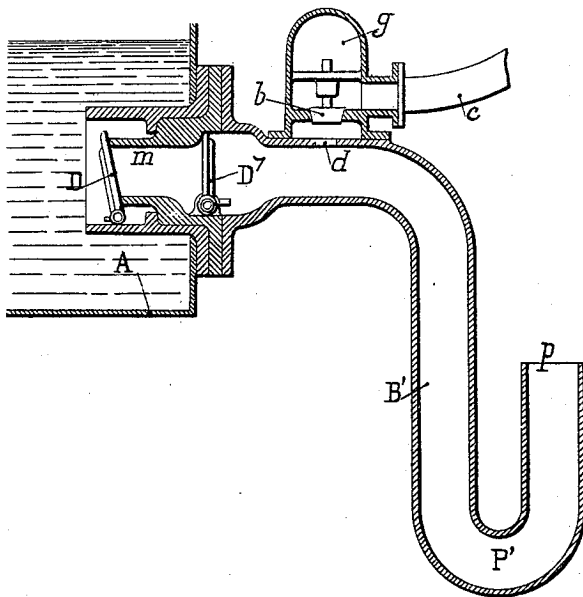
J. C. GELLY.  
HYDRAULIC RAM.

(Application filed Apr. 14, 1898.)

(No Model.)

4 Sheets—Sheet 3.

Fig. 4



Witnesses:

*F. D. Keedy*  
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by *James L. Norris*

atty

No. 640,125.

Patented Dec. 26, 1899.

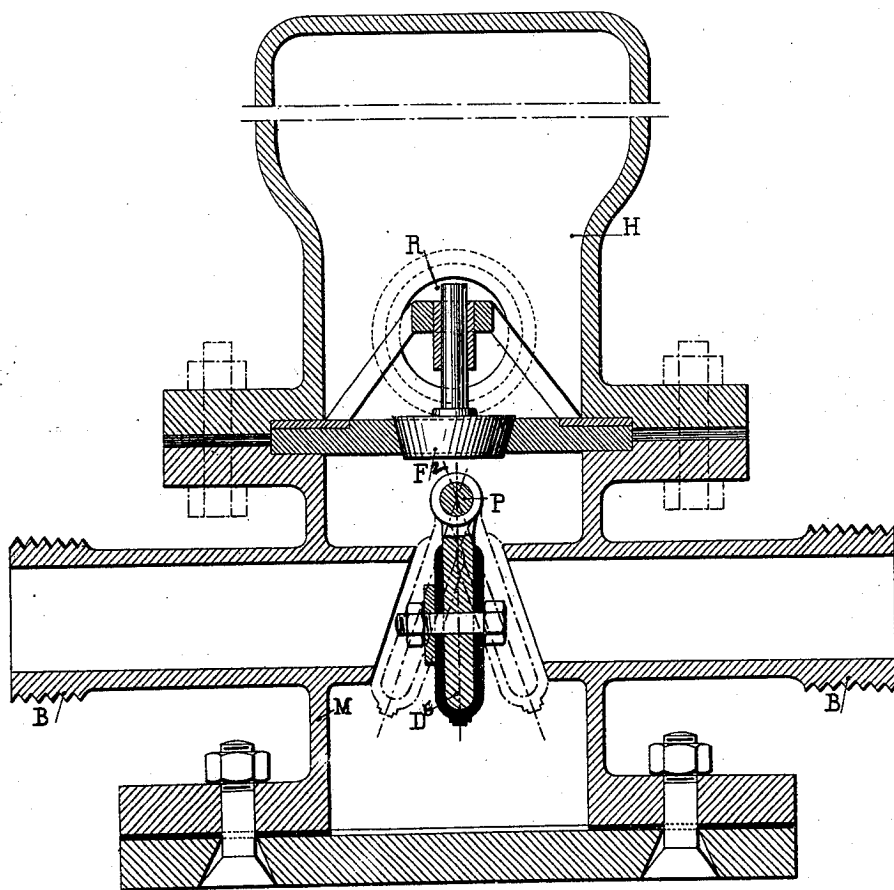
J. C. GELLY.  
HYDRAULIC RAM.

(Application filed Apr. 14, 1898.)

(No Model.)

4 Sheets—Sheet 4.

Fig. 5



Witnesses:

*J. B. Keeler*  
*W. Lee Helms*

Inventor:

*Joseph C. Gelly*  
by *James L. Norris*  
attg

# UNITED STATES PATENT OFFICE.

JOSEPH CHARLES GELLY, OF NOISY-LE-SEC, FRANCE.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 640,125, dated December 26, 1899.

Application filed April 14, 1898. Serial No. 677,611. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH CHARLES GELLY, a citizen of the Republic of France, residing at Noisy-le-Sec, France, have invented certain new and useful Improvements in Hydraulic Rams, (for which I have obtained Letters Patent in France, No. 260,496, dated December 2, 1897; in Germany, No. 30,638, dated December 8, 1897; and in Great Britain, No. 29,813, dated December 20, 1897,) of which the following is a specification.

This invention relates to hydraulic rams by means of which liquids are automatically raised.

It consists mainly of a combination of two pipes, one of which constitutes a descending pipe, while the other forms a conduit, in which pipes a body of liquid is made to circulate, having a *vis viva* produced by the height of the fall and which, by means of a flap-valve placed at the inlet of the descending pipe, automatically and suddenly breaks the continuity of the current, so as to divide it into two parts, one of which—namely, that in the descending pipe—serves to give the velocity—that is to say, the *vis viva* of the liquid current for bringing the flap-valve on its seat—and owing to the recoil movement of this descending part, caused by the atmospheric pressure, to reopen the said flap-valve and raise a suitable lift-valve, through the seat of which a portion of the liquid can be raised into the rising main. The other portion of the current effects the raising of a check-valve and passes into the rising main.

The apparatus is shown on the accompanying drawings, in which—

Figure 1 shows the ordinary construction of the apparatus. Figs. 2, 3, 4, and 5 show modified arrangements.

From a reservoir A, Fig. 1, containing the water or other liquid to be raised, extends a horizontal conduit B, terminating in a downwardly-directed vertical pipe B'. In the interior of the pipe B is a flap-valve D, pivoted at P to the sides of B and opening in the direction of the reservoir A, which valve bears against the end of pipe B', which is directly connected to B. A reservoir J H, provided with a lift-valve F and a rising delivery-pipe R, is branched upon the pipe B.

In the interior of the pipe B' is a flap-valve D'', opening in the contrary direction to D.

The pipe B' has opening *d*, which puts it in communication with a bell or vessel *g*, having a lift-valve *b* and a pipe *c*, connected to pipe R. The action of this apparatus is as follows: Assuming the flap-valves D and D' to be open and the lift-valve F to be on its seat, the liquid in A will flow through B and, passing through the openings of the valves D D'', will flow down the pipe B'. Its velocity, and consequently its *vis viva*, will gradually increase and at a certain moment will close the valve D. The liquid contained in B, by virtue of the velocity and *vis viva* it has attained, will open the valve F and will partly fill the reservoir J H, where it will compress the air and will eventually rise up the pipe R. When the *vis viva* of the liquid in B is exhausted, the pressure of the liquid above the valve F will close said valve. On the other hand, the body of the liquid in the pipe B', which has been suddenly separated from the body in B, also continues its downward flow through the pipe, thereby producing a vacuum behind it near the valve D at *m*; but at this moment the atmospheric pressure, only acting at *p* on the lower end of the body of liquid, behind which is a vacuum, causes this body to rise again and forces it back in the pipe B', and this recoil of the liquid will force the valve D open, closing the valve D'', which has for its object to prevent the body of liquid in B' from reëntering B and to cause it to be directed against the valve *b*, which is thus raised, so that through its seat a portion of the liquid passes into the bell *g*, whence it flows up the pipe *c* into the pipe R. The valve *b* will then close, owing to the difference of pressure acting on its sides, after which the continuous flow through the pipes B B' will recommence and the above-described action will be repeated. The reservoir A can either be at a higher or a lower level than or on the same level with the valve D. If it is at a lower level, then, for facilitating the starting of the apparatus, it may be necessary to close by means of a cock the discharge end of the pipe B' and to provide a check-valve at the entrance of the pipe B, and, lastly, to fill the entire conduit

B B' with liquid. On then opening the cock on B' the body of liquid is started in motion.

The pipes B B' may either be of the same or of different diameters and may have any desired relative position. Thus they may be connected directly end to end, as at Fig. 1, or the one may be branched on the other at any angle, as at Fig. 2, or they may be connected indirectly by the interposition of one or two closed boxes of any suitable form, such as M M', Fig. 3, in which are arranged the flap-valves D' D<sup>3</sup>, as also the lift-valves F' and b', with which boxes are connected the reservoir J' H' and the bell g', Fig. 3.

The pipes B B' may be straight or serpentine, either in elevation or in plan. The pipe B' need not be vertical, but its lower extremity must be below both the valve D and the upper surface of the liquid in the reservoir A. The two valves D D'' must open in contrary directions, D in the direction of the reservoir A—that is, toward the side of the entrance of the liquid in the pipe B—while D'' opens in the direction of the discharge. The valve D may be placed in the pipe B or at the end thereof, as at Fig. 1, or laterally above, as at D<sup>4</sup>, Fig. 2, or below or in a box M, as at D', Fig. 3. The seat of the valve D must be at the entrance of the descending pipe B', the lower or discharge end of which must be below the upper surface of the liquid in tank A.

The valve D'' may be placed in the pipe B', as shown in Fig. 1 and at D<sup>5</sup> in Fig. 2, in any suitable manner, or in a box M', as shown at D<sup>3</sup>, Fig. 3. It increases the useful effect of the apparatus; but in the case where the water is to be returned to the source or to be raised at a small height it may be omitted.

The tube c may be connected to the tube R, as shown in Fig. 1, or to the reservoir A, as at c', Fig. 2, or it may be led to any desired locality. In certain cases it may be advantageous to provide the discharge end of pipe B' with a bend P' or to let it dip into a receptacle.

The results obtained by means of the valves D and D'' may also be obtained by a single valve D<sup>6</sup>, Fig. 5. This valve is placed in a closed box M, containing only a check-valve F<sup>2</sup>, and oscillates between the openings of the tubes B B', so as to close the one or the other, according to the direction of the flow.

In the apparatus shown in Figs. 1, 2, and 3 both the direct motion of the body of liquid and its recoil motion are utilized. When it is desired to utilize the recoil motion only, the arrangement shown at Fig. 4 is used. The tube B, containing the directly-acting body of water, is then omitted, and there is interposed between the reservoir and the descending column B' a box or pipe containing the valve D<sup>7</sup>.

The advantage of the above-described apparatus consists in doing away with all springs, weights, or counterweighted levers and other secondary devices for transmission such as

have heretofore been employed for operating the valves in apparatus of this kind.

In addition the apparatus cannot become submerged at the low-water level. The water is raised to a greater height than with the ordinary hydraulic ram installed in the low-water level, while the improved apparatus can be placed at the high-water level.

The apparatus can be applied to all kinds of sources of supply even with small delivery. With very small supplies it may be fed continuously by the aid of a siphon-bend *a* at the supply, as at Fig. 2.

The principal advantage of this apparatus consists in dividing the body of liquid into two parts for the purpose of utilizing simultaneously the direct motion of the one part and to produce and utilize the inverse movement of the other part for elevating a portion of the liquid of each of the two bodies or to force them separately or both together into a turbine or other similar motive-power machine; also, the weight of the body of liquid which escapes from the discharge end of the descending pipe may be utilized in a suitable apparatus.

Having now described my invention, what I claim is—

1. In a hydraulic ram, the combination of a tank or reservoir, a conduit leading therefrom, comprising an inlet-pipe and a descending discharge-pipe, the latter having its outer end constructed or arranged to receive atmospheric pressure from above, check-valve mechanism for controlling the outflow and backflow of liquid in said pipe, and a delivery-pipe provided with a check-valve and communicating with said conduit as and for the purpose set forth.

2. In a hydraulic ram, the combination of a tank or reservoir, a conduit leading therefrom, comprising an inlet-pipe and a descending discharge-pipe, the latter having its outer end constructed or arranged to receive atmospheric pressure from above, a valve for checking the outward flow of liquid in said pipe, a valve for checking the backflow of liquid in said pipe, and delivery-pipes provided with check-valves and communicating respectively with said inlet and discharge pipes as and for the purpose set forth.

3. In a hydraulic ram, the combination of a tank or reservoir, a conduit leading therefrom, comprising an inlet-pipe and a descending discharge-pipe, the latter having its outer end constructed or arranged to receive atmospheric pressure from above, a valve seated in said conduit and controlling the supply end of said discharge-pipe, a check-valve in said discharge-pipe opening toward the discharge end thereof, and a delivery-pipe communicating with said conduit and provided with a check-valve, as and for the purpose set forth.

4. In a hydraulic ram, the combination of a tank or reservoir, a conduit leading there-



from, comprising an inlet-pipe and a descending discharge-pipe, the latter having its outer end constructed or arranged to receive atmospheric pressure from above, a valve controlling the supply end of said discharge-pipe and opening toward the supply, a valve controlling the backflow in said discharge-pipe and opening toward the discharge, a valve-controlled reservoir communicating with said inlet-pipe and a similar reservoir communicating with said discharge-pipe, as and for the purpose set forth.

5. In a hydraulic ram, the combination of

a descending discharge-pipe having its outer end constructed or arranged to receive atmospheric pressure from above, a valve controlling its supply end, an outwardly-opening check-valve in said pipe, and a valve-controlled reservoir communicating with said pipe, as and for the purpose set forth.

In witness whereof I have hereunto set my hand in presence of two witnesses.

JOSEPH CHARLES GELLY.

Witnesses:

GEORGES DELOM,  
EDWARD P. MACLEAN.

No. 647,000.

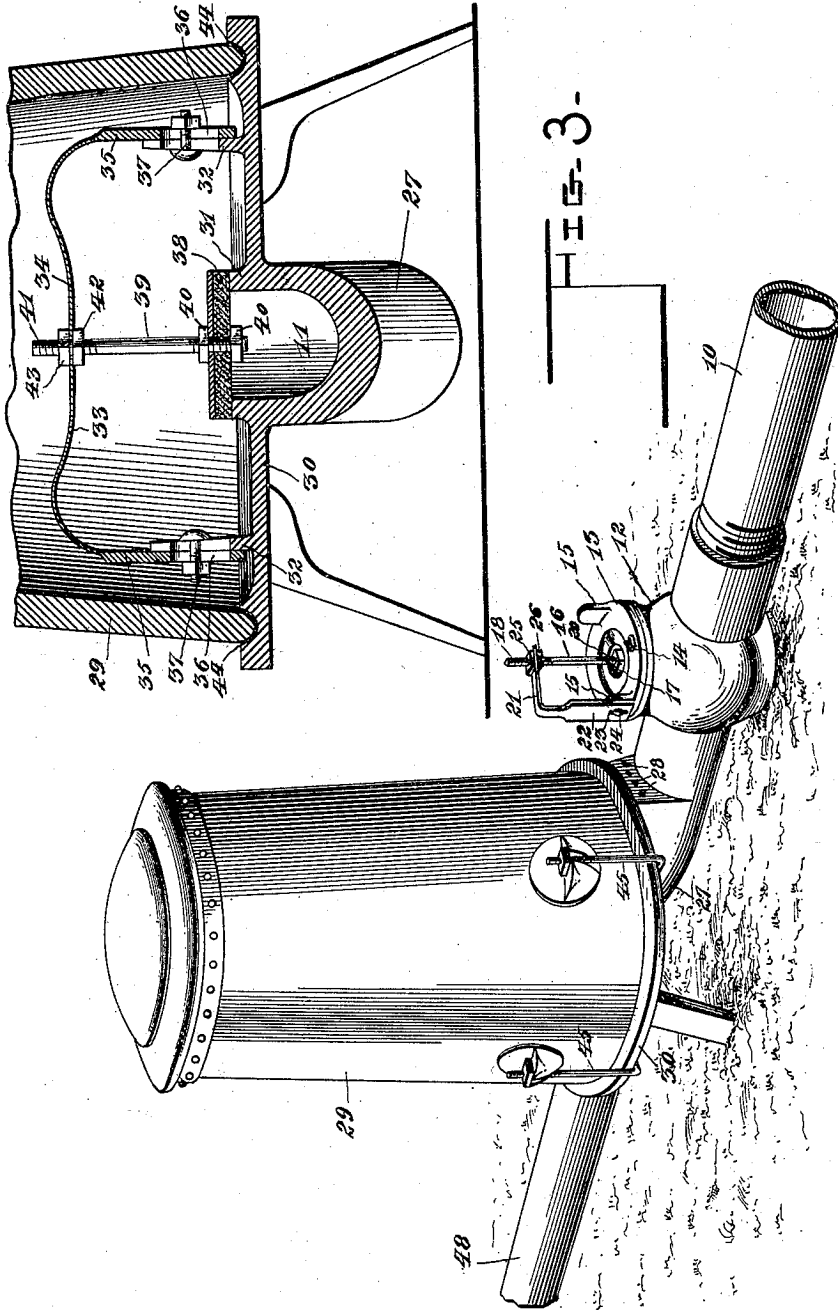
Patented Apr. 10, 1900.

J. M. KLINE.  
HYDRAULIC RAM.

(Application filed Aug. 30, 1899.)

2 Sheets—Sheet 1.

(No Model.)



Witnesses

*John T. Seaver*  
*H. J. Bernkopf*

J. M. Kline, Inventor

By *his* Attorneys,

*C. Snow & Co.*

No. 647,000.

Patented Apr. 10, 1900.

J. M. KLINE.  
HYDRAULIC RAM.

(Application filed Aug 30, 1899.)

(No Model.)

2 Sheets—Sheet 2.

FIG. 4-

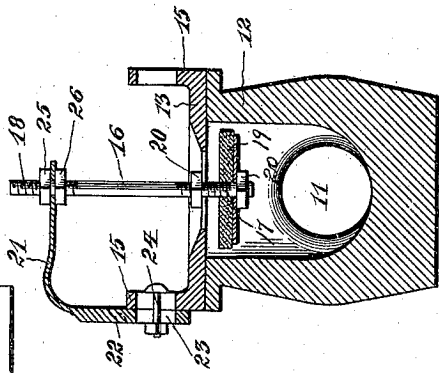
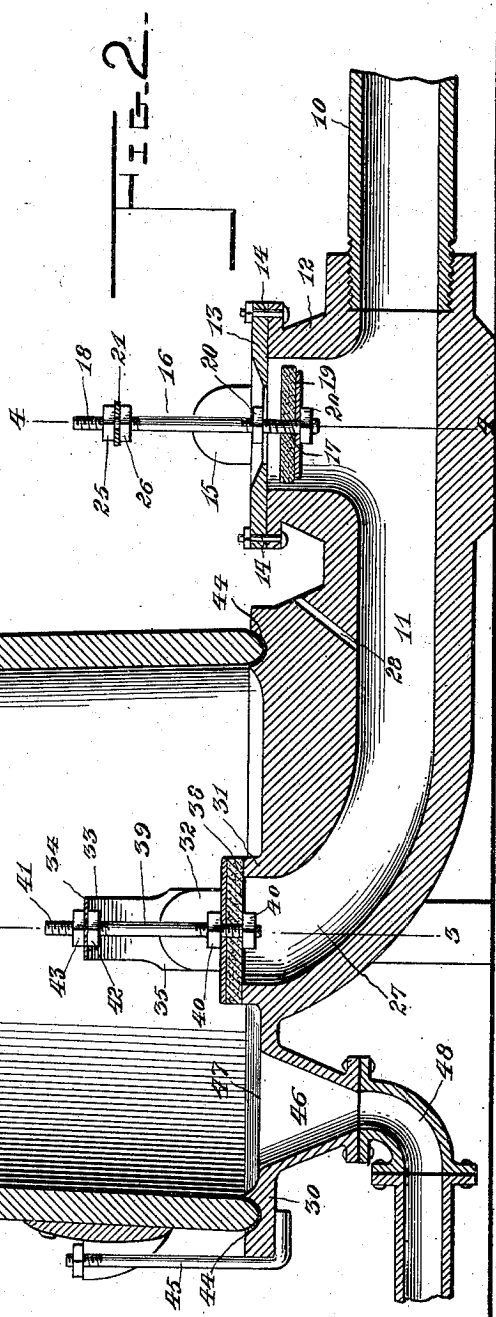


FIG. 2-



Witnesses

*John T. Deufferwiel*

*A. J. Bernhart*

By *his* Attorneys,

*J. M. Kline*, Inventor

*Cashow & Co.*

# UNITED STATES PATENT OFFICE.

JAMES M. KLINE, OF BEAVERTOWN, PENNSYLVANIA.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 647,000, dated April 10, 1900.

Application filed August 30, 1899. Serial No. 728,983. (No model.)

*To all whom it may concern:*

Be it known that I, JAMES M. KLINE, a citizen of the United States, residing at Beavertown, in the county of Snyder and State of Pennsylvania, have invented a new and useful Hydraulic Ram, of which the following is a specification.

My invention relates to improvements in hydraulic rams, and one object in view is to provide an improved construction of the relief-valve by which it is rendered extremely sensitive in action and the ram is made to operate automatically at all periods of service, thus obviating the necessity for manual operation of the relief-valve when the ram is started or at other periods of its service.

A further object is to provide an improved construction of spring-support for the relief and inlet valves by which said support may be adjusted to vary the tension of the spring-pressure on said valve and the valve may be adjusted independently of the spring-support to compensate for wear and to make it fit accurately to the valve-seat.

With these ends in view the invention consists in the novel combination of elements and in the construction, arrangement, and adaptation of parts, which will be hereinafter fully described and claimed.

To enable others to understand the invention, I have illustrated a preferred embodiment thereof in the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a perspective view of a single-acting hydraulic ram constructed in accordance with my invention. Fig. 2 is a vertical sectional elevation taken longitudinally through the ram shown by Fig. 1. Fig. 3 is a vertical transverse section on the plane indicated by the dotted line 3 3 of Fig. 2, and Fig. 4 is a similar transverse section in the plane of the dotted line 4 4 of Fig. 2.

The same numerals of reference are used to indicate like and corresponding parts in each of the several figures of the drawings.

10 designates the drive or pressure pipe, which may receive its supply of water from a creek or river, and 11 is the water-chamber. Said chamber has a vertical extension 12 extending above the plane of the drive-pipe at the point where the latter is coupled to said

chamber, and upon the upper end of the extension is fitted a seat-plate 13, the lower face of which constitutes a seat for the automatic relief-valve. This plate is secured firmly but detachably in position on the water-chamber by the transverse bolts 14, and the plate is also provided with one or more lugs 15, which are integral with said plate and extend upwardly therefrom.

The stem of the relief-valve is indicated by the numeral 16, said stem being provided with a short threaded length 17 at its foot, while the upper part of the stem is threaded for a considerable distance, as at 18. The relief-valve 19 consists of a metallic washer and a layer of suitable pliable material superposed upon the metallic washer, said valve being fitted on the lower threaded end 17 of the stem and secured firmly thereto by means of the clamping-nuts 20, which have threaded engagement with the length 17 of the stem, whereby the relief-valve may have its packing compressed firmly upon or between the washers by adjusting the nuts on the valve-stem. This relief-valve is supported in operative position within the extension of the water-chamber and in yieldable relation to the seat-plate 13 thereon by means of a single spring 21, which is shown more clearly by Fig. 4 of the drawings. This spring is formed of a single piece of metal by bending the same to provide an overhanging arm, the other end of the spring being widened in one direction and thickened in the opposite direction to produce a substantial unyielding foot or stock 22. The spring is arranged for its thickened and widened foot to bear laterally against one of the lugs 15, so that its arm will overhang the opening in the seat-plate 13 of the water-chamber. The thickened foot or stock of this single spring is provided with a vertical longitudinal slot 23, through which passes a transverse bolt 24, that is secured to the lug 15, whereby the spring is attached to the lug in a manner which insures vertical adjustment of the spring on the seat-plate of the water-chamber. A transverse aperture is formed in the yieldable overhanging arm of the spring near its free end for the upper threaded length 18 of the valve-stem to pass therethrough, said threaded length of the valve-stem having the clamping-nuts 25 26

screwed thereon to bind against opposite sides of the spring-arm, so that the stem and relief-valve may be adjusted in a vertical direction on the spring and independently of any adjustment of the slotted spring-stock on the seat-plate. I attach especial importance to this adjustable connection of the relief-valve stem to the spring-support and to the adjustable fastening of the spring-support to the seat-plate, because such connection between the stem and spring permits the valve to be adjusted in a manner to accurately fit the seat-surface on the plate 13 without disturbing the spring or involving variation in the tension thereof, and at the same time the last-described adjustable connection of the spring-support to the seat-plate enables the spring and valve to be adjusted in order to vary and regulate the tension of the spring, and thereby determine within the exact limits the pressure exerted by the spring upon the relief-valve, whereby the spring and valve may be adjusted to secure extreme sensitiveness in the action of the relief-valve.

The spring-support 21 is adjusted to maintain the relief-valve normally in a position free from engagement with the valve-seat, and said spring-support exercises its tension on the stem of the relief-valve in a manner to resist the upward movement thereof. At the same time, however, the spring-support is yieldable with the relief-valve under the pressure of the water acting against the under surface thereof, so that the relief-valve will be closed under the pressure of the water at the period of opening of the inlet-valve from the drive-pipe to the air-chamber of the hydraulic ram.

The delivery end of the water-chamber 11 is curved or extended in an upward direction by a gradual curvature thereof, as indicated by the numeral 27 in Fig. 2, for the purpose of discharging the water in an upward direction and into the air-chamber under minimum friction on the body or mass of moving liquid. This water-chamber is also provided with air-inlet ports 28, which are formed in an inclined direction to the longitudinal axis of the chamber and between the relief-valve and the upwardly-curved end 27, such ports serving to admit air to the water-chamber, from whence the air, with the water, will eventually find its way into the air-chamber under the intermittent flow of the water in its action on the ram.

The air-chamber 29 has its base 30 arranged in the same horizontal plane as the seat-plate of the water-chamber, said chamber-base having an inward valve-seat 31 coincident with the upwardly-curved end of the water-chamber. This base is also provided on opposite sides of the valve-seat with integral upright lugs 32, on which is adjustably seated the double spring 33, which sustains the inlet-valve in yieldable relation to the valve-seat. This double spring is made by bending a single piece of metal to the form shown by Fig.

3 of the drawings in order to produce the curved bridge portion 34, the same being formed with a central aperture adapted to receive the stem of the inlet-valve. The end portions of this bowed spring are widened in one direction and thickened in the opposite direction to form the feet or stocks 35, and said feet have the longitudinal vertical slots 36. The enlarged slotted feet of the double spring are applied laterally against the outer faces of the lugs 32 in a position to have the bridge portion 34 of said spring span and overhang the valve-seat. Bolts 37 are passed through the slotted feet of the spring and the lugs 32 to securely fasten the spring at its terminals to the lugs; but the bolts may be loosened for the purpose of adjusting the slotted spring-feet in an upward or downward direction, whereby the tension or pressure of the spring upon the inlet-valve may be regulated. This inlet-valve 38 consists of a metallic washer having a facing or packing of suitable material, and this valve is secured to a vertical stem 39 by means of the nuts 40. The upper end of the stem is externally threaded and passed through the central opening in the bridge portion of the double spring, suitable clamping-nuts 42 43 being screwed on the stem to bear against opposite sides of the spring, so as to clamp the stem firmly thereto and also to secure a limited vertical adjustment of the stem on the spring independently of any adjustment of the spring on the lugs 32.

A packing 44 is interposed between the lower edge of the shell, which forms the air-chamber and the base 30, said packing being compressed by adjusting the nuts on the bolts 45, that serve to couple the air-chamber shell to said base.

One of the important features of my improved ram is the provision of a tapering water-discharge nozzle 46, the same being integral with the base 30 of the air-chamber and located at any suitable point thereon with relation to the inlet-valve. This discharge-nozzle is essentially of tapering form, with its enlarged end uppermost and its smallest end at the bottom, thereby forming a port 47 between the nozzle and the air-chamber, which port greatly exceeds the diameter and area of the port at the lower end of the discharge-nozzle. An off-bearing pipe 48 has suitable connection with the lower extremity of this nozzle 46. The employment of the tapered nozzle permits the water contained in the chamber 29 and forced downwardly therein by the pressure of air, which accumulates in the upper part of the chamber, to freely enter the nozzle through the enlarged port 47 in the base of the chamber and facilitates the passage of the water through the pipe 46.

The ram shown by the accompanying drawings is of the type known to the art as "single-acting" for the purpose of utilizing the flow of water from a creek or river to accumulate in an air-chamber and to compress air therein,

the pressure of which is utilized to force the water from said air-chamber to a desired place of storage for service.

Changes may be made in the form and portion of some of the parts while their essential features are retained and the spirit of the invention embodied. Hence I do not desire to be limited to the precise form of all the parts as shown, reserving the right to vary therefrom.

Having thus described the invention, what I claim is—

1. In a hydraulic ram, the combination with a fixed lug, of a spring-support fastened adjustably to said lug, a valve-stem connected adjustably to the spring-support for adjustment therewith and for adjustment thereon independently of the spring adjustment on the supporting-lug, and a relief-valve clamped to said stem, said spring-support adjusted to normally hold the relief-valve in an open position, substantially as described.

2. In a hydraulic ram, the combination with a water-chamber having a relief-valve seat, and a fixed lug, of a spring having a thickened and slotted foot fitted against said lug, a bolt connecting the spring adjustably to the lug, a relief-valve, a vertical valve-stem attached to said valve and having a threaded end fitted in an overhanging arm of the spring, and clamping-nuts screwed on the stem and binding against the spring to adjustably fasten the stem thereto, the stem and valve being adjustable on the spring independently of any adjustment of the spring upon its lug and the

spring-support serving normally to hold the valve free from the seat, substantially as described.

3. In a hydraulic ram, the combination with an air-chamber having a valve-seat, and a water-chamber, of an arched spring-support secured adjustably at its end portions in the chamber, an inlet-valve, and a valve-stem secured to the inlet-valve and fastened adjustably to the spring-support, said inlet-valve and its stem being adjustable on said spring-support independently of any adjustment of the latter in the air-chamber, substantially as described.

4. In a hydraulic ram, the combination with an air-chamber having a valve-seat and the lugs on opposite sides of said seat, of an arched spring-support provided with the thickened and slotted feet fitted against said lugs, bolts which fasten the feet of the spring adjustably to the lugs, a valve-stem fitted centrally in the arched spring-support, nuts screwed on the stem and binding against said support to adjustably fasten the same to said support, and an inlet-valve fastened to the stem and adjustable therewith and with the spring-support, substantially as described.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

JAMES M. KLINE.

Witnesses:

GEO. SPAID,  
ALFRED SMITH.

No. 673,764.

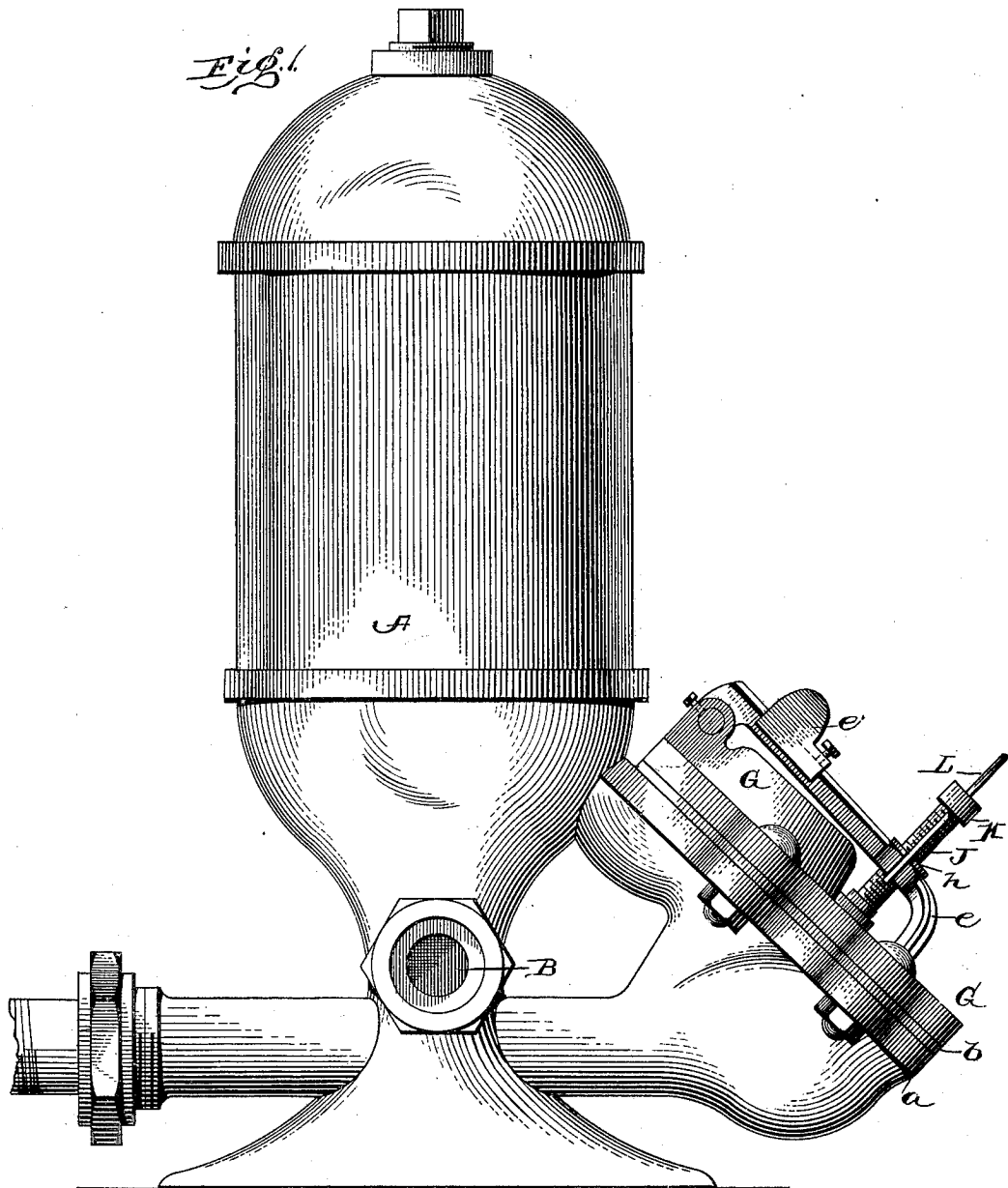
Patented May 7, 1901.

W. L. DEMING.  
HYDRAULIC RAM.

(Application filed Mar. 20, 1900.)

(No Model.)

3 Sheets—Sheet 1.



witnesses  
*J. M. Fowler Jr.*  
*T. B. Twyman*

Inventor,  
*Wm. L. Deming,*  
By *Wm. O. Dyer,*  
Att'y.

No. 673,764.

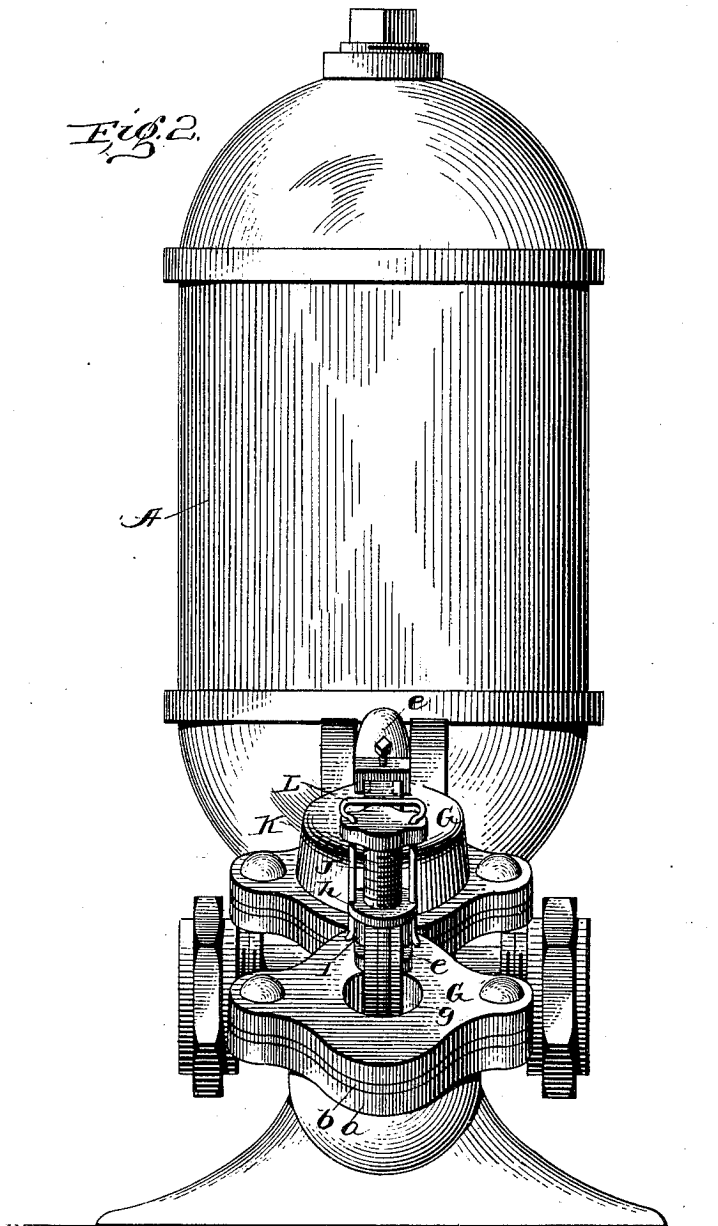
Patented May 7, 1901.

W. L. DEMING.  
HYDRAULIC RAM.

(Application filed Mar. 20, 1900.)

(No Model.)

3 Sheets—Sheet 2.



Witnesses:

J. M. Fowler Jr.  
W. B. Newton

Inventor:

Wm. L. Deming.  
By Wm. O. Dyer.  
Attu



No. 673,764.

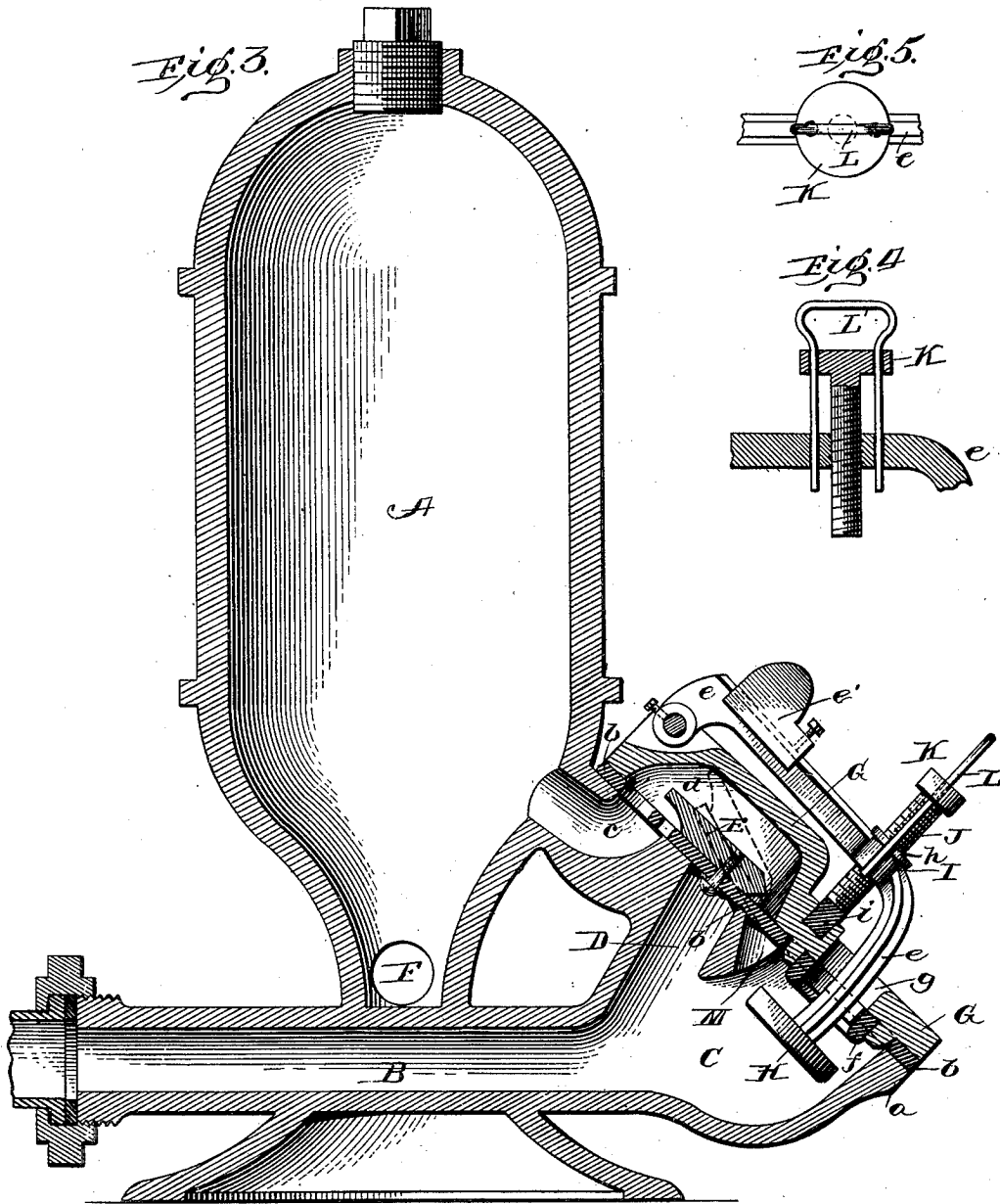
Patented May 7, 1901.

W. L. DEMING.  
HYDRAULIC RAM.

(Application filed Mar. 20, 1900.)

(No Model.)

3 Sheets—Sheet 3.



witnesses.  
J. M. Fowler Jr.  
V. B. Thurston.

Inventor:  
Wm. L. Deming  
By Mr. D. D. Dye  
Att'y.

# UNITED STATES PATENT OFFICE

WILLIAM L. DEMING, OF SALEM, OHIO, ASSIGNOR TO THE DEMING COMPANY, OF SAME PLACE.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 673,764, dated May 7, 1901.

Application filed March 20, 1900. Serial No. 9,393. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM L. DEMING, a citizen of the United States, residing at Salem, in the county of Columbiana and State of Ohio, have invented certain new and useful Improvements in Hydraulic Rams; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to automatic pumping apparatus, and has particular reference to hydraulic rams for elevating water and to certain improvements in their structural arrangement whereby the general efficiency of the ram is increased and its durability insured. With these objects in view the valves of the present construction are centralized and are located entirely outside of the air-chamber. They are also accessibly located beneath a single removable cap-plate.

Another feature of the invention resides in a fresh-air duct located between said valves and operating in conjunction with them to augment and maintain pressure in the air-chamber of the ram with each stroke of its impetus-valve.

Still another feature of invention is to be found in mechanism for adjusting and regulating the prescribed throw of the impetus-valve and in means for maintaining such adjustment against accidental displacement.

The invention will be hereinafter described, and particularly pointed out in the claims following.

In the accompanying drawings, which form part of this specification and whereon the same letters of reference indicate corresponding parts in the several views, Figure 1 is a side elevation of the invention in position for use. Fig. 2 is a front elevation of same. Fig. 3 is a vertical central section of the improved ram, showing the interior of its air-pressure chamber, drive-pipe, and valve-chambers, also the operating-valves and means for controlling their action. Figs. 4 and 5 are fragmentary detail views showing, respectively, a side elevation and top plan view of a modified form of regulating mechanism for the impetus-valve.

Reference being had to the drawings and

letters thereon, A indicates the pressure-chamber of my improved ram, B the lowermost underlying end of the drive-pipe, and C an enlargement at extremity of said pipe B, whereupon or wherein are located both valves of the invention, as will hereinafter more fully and at large appear. Adjacent to the extremity or outlet *a* of said drive-pipe B the enlargement C is broken by an upwardly-projecting supply-port D, which in turn is guarded by a discharge-valve E, the latter preferably secured to and hinging upon a suitable packing *b*, covering the surface of said enlargement. By reference to Fig. 3 it will be observed that neither pipe B nor port D have direct communication with the pressure-chamber A. Beyond valve E, however, there is a port *c*, which opens directly into the air-chamber. Through this the water-supply finds its way to the pressure-chamber A after passing valve E, and from thence is delivered to the point of utilization by one or both of the discharge-pipes F F, as will be set forth in a statement of operation to follow. Covering the otherwise open end of enlargement C is a single removable cap G, by preference bolted in place, as shown, immediately above the packing *b* and having cast or otherwise formed therein a chamber *d*, constituting a housing for valve E and serving to establish communication between port D and port *c* when said valve is raised.

Upon cap-plate G, preferably at its upper end, is pivoted an oscillating valve-stem *e*, bearing a longitudinally-movable adjusting-weight *e'*, and at its lower extremity the impetus-valve H of the invention, which valve contacts upon each upward stroke with a suitable valve-seat *f*, secured in cap G, immediately below the outlet or waste port *g*. Upon stem *e*, at a median point in its length, is a flanged boss I, perforated, as shown by Figs. 4 and 5, or preferably indented upon its sides by grooves *h h*, as shown by Figs. 1, 2, and 3. In said boss I is mounted a limiting-screw J, its lower end adapted to contact with a cushion *i* and its upper end bearing a T-shaped head K. The head K is in reciprocal relation with a two-pronged metallic clip L, of relatively stiff spring-wire, the prongs whereof rest in grooves *h h*, afore-

said, to prevent an accidental change in adjustment of screw J and a consequent change in the stroke of the impetus-valve H.

The upper edge of outlet *a* at the extremity of drive-pipe B is indented by a depression or fresh-air passage M, which, as shown by Fig. 3, terminates in close proximity to supply-port D and is closed by the overlying portion of packing *b*, except when the latter is lifted at this point by an upward throw of valve E, as clearly indicated by dotted lines in Fig. 3, for the purpose of introducing air to chamber A with each stroke of the impetus-valve H.

This being the generally preferred construction of my invention, its use, briefly stated, is as follows: Presuming the present invention to be suitably located for action and that the usual requirements as to a source of water-supply, its natural fall, the length and inclination of drive-pipe, and elevation of the distributing-tank all to be present, the general principle of operation is then very similar to that of the ordinary ram. Water entering pipe B from an elevated spring or other source of supply flows through outlet-port *g* until there is sufficient accumulated pressure to close the impetus-valve H. This accomplished, the water in pipe B finds another outlet through port D, lifting valve E, as shown by dotted lines, Fig. 3, in its passage to chamber *d*, and thence through port *c* to pressure-chamber A. In the meantime air accumulates after each stroke of valve H in passage M, which it naturally enters through the upper side of port *g*. The lifting of discharge-valve E immediately frees the air previously trapped in said passage M, so that it is driven by force of the water into pressure-chamber A for the purpose of augmenting and maintaining the air-pressure therein. The expansive qualities of the air in chamber A serve to constantly force water therefrom into and through discharge-pipe F to an elevated distributing-tank in the usual manner, from whence it may be drawn to points of utilization.

Obviously the resistance offered by impetus-valve H may be regulated according to requirements by adjustment of weight *e'* upon stem *e*, and the stroke of said impetus-valve may be limited to a nicety by adjustment of the limit-screw J. The last-mentioned adjustment when necessary is conveniently accomplished by first withdrawing clip L from the indentations *h h*; secondly, by rotating said limit-screw through the agency of said clip L until the desired adjustment is obtained, and finally replacing the clip L in the depressions *h h* to prevent the possibility of accidental displacement of the screw, which otherwise might be worked up by continual pounding of valve H, the stroke of which it serves to limit.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a hydraulic ram the combination with a drive-pipe, a pressure-chamber, an impetus-valve, a discharge-valve located in a plane above that of the impetus-valve, and an air-passage fed from the impetus-valve and relieved through the discharge-valve, substantially as described. 70

2. In a hydraulic ram the combination with a drive-pipe, a pressure-chamber, an impetus-valve, a discharge-valve located in a plane above that of the impetus-valve, and an upwardly-extending air-passage located between said valves adapted to be fed by the former and exhausted through the latter, substantially as described. 75 80

3. In a valve the combination with a valve-stem and a limit-screw for regulating the stroke thereof, of a clip adjustable longitudinally upon the limit-screw said clip having an enlarged protruding end and dependent prongs, the latter for engaging depressions in the stem aforesaid, substantially as described. 85 90

4. In a valve the combination with a valve-stem and a limit-screw for regulating the stroke thereof, of a spring-clip adjustable longitudinally upon the limit-screw said clip having an enlarged protruding end and dependent prongs with flaring extremities, said prongs for engaging depressions in the stem aforesaid, substantially as described. 95

5. In an impetus-valve for hydraulic rams, the combination with a valve-stem bearing an adjusting-weight, of a limit-screw for regulating the stroke of said valve, a spring-clip longitudinally movable in the head of said screw, and depressions in the valve-stem for receiving the ends of said clip, substantially as described. 100 105

6. In an impetus-valve for hydraulic rams, the combination with a valve-stem bearing a flanged boss, of a limit-screw in threaded relation with said boss for regulating the stroke of the valve, a bifurcated spring-clip longitudinally movable in the head of said screw, and depressions in the flanged boss for receiving the ends of the clip aforesaid, substantially as described. 110 115

7. In a hydraulic ram the combination with a drive-pipe having an enlarged discharge end containing waste and discharge ports, a single removable cap-plate covering said enlargement and ports, impetus and discharge valves removable with said cap-plate, and a pressure-chamber, substantially as described. 120

8. In a hydraulic ram the combination with a drive-pipe having an enlarged discharge end containing waste and discharge ports, a single removable cap-plate covering said enlargement and ports, impetus and discharge valves removable with the cap-plate, a valve-chamber formed in said cap-plate for housing the discharge-valve, and a pressure-chamber, substantially as described. 125 130

9. In a hydraulic ram the combination with a drive-pipe having an enlarged discharge end containing waste and discharge ports, a

single removable cap-plate covering said enlargement and ports, impetus and discharge valves removable with the cap-plate, a valve-chamber formed in the cap-plate for housing  
5 the discharge-valve, a pressure-chamber, and a port connecting said valve and pressure chambers, substantially as described.

In testimony whereof I subscribe my signature in presence of two witnesses.

WILLIAM L. DEMING.

Witnesses:

W. C. BOYLE,

F. J. MULLINS.

No. 715,167.

Patented Dec. 2, 1902.

J. A. SNAVELY.  
HYDRAULIC RAM.

(Application filed June 4, 1902.)

(No Model.)

FIG. 2

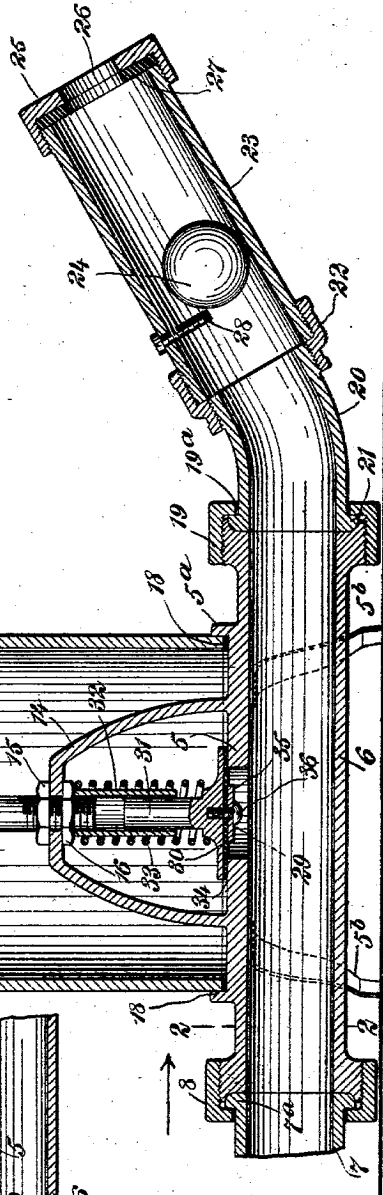
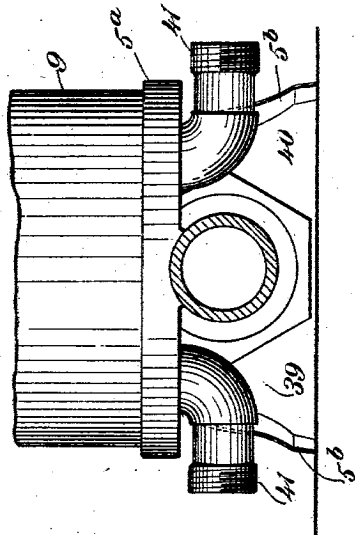


FIG. 1

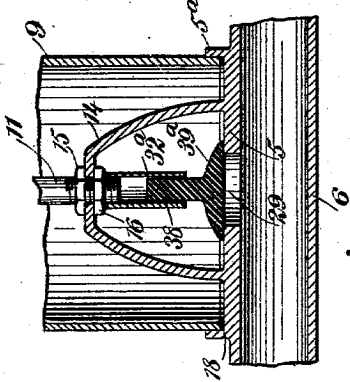


FIG. 3

WITNESSES:

*J. S. Prophy*  
*A. J. Bernhard*

INVENTOR  
*John A. Snavely*  
BY *Munn*  
ATTORNEYS.

# UNITED STATES PATENT OFFICE.

JOHN ALEX. SNAVELY, OF CROCKETT DEPOT, VIRGINIA.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 715,167, dated December 2, 1902.

Application filed June 4, 1902. Serial No. 110,185. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN ALEX. SNAVELY, a citizen of the United States, and a resident of Crockett Depot, in the county of Wythe and State of Virginia, have invented new and useful improvements in Hydraulic Rams, of which the following is a full, clear, and exact description.

My invention relates to improvements in hydraulic rams; and one object that I have in view is the provision of valved means for controlling the intermittent flow of the current under pressure, so as to vary the number of pulsations per minute and to secure a decrease or increase in the capacity of the apparatus.

Further objects of the invention are to simplify the construction of the apparatus in minor parts with a view to increasing its durability and efficiency, while reducing the cost of manufacture, to provide means for deadening the sound and limiting the play of the waste-valve, to enable one or more discharge-pipes to be employed, and to provide a novel form of check-valve adapted to quickly seat itself after each pulsation and to serve as a buffer, so as to minimize wear.

With these ends in view the invention consists of a hydraulic ram embodying novel features of construction and arrangement of parts, which will be hereinafter fully described and claimed.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a vertical sectional elevation through a hydraulic ram embodying my invention. Fig. 2 is a sectional elevation taken in the plane of the dotted line 2 2 of Fig. 1, looking in the direction of the arrow, and showing a series of branches adapted for the union of a like number of discharge-pipes; and Fig. 3 is a sectional elevation of another style of check-valve which may be used in lieu of the spring-actuated valve shown in Fig. 1.

In carrying my invention into practice I employ a base 5, which has a tubular member 6, made or cast as an integral part thereof, said tubular member forming a section of the drive-pipe, the latter being indicated at

7 and united to the tubular member by means of a flanged coupling 8, which is shown by Fig. 1 as being screw-threaded to one end portion of the tubular member 6 and having engagement with a flanged end 7<sup>a</sup> of the drive-pipe. The base 5 is preferably embodied in the form of a flat plate or disk having an upstanding flange 5<sup>a</sup>, in which is received the lower edge portion of the shell 9, the latter forming the usual air-chamber 10. The shell 9 is provided with a head 9<sup>a</sup>, which may be made in one piece with said shell, or it may be cast in a separate piece therefrom, and this shell is clamped firmly upon the base by the employment of a single bolt 11. Said bolt is screw-threaded at its upper and lower extremities, the upper threaded extremity passing through an opening provided centrally in the head 9<sup>a</sup> and receiving the capped nut 12, a washer or gasket 13 being interposed between the head and said nut in order to make an air-tight joint at the point where the bolt passes through the head of the shell.

The base 5 is provided with an upstanding yoke or stirrup 14, the same being preferably cast as an integral part of said base and disposed within the air-chamber 10, and at its crown the yoke or stirrup has a vertical opening adapted to receive the lower flanged extremity of the bolt 11. The chambered shell is clamped firmly upon the base 5 by the nuts 15 16, which are screwed on the threaded lower part of the bolt 11 and are arranged to engage with the upper and lower edges of the crown forming a part of the yoke or stirrup, said pair of nuts 15 16 cooperating with the yoke in firmly holding the bolt and the shell upon the base. If desired, any approved means may be employed to hold the lower nut 16 against turning on the lower part of the vertical bolt. Furthermore, the bolt 11 may be provided at a point intermediate of its length with the angular or polygonal section 17, adapted to receive a wrench for the purpose of turning the bolt. A gasket or washer 18 is interposed between the lower edge of the vertical shell 9 and the top face of the base 5, and this gasket is adapted to be compressed by the operation of tightening the cap-nut 12, thus preventing the leakage of air and water between the base and the vertical shell.

The tubular member 6, which is made an integral part of the base, is extended or prolonged beyond the flange 5<sup>a</sup> at one side of the shell, and to the extremity of this extended part of the tubular member is connected an elbow 20 by means of the coupling 19. As shown by Fig. 1, the elbow is provided at its inner end with a flange 21, adapted to be embraced by an inwardly-extending flange 19<sup>a</sup> of the coupling, the latter being screwed to the projecting end portion of the tubular member 6, whereby the elbow has a swiveled connection with the tubular member in order to communicate directly therewith. This elbow is bent or curved to have one end portion lie at an angle to the other end portion, and in practice I find that good results are attained by bending or curving the elbow at an angle of twenty or thirty degrees or at any intermediate angle between the two. The elbow is flared or enlarged somewhat toward its free or unattached end, and to said end of the elbow is coupled, as at 22, a short length of pipe 23, which contains the valve 24 and is adapted to serve as the waste overflow for the pulsating column of water. This waste-pipe is united in abutting relation to the enlarged end of the swiveled adjustable elbow, and said waste-pipe and its valve are adapted to partake of the adjustments which may be given to said elbow. The waste-pipe corresponds in diameter to the flared or enlarged part of the elbow, and at the outer end of this waste-pipe is provided a removable cap 25, having an opening or port 26, through which waste-water is adapted to flow until checked by the seating of the automatic waste-valve 24. This waste-valve is embedded in the form of a ball or sphere adapted to travel or move freely into the waste-pipe, which is necessarily inclined to the horizontal tubular branch 6 owing to the presence of the elbow 20 between the parts; but this valve is forced to its seat by the impulse or pulsation of the moving column of water, the movement of the valve in the opposite direction being opposed by the liquid contained in the waste-pipe and elbow. In the operation of the valve it is constantly turning or shifting, so that it does not strike constantly at one place against the seat which may be provided by the perforated cap 25, thus keeping the valve in a round or spherical condition. The diameter of the valve 24 exceeds the opening 26, and said valve may be made of brass, bronze, or other material suitable for the purpose. In apparatus of small capacity the ball-valve may be of solid metal; but in large-sized rams a hollow and more or less buoyant valve may be employed.

To deaden the noise due to the impact of the metallic valve against the metallic cap, I may employ a washer 27, of rubber or other suitable material, and, if desired, this noise-deadening washer may have a thin metallic face-plate applied thereto in a position for engagement with the valve. The enlarged

waste-pipe allows a larger-sized ball-valve to be used, and consequently admits of the use of a comparatively large opening in the cap, thus permitting as much water to escape as the drive-pipe can carry. The rolling valve is prevented when the ram is stopped from passing into the elbow by the employment of a stop located between the inclined waste-pipe and said elbow, and this stop is preferably embedded in the form of a screw 28, which is attached to the inclined pipe by screwing it into a threaded hole within said pipe, the screw lying in the path of the rolling valve.

The base 5 may be provided with suitable legs 5<sup>b</sup>, adapted to sustain the same in a proper raised position, and in this base is provided an opening 29, the latter being disposed within the limits of the upstanding yoke or stirrup and establishing communication between the tubular member 6 and the air-chamber 10. This opening 29 may be controlled by a suitable form of check-valve, one style of which is shown by Fig. 1 and another by Fig. 3.

The check-valve 30 of Fig. 1 is provided with an upstanding stem 31, which is loosely fitted into a guide-sleeve 32, that is screwed to the lower threaded extremity of the vertical bolt 11 at a point below the lower check-nut 16, firmly attaching the guide-sleeve to the bolt and retaining it in proper position within the yoke or stirrup. A coiled spring 33 is fitted loosely around the sleeve in order that its upper end may be seated against the check-nut 16, while its lower end bears upon the check-valve 30, and this spring serves to quickly close the valve on the recedence of the column of water, and it also serves as a buffer to reduce some of the wear on the parts of the apparatus during the service thereof. The check-valve 30 is provided with a gasket or compressible facing 34, which is held in place by means of the washer 35 and a screw 36, the latter passing through suitable holes in the washer and the gasket and embedded in the check-valve.

In Fig. 3 of the drawings I have shown a valve which is made of rubber or other elastic material, and in this type of valve the spring and the gasket are omitted, although the elastic valve 39<sup>a</sup> is made in one piece with a stem 38, that is slidably fitted in a guide-tube 32<sup>a</sup>, which is attached to the lower extremity of the bolt or rod 11. This valve is simpler and cheaper than that shown in Fig. 1, and on the inflow of water said valve moves freely in an upward direction and is adapted to be compressed, so as to afford plenty of room for the free ingress of water into the chamber 10.

The discharge-pipe may be united or coupled to the shell 9 in the usual way, so as to have communication with the air-chamber 10, thus resembling an ordinary or common hydraulic ram; but in Fig. 2 I have shown a peculiar form of the base which makes provision for the attachment of two or more

drive-pipes. The base is adapted to be provided with a series of offstanding discharge branches 39 40, which are shown as extending in opposite directions from the tubular member 6 and leading from opposite sides of the vertical shell 9, said branches having threaded outer ends 41 for the attachment of the proper number of discharge-pipes. It is evident, however, that only one discharge-pipe may be coupled to one of the branches, and in this event the other branch is adapted to be closed by the application of a threaded cap to the nut 41, said cap preventing leakage of water from the ram and affording a convenient means for drawing off the water from the chamber 10 and the discharge-pipe when it is desired to cut the apparatus out of service.

The operation of the ram is similar to other well-known machines of its class; but the action of the cut-off is about as follows: The ball-shaped valve being in proper position, the column of water is admitted and at once drives the ball to its seat, the latter suddenly checking the moving column of water. The recoil of the column at once allows the ball to roll down the inclined tube until it is caught by the returning current, the ball-valve being again forced to its seat, so that the action is repeated indefinitely. During the recoil of the column of water due to the check it receives by the seating of the valve the pressure of the column overcomes the resistance of the check-valve and some of the water passes into the chamber 10, so as to compress air therein, the same recoiling and forcing the water through the discharge pipe or pipes to the proper height.

It will be noticed that the inclination of the waste-pipe to the tubular branch 6 may easily be varied by adjusting the swiveled elbow 20, and this adjustment of the elbow on the inclined pipe may be effected by pushing the parts to one side or the other, thereby moving the inclined pipe more or less to an inclined position, such adjustment of the inclined pipe taking place without the employment of adjusting screws or springs. The angular disposition of the inclined waste-pipe to the horizontal tubular member 6 determines the number of pulsations which may be secured in the moving column of water, and by raising the inclined pipe to its highest limit afforded by the elbow 20 the number of pulsations can be reduced to as low as fifteen per minute, while the adjustment of the pipe toward the horizontal position allows the number of pulsations to be increased up to one hundred per minute or less. The employment of the elbow having a bend of twenty or thirty degrees does not materially deflect or retard the movement of the column of water to any appreciable extent as compared with other rams, wherein the current is deflected to at least ninety degrees, thus enabling the column of water to recover sooner, thereby striking more strokes per minute, and consequently

raising a greater volume of water with the same energy.

Changes in the form, proportion, and minor details of the parts may be made without departing from the spirit or sacrificing the advantages of my invention, and I therefore reserve the right to make such alterations as fall within the scope of the invention as defined by the annexed claims.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In a hydraulic ram, the combination with a drive-pipe and a valved controlled reservoir, of an inclined waste-pipe in communication with said drive-pipe and shiftable to different angular positions relative thereto, and a waste-valve operable in said inclined waste-pipe.

2. In a hydraulic ram, the combination with a drive-pipe and a valved air-chamber, of an inclined waste-pipe in communication with said drive-pipe and shiftable to different angular positions relative thereto, and having a seat at the discharge-opening in the waste-pipe, and a spherical valve fitted in the waste-pipe to roll or travel therein and adapted to be moved by the column of water against said seat of the waste-pipe.

3. In a hydraulic ram, the combination with a drive-pipe and a valved air-chamber, of an elbow having a swiveled connection with said drive-pipe, an inclined waste-pipe united to said elbow and adjustable therewith to different positions relative to the drive-pipe, and a waste-valve operable in said waste-pipe.

4. In a hydraulic ram, the combination with a drive-pipe and a waste-valve, of an air-chambered shell communicating with said drive-pipe and confined in place by a single bolt or rod, a yoke to which said bolt or rod is attached, a sleeve secured to the bolt or rod, a check-valve controlling the communication between the drive-pipe and the air-chamber and having a stem fitted slidably in said sleeve and the spring actuating against said check-valve and held in place by the sleeve.

5. In a hydraulic ram, a base having an upstanding flange, and a tubular member made integral therewith, said base having a series of discharge branches, one of which is adapted to be closed by a suitable cap, combined with a shell fitted to the base, a yoke extending upwardly from the base and fitted in the shell, a single bolt attached to the shell and the yoke, a drive-pipe coupled to the tubular member, and an inclined waste-pipe having a valve and adjustably connected to the other end of the tubular member.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN ALEX. SNAVELY.

Witnesses:

T. F. KIDD,  
A. L. SNAVELY.



No. 753,560.

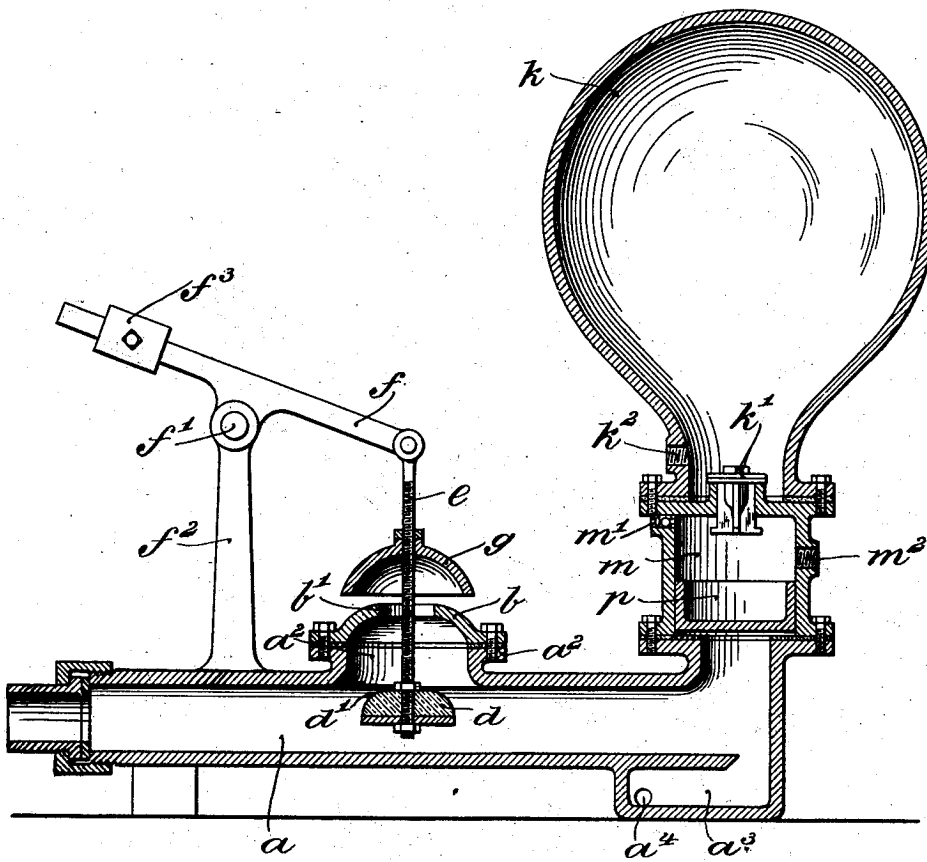
PATENTED MAR. 1, 1904.

G. H. EARLE, JR. & G. B. SHAINLINE.

HYDRAULIC RAM.

APPLICATION FILED APR. 27, 1903.

NO MODEL.



*Witnesses*  
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*James Wake*

*George H. Earle Jr.*  
*George B. Shainline*  
*Inventors*

*By* *Joseph H. Saulson*  
*Attorney*

# UNITED STATES PATENT OFFICE.

GEORGE H. EARLE, JR., OF BRYN MAWR, AND GEORGE B. SHAINLINE,  
OF WAYNE, PENNSYLVANIA.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 753,560, dated March 1, 1904.

Application filed April 27, 1903. Serial No. 154,538. (No model.)

*To all whom it may concern:*

Be it known that we, GEORGE H. EARLE, JR., residing at Bryn Mawr, in the county of Montgomery, and GEORGE B. SHAINLINE, residing at Wayne, in the county of Delaware, State of Pennsylvania, citizens of the United States, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

Our invention has relation to a hydraulic ram, and in such connection it relates to the construction and arrangement of parts constituting such a ram. In devices of this class, wherein the flow of a stream of water into the ram was depended upon to elevate the water from the source of supply into a container or reservoir and to maintain the water in the container or reservoir under pressure, it sometimes happened that the flow of water into the ram became impaired and its force so reduced that the plunger-valve upon the intake-pipe could not be operated, and hence no flow or force could be exerted to lift the water into its reservoir.

The principal objects of our invention are, first, to so construct and rearrange the plunger-valve of the intake-pipe that it may be readily adjusted according to the flow of water into the intake-pipe, whereby upon a diminution of said flow the plunger-valve may still be operated to close the outlet from the intake-pipe and to permit the inflowing water to deliver its blow upon the ram proper, and, second, to so reconstruct and rearrange the water-lifting valve in the air-chamber of the ram proper as to utilize to the fullest extent the lifting power from the blow of the inflowing water and to minimize the tendency of the water-lifting valve to become impaired, disarranged, or broken.

The nature and scope of our invention will be more fully understood from the following description, taken in connection with the accompanying drawing, forming part hereof, and which illustrates in longitudinal section a hydraulic ram embodying main features of my present invention.

Referring to said drawing,  $a$  represents the intake-pipe, into which the water from a brook,

stream, or impure source flows. Upon the pipe  $a$ , intermediate of its inlet and discharge ends, is formed a seat  $b$ , of preferably oval shape, having a central opening  $b'$  of circular outline. The seat  $b$  may be of brass or other suitable material and is bolted or otherwise secured to a flange  $a^2$  upon a correspondingly-shaped opening in the pipe  $a$ . The flanged opening  $a^2$ , seat  $b$ , and opening  $b'$  in the seat constitutes an outlet or overflow for the impure water in the pipe  $a$  during its reflex movement in said pipe  $a$ . A plunger  $d$ , shaped to fit the interior of the seat-plate  $b$  and having an upper surface  $d'$ , adapted to bear against and to close the opening  $b'$  in said seat  $b$ , is suspended from a rod  $e$ , preferably screw-threaded at its upper end and traversing the opening  $b'$  of the seat  $b$ , so as to hold the plunger  $d$  within the pipe  $a$  below the seat  $b$ . The rod  $e$  is made, preferably, of metal and depends from one end of a lever or arm  $f$ , which is supported in a fulcrum  $f'$  intermediate of its ends by means of a bracket or standard  $f^2$ , preferably supported by the pipe  $a$ . On the free end of the lever  $f$  is a movable or adjustable counterweight  $f^3$ . The fulcrum  $f'$  of the lever  $f$  is arranged eccentrically on the standard  $f^2$ , so that the end from which the rod  $e$  is suspended is normally in a lower position than the counterweight  $f^3$ . This arrangement insures the lowering of the plunger  $d$ , and hence the opening of the seat  $b$ , when the plunger  $d$  is not elevated by the inrushing water in the pipe  $a$ . Arranged upon the rod  $e$  above the seat  $b$  is a plate  $g$ , preferably bell-shaped, adapted to be adjusted up and down upon the rod  $d$  to either approach the opening  $b'$  in the seat  $b$  or to recede therefrom. The water escaping from the seat  $b$  is adapted to strike this plate  $g$  with varying force, according to the distance the plate  $g$  is above the seat  $b$  and according to the force of the water flowing into the pipe  $a$ . The plate  $g$  acts as a governor and enables the plunger  $d$  to drop below current or flow of water. By moving the governor-plate  $g$  up or down upon the rod  $d$ , according to the variations in the flow of water into the pipe  $a$ , there will be secured an upward thrust upon the governor-

plate *g*, thereby raising the plunger *d* to enable it to seat itself in the seat *b*. Thus if the force of the water in the pipe *a* is insufficient to lift the plunger *d* then the plate *g* is advanced on the rod *e* toward the seat *b* until the force of the escaping water exerted upon the governor-plate *g* assists in lifting the plunger *d* properly to the seat *b*.

The reservoir or container *k*, wherein water under pressure is to be stored, has at its base a check-valve *k'*, arranged to permit water and air to be forced from the spring-water chamber *m* into the reservoir *k* and to prevent a return of water from said reservoir *k* into said spring-water chamber *m*. The chamber *m* is formed of metal and in one of its walls is arranged a check-controlled air-inlet *m'*. The chamber *m* has also an inlet *m<sup>2</sup>* for spring or pure water. Within the chamber *m* is closely fitted a box-shaped valve *p*, of metal or rigid material. The sides of the box-valve *p* are so arranged that when the valve-box *p* is raised its sides cut off or close the water-inlet *m<sup>2</sup>* and the air-inlet *m'*. The box-valve *p* normally closes the discharge end of the inlet-pipe *a*, and when water flows into said pipe *a* with the plunger *d* closed it delivers upon the base of the box-valve *p* a blow sufficient to raise the box-valve *p* and to force the water in the chamber *m* under pressure into the reservoir or container *k*. The water from the reservoir *k* is led away through an opening *k<sup>2</sup>* to the place where the water is to be used. In the base of the pipe *a* is arranged a catch-basin *a<sup>3</sup>*, into which dirt or sediment may fall and from which it may be removed through a valve-controlled opening *a<sup>4</sup>*.

Having thus described the nature and objects of our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In a hydraulic ram, a spring-water chamber provided with a water-inlet and an air-inlet, a reservoir arranged above said chamber and having a valve-controlled inlet, a box-

shaped valve arranged within said chamber, an intake-pipe arranged below the base of the valve of said chamber and having between its inlet and discharge an overflow-opening provided with a seat, a plunger-valve adapted to engage the seat of said opening, a rod traversing the seat and opening and carrying said plunger-valve, a lever-arm from one end of which said rod is suspended, and a bell-shaped governor-plate adjustable on said rod toward or away from said seat.

2. In a hydraulic ram, a spring-water chamber, an inlet for water to said chamber, an air-inlet for said chamber, a reservoir arranged above said chamber, a valve-controlled inlet arranged to permit water to flow only from the chamber into the reservoir, a box-shaped valve arranged within the chamber, said valve formed of rigid material, and an intake-pipe arranged below the base of said valve so that the inflowing water may strike upon said base.

3. In a hydraulic ram, an intake-pipe having an overflow-opening and a delivery end, a plunger arranged within the pipe and adapted when elevated by the water in the pipe to close the overflow-opening, a governor-plate cooperating with the plunger and arranged outside the pipe above the overflow-opening, means for adjusting said plate toward or away from the overflow-opening, a spring-water chamber arranged above the delivery end of the pipe, and a box-shaped valve of rigid material arranged in said chamber, the base of said valve normally resting upon the delivery end of said intake-pipe.

In testimony whereof we have hereunto set our signatures in the presence of two subscribing witnesses.

GEORGE H. EARLE, JR.  
GEORGE B. SHAINLINE.

Witnesses:

EVA S. HAYMAN,  
JAMES WARK.

No. 758,259.

PATENTED APR. 26, 1904.

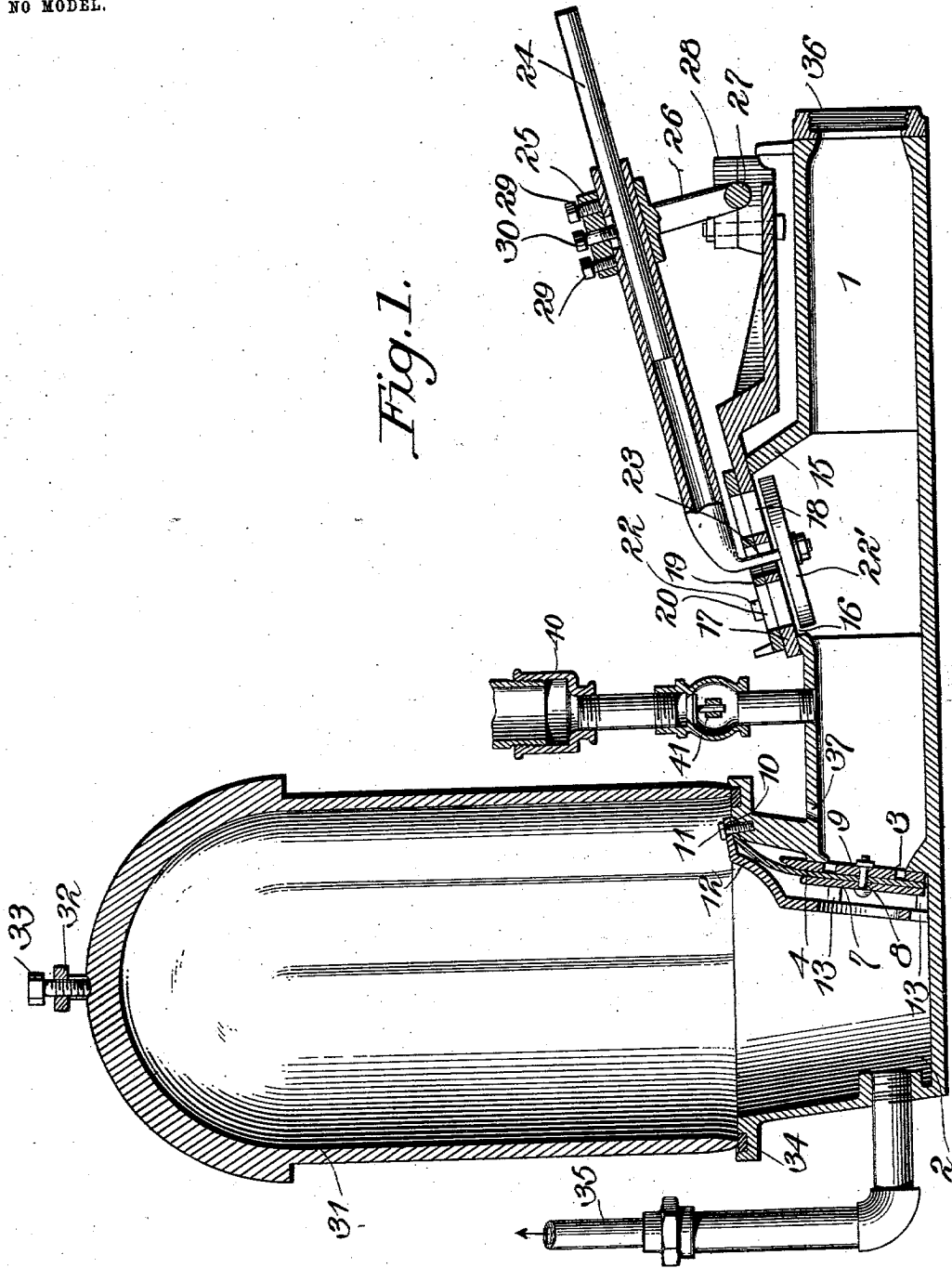
J. M. KLINE.  
HYDRAULIC RAM.

APPLICATION FILED AUG. 17, 1903.

2 SHEETS—SHEET 1.

NO MODEL.

Fig. 1.



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PATENTED APR. 26, 1904.

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HYDRAULIC RAM.  
APPLICATION FILED AUG. 17, 1903.

NO MODEL.

2 SHEETS—SHEET 2.

Fig. 2.

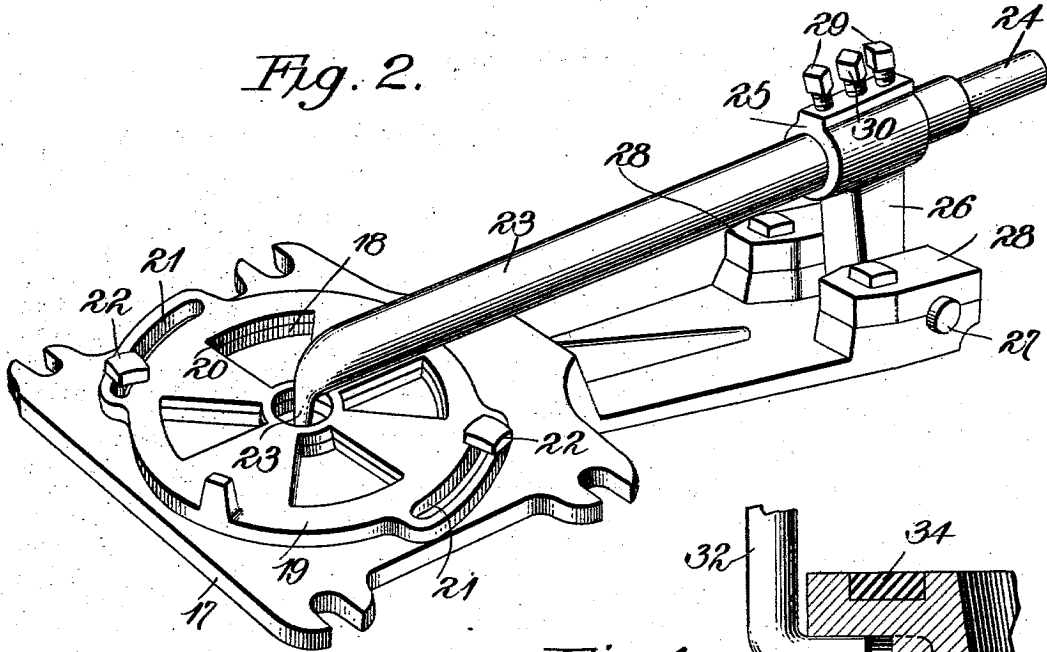


Fig. 4.

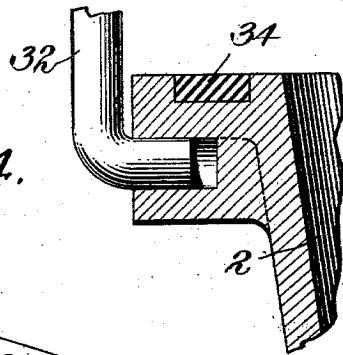
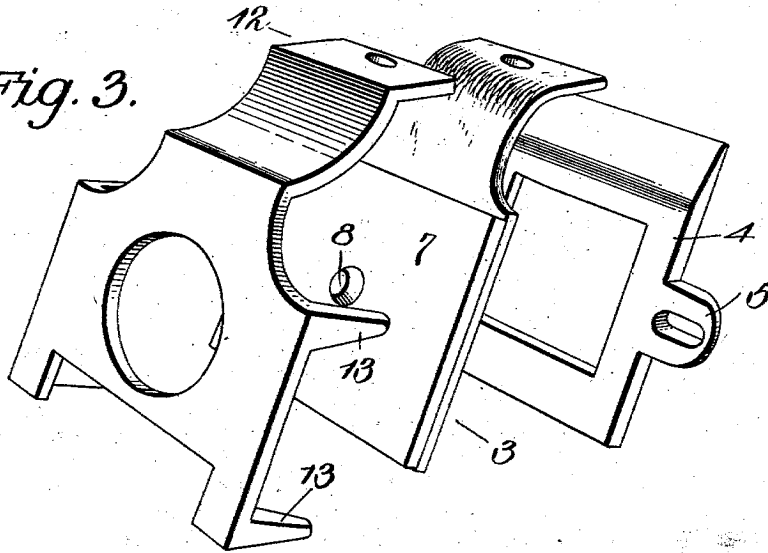


Fig. 3.



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# UNITED STATES PATENT OFFICE.

JAMES M. KLINE, OF BEAVERTOWN, PENNSYLVANIA.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 758,259, dated April 26, 1904.

Application filed August 17, 1903. Serial No. 169,780. (No model.)

*To all whom it may concern:*

Be it known that I, JAMES M. KLINE, a citizen of the United States, residing at Beavertown, in the county of Snyder and State of Pennsylvania, have invented a new and useful Hydraulic Ram, of which the following is a specification.

This invention relates to improvements in hydraulic rams.

One object of the invention is to provide a ram in which the escape-valve is adjustably weighted, so that a resistance to the closing movement may be altered in accordance with the volume, pressure, or head of the water.

A further object of the invention is to provide a ram with an escape-valve opening or port the area of which may be readily adjusted in accordance with the volume of water.

A still further object of the invention is to provide a ram in which a volume of impure water, such as the water of a running stream, may be employed to pump pure water, as from a spring, to a house or other point of consumption.

A still further object of the invention is to provide a hydraulic ram with an air-chamber that may be readily detached should it become necessary to examine or repair the check-valve, and it may be held in place by means of a small yoke and a single set-screw.

A still further object of the invention is to provide a ram in which the entrance and discharge ports are arranged on the same horizontal line, so that the head of the water on entering will serve to assist in discharging the water, and all unnecessary waste of pressure or force will be prevented.

With these and other objects in view, as will more fully hereinafter appear, the invention consists in the novel construction and arrangement of parts hereinafter described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the form, proportions, size, and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of the invention.

In the accompanying drawings, Figure 1 is a longitudinal sectional elevation of a hydraulic

ram constructed in accordance with the invention. Fig. 2 is a detail perspective view of the escape-valve, its port, and carrying-lever. Fig. 3 is a similar view of the main check-valve and its cage. Fig. 4 is a detail section of a portion of the air-chamber, showing the pivot-sockets of the air-dome-clamping yoke.

Similar numerals of reference are employed to indicate corresponding parts throughout the several figures of the drawings.

The entrance-chamber 1 of the ram communicates in the usual manner with the air-chamber 2, and between these two chambers is a check-valve 3 to prevent the backflow of water. As the main portion of the ram is formed of rough cast metal, which would prevent the direct application of a valve with expensive finishing, a separate valve-seat 4 is formed of a ring of metal of a shape corresponding to the cross-sectional contour of the inlet and provided with ears or lugs 5, having suitable openings for the passage of securing-bolts. The valve proper is formed of a suitably-shaped piece of leather and is provided with a weight-plate 7, that serves in part to maintain the valve member in proper position, and said plate is confined in place by a suitable bolt 8, extending through the valve and through a small metallic plate 9, arranged at the inner face of the valve and entering the inlet when the valve is closed.

The valve proper may be formed of a piece of leather or other suitable material, and its upper end is somewhat contracted in width and is bent over an upper flange 10 at the upper portion of the stationary base of the ram and is confined in place by a bolt 11, that also extends through the upper end of a plate 12. This plate forms a valve-cage and is held in proper spaced relation to the valve by means of lugs or fingers 13, that rest against the inner wall of the air-chamber, the plate preventing excessive opening movement of the valve.

The water-chamber 1 is provided with a vertically-disposed flange 15, defining an opening 16, which may be of rectangular or other form, and on this flange is seated a cover 17, that may be bolted or otherwise secured to

the ears or lugs projecting from the flange, and said cover-plate is preferably disposed at an angle to the horizontal in order that the action of the valve, which at times covers openings in the cover, may be made more uniform and regular. The cover 17 is provided with a number of openings 18 and has a revoluble regulating-disk 19, provided with similar openings 20.

The disk is provided with a pair of arcuate slots 21, through which pass bolts 22, the construction permitting rotative movement of the disk to an extent sufficient to secure the regular adjustment of the openings, and by tightening the bolts the disk may be locked in any desired position. This feature is important in that it permits of the adjustment of the device in accordance with the quantity of water, and this prevents the waste of water in dry season or where a spring or other source of supply is limited.

The escape-valve 22' is formed of a thick disk of rubber carried by a bar 23, that extends through a central opening formed in the disk 19 and the cover 17, and the main body of the bar being hollow and adapted to receive a slidable weight 24. The rear end of the bar extends through a collar 25, formed at the upper end of an arm 26, the lower end of said arm having trunnions 27, adapted to suitable bearings in blocks 28, that are carried by the rearwardly-extended portion of the cover-plate 17 for convenience in manufacture. The hollow bar 23 is locked in the sleeve or collar 25 by means of a pair of set-screws 29, while the weight is held in any position to which it may be adjusted by means of a set-screw 30, passing through a threaded opening in the sleeve or collar and an auxiliary opening in the hollow bar 23. This weight may be adjusted in order that greater or less resistance may be offered to the closing movement of the valve, and thus govern the speed of operation of the ram and the pressure imparted to the water, so that the water may be elevated to a greater or less height.

The air-chamber has a removable dome 31, that is seated on the upper flange of the body portion or box of the air-chamber and is held in place by means of a yoke 32. The lower ends of the yoke are turned inward and are received in suitable openings in opposite sides of the body portion of the air-chamber, while the upper or central portion of the yoke has a threaded opening for the reception of a set-screw 33, which bears against the top of the dome and forces the same firmly against its seat, a suitable packing-ring 34 being introduced between the dome and flange in order to form an air-tight joint.

The eduction-pipe 35 is arranged in a direct horizontal line with a water-supply pipe 36, so that the course of the water entering the water-chamber and from thence passing to the air-chamber may be in a direct line

with the discharge and all of its power utilized, the force of the flow being added to some extent to the reactionary force due to the expansion of air in the dome 31 in order to check the water through the pipe 35. The casing is provided with an opening 37, through which air is admitted to renew the supply in the air-chamber.

In the operation of the ram as thus far described the water entering the chamber first escapes past the valve 22 and then in the usual manner closes said valve and forces open the check-valve 3 and passes quickly into the air-chamber, effecting the admission of the air and the subsequent expansion of the air closing the valve 3 and forcing the water to the eduction-pipe 35.

In carrying out the present invention, especially where the water is to be used for drinking purposes and where the supply is limited, it is designed to utilize a body of impure-water for pumping purposes. It often happens that a spring or similar source of pure-water supply is adjacent to a running stream the power of which would be sufficient to force the spring-water to the point of consumption, while the quantity of water in the spring would not be sufficient for the purpose. In such cases the less desirable or impure water may be made to force the spring-water without waste to the point of consumption. This is accomplished by tapping into the air-chamber 1 a feed-pipe 40, communicating with the spring, and the water from the spring flows through this pipe to the water-chamber a constant stream, a check-valve 41 being introduced in the pipe in order to prevent backflow at any time. The purer water will fill the space from a point intermediate of the escape-valve and the pipe 40 to the eduction-pipe 35, while the impure water entering through the pipe 36 will not mingle therewith, and the force or head of both bodies of water is utilized in pumping the spring-water through the pipe 35.

In the starting of the operation it may be assumed that the two bodies of water entering through the pipes 36 and 40 will both flow in the direction of the escape-valve 22, but owing to the superior volume of impure water a comparative proportion of the spring-water will escape, but the inflow will be sufficient to prevent the purer water from passing beyond the pipe 40. The usual operation will then follow at regular intervals, the escape-valve being closed, and the water in the chamber 1 will be moved in the direction of the air-chamber 2, opening the check-valve 3 against the pressure of air in the chamber 2. It is only the spring-water, however, which enters the air-chamber. On the closing of the check-valve 3 and the regurgitation of the water the small body of spring-water left in the water-chamber will tend to force back the impure water, and both bodies of water will, as before, flow in

the direction of the escape-valve. The supply-pipes are so proportioned as to prevent intermingling of any of the impure water with the spring-water, and this can only occur where  
 5 the volume of spring-water is less than the pumping capacity of the ram. The amount of water utilized may be adjusted by means of the valve 22, and the speed of operation of the ram and the pressure exerted on the water  
 10 may be readily adjusted by shifting the weight 24 in the hollow bar 23.

Having thus described the invention, what is claimed is—

1. In a hydraulic ram, an escape-valve, a  
 15 hollow bar carrying said valve, a pivotally-mounted arm having a clamping sleeve or collar for engaging said bar, a slidable weight for which said hollow bar forms a housing and in which it is longitudinally adjustable,  
 20 and a set-screw carried by the sleeve or collar and extending through an opening in the bar to engage and lock the weight in adjusted position.

2. In a hydraulic ram, a water-chamber having an escape-valve opening, a ported cover-plate for the opening, an escape-valve adapted to seat against the under side of said plate, a pair of spaced bearing-boxes carried by the  
 30 plate, an arm having trunnions adapted to said bearing-boxes, a sleeve or collar carried by the arm, a hollow bar clamped to said sleeve or collar and connected to the valve, a slidable weight adapted to said hollow bar and a clamping-screw for holding said weight in  
 35 adjusted position.

3. In a hydraulic ram, a water-chamber having a top wall provided with openings for the escape of water, an upwardly-closing escape-valve adapted to seat against the inner surface  
 40 of the said wall, a carrying-rod for said escape-valve, a ported regulating-disk held against the outer surface of the wall and adjustable thereon to vary the effective area of the escape-ports, both the regulating-disk and

the upper wall having central openings for  
 45 the passage of the escape-valve carrying-rod, and means for locking the regulating-disk in adjusted position.

4. In a hydraulic ram, a water-chamber, a detachable ported cover-plate forming the upper  
 50 wall of the chamber, said plate being provided with a plurality of escape-ports and having an approximately central opening, an escape-valve adapted to seat against the inner face of the plate, a ported regulating-disk for  
 55 adjusting the effective area of the escape-ports, said regulating-disk being arranged on the upper surface of the plate and being provided with a pair of diametrically-opposed arcuate slots and having a centrally-disposed  
 60 opening alining with the opening of the cover-plate, guiding and locking bolts extending through the arcuate slots and tapped into the cover-plate, said bolts forming guides for the movement of the disk-valve, and an escape-  
 65 valve carrying-bar extending loosely through the central openings of the disk-valve and cover-plate.

5. In a hydraulic ram, a box or casing divided into a water-chamber and an air-chamber  
 70 between, a ring arranged around the opening between the two chambers and forming a valve-seat, a flexible valve adapted to the seat and connected at its upper end to the wall of the air-chamber, a weight-plate secured to the  
 75 lower portion of the valve and serving to hold the same in proper position, and an auxiliary plate having a plurality of studs or fingers and forming a cage for the valve, substantially  
 80 as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

JAMES M. KLINE.

Witnesses:

ALFRED SMITH,  
 S. A. WETZEL.



No. 767,516.

PATENTED AUG. 16, 1904.

E. H. FOSTER.  
HYDRAULIC RAM.

APPLICATION FILED JAN. 26, 1903.

NO MODEL.

Fig.1

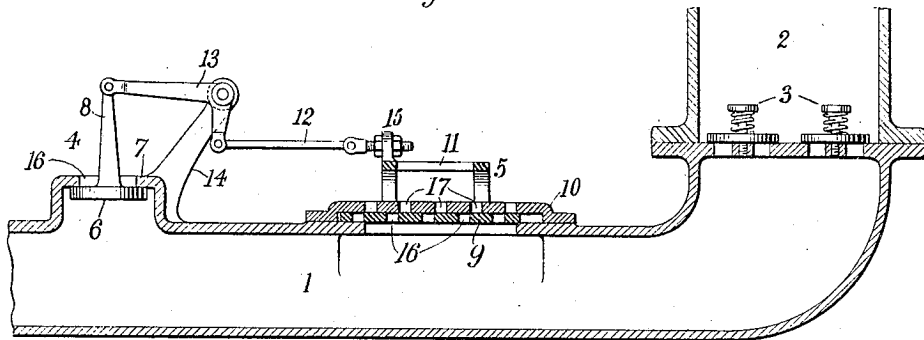


Fig.2

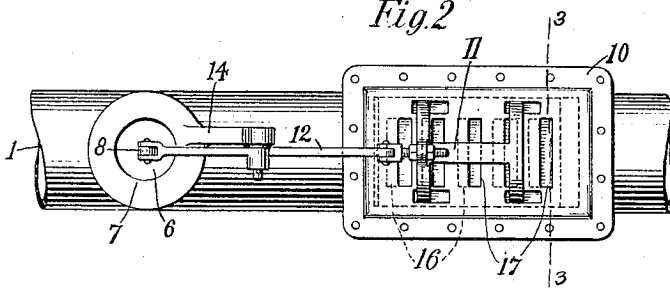


Fig.3

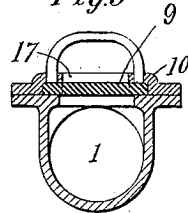


Fig.4

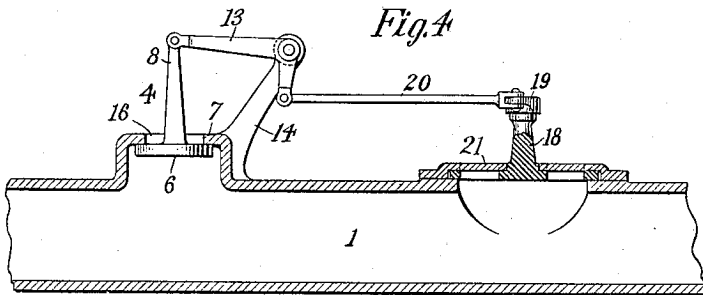
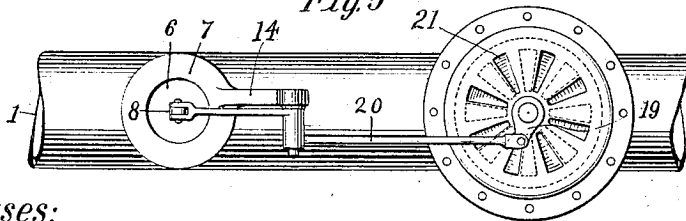


Fig.5



Witnesses:

Raphael Netter  
S. Dunham.

Inventor  
Ernest H. Foster

by Kerr, Page & Cooper, Attys.

# UNITED STATES PATENT OFFICE.

ERNEST H. FOSTER, OF NEW YORK, N. Y.

## HYDRAULIC RAM.

SPECIFICATION forming part of Letters Patent No. 767,516, dated August 16, 1904.

Application filed January 26, 1903. Serial No. 140,457. (No model.)

*To all whom it may concern:*

Be it known that I, ERNEST H. FOSTER, a citizen of the United States, residing at New York, county and State of New York, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification, reference being had to the drawings accompanying and forming part of the same.

Heretofore in the manufacture of rams of large size and power it has been found that the working or waste valve gives out after the apparatus has been in use but a comparatively short time. This is due to the great unbalanced or unsupported area necessary in a working valve of large size, on account of which the shock of sudden closing exerts a strain which the valve cannot long sustain. In order to overcome this difficulty, so that rams of large size may be constructed which will have as long life as the less powerful ones now in use, I have devised a waste-valve which with large capacity has very small unsupported area.

My invention, which consists of the novel features and combinations more particularly pointed out in the claims, is illustrated in the drawings, in which—

Figure 1 is a section of a ram having my improved valve. Fig. 2 is a top plan view of the valve. Fig. 3 is a section on line 3 3 of Fig. 2. Figs. 4 and 5 are section and plan, respectively, of a modification.

The drive-pipe 1 is of any convenient form and is connected in the usual manner with an air-chamber 2, having suitable valves 3.

In lieu of the customary single escape or working valve I use a double arrangement consisting of a pilot-valve 4 and a main valve 5. The pilot-valve consists, preferably, of a disk 6, adapted to fit a seat 7 and carrying a vertical stem 8. The opening and closing of this valve differs in no way from the operation of the ordinary waste-valve; but it is much smaller than would be required for a ram of the size on which it is used. In order, therefore, to compensate for its small size, I employ another valve 5, closed not directly

by the friction of the escaping water, but by the pilot-valve.

The valve 5 consists of a gridiron-plate 9, sliding in suitable guideways formed by the flanged plate 10 on the upper side of the drive-pipe and preferably adjacent the pilot-valve. Immediately below the sliding plate 9 are similar openings in the drive-pipe, as shown, to register with those in the plate 9. The plate carries a bail 11, having connected thereto a jointed connecting-rod 12, which latter is connected to one arm of a bell-crank lever 13, pivotally mounted on an arm 14. The other arm of the bell-crank is connected to the vertical stem 8 of the pilot-valve.

It will be readily understood from the foregoing that by means of the screw-thread devices 15 on the end of the rod 12 the relation between the pilot-valve and the plate-valve may be so adjusted that when the former is opened by the fall of pressure in the drive-pipe the latter will move forward, so as to bring the two sets of openings into register. The water in the pipe 1 now has ample means of escape through the openings 16 17. When the flow through 16 has attained a sufficient momentum, the pilot-valve closes suddenly in the usual manner, closing, by means of the connecting-levers, the plate also, after which the water enters the air-chamber. Thus it will be seen that while the valves for the waste are of large capacity they are so constructed as to have very small unsupported areas. Consequently the impact of the water as they are closed is sustained without danger of the valve giving way. At the same time they may be made comparatively light in weight, thereby effecting an appreciable economy in manufacture. The pilot-valve being operated by a volume of water much greater than is sufficient merely to close it, develops enough power to actuate the valve 5 with certainty—that is, the latter is not too heavy a load to prevent the system from always operating. On the other hand, the load is sufficient to dampen or check the speed of the pilot-valve in closing, so that the shock and consequent strain is considerably reduced

without materially affecting the efficiency of the engine.

The operation of the modified form shown in Figs. 4 and 5 is essentially the same as the foregoing. In this form a rotary plate-valve 5 17 is substituted for the sliding plate, having a crank-arm 18 and crank 19, which latter is connected to the bell-crank lever by the rod 20. Thus the opening and closing of the pilot-valve will rotate the other to cover or 10 uncover the corresponding openings 21 in the drive-pipe.

It is obvious that my invention is capable of many embodiments other than the one described, and therefore I do not consider myself limited thereto. For example, other forms of valves might be used or other means of operatively connecting the two together, or the pilot-valve might be arranged to operate 20 a plurality of main valves. Many other variations will readily suggest themselves to the engineer or any one skilled in this art.

Therefore what I claim is—

1. In a hydraulic ram, the combination of 25 a drive-pipe, a pilot waste-valve, a second waste-valve, and means connecting said valves whereby said second waste-valve is operated by said pilot-valve, as set forth.
2. In a hydraulic ram, the combination with

a drive-pipe, of a pilot-valve operated by the liquid in said pipe, and a second valve operated by said pilot-valve, as set forth. 30

3. In a hydraulic ram, the combination with a drive-pipe, of a pilot-valve operated by the liquid in said pipe, a second valve, and a system of levers connecting said valves whereby the pilot-valve actuates the second valve, as set forth. 35

4. In a hydraulic ram, in combination, a pilot-valve, a drive-pipe having a series of openings therein, a plate having openings corresponding to the openings in the drive-pipe movably mounted on said pipe, and means whereby the operation of the pilot-valve moves said plate to throw its openings in and 45 out of register with the openings in the drive-pipe, as set forth.

5. In a hydraulic ram, in combination, a drive-pipe, a pilot-valve having a stem, a bell-crank lever attached thereto pivotally mounted on said pipe, and a second valve connected to said lever, whereby said pilot-valve operates said second valve. 50

ERNEST H. FOSTER.

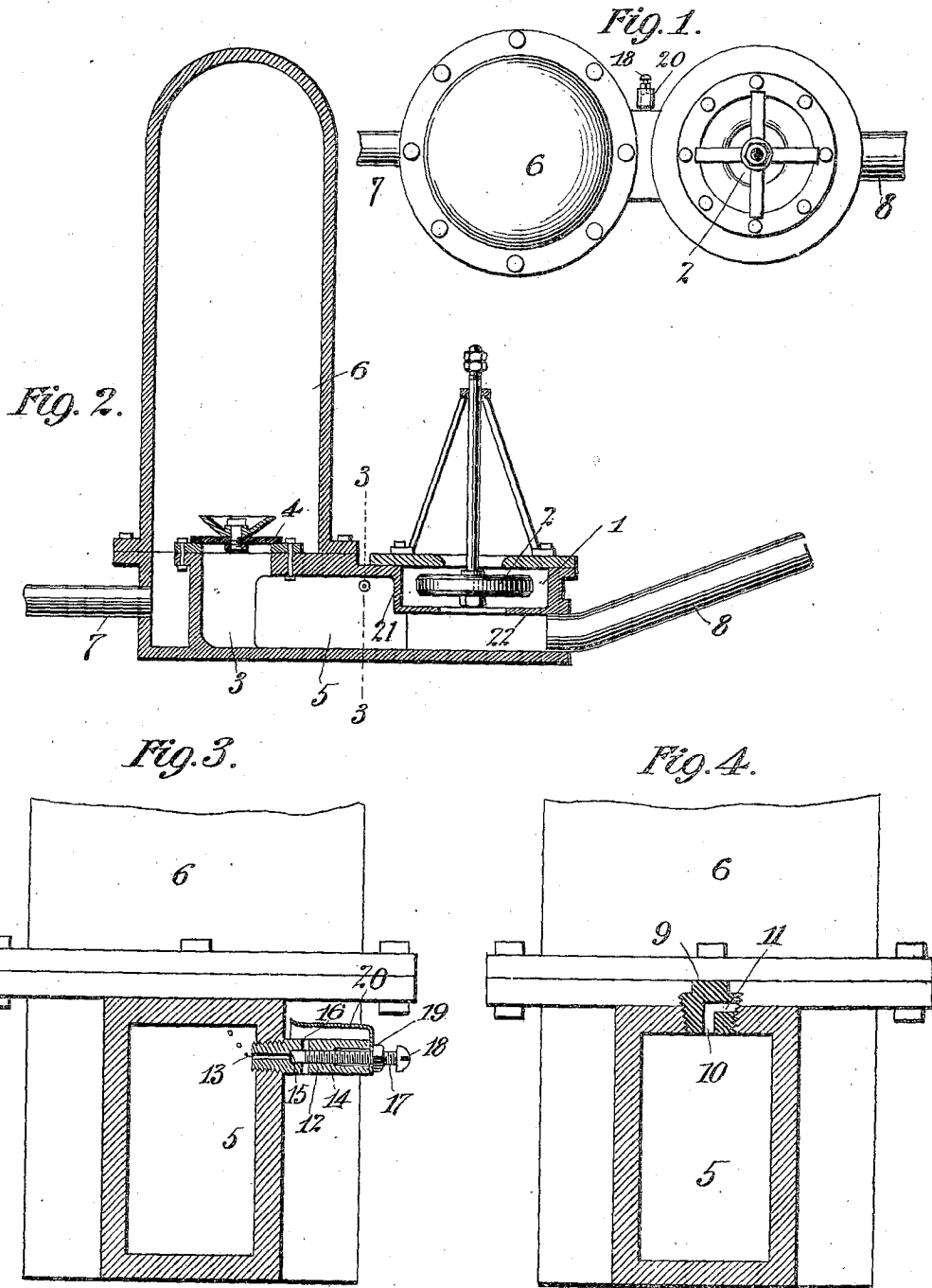
Witnesses:

S. S. DUNHAM,  
W. H. CAPEL.

No. 835,855.

PATENTED NOV. 13, 1906.

A. H. FRANCFORT.  
AIR FEED FOR HYDRAULIC RAMS.  
APPLICATION FILED AUG. 21, 1905.



Witnesses  
Frank S. Ober  
Waldo M. Chapin

Inventor  
Alfred H. Francfort  
By his Attorneys  
Rosentbaum & Stockbridge

# UNITED STATES PATENT OFFICE.

ALFRED H. FRANCFORT, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO  
NIAGARA HYDRAULIC ENGINE CO., A CORPORATION OF PENNSYLVANIA.

## AIR-FEED FOR HYDRAULIC RAMS.

No. 835,855.

Specification of Letters Patent.

Patented Nov. 13, 1906.

Application filed August 21, 1905. Serial No. 274,992.

*To all whom it may concern:*

Be it known that I, ALFRED H. FRANCFORT, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented a new and Improved Air-Feed for Hydraulic Rams, of which the following is a full, clear, and exact description.

My invention relates to hydraulic rams, the same residing particularly in the means for feeding air to the air-chamber for maintaining a constant air cushion or pressure therein.

As is well known, in this class of devices the pumping action of the water is effected against a cushion of air in an air-chamber, and unless air be constantly supplied to such chamber that which was originally contained therein will be absorbed by the water, and the pumping action will then be effected against a solid unyielding body. Various expedients have been resorted to for feeding air to the air-chamber of a hydraulic ram, most of them depending for their action upon the reduction in the pressure after the blow has been struck by the water, the said reduction in pressure serving to draw in through a suitable orifice a small quantity of air, which upon the next stroke is forced up into the air-chamber. It is necessary, however, that the quantity of air thus admitted be very accurately regulated, and the size of the opening or orifice must necessarily be adjusted for every machine which is installed on account of the varying conditions under which different machines are called upon to operate.

My invention is designed for the production of an air-feed for hydraulic rams in which the quantity of air admitted after each stroke thereof may be controlled with absolute accuracy and without danger of clogging any of the ports or orifices. It is also designed for the purpose of providing such an air-feed in which danger of drawing the air-bubble back into the impetus-valve chamber is reduced to a minimum and the danger of forcing the air-bubble out through the passage through which it entered is absolutely prevented.

The details of the invention will hereinafter appear, and that which I regard as new will be set forth in the claims.

In the drawings forming part of this specification, Figure 1 is a plan view of a hydraulic

ram embodying my improvements. Fig. 2 is a longitudinal section of the same. Fig. 3 is a transverse section on the line 3 3 of Fig. 2, and Fig. 4 is a similar view showing an old form of construction upon which my invention is an improvement.

Like reference-numerals indicate like parts in the different views.

The casing of the hydraulic ram shown is provided with a valve-chamber 1 for the impetus-valve 2, a valve-chamber 3 for the main valve 4, and a passage 5 between said valve-chambers. The air-chamber 6 is secured to said casing above the main valve 4 and has leading therefrom a delivery-pipe 7. The drive-pipe 8 enters the casing at a point beneath the impetus-valve 2, as clearly shown.

All of these parts are old and well known, being substantially the same as the corresponding parts shown in the patent to Smith, No. 748,113, dated December 29, 1903, and the operation thereof is well understood.

The air-inlet, through which air is admitted for maintaining the pressure within the chamber 6, is ordinarily located in the passage 5 between the valve-chambers 1 and 3. A common form of such device is illustrated in Fig. 4 of the drawings, in which, as will be seen, the upper wall of the rectangular passage 5 is provided with a tapering screw-threaded opening, into which a plug 9, having a correspondingly-shaped screw-threaded cone-shaped head, is adapted to fit. This plug has a port 10 therein, which extends upwardly from its central point and communicates with a transverse port 11. To regulate the admission of air with the plug 9, it is necessary to screw the same into the upper wall of the passage 5 to a greater or less extent, and thus cut off by the wall of said passage a greater or less part of the port 11. It will be obvious, however, that if the plug 9 be screwed in to its greatest extent and the device is adapted to admit air a certain predetermined portion of the port 11 will be exposed. The size of the passage through the plug 9 therefore cannot be decreased, as said plug had been screwed in to the limit of its movement. If it be desired to increase the size of the passage through said plug, it is necessary to unscrew the same partially from the opening in the wall of the passage 5;

but in this case the outer screw-threaded walls of said plug are removed from the walls of the opening in which it fits, and consequently a leak takes place around said plug. The same is therefore very deficient in providing for the accurate regulation of the air-supply to the passage 5. Moreover, as this plug 9 is located in the top wall of the passage 5 there is always a tendency to force back the bubble of air which enters through the ports 11 10 through the same passage. This defeats the very purpose of the air-feed.

By my invention, which is most clearly illustrated in Fig. 3 of the drawings, these objections are entirely overcome. I employ a plug 12, having a screw-threaded cone-shaped end which is adapted to fit a correspondingly-shaped screw-threaded opening in the side wall of the rectangular passage 5 between the valve-chambers 1 and 3. This opening in said side wall is located a short distance beneath the top of said passage. The plug 12 is provided with a central aperture or port 13 at its inner end and with an enlarged screw-threaded axially-arranged opening 14 in line with the port 13.

A shoulder 15 is formed at the meeting-point of the port 13 and opening 14, and a transverse port 16, intersecting the opening 14, is also provided in the plug 12.

Fitting within the opening 14 in said plug is an adjusting-screw 17, having a head 18 thereon and provided with a jam-nut 19, by means of which it may be locked in adjusted position. The inner end of the screw 17 is adapted to engage the shoulder 15 to cut off entirely the passage for air through the plug 12 and is adapted to be moved, as shown in Fig. 3 of the drawings, to a position opposite the transverse port 16 for the purpose of regulating the size of the passage through said plug. The inner end of said screw is cut off square, so that an annular passage between it and the inner wall of the opening 14 is avoided, which would be produced when the ordinary form of needle-valve is employed. These annular passages are objectionable in that clogging is much more apt to occur when they are formed. The plug 12 is somewhat elongated in order that it may project out to a point where ready access may be had thereto. It is also provided with a semicircular shield or guard 20, held in place by the jam-nut 19, the said shield being provided for the purpose of cutting off the port 16 from the waste water escaping through the passage controlled by the valve 2. Without the provision of this shield there is danger of the passage through the plug 12 being filled with water and that upon the reaction of the ram water will be sucked in through the port 13 instead of air.

Now it will be observed that all that is necessary to do in order to apply my device is to screw the cone-shaped end of the plug

12 into the threaded opening in the side wall of the passage 5, and once in place it is never necessary to remove the same. It may be screwed up just as tight as may be desired, which cannot be done in the case of plug 9. (Shown in Fig. 4.)

When a ram is first installed, it is necessary to cut off the supply of air altogether until sufficient pressure has been generated within the air-chamber 6. With my device this may be done by simply screwing up the screw 17 until the inner end thereof comes into engagement with the shoulder 15. When sufficient time has elapsed for a body of water to have accumulated in the chamber 6 beneath the air at the upper part of said chamber, the screw 17 is moved outwardly until it assumes a position substantially as shown in Fig. 3 of the drawings, where the transverse port 16 is partially uncovered. An opening is thus produced through which air may be admitted to the passage 5. The size of this opening, however, will necessarily vary with the conditions under which the ram is operated. Consequently the adjustment can never be finally made until after installation. When once made, it remains permanently. After adjustment of the screw 17 therefore the jam-nut 19 is turned and the screw locked in position.

The port 16 is cut off from the overflow-water from the valve 2, and upon "back-kick" or reaction of the ram when a reduction in the pressure within the passage 5 takes place a small quantity of air is drawn in through the ports 16 and 13 in a well-known manner. This small quantity of air in the form of a bubble rises to the top of the passage 5 out of line with the inner end of the port 13, and consequently cannot upon the next stroke of the ram be forced back through the ports 13 and 16. On the other hand, it is forced up through the valve-chamber 3 into the air-chamber 6 and serves to replenish such air in said chamber as may be absorbed by the water therein. Said air-bubble is also prevented from being drawn back into the valve-chamber 3, from which it might be forced out through the opening controlled by the impetus-valve 2, by the vertical wall 21, which supports the diaphragm 22.

Having now described my invention, what I claim is—

1. In a hydraulic ram, having the usual impetus-valve, main valve and passage between the same, a plug secured to and extending through one of the side walls of said passage, the said plug having longitudinal and transverse ports, a regulating-screw for controlling the passage through said ports, a shield embracing said plug for cutting off said transverse ports from the waste water and a jam-nut on said screw for preventing the turning movement thereof, the said nut

acting upon said shield for holding the latter in place.

2. In a hydraulic ram, having an impetus-valve, a main valve and a passage connecting the same having a horizontal portion therein, an air-feed extending through the side wall of the horizontal portion of said passage at a point below the upper end thereof, and a wall in the horizontal portion of said passage

between said air-feed and the chamber of said impetus-valve, as and for the purpose set forth.

In witness whereof I subscribe my signature in the presence of two witnesses.

ALFRED H. FRANCFORT.

Witnesses:

WM. M. STOCKBRIDGE,  
FRANCIS OBER.

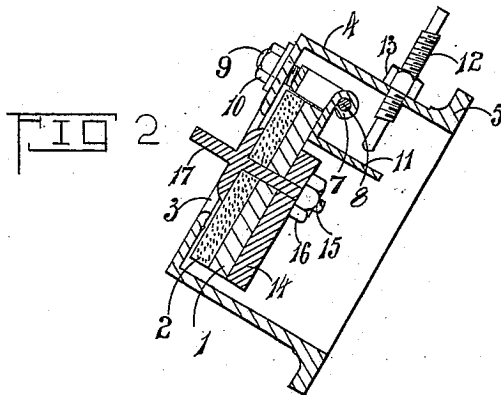
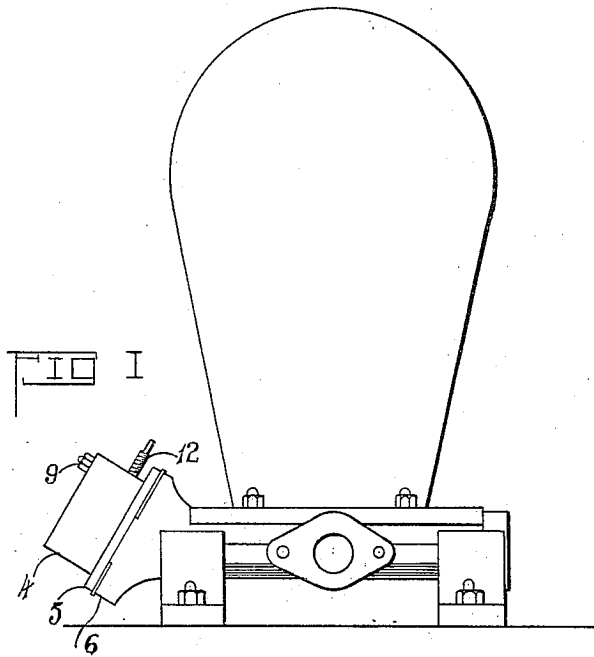
No. 841,563.

PATENTED JAN. 15, 1907.

J. NORTHEY.

PULSATING VALVE FOR HYDRAULIC RAMS.

APPLICATION FILED SEPT. 18, 1905.



Witnesses.  
E. P. O. Donnell  
Chas. T. Wilson

Inventor.  
John Northey.  
by his Attorney.  
Alfred Hayward.



# UNITED STATES PATENT OFFICE.

JOHN NORTHEY, OF CHRISTCHURCH, NEW ZEALAND.

## PULSATING VALVE FOR HYDRAULIC RAMS.

No. 841,563.

Specification of Letters Patent.

Patented Jan. 15, 1907.

Application filed September 18, 1905. Serial No. 278,878.

*To all whom it may concern:*

Be it known that I, JOHN NORTHEY, a subject of His Majesty the King of Great Britain and Ireland, residing at 34 Kilmore street, Christchurch, in the Provincial District of Canterbury, in the Colony of New Zealand, have invented certain new and useful Improvements in Pulsating Valves for Hydraulic Rams, of which the following is a specification.

The invention relates to hydraulic rams; and its object is to provide a pulsating valve which shall be practically noiseless and also to so construct said valve and its casing that it may be readily applied to existing rams.

According hereto I employ a disk valve, which is hinged upon a screwed stud passing through the valve-casing, so that a nut thereon may be removed to enable the valve to be taken out of the casing.

The beat of the valve is preferably of rubber to deaden sound.

The return throw of the valve is regulated by a set-screw passing through the casing and adapted to engage with a tailpiece projecting from the valve. A stud passing through the valve has a projection which extends beyond the casing and is employed to hold the valve up to its seat when it is desired to stop the ram. The valve is arranged at an inclination, with its hinge uppermost, and a balance-weight is employed in the form of a tapering washer or otherwise which overcomes the tendency of the valve to remain closed. The walls of the casing may be regularly cylindrical or curved.

Referring to the accompanying drawings, Figure 1 is a side elevation of a ram with my valve attached, and Fig. 2 is a vertical central sectional elevation of the valve and casing.

The disk valve 1 has the rubber face 2,

adapted to close the opening 3 in the casing 4, which has a flange 5, adapted to be connected upon the flange 6 of a hydraulic ram of ordinary construction. The valve has a hinge 7, which is pivoted upon a pin 8, extending laterally from a screwed stud 9, which passes through the valve-casing and is secured in position by a nut 10. The tail-piece 11, extending from the hinge, engages with a stud 12, which is screwed through the casing and secured by a lock-nut 13. A balance-weight 14 is secured to the under side of the valve by a stud 15, which passes through the rubber face, the valve, and the balance-weight and has a nut 16 upon its end. A projection 17 from the stud is used to hold the valve up to its seat when it is desired to stop the ram.

What I claim, and desire to secure by Letters Patent of the United States, is—

A pulsating valve for hydraulic rams comprising in combination, a casing having a discharge-opening, a metal disk valve hinged upon a screwed stud passing through said casing, a rubber face upon said valve adapted to close said opening, a tailpiece projecting from the hinge of the valve, a set-screw passing through the casing adapted to contact with said tailpiece, a balance-weight secured to the under side of the valve, and a stud passing through and securing together the valve the rubber face, and balance-weight and having an extension projecting beyond the casing by which the valve may be held substantially as specified.

In testimony whereof I have signed my name to this specification in the presence of two witnesses.

JOHN NORTHEY.

Witnesses:

A. H. HART,  
L. ROY SMITH.

No. 845,402.

PATENTED FEB. 26, 1907.

A. H. FRANCFORT.  
HYDRAULIC RAM.

APPLICATION FILED NOV. 17, 1905.

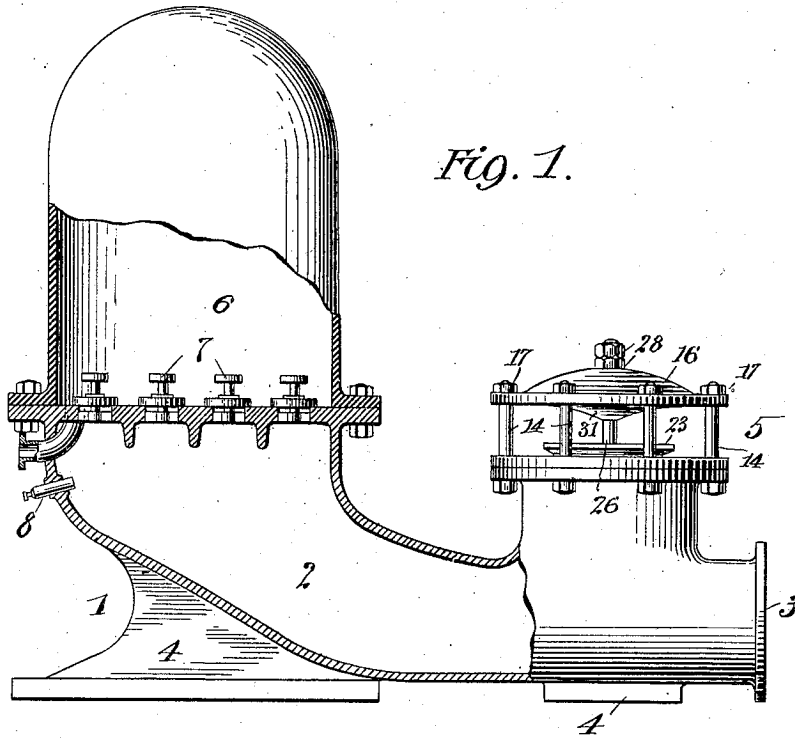


Fig. 1.

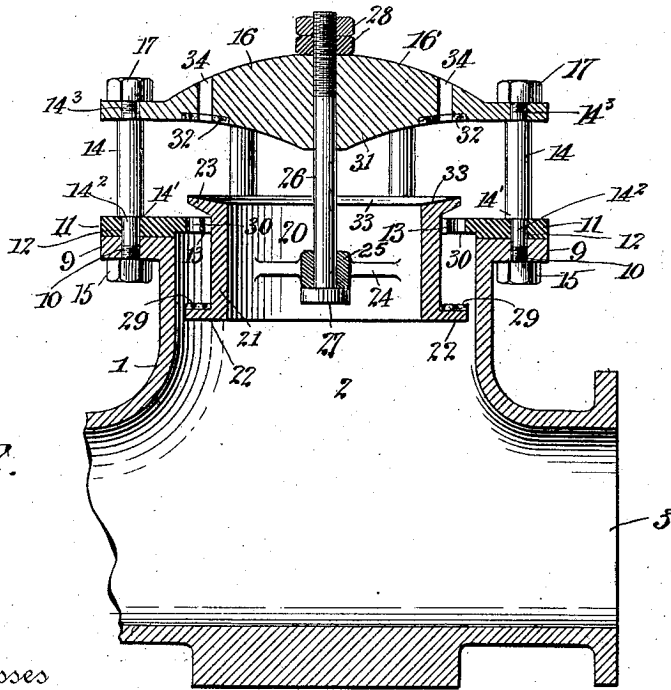


Fig. 2.

Witnesses  
Francis Ober  
Haldo M. Chapin

Inventor  
Alfred H. Francfort.  
By his Attorneys  
Rosenbaum & Stockbridge

# UNITED STATES PATENT OFFICE.

ALFRED H. FRANCFORT, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO  
NIAGARA HYDRAULIC ENGINE COMPANY, A CORPORATION OF  
PENNSYLVANIA.

## HYDRAULIC RAM.

No. 845,402.

Specification of Letters Patent.

Patented Feb. 26, 1907.

Application filed November 17, 1905. Serial No. 287,839

*To all whom it may concern:*

Be it known that I, ALFRED H. FRANCFORT, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a full, clear, and exact description.

My invention relates to hydraulic rams.

The main purpose of the invention is to improve the main valve or gate of the ram so that it will work efficiently under all conditions and with a minimum shock or jar of impact.

A further object of the invention is to devise a form of valve for hydraulic rams in which the moving part shall be of very light and strong construction and in which the seat shall be sufficiently heavy to withstand the movements of the valve thereagainst.

A still further object of the invention is to provide a valve which shall operate in a very quick and abrupt way so as to check the column of fluid in the ram with a maximum degree of suddenness.

With these and other objects in view my invention consists in the construction, combination, location, and arrangement of parts, all as will be more fully hereinafter set forth, as shown in the accompanying drawings, and finally particularly pointed out in the appended claims.

In the drawings, Figure 1 is a side elevation, partly in section, of a hydraulic ram embodying the principles of my invention. Fig. 2 is a detail sectional view of the valve.

As a general principle it may be stated that the pressure obtainable from a hydraulic ram is roughly proportional to the suddenness with which the fluid column is checked therein. Inasmuch as the closing valve or gate is itself closed by the fluid-pressure, the suddenness with which it closes can be increased by enlarging the area acted upon by such fluid-pressure and diminishing the weight so that the inertia of the parts to be moved is lessened. In carrying out my invention I adopt both of these features, and I further secure the additional advantage that by a less weight of the valve and moving parts I greatly reduce the shock of impact of the valve against its seat. In the usual forms of valves for hydraulic rams the shape of the valve renders it structurally weak, and

it has been customary to make it larger and more massive in order to secure greater strength; but the increased size is accompanied by a corresponding increase in weight and inertia, so that the valves hitherto used have been sluggish in action and destructive to both valve and seat by virtue of such great inertia. In my present invention I increase the strength of the valve, not by making it more heavy, but by modifying its form into one which is capable of withstanding large strains.

A feature of my invention insures a perfect closure of the valve in spite of sand or other articles in the water or fluid acted upon. For this purpose I provide a yielding washer or ring, which the valve engages in closing.

Referring now to the drawings, 1 indicates the casing, having a main central chamber 2 and an inlet-pipe connection 3, through which the fluid is admitted from the drive-pipe.

4 indicate supporting-legs, which may be integral with the casing 1, so as to firmly hold the latter in an upright or any desired position.

Communicating with the central chamber 2 is the main valve or gate (broadly designated as 5) and an equalizing-chamber 6, which has any number of check-valves 7 to preclude the escape of liquid impelled therein.

8 indicates the usual air-valve which is employed in this class of apparatus to supply a small quantity of air to the fluid so as to compensate for that absorbed by the water in the equalizing-chamber 6.

Referring now more particularly to Fig. 2 of the drawings, I have indicated in detail the construction of the main valve or gate 5. The casing 1 has a flange 9, with bolt-holes 10 annularly spaced around the same. 11 denotes an additional flange or collar, having bolt-holes 12, similar to the bolt-holes 10 above mentioned and which can be placed in alinement therewith. The collar 11 has an internal neck portion 13, the construction of which will later be more particularly described. Extending through the alined bolt-holes 10 and 12 and projecting upward therefrom are a plurality of bolts or studs 14, which have shoulders 14' and threaded ends 14<sup>2</sup>, upon which are screwed the nuts 15, so as to firmly clamp the collar 11 to the flange 9 and

maintain the studs 14 in rigid relation. 16 indicates a cap which forms the main valve-seat and which is firmly held in position by nuts 17. The nuts 17 are screwed onto the threaded extremities 14<sup>s</sup> of the studs 14, which are passed through alined holes in the cap 16 for this purpose. In this way the cap 16 is rigidly held above and parallel to the neck 13, above referred to. While I consider this method of supporting the cap 16 as a practical and desirable one, I do not desire to be limited or restricted thereto, since other ways of supporting the cap are equally applicable. I will now describe the features of the valve element and the manner in which it is actuated to secure a very sudden closure and a very abrupt cutting off of the liquid fluid. 20 designates the valve element, which I have shown in the form of a tubular shell 21 with integral flanged edges 22 23. The flange 22 is conveniently disposed in a plane normal to the tubular shell 21, while the flange 23 has been shown as having a special form coöperating with the valve-seat, as will be hereinafter stated. 24 indicates a spider, which may be formed of arms integral with the shell 21 and projecting from a central hub 25. The hub 25 has a central hole therein, through which passes a guiding-stem 26, axially projecting from the cap 16. 27 denotes a head at the lower end of the stem 26, by which the downward movement of the valve is limited, and 28 indicate adjusting-nuts upon the stem by which its effective length below the cap is varied so as to regulate the stroke of the valve to any desired degree. The flange 22, previously described, is of a diameter to clear the walls of the chamber 2 by a small space sufficient to permit a slight flow of water therethrough under certain conditions, and at the limit of upward movement of the valve the flange 22 comes into engagement with the neck 13, above mentioned, which constitutes a supplemental valve-seat. 29 denotes a packing-washer or gasket which may be imposed between the parts so as to insure against grains of sand in the fluid from preventing proper closure of the valve. The yielding character of the material used permits it to give slightly and allow room for any foreign particles which may be caught between the valve and seat in closing. In practice I make the opening of the neck 13 of such a diameter as to just clear the outer wall of the shell 21, although this is not essential. 30 indicate a plurality of holes or openings spaced around the neck 13 and located above the flange 22. I regard these holes or openings or some equivalent thereof as an important feature of the invention, since by their use I secure a much more rapid and effective checking of the liquid current than would otherwise be possible. The size, shape, and number of such openings is immaterial, and,

if desired, they may be in the form of recesses or notches on the inside edge of the neck member sufficient to permit a proper flow of liquid therethrough. The cap 16 has its lower face or surface 31 shown as formed in a special way, so as to deflect the stream of fluid which moves thereagainst tangentially and outward, so as it will escape freely. In other words, the liquid current has a passage of substantially uniform section and without any sharp turns or curves therein to traverse in its flow through the valve, which is a common and serious defect of valves now in use. For this purpose I make such surface of a generally conical form, the cone elements being slightly curved, however, so as to give a flaring rather than a true cone outline. It may, however, be otherwise shaped. The axis of the cone corresponds to the axis of the valve member 20, so that the latter is capable of seating against an annular zone or ring upon the conical surface, and in order to make a proper seating engagement I form the flange 23, above mentioned, of a conical or flaring outline, so that it will accurately engage and register with the opposed cone surfaces of the valve-seat. The particular conical shape of the surface 31 of the cap 16 and of the corresponding surface of the valve member 20 presents certain advantages, but is not essential to the effective operation of the device. 32 indicates an annular packing-ring or gasket inset into a recess in the conical face 31, which serves to cushion the impact of the valve and also insure efficient closure in the same way as the washer 29 above described. 34 indicate a plurality of holes or openings which are spaced annularly around the valve-seat 32 and extend outward through the cap.

The operation is as follows: The valve member 20 normally lies at its lowermost position, as shown in Fig. 2, with the hub 25 resting upon the head 27 and a free opening or space between the valve-face 33 and its seat 32. Under these circumstances the liquid from the drive-pipe passes into the chamber 2 and freely outward through the valve, where it overflows and escapes. As the fluid continues to escape its velocity becomes greater and eventually the combined pressure against the flange 22 and the friction through the valve 20 is sufficient to raise the valve, which thereupon moves toward its seat. As the valve moves upward all the liquid above the flange 22 is free to escape through the holes 30, and the valve being of very light construction rapidly closes with great suddenness. As the valve-face 33 approaches its seat the liquid between the opposed surfaces is free to escape through the passages 34, so that at no time in its stroke is the movement of the valve impeded. By reason of the space between the flange 22 and its wall the liquid is

free to pass therethrough until the final instant of closing movement. In practice as the valve approaches its seat the flow through the openings 30 becomes greater until the entire current is suddenly checked by the complete closure of the valve. In this action the resistance of the fluid behind the flange 22 is largely compensated by the pressure of the upward jets through the holes, which impinge against the flange 23 and assist the closing movement of the valve. It will be seen that when the valve is opened the conical face 13 of the cap 16 deflects the liquid from its axial direction, so that it is free to flow away, but practically the entire surface friction of the moving liquid is effective to exert a closing pressure upon the valve member. The latter is thereby impelled with considerable force, and in view of its light construction it acquires a very rapid movement. The impact strains are in the direction of greatest strength in the valve member—namely, along the elements of its cylindrical walls—and the flanges 22 and 23, in addition to their functions previously stated, serve as strengthening-ribs and further insure against breakage of the valve.

It will be observed that the hydraulic pressure at the moment of the closing impact is borne by the interior cylindrical walls of the valve and the bottom face of the valve-seat, and this pressure is therefore applied in a manner best adapted to receive it—namely, in the direction of greatest strength of the valve member—along the arch of its cylindrical outline. A valve-seat can be made as strong and heavy as is necessary, since this part has no movement and it is amply able to resist any hydraulic pressure which is brought against it in the checking action.

What I claim is—

1. In a hydraulic ram, a gate or valve having a main valve-seat, a neck portion constituting a supplemental valve-seat, and a hollow valve member movable within said neck portion and provided with a flange adapted to engage said neck portion when the valve is closed.

2. In a hydraulic ram, a gate or valve having a main valve-seat, a neck portion constituting a supplemental valve-seat, and a hollow valve member movable within said neck portion, the upper end of said valve member cooperating with the main valve-seat and the lower end thereof provided with a flange cooperating with the supplemental valve-seat.

3. In a hydraulic ram, a casing having a chamber with an opening therein, a valve-seat opposite said opening, a hollow valve, provided with a flange, controlling the passage through said opening and vertically movable therein, means for guiding said valve, and a supplemental valve-seat with which the flange on said valve cooperates.

4. In a hydraulic ram, a valve or gate hav-

ing a main valve-seat, a neck portion constituting a supplemental valve-seat, and a hollow valve member movable within said neck portion and provided with a flange adapted to engage the under side of said neck portion when the valve is closed, a passage being provided for the escape of the water above said flange when the valve member is moved to its closing position.

5. In a hydraulic ram, a valve or gate having a valve-seat with a conical face, a valve member comprising a flanged cylindrical shell cooperating therewith and a supplemental seat against which the flange on said shell closes.

6. In a hydraulic ram, a valve or gate having a neck portion constituting a valve-seat, a cylindrical shell having a flange engaging the under side of said neck portion, and a second valve-seat having a conical face engaging said shell.

7. In a hydraulic ram, a gate or valve having a neck portion, a cap supported therefrom and having a valve-seat with a conical face, and a hollow valve member guided by said neck and movable against said seat, and provided with a flange adapted to engage the under side of said neck portion.

8. In a hydraulic ram, a gate or valve having a neck portion, a cap having a conical valve-seat supported therefrom, and a hollow valve having flanges engaging said neck portion and seat.

9. In a hydraulic ram, a valve or gate having a neck portion, studs projecting therefrom, a cap supported by said studs and having a conical valve-seat, and a valve comprising a flanged shell engaging said seat.

10. In a hydraulic ram, a valve or gate having a neck portion, a valve-seat supported axially thereto and having a conical face, and a flanged shell guided to move axially of said neck portion against said valve-seat.

11. In a hydraulic ram, a valve or gate having a neck portion, a flanged shell guided axially thereof, and a valve-seat fixedly supported in alinement with said shell and axial thereof, the flange on said shell engaging said neck portion when the valve is closed.

12. In a hydraulic ram, a casing having a central chamber with an opening therein, a cap supported opposite said opening and having a stem projecting axially therein, and a valve comprising a cylindrical shell guided by said stem, and having a pair of flanges cooperating respectively with the walls of said casing, and said valve-seat.

13. In a hydraulic ram, a valve or gate having a neck portion, a valve-seat supported in alinement therewith, openings being provided through said neck portion and said valve-seat, and a valve comprising a shell having a pair of flanges adapted to engage said neck portion and valve-seat.

14. In a hydraulic ram, a neck portion

having studs radially projecting therefrom, a cap supported from said studs and having a valve-seat upon its under face, a valve member comprising a shell having a pair of flanges engaging said neck portion and seat, said neck portion and seat being provided with openings for the escape of fluid imprisoned thereagainst.

15. In a hydraulic ram, a hollow cylin-

dric valve having a pair of flanges, surfaces engaged by said flanges, and gaskets for cushioning the impact between such parts.

In witness whereof I subscribe my signature in the presence of two witnesses.

ALFRED H. FRANCFORT.

Witnesses:

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No. 846,075.

PATENTED MAR. 5, 1907.

J. D. & W. H. WEAVER.  
HYDRAULIC RAM.

APPLICATION FILED OCT. 3, 1906.

3 SHEETS—SHEET 1.

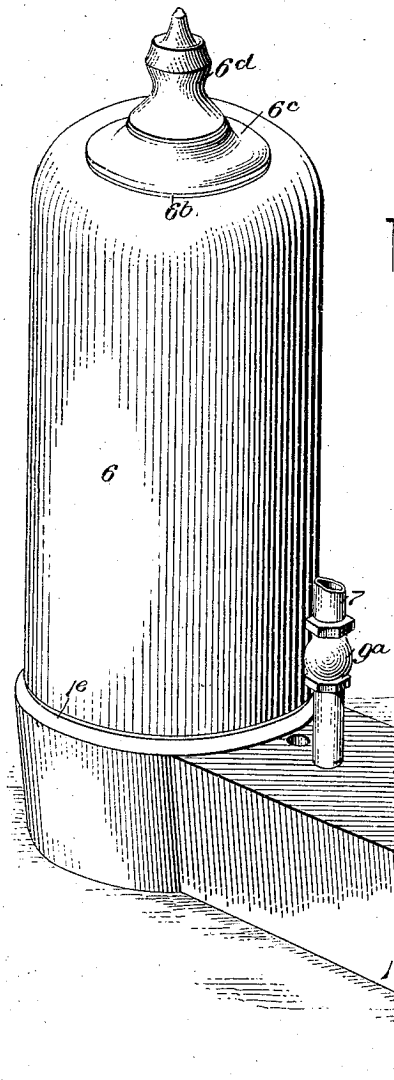


Fig. 1.

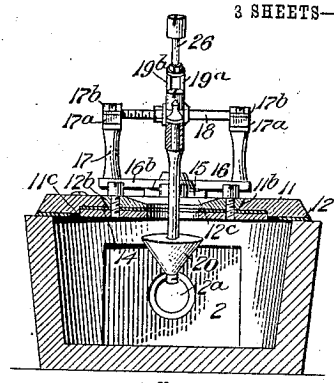


Fig. 4.

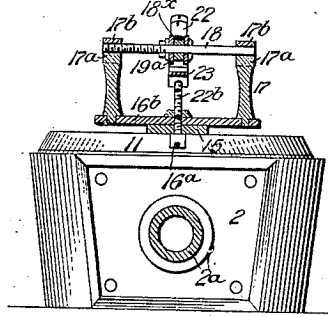


Fig. 5.

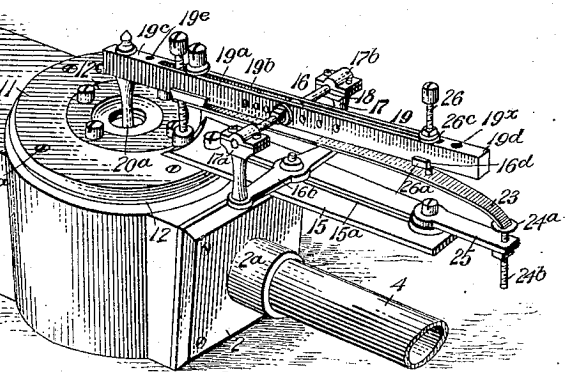
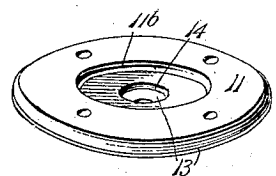


Fig. 6.



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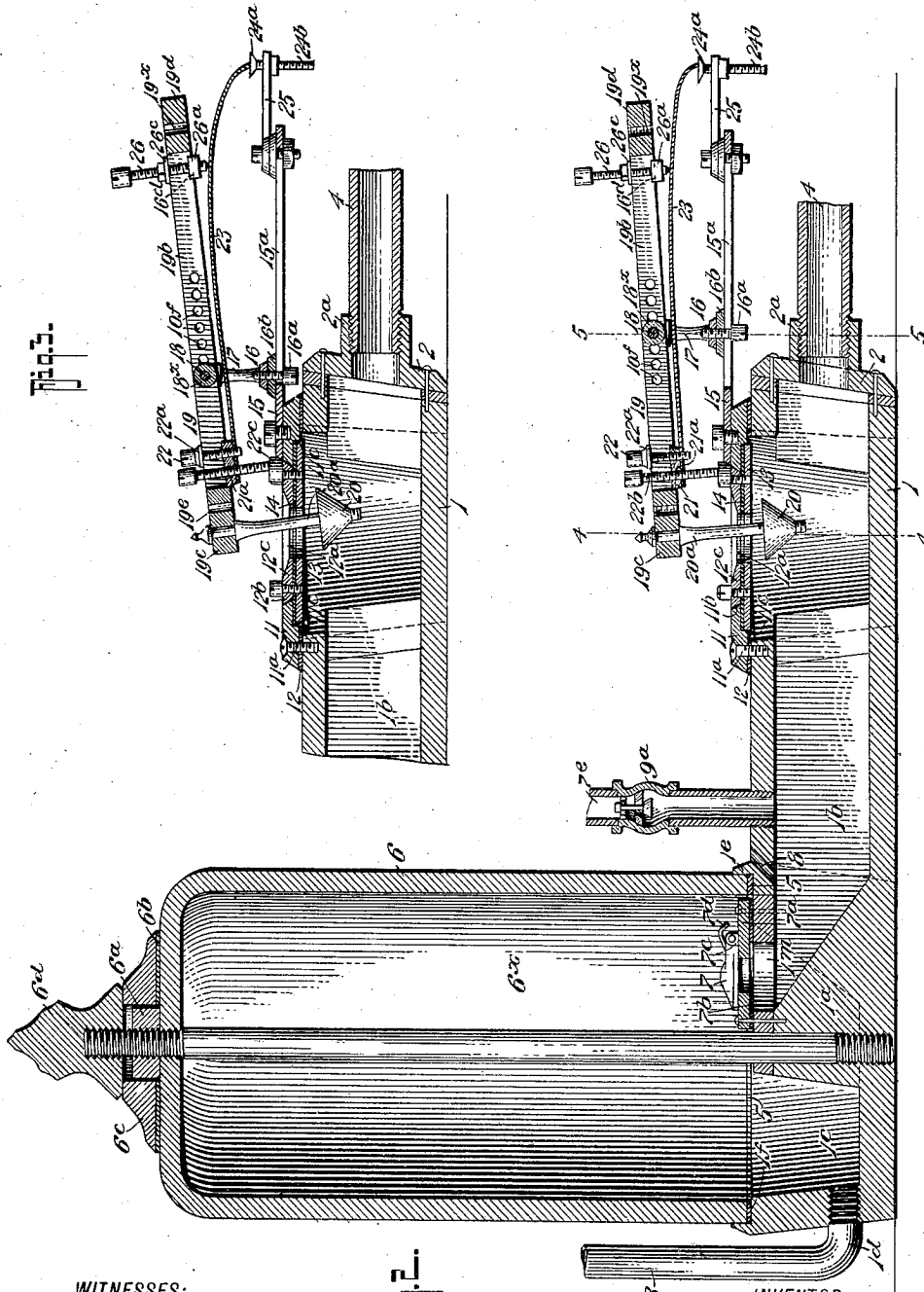
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3 SHEETS—SHEET 3.

Fig. 8.

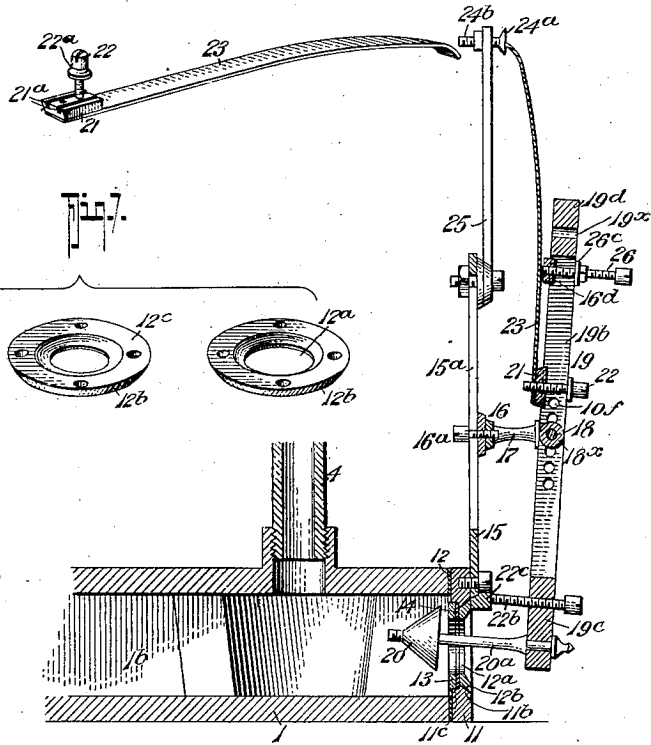


Fig. 7.

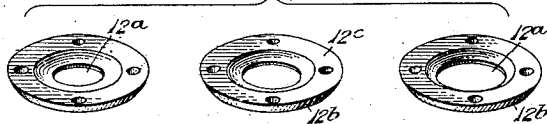


Fig. 9.

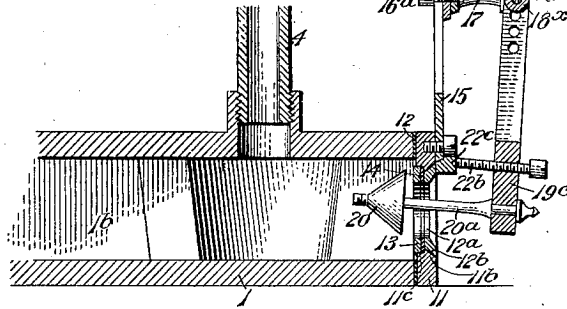
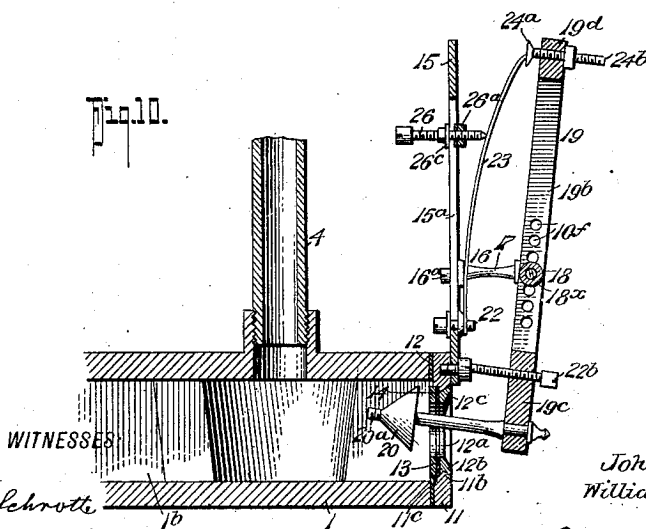


Fig. 10.



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## HYDRAULIC RAM.

No. 846,075.

Specification of Letters Patent.

Patented March 5, 1907.

Application filed October 3, 1906. Serial No. 337,228.

*To all whom it may concern:*

Be it known that we, JOHN D. WEAVER and WILLIAM H. WEAVER, residing at Beavertown, in the county of Snyder and State of Pennsylvania, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

Our invention relates to new and useful improvements in hydraulic rams; and it primarily has for its object to provide a ram of a very simple and effective construction in which the escape-valve mechanism is capable of various adjustments, so that the resistance to the closing movement of the valve may be varied in accordance with the volume, pressure, or head of water to enable a long, short, or intermediate stroke to be obtained.

Our invention also has for its object to provide an improved construction of hydraulic ram in which the escape-valve port can be increased or diminished in area to any predetermined degree, depending upon the volume of water in use.

Again, our invention has for its object to provide an escape-valve and cooperating mechanism therewith of such nature and character as to operate to cause a uniform and continuous operation of the ram, the entire parts being so arranged that they will quickly and effectively serve their intended purposes.

Our invention has for its object to provide an improved means for attaching the air-chamber to the ram-bed so that the same can be removed for cleaning purposes or repairs, as may be desired.

Generically our invention resides in a ram having a water or ram chamber, at one end of which an air-chamber is removably held, the ram chamber or bed having a transverse partition beneath the air-chamber to form an inlet and exit channel to and from the air-chamber, the inlet-channel being controlled by a one-way flap-valve. At the other end of the ram or bed chamber the inlet-pipe is connected, and the ram-chamber is provided with an outlet or escape port, the size of which is controlled by an apertured valve-ring closable by an escape-valve that is mounted on one end of a balance-beam, which in turn is fulcrumed in bearings on a supporting member that is adjustably held on a stationary bracket connected to the ram-bed. The balance-beam is provided with an adjusting-

screw and with a balance-spring and adjusting-screw therefor, the end of the balance-spring cooperating with an adjustable anvil on an extension-bracket secured to the main supporting-bracket, that in turn is secured to the ram-bed.

The principal portion of our invention resides in the escape-valve and its controlling mechanism.

With other objects in view than have been heretofore specified our invention comprises certain novel construction, combination, and arrangement of parts, all of which will be first described in detail and then be specifically pointed out in the appended claims, reference being had to the accompanying drawings, in which—

Figure 1 is a perspective view showing our invention. Fig. 2 is a central vertical longitudinal section thereof, showing the position of the parts when the balance-beam is adjusted to have its fulcrum-shaft midway its ends. Fig. 3 is a detail longitudinal section showing the adjustment of the parts when the balance-beam has its fulcrum-shaft at the nearest point to the valve-rod. Fig. 4 is a cross-section on the line 4 4 of Fig. 2. Fig. 5 is a cross-section on the line 5 5 of Fig. 2, taken through the fulcrum of the balance-beam. Fig. 6 is a detail perspective view of the valve-seat-holding plate of the ram-bed and its attached parts. Fig. 7 is a detail perspective view of a series of valve-port seats, showing different-sized outlet-apertures. Fig. 8 is a detail perspective view of the control-spring carriage and its attached parts. Fig. 9 is a diagrammatic side elevation of a modified form of our invention. Fig. 10 is a similar view of a further modification of our invention.

Referring now to the accompanying drawings, in which like letters and numerals of reference indicate like parts in all of the figures, 1 designates the ram-bed, which is preferably formed of a hollow cast-iron member having its inlet end closed by a cap-plate 2, which is provided with an inlet 2<sup>a</sup> for the operating or feed water. At the end opposite the inlet end the ram-bed 1 has its chamber crossed by a dam or wall 1<sup>a</sup>, which divides the ram-chamber into the main chamber 1<sup>b</sup> and the outlet-chamber 1<sup>c</sup>, which communicates at its bottom with the outlet or education port 1<sup>d</sup>, to which the offtake-pipe 3

communicates. The inlet 2<sup>a</sup> communicates with the supply-pipe 4 from the source of water-supply which operates the ram. The ram-bed has an annular flap 1<sup>e</sup> at its rear and a seat 1<sup>f</sup> to receive a gasket 5, upon which the hollow bell 6, which forms the compression-chamber, is seated. The bell 6 is held on the ram-bed by a rod, which is secured in the dam or wall 1<sup>a</sup> and which projects through the bell top to receive the nut 6<sup>a</sup>, washer 6<sup>b</sup>, and ornamental ring and knob 6<sup>c</sup> and 6<sup>d</sup>, respectively. The chamber portion 1<sup>e</sup> is in free communication with the bell-chamber 6<sup>x</sup>, while the chamber 1<sup>b</sup> communicates with the bell-chamber 6<sup>x</sup> through a valve mechanism which comprises a valve-plate 7<sup>a</sup>, held over an aperture 1<sup>m</sup> in the dam, a gasket 7<sup>b</sup> being interposed between the plate 7<sup>a</sup> and the wall of the dam. The plate 7<sup>a</sup> has ears 7<sup>c</sup>, to which the flap-valve 7 is hinged. The flap-valve 7 has a heel 7<sup>d</sup> to limit its opening movement. The ram-bed casing has an air-chamber aperture 8, through which air passes to the reservoir to supply the air-chamber whenever necessary.

In practice it sometimes occurs that a spring or other source of pure-water supply is adjacent a running stream the power of which would be sufficient to force the spring-water to the point of consumption, while the quantity of water in the spring would be insufficient for the purpose. When such is the case, the impurer water of the spring may be made to force the spring-water to the point of consumption without waste by tapping into the chamber 1<sup>b</sup> of the ram-bed a feed-pipe 7, which communicates with the spring and through which the water from the spring flows into the ram-chamber 1<sup>b</sup> in a constant stream, a check-valve 9<sup>a</sup> being introduced into the pipe 9 to prevent backflow at any time.

The ram-bed has an escape-opening 10, to which is fitted a valve-seat-carrying plate 11. The plate 11 is bolted onto the ram-bed by screw-bolts 11<sup>a</sup>, an intervening washer 12 being provided to effect a water-tight joint. The plate 11 has a valve-seat aperture to receive the valve-seat ring 12, which has a beveled edge 12<sup>b</sup> to seat on the beveled portion 11<sup>b</sup> of the plate 11 and which is screwed onto the annular ring 13, held in a socket portion 11<sup>c</sup> of the plate 11, a washer 14 being provided between the plates 11 and 12 and the ring 13.

In practice the valve-plates 12 are made with different-sized apertures 12<sup>a</sup>, so that a plate having an aperture of the desired size may be used, the size of the aperture depending upon the volume and pressure of the operating-water.

15 designates a slotted arm secured at one end to the plate 11 and having a slot 15<sup>a</sup> to receive the screw-bolts 16<sup>a</sup> of a bearing member 16. The bearing member 16 comprises

a base-plate 16<sup>b</sup>, through which the bolt 16<sup>a</sup> passes. From the outer ends of the plate 16<sup>b</sup> pillars or posts 17 project upwardly and terminate in half-bearings 17<sup>a</sup>, which cooperate with the bearing-caps 17<sup>b</sup>, that are secured thereon. A shaft 18 is held in the post-bearings and passes adjustably through a balance-beam 19, as shown. The beam 19 is formed of a pair of parallel plates 19<sup>a</sup> 19<sup>b</sup>, spaced apart at their ends by spacing-blocks 19<sup>c</sup> 19<sup>d</sup>, the spacing-block 19<sup>c</sup> at the front of the beam having a threaded aperture 19<sup>e</sup>, as indicated, for a purpose presently explained.

The valve-stem 20<sup>a</sup> is secured to the balance-beam 19 at its front end and projects through the valve-aperture in the valve-seat plate 14, the cone-shaped valve 20 being secured upon the stem 20<sup>a</sup>, as indicated.

The balance-beam 19 is provided with a plurality of apertures 10<sup>f</sup> to receive the pivot-bearing shaft 18, before referred to, the shaft 18 being secured to the beam by nut-and-screw connection, as indicated. A spacing-collar 18<sup>x</sup> is provided on the shaft between the parallel bars of the balance-beam 19.

21 designates a sliding carriage that has grooves 21<sup>a</sup> to receive the bars of the balance-beam and which is secured on the balance-beam by a screw-bolt 22, having a collar 22<sup>a</sup> to engage the upper portion of the beam. The carriage 21 has a threaded aperture 21<sup>a</sup> to permit passage of the adjusting-screw 22, which engages the anvil 22<sup>a</sup>, as shown.

To the carriage 21 is secured a leaf-spring 23, whose front end engages with an adjustable anvil-head 24<sup>a</sup> on a screw-rod 24<sup>b</sup>, that is adjustably held in an extension member 25, that is screwed to the bracket 15 by a bolt and nut that passes through the slot therein.

The tension of the leaf-spring 23 is regulated by an adjusting-screw 26, that passes through a sliding carriage 26<sup>a</sup>, which has slot portions 26<sup>b</sup> to receive the bars of the balance-beam 19, a nut-collar 26<sup>a</sup> being provided on the adjusting-screw 26 to lock the same in its adjusted positions. The rear spacing-block of the balance-beam 19 is provided with a threaded aperture 19<sup>x</sup> to receive the adjusting-screw when it is desired not to use the sliding carriage therewith. Likewise the front adjusting-screw can be passed through the aperture 19<sup>e</sup> in the front spacing-block of the balance-beam 19 when it is not desired to pass it through the spring-carriage.

In Fig. 9 we have shown a modified arrangement of our invention in which the valve-controlling mechanism instead of being substantially horizontal may be held into a substantial vertical position, and in this form of our invention we have shown the leaf-spring adjusted into a different position than that shown in Fig. 1 of the drawings, it being un-

derstood that when the spring is arranged for adjustment in the position shown in Fig. 9 that the extension-bracket must be longer than that shown in Fig. 1.

5 In Fig. 10 we have shown a still further modification of our invention in which the leaf-spring 23 is secured to the bracket member 15 and has its free end engaging an anvil bolt member on the balance-beam, the adjusting-screw being slidably mounted on the bracket 15, and the extension-bracket shown in the other figures of the drawing is omitted.

So far as described it will be seen that when connection is made with the spring-water the purer water will fill the space from a point intermediate the escape-valve and the pipe that communicates with the spring to the eduction-pipe 3, while the impure water entering through the pipe 4 will not mingle therewith, and the force or head of both bodies of water is utilized in pumping the spring-water from the spring.

In starting the operation of my invention it will be observed that the two bodies of water entering through the pipes 4 and the pipe 7 will both flow in the direction of the escape-valve; but owing to the superior volume of impure water a comparatively small proportion of the spring-water will escape, but the inflow will be sufficient to prevent the impure water from passing beyond the pipe 7. The usual operation will then follow at regular intervals. The water rushing through the induction-port 2<sup>a</sup> into the chamber 1<sup>b</sup> will cause the escape-valve to close, while the fresh water will rush into the air-chamber through the flap-valve, and there compress the air until all pressure is exhausted, thereby causing dead or still water in the chamber 1<sup>b</sup> between the flap-valve and the escape-valves, since the dead or still water is of no kinetic force. The escape-valve will open when the flap-valve closes, and the compressed air within the compression-chamber will force the water through the eduction-pipe 3 until the compressed air within the compression-chamber returns to normal pressure. The flap-valve will then open and allow a volume of water to flow, thereby causing a repetition of the operation just mentioned.

By reason of the adjustable features of the balance-beam and its bearing the leverage thereof can be varied, and by reason of the adjustable spring-carriage the tension of the leaf-spring can be likewise varied, and hence the operative mechanism of the escape-valve can be readily and easily adjusted to suit the different requirements of the different users, it being understood that the adjustment of the balance-beam will vary with the force of the water and the quantity of the water available and as other conditions may require.

65 From the foregoing description, taken in

connection with the accompanying drawings, it is thought the complete construction, operation, and numerous advantages of our invention will be readily understood by those skilled in the art to which it appertains, and we desire to say that many slight changes in the detail construction, combination, and arrangement of parts may be made without departing from the spirit of the invention or the scope of the appended claims.

What we claim is—

1. An apparatus of the class described, comprising the combination with the ram bed and chamber having an inlet and an eduction port, and the compression-casing having a compression-chamber, of an escape-valve mechanism comprising a valve-seat-carrying plate securable over the escape-aperture of the ram-bed, a bracket projecting therefrom, an adjustable bearing member carried by the bracket, a balance-beam having a shaft mounted in said bearing member, a valve-seat plate secured to said carrying-plate, a valve cooperating therewith and connected with the balance-beam, and means for adjusting the operation of the valve, substantially as shown and described.

2. In a hydraulic ram, the combination with the ram-chamber, the compression-cylinder and the escape-port, of a valve mechanism for controlling said escape-port, said valve mechanism comprising a pivotally-mounted balance-lever, a bearing for said lever and means cooperating with the bearing so that the bearing may be adjusted to various positions to vary the fulcrum of the balance-lever, substantially as shown and described.

3. In a hydraulic ram, the combination with the ram-bed and the compression-cylinder, of an escape-valve mechanism comprising a valve-seat removably held over the escape-aperture in the ram-bed, said valve-seat having an aperture, a valve for closing said seat-aperture, a balance-beam to one end of which said valve is connected, a supporting-bracket, a bearing member adjustably secured thereto, a bearing-shaft for said balance-beam held in said bearing member, and means for adjusting the movement of said balance-beam, substantially as shown and described.

4. In a hydraulic ram, the combination with the ram-bed and the compression-cylinder, of an escape-valve mechanism comprising a valve-seat removably held over the escape-aperture in the ram-bed, said valve-seat having an aperture, a valve for closing said seat-aperture, a balance-beam to one end of which said valve is connected, a supporting-bracket, a bearing member adjustably secured thereto, a bearing-shaft for said balance-beam held in said bearing member, means for adjusting the movement of said balance-beam, and tension devices cooperating

ing with the balance-beam, substantially as shown and described.

5. In a hydraulic ram, the combination with the ram-bed and the compression-cylinder, of an escape-valve mechanism comprising a valve-seat removably held over the escape-aperture in the ram-bed, said valve-seat having an aperture, a valve for closing said seat-aperture, a balance-beam to one end of which said valve is connected, a supporting-bracket, a bearing member adjustably secured thereto, a bearing-shaft for said balance-beam held in said bearing member, means for adjusting the movement of said balance-beam, and adjustable tension devices coöperating with the balance-beam, substantially as shown and described.

6. An apparatus of the class described, comprising the combination with the ram-bed and the compression-cylinder, said ram-bed and said compression-cylinder having valved communication, said ram-bed having induction and eduction ports, and having an escape-port, a valve-seat-carrying member detachably secured over said escape-port, an apertured valve-seat carried by said carrying member and detachably connected thereto, a valve for closing said seat-aperture, said valve having a stem projecting through said seat-aperture, a slotted bracket member secured to said carrying-plate, a supporting member having bearings and adjustably secured to said slotted bracket, a balance-beam having a shaft mounted in said support-bearings, means for adjusting the balance-beam shaft to various positions along the beam to vary its fulcrum, an extension-bracket secured to said first-mentioned bracket, an anvil secured to said extension-bracket, a sliding carriage adjustably secured to said balance-beam, a leaf-spring carried by the sliding carriage to engage the extension-bracket anvil, means for adjusting the tension of said spring, and means for adjusting the stroke of said balance-beam.

7. An apparatus of the class described, comprising the combination with the ram-bed and the compression-cylinder, said ram-bed and said compression-cylinder having valved communication, said ram-bed having induction and eduction ports, and having an escape-port, a valve-seat-carrying member detachably secured over said escape-port, an apertured valve-seat carried by said carrying member and detachably connected thereto, a valve for closing said seat-aperture, said valve having a stem projecting through said seat-aperture, a slotted bracket member secured to said carrying-plate, a supporting member having bearings and adjustably secured to said slotted bracket, a balance-beam having a shaft mounted in said support-bearings, means for adjusting the balance-beam shaft to various positions along the beam to vary its fulcrum, an adjustable extension-

bracket secured to said first-mentioned bracket, an adjustable anvil secured to said adjustable extension-bracket, a sliding carriage adjustably secured to said balance-beam, a leaf-spring carried by the sliding carriage for engaging the adjustable extension-bracket anvil, means for adjusting the tension of said spring, and means for adjusting the stroke of said balance-beam.

8. The combination with the hollow ram-bed having one end open, of a closure-cap for said open end having an induction-port, said ram-bed having a dam near the other end and an eduction-port, a compression-housing removably secured over said dam, and having valve communication with the inlet-chamber of the ram-bed, said ram-bed having an air-admitting aperture, and a supplemental induction-port and an escape-aperture, a valve-seat-carrying plate removably secured over said escape-port, an apertured valve-seat removably carried by said carrying-plate, a valve for coöperating with said valve-seat having a stem projecting through the aperture therein, a balance-beam secured to said valve-stem, a shaft carried by said balance-beam, a bracket projecting from said ram-bed, a support having bearings to receive the balance-beam shaft and adjustably secured to said bracket, a sliding carriage mounted on said balance-beam, a leaf-spring carried by said sliding carriage, a second sliding carriage mounted on said balance-beam, means carried by the second sliding carriage for adjusting the tension of the leaf-spring, means for adjusting the stroke of the balance-beam, and means carried by the bracket for engaging the leaf-spring, substantially as shown and described.

9. The combination with the hollow ram-bed having one end open, of a closure-cap for said open end having an induction-port, said ram-bed having a dam near the other end and an eduction-port, a compression-housing removably secured over said dam, and having valved communication with the inlet-chamber of the ram-bed, said ram-bed having an air-admitting aperture and a supplemental induction-port and an escape-aperture, a valve-seat-carrying plate removably secured over said escape-port, an apertured valve-seat removably carried by said carrying-plate, a valve for coöperating with said valve-seat having a stem projecting through the aperture therein, a balance-beam secured to said valve-stem, a shaft carried by said balance-beam, a bracket projecting from said ram-bed, a support having bearings to receive the balance-beam shaft and adjustably secured to said bracket, a sliding carriage mounted on said balance-beam, a leaf-spring carried by said sliding carriage, a second sliding carriage mounted on said balance-beam, means carried by the second sliding carriage for adjusting the tension of the leaf-spring,

means for adjusting the stroke of the balance-beam, means carried by the bracket for engaging the leaf-spring, said balance-beam comprising a pair of parallel members and spacing-blocks secured between the ends thereof substantially as shown and described.

10. The combination with the hollow ram-bed having one end open, of a closure-cap for said open end having an induction-port, said ram-bed having a dam near the other end and an eduction-port, a compression-housing removably secured over said dam, and having valved communication with the inlet-chamber of the ram-bed, said ram-bed having an air-admitting aperture and a supplemental induction-port and an escape-aperture, a valve-seat-carrying plate removably secured over said escape-port, an apertured valve-seat removably carried by said carrying-plate, a valve for cooperating with said valve-seat having a stem projecting through the aperture therein, a balance-beam secured to said valve-stem, a shaft carried by said balance-beam, a bracket projecting from said ram-bed, a support having bearings to receive the balance-beam shaft and adjustably secured to said bracket, a sliding carriage mounted on said balance-beam, a leaf-spring carried by said sliding carriage, a second sliding carriage mounted on said balance-beam, means carried by the second sliding carriage for adjusting the tension of the leaf-spring, means for adjusting the stroke of the balance-beam, means carried by the bracket for engaging the leaf-spring, said balance-beam comprising a pair of parallel members and spacing-blocks secured between the ends thereof, and said sliding carriages having grooves to receive the parallel members, substantially as shown and described.

11. The combination with the hollow ram-bed having one end open, of a closure-cap for said open end having an induction-port, said ram-bed having a dam near the other end and an eduction-port, a compression-housing removably secured over said dam, and having valved communication with the inlet-chamber of the ram-bed, said ram-bed having an air-admitting aperture and a supplemental induction-port and an escape-aperture, a valve-seat-carrying plate removably secured over said escape-valve, an apertured valve-seat removably carried by said carrying-plate, a valve for cooperating with said valve-seat having a stem projecting through the aperture therein, a balance-beam secured to said valve-stem, a shaft carried by said balance-beam, a bracket projecting from said ram-bed, a support having bearings to receive the balance-beam shaft and adjustably secured to said bracket, a sliding carriage mounted on said balance-beam, a leaf-spring carried by said sliding carriage, a second sliding carriage mounted on said balance-beam, means carried by the second sliding carriage for adjusting the tension of the leaf-spring, means for adjusting the stroke of the balance-beam, means carried by the bracket for engaging the leaf-spring, said balance-beam comprising a pair of parallel members and spacing-blocks secured between the end thereof, said sliding carriages having grooves to receive the parallel members, said spacing-blocks having threaded apertures to receive adjusting-screws substantially as shown and described.

JOHN D. WEAVER.

WILLIAM H. WEAVER.

Witnesses:

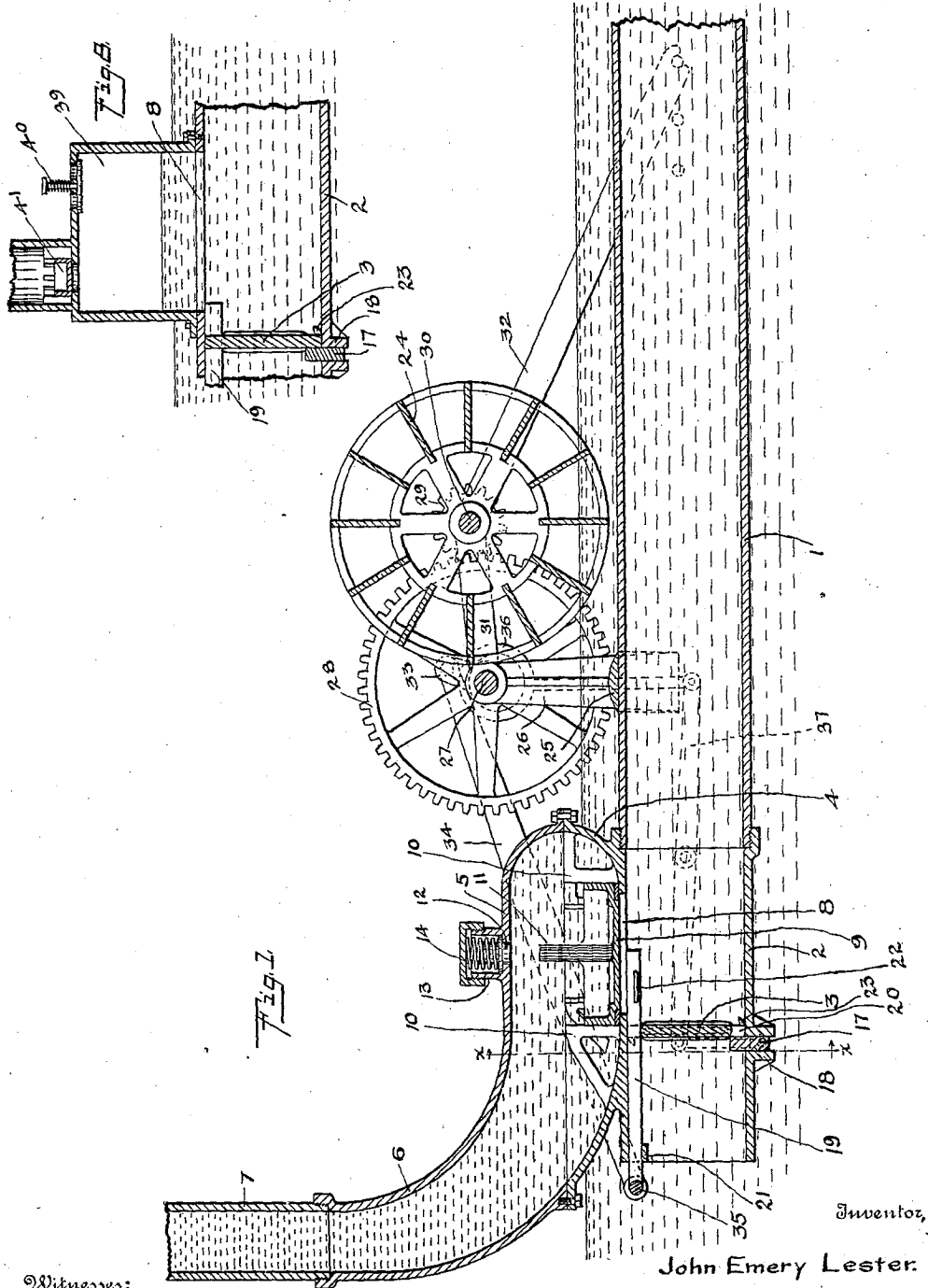
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JOHN A. WETZEL.

No. 868,194.

PATENTED OCT. 15, 1907.

J. E. LESTER.  
HYDRAULIC RAM.  
APPLICATION FILED APR. 9, 1906.

2 SHEETS—SHEET 1.



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*David O. Barnell,*

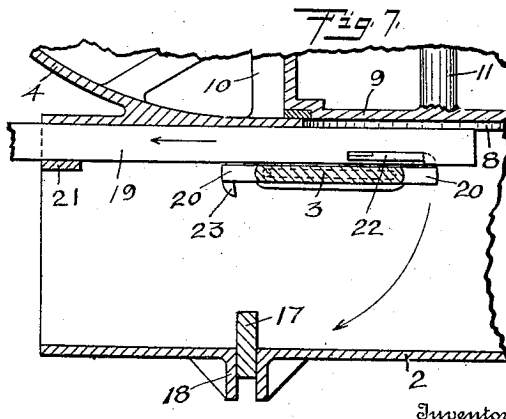
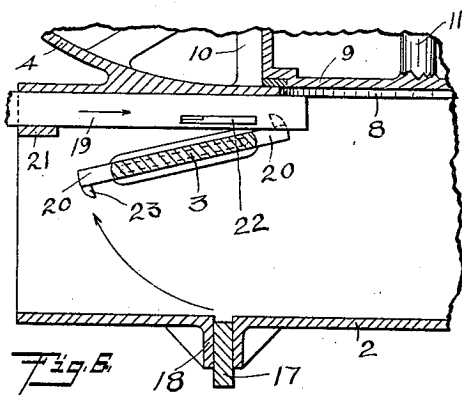
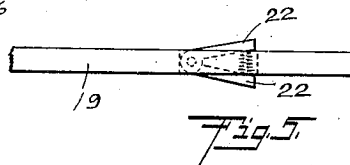
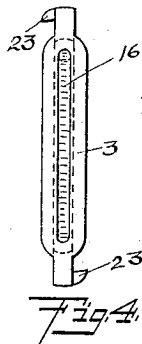
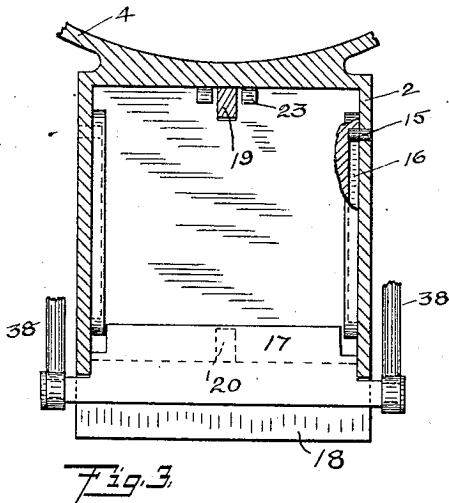
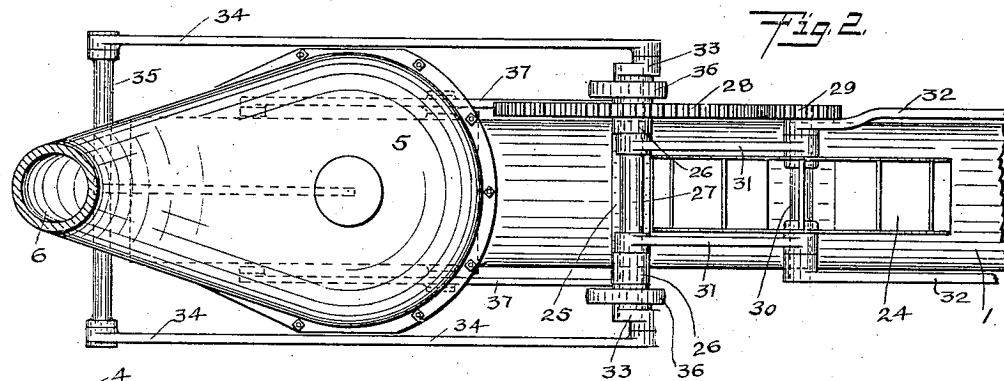
Attorney.

No. 868,194.

PATENTED OCT. 15, 1907.

J. E. LESTER.  
HYDRAULIC RAM.  
APPLICATION FILED APR. 9, 1906.

2 SHEETS—SHEET 2.



Witnesses:

*J. M. Hramok*  
*J. R. Armstrong*

Inventor,  
John Emery Lester

By *David O. Barnell*

Attorney.



# UNITED STATES PATENT OFFICE.

JOHN EMERY LESTER, OF BEATRICE, NEBRASKA.

## HYDRAULIC RAM.

No. 868,194.

Specification of Letters Patent.

Patented Oct. 15, 1907.

Application filed April 9, 1906. Serial No. 310,842.

To all whom it may concern:

Be it known that I, JOHN EMERY LESTER, a citizen of the United States, and a resident of Beatrice, in the county of Gage and State of Nebraska, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

My invention relates to hydraulic rams and it is the object thereof to provide a device of this character suitable for use in running streams of only moderate fall where it is impossible to secure any considerable head of water without damming the stream or running pipes for long distances, and where it is desired to raise large quantities of water for moderate heights, as in irrigation works.

Further objects of my invention are to provide a mechanically-controlled swinging gate for stopping the outlet from the supply pipe, which gate when open will not restrict or impede the flow of water through the pipe; to provide means for adjusting the mechanical controlling means so as to vary the period of discharge of the mechanism; and to provide means by which the mechanism may be used for compressing air where it is not desired for use in raising water.

Constructions embodying my invention are shown in the accompanying drawings in which

Figure 1 is a longitudinal section of the mechanism arranged for elevating water, Fig. 2 is a plan view of the same, Fig. 3 is a detail transverse section on the line  $x-x$  of Fig. 1, Fig. 4 is a detail side elevation of the swinging gate, Fig. 5 is a detail plan view of the reciprocating latch bar, Figs. 6 and 7 are detail longitudinal sections showing the operation of the gate, and Fig. 8 is a detail showing the modification necessary to adapt the mechanism for compressing air.

In the construction shown in Fig. 1 I provide a cylindrical supply pipe 1 which is placed in the stream of running water parallel with the general direction of the current therein. This pipe is so arranged as to be completely submerged and may be carried by floating barges or, in shallow streams, laid on the bed of the stream. The up-stream end of the pipe, shown in the drawings as broken away, is left open but may be covered with screening of coarse mesh to exclude large obstructions and debris therefrom. The length of the pipe is varied according to the diameter thereof and the varying conditions which may be met with in practice. At the lower or down-stream end of the pipe is placed the gate chamber casing 2 which is of rectangular cross section and preferably attached to the pipe 1 by a screwed connection, as shown. Within the gate chamber is hung the swinging gate 3 which is arranged to be alternately opened and closed, as will be explained in detail hereinafter. Above the gate chamber is the valve chamber of which the lower part of the casing, 4, may be made integral with the gate casing, the upper part of the valve chamber casing, 5, being bolted there-

to and having thereon an upwardly extending neck 6 leading to the discharge pipe 7, as shown.

The opening 8 between the gate chamber and valve chamber is normally closed by the check valve 9 which is retained in operative position by the vertical guides 10. When the valve is raised the stem 11 engages the plunger 12 which is slidably retained in the nipple 13 on the casing 5. A spring 14 presses the plunger yieldingly downward and absorbs the shock occasioned by the impact of the valve stem thereon.

In the sides of the casing 2 adjacent the top thereof are the pins 15 which extend into the grooves 16 in the sides of the gate, as shown in Figs. 3 and 4, said pins forming pivots on which the gate hangs, turns and slides. Passing through a slot in the bottom of the casing 2 is the vertically reciprocal gate stop 17, the same being guided by the downwardly extending flanges 18 on the casing. The longitudinally reciprocal latch bar 19 extends along the upper side of the casing 2, passing through one of the notches 20 in the gate 3 and being guided by the loop 21 on the casing, as shown. In a slot adjacent the inner end of the bar are the spring actuated latches 22. The said latches are normally in the laterally extended position shown in Fig. 5 but may be pressed inwardly so as to lie flush with the sides of the bar 19 when passing through the notch 20 during the forward stroke of the latch bar. On each face of the gate adjacent one of the notches 20 are hooks 23 with which the latches 22 are adapted to engage during the rearward stroke of the latch bar.

The reciprocating gate stop and latch bar may be actuated by any suitable mechanism connected therewith and regulated to move the same at the proper relative periods. In the drawings the said devices are shown as actuated by a small current- or paddle-wheel 24 of ordinary construction. On the pipe 1 back of the gate and valve chamber casings is secured the saddle 25 having thereon the standards 26 carrying boxes in which is journaled the crank shaft 27. On said shaft is a gear 28 which meshes with a pinion 29 on the paddle-wheel shaft 30, said shaft being connected to the shaft 27 by the radius bars 31. From the shaft 30 the brace bars 32 extend diagonally rearward and engage pins on the sides of the pipe 1, as indicated by dotted lines in Fig. 1, several of such pins being provided so that by engaging the bars therewith the paddle-wheel may be raised or lowered so as to dip more or less in the water. On the ends of the shaft 27 are the cranks 33 from which the connecting rods 34 extend forward to the cross head 35 on the latch bar. Adjacent the cranks 33 are the eccentrics 36 of which the rods connect with the rear ends of the walking beams 37 which are fulcrumed on the sides of the casing 2 and have their front ends connected with the gate stop by the rods 38, as shown. The latch bar and gate stop are thus operated synchronously and at a rate proportional

to the speed of the current in which the ram is placed, the wheel 24 being adjusted by means of the brace bars 32 to dip in the water an amount sufficient to cause the actuation of the devices at the most advantageous speed.

5 The operation of the gate will be obvious by reference to Figs. 6 and 7. At the downward stroke of the gate stop the lower end of the gate is released so that the flow of water from the supply pipe swings the same forward as shown and indicated by the arrow in Fig. 6.  
 10 The latch bar then beginning the rearward stroke, the latches 22 engage the hooks 23, raise the gate to horizontal position, and push the same back to the position shown in Fig. 7. At the beginning of the forward stroke of the latch bar the latches release the hooks on  
 15 the gate which then tends by its own weight to fall to the vertical position. A flow of water having been established through the gate chamber during the time that the gate was open and being pushed back by the latch bar, the current through the chamber has a further  
 20 tendency to close the gate which, swinging forward with the current, does not check the same until reaching the vertical position and striking the stop 17 which meanwhile has been raised to the position shown in Fig. 7. The flow of water through the supply pipe  
 25 and gate chamber being thus suddenly stopped, the momentum of the water therein causes a pressure in the gate chamber sufficient to raise the check valve 9 and force a quantity of water into the valve chamber and up through the discharge pipe 7. As the gate is turned  
 30 over at each operation thereof the stop 17 must extend high enough to cover the lower of the notches 20 and prevent leakage of water through the same when the gate is closed, the upper of the notches 20 being always closed by the latch bar.  
 35 It may be noted that owing to the rectangular form of the gate chamber its sectional area is greater than that of the supply pipe, the diameter of which is equal to the side of the chamber. This increased area in the  
 40 gate chamber compensates for the slight reduction of flow which would otherwise be caused by the gate when open and in horizontal position, and a flow of water may be established through the pipe and chamber at a velocity equal to that of the current outside the pipe.  
 45 Should it be desired to use the ram for compressing air, an air chamber 39 is provided above the opening 8 in the gate chamber, the check valve 9 being omitted and the air chamber being provided with an inlet valve 40 opening to atmosphere and an outlet valve 41  
 50 opening into a discharge pipe, as shown in Fig. 8. The operation in compressing air will be obvious, the water alternately flowing up into the air chamber to force the contents thereof out through the valve 41, and falling back to the level of the stream when the gate 3  
 55 is opened, thus admitting another charge of air into the chamber 39 through the inlet valve 40.

Now, having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a hydraulic ram, a supply pipe, a waste outlet, a pivotally hung gate adapted to close said outlet, said gate when released being openable toward the outlet by pressure of water from the supply pipe, and motor-controlled mechanism for releasing the gate and for returning the same to a position such that it may be closed by movement toward the outlet. 60
2. In a hydraulic ram, a supply pipe, a waste outlet, a pivotally hung gate adapted to close said outlet, a releasable stop limiting movement of the gate toward the outlet, said gate when released being openable toward the outlet by pressure of water from the supply pipe, a discharge pipe, a valved connection between the same and the supply pipe, and motor-controlled means for releasing the gate stop and for returning the gate to a position such that it may close by swinging against the stop and toward the outlet. 65
3. In a hydraulic ram, a substantially horizontal supply pipe, a chamber connected therewith and having an outlet in horizontal alinement with the same, a gate for closing said outlet, said gate having grooves in the sides thereof, pins entering said grooves and forming pivots on which the gate may turn and slide, a reciprocal stop for engaging the lower part of the gate to limit movement thereof toward the outlet, and mechanism for turning the gate to horizontal position, sliding the same away from the outlet, releasing the same to permit it to swing against the stop and releasing the stop to permit the gate to swing past the same toward the outlet. 70
4. In a hydraulic ram, a substantially horizontal supply pipe, a chamber connected therewith and having an outlet in horizontal alinement with the same, a gate pivotally hung within the chamber and adapted to close the outlet thereto, a vertically reciprocal stop for limiting the swing of the gate toward the outlet, a horizontally reciprocal latch bar for turning the gate to open position and sliding the same to a position such that a current of water through the chamber will tend to close the gate, and mechanism for synchronously operating the gate stop and latch bar. 75
5. A hydraulic ram comprising a supply pipe submerged in a running stream of water substantially parallel with the general direction of the current therein, a discharge pipe, a valved connection between the same and the supply pipe, a waste outlet, a gate arranged adjacent said outlet, said gate being hung to permit a longitudinal sliding motion in one direction and a swinging motion in the opposite direction, and a releasable stop for interrupting the swinging motion at such position that the gate will close the said outlet. 80
6. In a hydraulic ram, a supply pipe, a waste outlet, a chamber adjacent said outlet, a gate disposed within said chamber, said gate being hung to permit a swinging motion thereof from the supply pipe toward the waste outlet, the gate during said swinging motion passing a position at which it closes the outlet, a releasable stop for interrupting the swing of the gate at such closed position, and means for returning the gate to its initial position by a longitudinal sliding motion. 85

In testimony whereof I have hereunto subscribed my name in the presence of two witnesses.

JOHN EMERY LESTER.

Witnesses:

D. O. BARNELL,  
 J. L. ARMSTRONG.

No. 881,314.

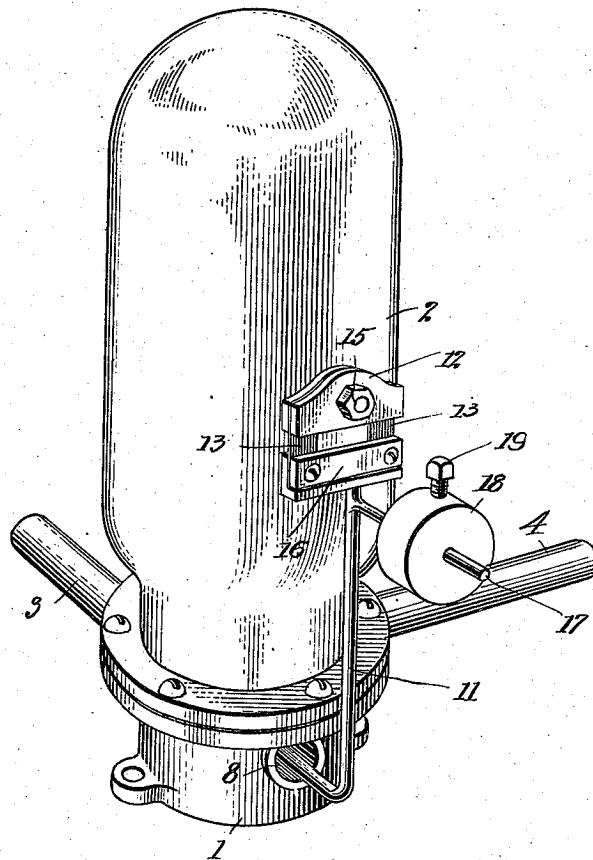
PATENTED MAR. 10, 1908.

A. H. FRANCFORT.  
HYDRAULIC RAM.

APPLICATION FILED FEB. 26, 1907.

2 SHEETS—SHEET 1.

Fig. 1



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*Waldo M. Chapin*

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By his Attorneys  
*Rosenbaum & Stockbridge*

No. 881,314.

PATENTED MAR. 10, 1908.

A. H. FRANCFORT  
HYDRAULIC RAM.

APPLICATION FILED FEB. 26, 1907.

2 SHEETS—SHEET 2.

Fig. 2.

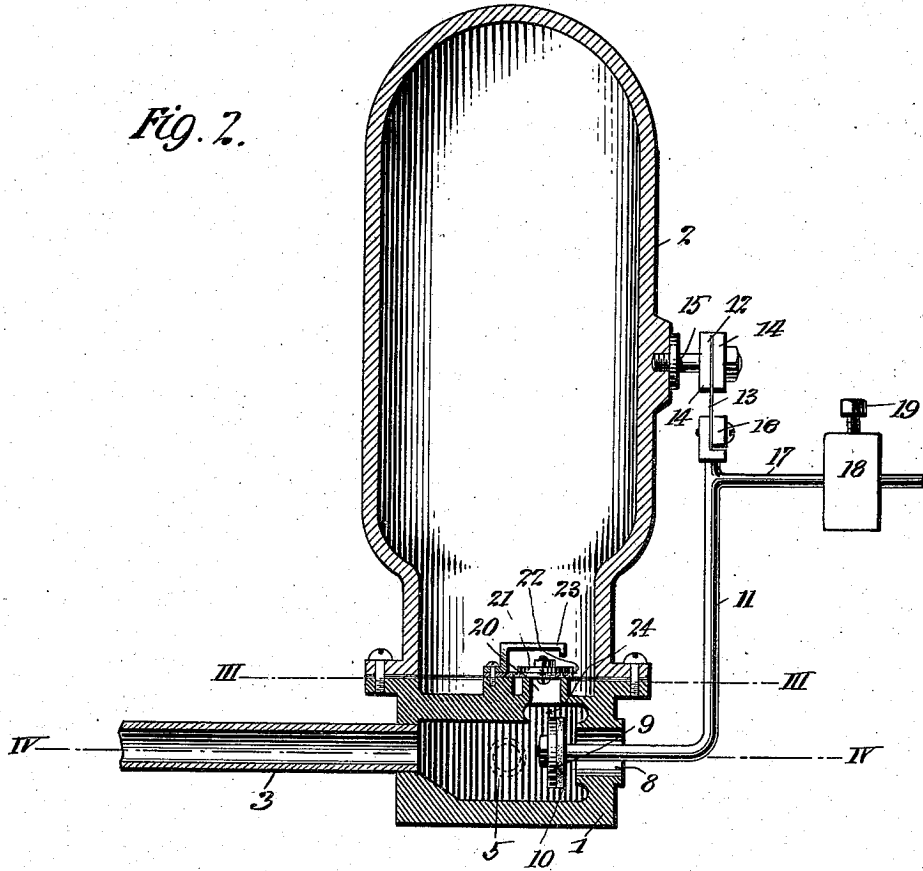


Fig. 3.

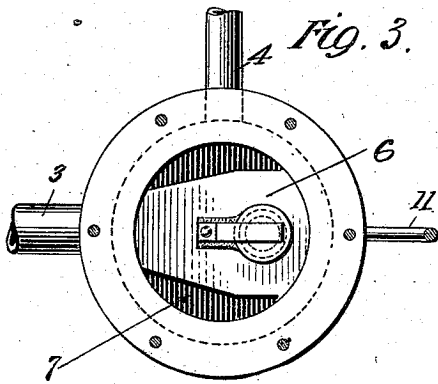
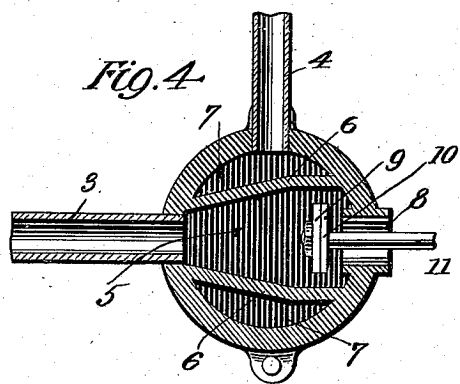


Fig. 4.



Witnesses:  
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By *his Attorneys*  
*Rosenbaum & Stockbridge*

# UNITED STATES PATENT OFFICE.

ALFRED H. FRANCFORT, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO NIAGARA HYDRAULIC ENGINE COMPANY, A CORPORATION OF PENNSYLVANIA.

## HYDRAULIC RAM.

No. 881,314.

Specification of Letters Patent.

Patented March 10, 1908.

Application filed February 26, 1907. Serial No. 359,421.

*To all whom it may concern:*

Be it known that I, ALFRED H. FRANCFORT, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a full, clear, and exact description.

My invention relates to hydraulic rams, and particularly to several features of improvement therein by which it is rendered more efficient in operation, and more simple and durable in construction.

In hydraulic rams the fluid stream, the pressure of which it is desired to increase, is led through a drive pipe into a chamber having different outlet valves. These valves operate to intermittently check the flow of fluid in the drive pipe so as to obtain and make use of an increased pressure arising from the momentum of the fluid. These principles are well known and of universal application in all rams.

The present invention relates to certain improvements in the valve mechanism by which the flow of the fluid is checked more abruptly in the drive pipe, and certain other advantages obtained, which will be later more particularly pointed out.

With these objects in view the invention consists in the features of construction and combination hereinafter set forth and claimed.

In the drawings: Figure 1 is a perspective view showing the general appearance of a hydraulic ram embodying the principles of my invention; Fig. 2 is a sectional view of the same; Fig. 3 is a view of the line III—III of Fig. 2, looking downward; and Fig. 4 is a section on the line IV—IV of Fig. 2.

In addition to the general principles above outlined relating to the operation and efficiency and which I desire to improve, there are certain practical considerations in the use of hydraulic rams which give rise to annoyance and trouble. One such important practical consideration is the fact that the hydraulic ram is almost constantly in operation and is generally located at a river bank, or at some place where expert supervision is not given, so that the movable parts generally become badly worn at the pivots and journal bearings. When this occurs, the ram does not work properly and the bearings

have to be renewed. In carrying out the present invention I aim to avoid the use of journals or bearings which require attention or lubrication. There is a further practical feature to be obtained in all hydraulic rams, and this is the introduction of a small body of air into the pressure chamber along with the water. A body of air is required in the pressure chamber to keep the pressure equalized, and unless this air is constantly replenished in the manner above mentioned, it will be soon carried away by the fluid which issues from the chamber. In some cases the air has been supplied through a small auxiliary valve, but in the present case I so form the valves and parts that it is supplied in the normal operation of the ram without any special valve.

Referring to the drawings in which like parts are designated by the same reference sign, 1 indicates the base, and 2 the pressure chamber of a hydraulic ram. The fluid is admitted through the drive pipe 3, and finally issues through the delivery pipe 4, to the point where it is to be used. The base 1 contains all of the valve mechanism for controlling the action, and it will be observed that this base is located directly beneath, and in a sense forms an extension of, the pressure chamber 2. I consider this arrangement as an important feature of the invention in that it secures a very compact arrangement of the parts, and certain other points of advantage which will later more particularly appear. The base 1 of the ram has an internal chamber 5, which is of considerably less size than the base, being narrow and elongated, and in the line of the drive pipe 3. This central chamber 5 is conveniently constructed in this way by having a web or partition 6, in the base which surrounds such chamber 5. In this way there are left two cavities 7, at either side of the chamber 5, and one of these cavities 7 is utilized as a passage or outlet connection to the delivery pipe 4. Also directly in line with the drive pipe 3 there is an opening 8, constituting the overflow valve. 9 designates the valve member therefor which is a metal disk or plate, having a washer 10. This valve member is fixed to the lower end of an angularly bent rod 11, which projects through the opening 8, and is flexibly hung to a part 12, of the fixed frame by flexible

strips 13, of resilient metal. The fixed part 12 of the frame is conveniently made of a pair of metal blocks 14, rigidly clamped together, and to the pressure chamber 2 by the stud bolts 15. The strips 13 of resilient metal are likewise anchored to the bent arm 11 by a suitable clamp or clamps 16. There is an extension 17 of the bent arm 11 adapted to receive a weight 18. This weight is adjustable on the extension 17 by means of a set screw 19.

The upper surface of the partition or wall 6 has a check valve 20, of any convenient form, for example, comprising a metallic disk 21, secured to a leather facing 22, and capable of slight vertical movement, limited by the overhang stop 23. It is evident that this valve allows fluid to pass up into the pressure chamber 2 whenever the pressure in the chamber 5 exceeds a certain amount.

I provide a special cavity directly beneath the valve 20, and I further so arrange the parts that the valve member 9 works partly in this cavity in its movement. The cavity is formed by coring out the metal of the base 1, as clearly shown at 24. And this cored-out portion is directly above the opening of the valve 8.

The operation is as follows: Under normal conditions the valve 9 is held open by the weight 18, and when fluid flows inward through the drive pipe 3, it passes into the chamber 5, and freely out through the opening 8. The path of the flow is therefore straight throughout, and the fluid quickly increases its velocity. After a very short interval of time the velocity is so great that the fluid stream impinging against the valve member 9 overcomes the gravity of the weight 18 and closes this valve. The pressure immediately mounts up in the chamber 5, due to the momentum of the fluid in the drive pipe, and becomes great enough to raise the valve member 21, and pass into the pressure chamber 2. When the flow is arrested, and its pressure has been utilized in this way, the valve member 21 closes, and the valve member 9 opens, and this cycle of movement is indefinitely repeated. All the movement of the valve member 9 takes place through the flexibility of the resilient metal strips 13. As these are not deformed beyond their elastic limit in the action,

there is no wear, and this part of the mechanism lasts indefinitely.

The functions of the cavity 24 in supplying a small quantity of air at each actuation of the ram, are as follows: Whenever the valve 9 opens under the action of the weight 18, it creates a certain suction in such act, so that air enters from the outside and bubbles upward where it is immediately received and collected in said cavity 24. At this point it is in a position to be immediately impelled into the pressure chamber 2 with the next fluid charge. It is found that the amount of air admitted in this way is sufficient for all practical purposes in the operation of the ram. In some cases the pocket or cavity 24 may be omitted and still secure the above function to a certain extent. This is due to the arrangement of having the pressure chamber directly above the overflow valve. Both the pressure chamber and the check valve thereof are in intimate proximity and immediately above the valve member 9 of the overflow orifice, so that the bubbles of air which find their way inward through the overflow pass immediately upward into the pressure chamber and are not again expelled through the overflow orifice, as in the usual construction of hydraulic rams.

What I claim, is:—

A hydraulic ram having a base with an interior chamber having a valve opening and a flat inside upper face, a valve member within the chamber and comprising a disk cooperating with said opening and disposed in a substantially vertical plane perpendicular to said flat face, said chamber having a pocket or cavity 24 in said flat upper face directly above the valve member and into which said valve member projects slightly, said cavity or pocket having a larger diameter at its interior than at its point of communication with said chamber, and a pressure chamber communicating with said cavity or pocket at the upper side thereof, said communication being the only one provided between said chambers.

In witness whereof, I subscribe my signature, in the presence of two witnesses.

ALFRED H. FRANCFORT.

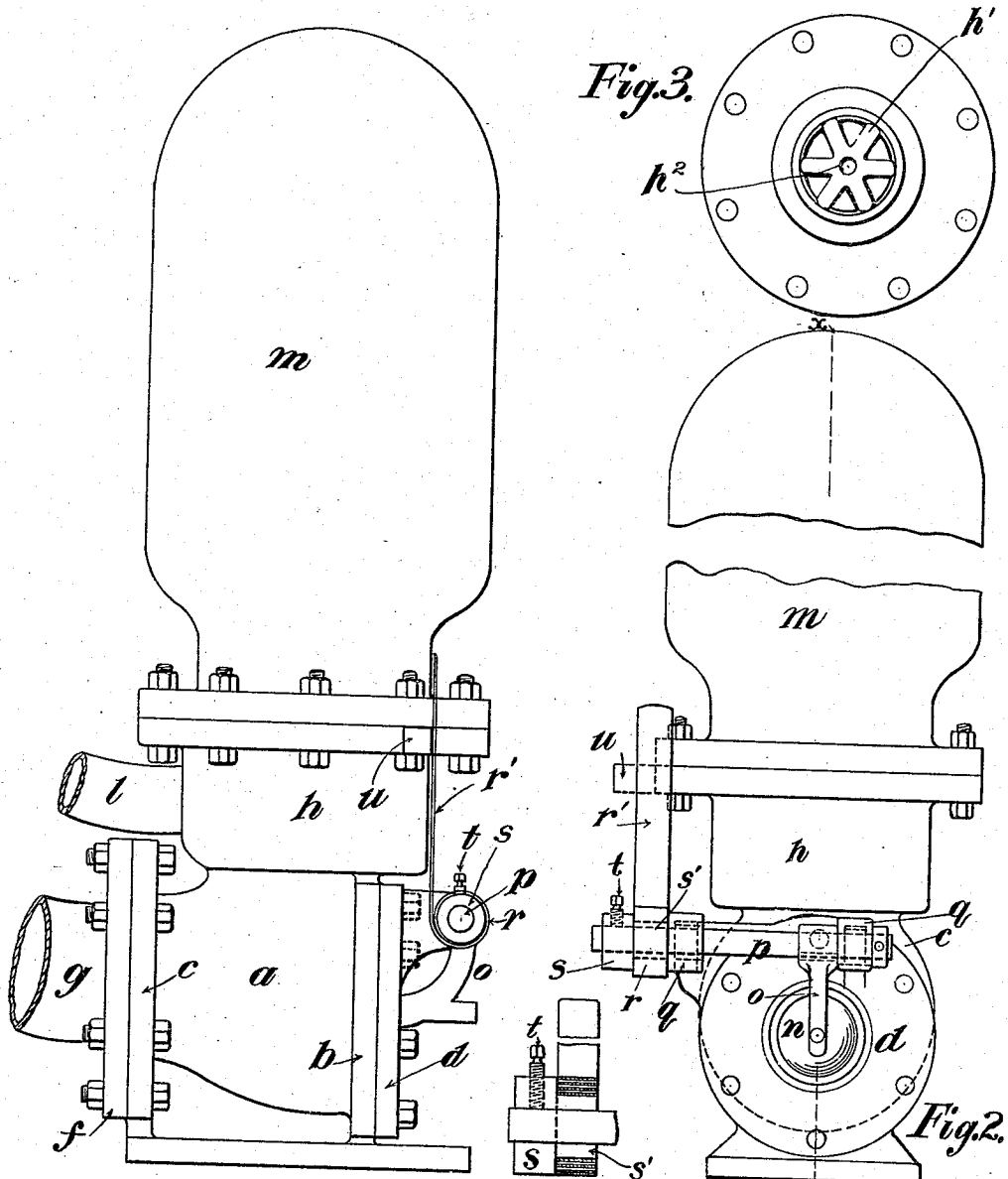
Witnesses:

WALDO M. CHAPIN,  
MAY BIRD.

P. E. ALGER.  
 HYDRAULIC RAM.  
 APPLICATION FILED APR. 13, 1907.

933,283.

Patented Sept. 7, 1909.  
 3 SHEETS—SHEET 1.



WITNESSES: *Fig. 1.*

*A. W. Gerking*  
*Cecil Long*

*Fig. 4.*

INVENTOR

*Philip E. Alger*  
 by *J. Heister*  
 ATTY.





P. E. ALGER.  
HYDRAULIC RAM.  
APPLICATION FILED APR. 13, 1907.

933,283.

Patented Sept. 7, 1909.  
3 SHEETS—SHEET 3.

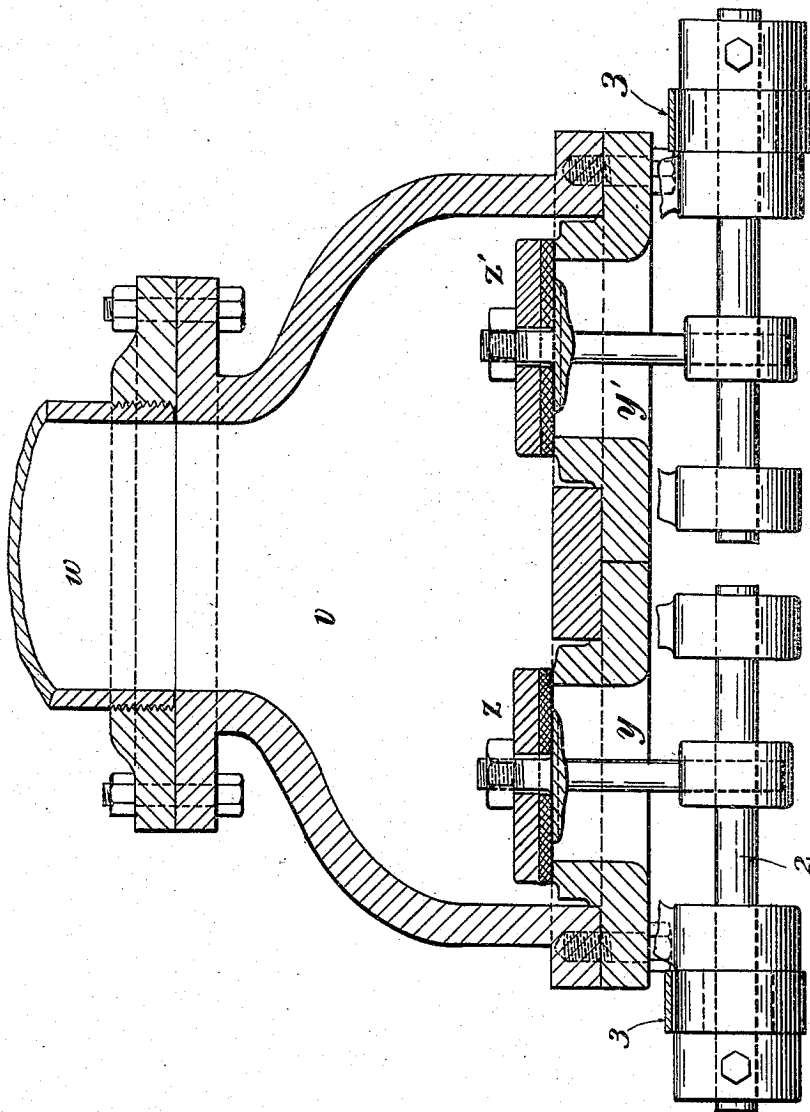


Fig. 7.

WITNESSES:

A. W. Gerking  
Cecil Long

INVENTOR:

Philip E. Alger  
by J. J. Greider

ATT'Y.

# UNITED STATES PATENT OFFICE.

PHILIP E. ALGER, OF PORTLAND, OREGON, ASSIGNOR TO COLUMBIA ENGINEERING WORKS, OF PORTLAND, OREGON, A CORPORATION OF OREGON.

## HYDRAULIC RAM.

933,283.

Specification of Letters Patent.

Patented Sept. 7, 1909.

Application filed April 13, 1907. Serial No. 368,116.

To all whom it may concern:

Be it known that I, PHILIP E. ALGER, a citizen of the United States, and a resident of Portland, in the county of Multnomah and State of Oregon, have invented a new and useful Improvement in Hydraulic Rams, of which the following is a specification, reference being had to the accompanying drawings as constituting a part thereof.

This invention relates to that type of hydraulic ram heretofore invented by Frederick Hesse, and has for its object to overcome certain defects which were discovered in the practical operation of the latter, namely: The waste-valve in the ram referred to was opened during the periods of regurgitation by the force generated by an oscillating pendulum weight, but it was found that the pendulum would periodically be out of synchronism with the cyclic motion of the waste-valve, whereupon the ram could be brought to a standstill and it was necessary for the same to be started over. To prevent this condition, I have eliminated the pendulum mechanism and substituted therefor a spring by which the waste-valve is dependably operated, and I provide also means for adjusting the tension of the spring, the whole device being arranged and cooperating as hereinafter fully described.

In order to readily understand the purpose of my improvements, I have given full illustrations of the construction of the ram referred to.

In the drawings, Figure 1 is a side elevation of my hydraulic ram; Fig. 2 is a front view thereof, drawn on a somewhat reduced scale; Fig. 3 is a plan of the valve-seat of the delivery valve; Figs. 4 and 5 are details of construction, more fully described in the body of the specification; Fig. 6 is a vertical longitudinal section taken approximately on a line  $x-x$  of Fig. 2; and Fig. 7 is a plan section of a modification of my ram, adapting the same to be used in connection with a larger drive-pipe.

The general construction of the ram referred to may be more readily observed from Fig. 6. It comprises a short body,  $a$ , made with flanges  $b$ ,  $c$ , to the former of which is bolted a waste-valve seat  $d$ , having a central opening  $e$ , and to the flange  $c$  is bolted a companion flange  $f$ , in which is inserted the drive-pipe  $g$ . The upper part of the body is made with a delivery-valve opening con-

trolled by a valve  $j$ , and has integrally formed thereon a delivery chamber  $h$ , having an outlet  $k$ , in which is inserted the delivery pipe  $l$ . On the chamber  $h$  is mounted an air chamber  $m$ . The delivery pipe  $j$  rests on a gridiron web  $h'$  made with a central eye  $h^2$  (see Fig. 3) through which extends a bolt-like valve-stem  $j'$ , on which is a coil-spring  $j^2$ , the tension of which is adjustable by a nut  $j^3$  to regulate the degree of resistance of the valve  $j$ .

The waste-valve opening  $e$  is controlled by a disk valve  $n$ , which is rigidly connected by its stem  $o$  to a spindle  $p$ , journaled in bearings  $q$ ,  $q$ , integral parts of the valve-seat casting  $d$ . Excepting the means of periodically opening the waste-valve, the foregoing description represents the ram prior to my improvement thereof. To accomplish the purpose of my improvement, the waste-valve  $n$  is controlled by a spring  $r$ , fastened to a boss  $s'$  of the collar  $s$  (see sections Figs. 4 and 5), and the collar  $s$  is adjustably fixed on the spindle  $p$  by a set-screw  $t$ . The spring  $r$  terminates in a straight leaf  $r'$ , which bears against a lug  $u$  or other fixed object on the exterior of the delivery chamber  $h$ . To aid the reading of Fig. 6 the position of the spring is therein indicated in dotted outline.

The function of the spring  $r$  is to open the waste-valve automatically as soon as the pressure on the interior face of the valve disk will permit it, and by moving the collar  $s$  circumferentially on the spindle  $p$ , the tension of the spring  $r$  may be increased or diminished to suit the conditions present. When a large volume of water is available, the tension of the spring  $r$  is increased to give the waste-valve  $n$  a longer interval of opening, thus causing the flow of drive water to reach its maximum speed before closing the valve. This condition permits a maximum quantity of water to be lifted and discharged through the delivery pipe  $j$ , and is the proper adjustment of the ram when it is desired to lift a maximum quantity of water without regard to economy in the waste of the drive water. On the other hand, when only a small volume of water is available, the tension of the spring  $r$  is to be diminished so as to make the opening of the waste-valve as short and quick as possible, this reduces the duration of the flow and the resultant friction of water in the drive-pipe,

causing a greater number of impulses in a given unit of time. By this adjustment a large quantity of water is lifted in proportion to the quantity wasted. The adjustment of the spring  $r$  controlling the waste-valve is also an essential ingredient of my invention to enable the adjustment of the ram to meet the conditions of a high or low head of water; that is to say, when having to deal with a high head the force of the spring  $r$  would have to be increased, and in case of a low head the power of the spring would have to be correspondingly diminished.

The parts described cooperate as follows: Supposing the drive-water to have filled the ram-body and to be in a state of equilibrium and rest, if the waste-valve  $n$  be then opened by pushing it back with sufficient force to overcome the pressure against its interior, the water will begin to flow out of the waste-valve  $e$  with increasing velocity. The delivery-valve  $j$  will remain closed during the flow of water through the outlet  $e$ . When the force of impact against the waste-valve is sufficient to overcome the tension of the spring  $r$  and the waste-valve is forced against its seat, the energy contained in the moving column of water will be directed against the delivery-valve  $j$ , opening the latter and forcing the water into the delivery-chamber  $h$ , and the superimposed air-chamber  $m$ , compressing the air in the latter. And as soon as equilibrium is established above and below the discharge valve  $j$ , the compressed air in the air-chamber  $m$  will push back the water and close the valve  $j$ , as apparent. The water which escapes downward through the delivery-valve  $j$  before the closing thereof, imparts a backward or regurgitating movement to the water in the ram-body and drive-pipe, sufficient to generate a partial vacuum behind the waste-valve  $n$ , and by so doing relieves the interior pressure against the latter and permits the spring  $r$  to act and open the waste-valve, whereupon the cycle of motion is resumed, and the action of the waste-valve becomes thenceforth automatic. The partial vertical suspension of the waste-valve opposes only a fraction of its weight against the action of the spring  $r$ , and this arrangement enables the use of a comparatively low tension spring, which in turn minimizes the resistance to the force of effluent water.

When it is desired to build a ram of larger size embodying my improvements, I modify the construction of the ram-body, as shown, for example, in Fig. 7.

The theory of such modification is that the capacity of the waste-valve passage is proportionate to its diameter and the capacity of the drive-pipe is as the square of its diameter, thus in a large sized ram, the lift of the waste-valve must be greater to afford the same escape for the waste-water; but a greater lift causes a correspondingly greater impact, a fact which generally prevents the use of rams of large diameter. In my modification, the body  $v$  is connected to a large drive-pipe  $w$ , and is expanded, so as to allow the drive-water to pass through a plurality of waste-valve openings,  $y, y'$ , individually of smaller diameter than required but aggregating the same area of passage as would be afforded by a single waste-valve of the required diameter. The waste-valve disks  $z, z'$ , shown in Fig. 7, are suspended from a spindle 2, arranged and journaled the same as the spindle  $p$  in the smaller type, and the spindle of such disk-valves is controlled by one or more springs 3, the parts operating substantially as above described of the single waste-valve.

The throat  $i$  of the delivery-valve constitutes a receptacle for holding part of the air admitted during each opening of the waste-valve, and which air enters from the throat into the air-chamber upon each opening of the delivery-valve, a snifter-valve not being required in this type of ram.

I claim:

In a hydraulic ram, the combination with a body having a vertical enlargement and a waste-outlet in the lower part thereof, of a valve seat secured to said outlet, hinged lugs projecting outward from the upper part of said valve seat, a spindle supported by said lugs, a waste-valve provided with an outwardly projecting curved arm by which it is connected to said spindle, a set collar on said spindle, a leaf spring, one end of which is affixed to and coiled on said set collar, and the upper end projecting outward, and a lug on the body, against which the projecting end of said spring bears.

PHILIP E. ALGER.

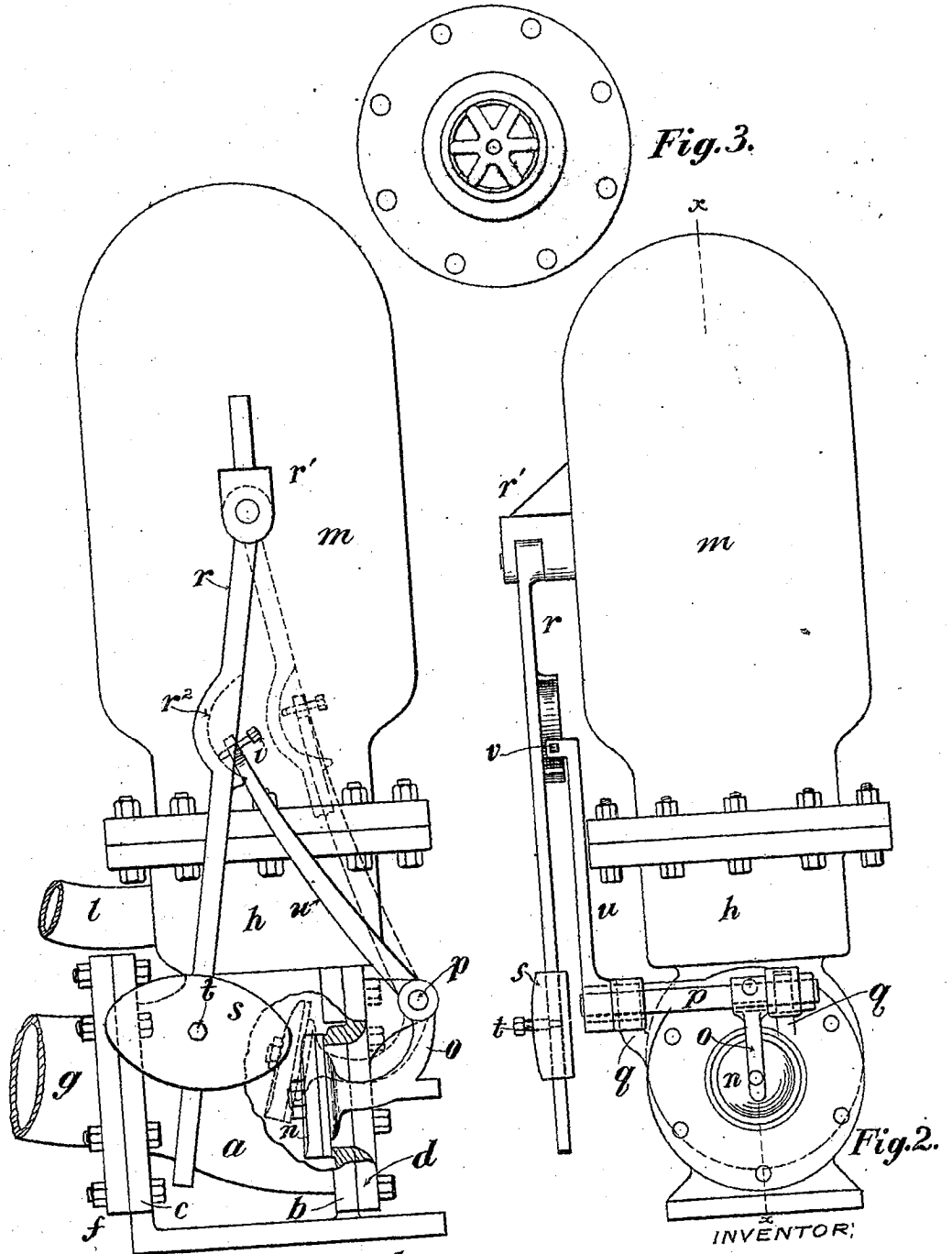
Witnesses:

CHAS. M. GUNN,  
T. J. GEISLER.

F. HESSE.  
 HYDRAULIC RAM.  
 APPLICATION FILED APR. 13, 1907.

Patented Oct. 5, 1909.  
 2 SHEETS—SHEET 1.

936,244.



WITNESSES: **Fig. 1.**

A. D. Gerking  
 Cecil Long

**Fig. 2.**

INVENTOR:

Frederick Hesse  
 by J. H. Sisler ATT'Y.

F. HESSE.  
 HYDRAULIC RAM.  
 APPLICATION FILED APR. 13, 1907.

936,244.

Patented Oct. 5, 1909.  
 2 SHEETS—SHEET 2.

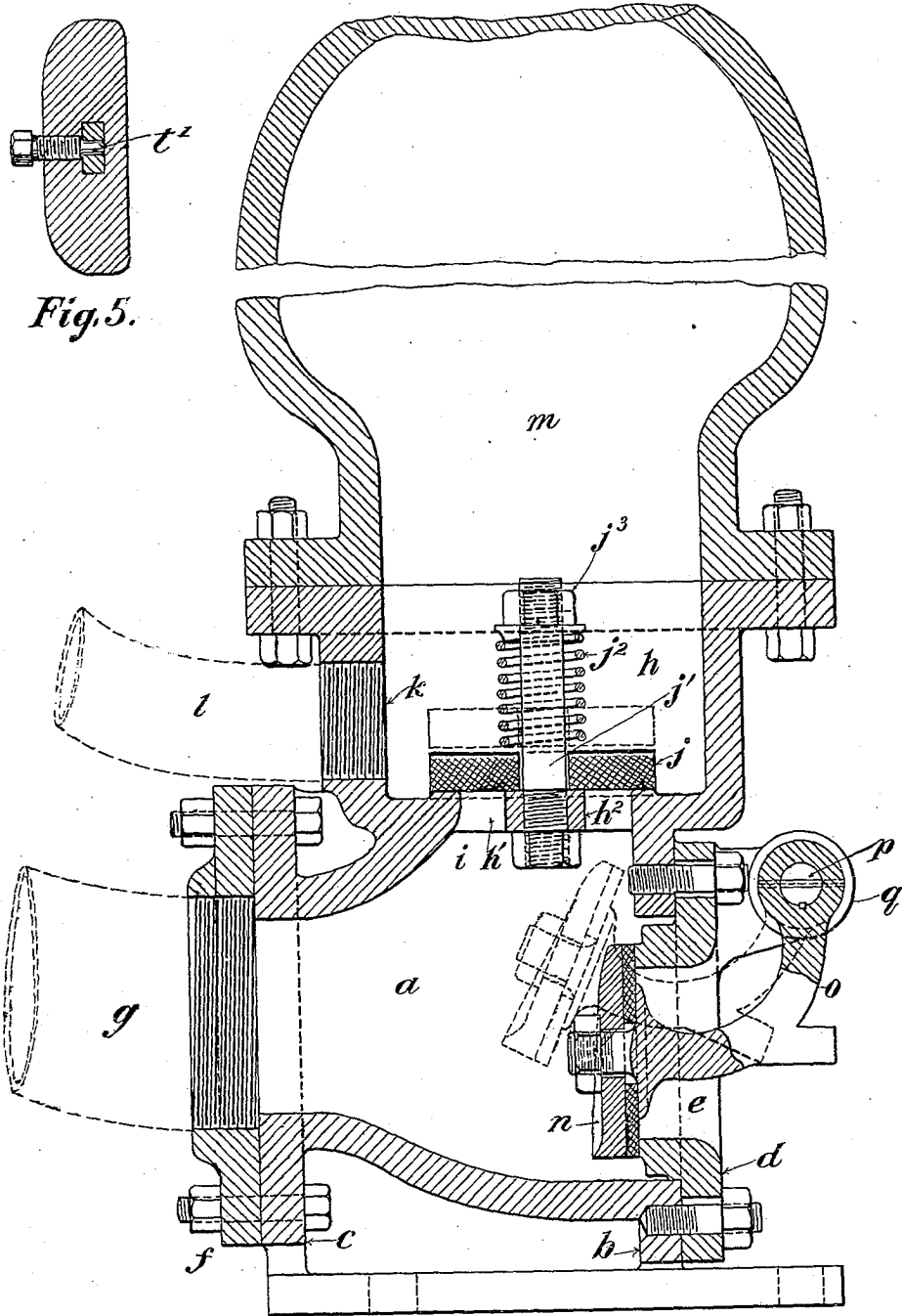


Fig. 5.

Fig. 4.

WITNESSES:  
*A. D. Gering.*  
*Cecil Long.*

INVENTOR:  
 Frederick Hesse  
 by *F. J. Geisler* ATT'Y.

# UNITED STATES PATENT OFFICE.

FREDERICK HESSE, OF PORTLAND, OREGON, ASSIGNOR TO COLUMBIA STEEL COMPANY,  
OF PORTLAND, OREGON, A CORPORATION OF OREGON.

## HYDRAULIC RAM.

936,244.

Specification of Letters Patent.

Patented Oct. 5, 1909.

Application filed April 13, 1907. Serial No. 368,118.

To all whom it may concern:

Be it known that I, FREDERICK HESSE, a citizen of the United States, and a resident of Portland, county of Multnomah, and State of Oregon, have invented a new and useful Improvement in Hydraulic Rams, of which the following is a specification, reference being had to the accompanying drawings as constituting a part thereof.

This invention has for its object to place in the hands of an ordinarily intelligent person, having some knowledge of the fundamental principles of a water-ram, a simple yet efficient device, easily and inexpensively installed, requiring but a short drive-pipe; easily maintained in good condition and readily adjusted to meet changes in the state of the drive-water; economical in its consumption of drive-water, and having its valve-mechanism so arranged as to minimize the shock and wear of service. To this end my ram is constructed as illustrated in the accompanying drawings, in which:

Figure 1 represents a side elevation thereof with parts in section; Fig. 2 is a front view thereof, drawn on a somewhat smaller scale than the preceding figure; Fig. 3 is a plan of the valve seat of the delivery valve; Fig. 4 is a vertical longitudinal section, taken approximately centrally of Fig. 2; and Fig. 5 is a detail of construction.

The letters designate the parts described.

By reference more particularly to Fig. 4, it will be seen that the ram comprises a short body *a*, made with flanges *b*, *c*, to the former of which is bolted a waste-valve seat *d*, having a central opening *e*; and to the flange *c* is bolted a companion-flange *f*, in which is inserted the drive-pipe *g*. The body has a vertical enlargement at the waste outlet, and the latter is located in the lower part of said enlargement. The upper part of the body is made with a throat or valve-opening *i*, controlled by a delivery valve *j*, and has integrally formed thereon the lower part of a pressure chamber *h*, having an outlet *k*, in which is inserted the delivery-pipe *l*. On said upper part of the pressure chamber *h* is mounted a dome *m*. The delivery-valve *j* rests on a gridiron web *h'* made with a central eye *h<sup>2</sup>* (compare Fig. 3) through which extends a bolt-like valve stem *j'*, on which is a coil-spring *j<sup>2</sup>*, the tension of which is adjustable by a nut *j<sup>3</sup>*, to regulate the degree of resistance of the valve *j*. The

waste-valve opening *e* is controlled by the disk-valve *n*, which is rigidly connected by its stem or arm *o*, to a spindle *p*, journaled in bearings *q*, *q*, integral parts of the valve-seat casting *d*. The waste-valve *n* is controlled by pendulum mechanism comprising the following devices: A rod *r* is pivotally suspended from a bearing *r'* projecting from the air chamber *m*. Integrally formed on the rod *r* is a concaved cam-path *r<sup>2</sup>* the purpose of which will presently appear. On the lower end of the rod *r* is movably fastened a weight *s*. A horizontal section of the latter is seen in Fig. 5. It has a vertical aperture to receive the rod *r* and a set-screw *t*, the point *t'* of which is reduced so as to be adapted to be inserted in one of a series of perforations provided therefor in the lower end of the rod *r*, so as to permit the proper adjustment of the weight *s*. Rigidly affixed to one end of the spindle *p* is a rocker-arm *u*, in the upper end of which is an adjustable contact point *v*, resembling a set-screw made with a rounded point. The point *v* impinges against and travels on the cam-path *r<sup>2</sup>* of the pendulum rod, during the oscillations of the latter. By raising or lowering the pendulum weight *s*, the stroke of the waste-valve *n* is shortened or lengthened in correspondence with the shorter or longer oscillations of the pendulum. By advancing the contact point *v* toward the cam-path *r<sup>2</sup>* oscillations of greater amplitude are attained, thereby causing a wider opening of the waste-valve, and also a quicker return movement of the pendulum. Such quicker return movement is due to the fact that in forcing the pendulum to an extreme position the drive-water, in the act of closing the waste-valve, has more work to do, and consequently will exert less force in doing so. For in all cases the pendulum swings farther than the movement of the upper end of the rocker-arm *u*; and thus the smaller the force applied through the rocker-arm against the pendulum the less will be the distance the latter recedes from the bearing-point *v* of the rocker-arm in completing its oscillation.

The operation of my ram is as follows: The drive-water flows through the open waste-valve *n* until the required velocity is attained, upon which the continued impact of the drive-water against said valve will close the same. While the waste-valve is closing the rocker-arm, *u*, moving in the op-

posite direction, forces the pendulum to one end of its path. On its return swing the pendulum pushes against the rocker-arm and again opens the waste-valve, and one cycle of motion is completed, which thereupon is repeated in synchronism with the continuing oscillations of the pendulum. During its flow through the waste outlet of the ram the water has gathered a certain amount of energy, which, when its flow is suddenly arrested, by the closing of the waste-valve, will exert a sufficient force against the delivery-valve *j* to overcome the pressure on the top of the latter, lifting said valve and allowing a portion of the water to enter the pressure chamber *h* and thence into the dome mounted on said pressure chamber *h*, compressing the air in the dome. The flow of water into the pressure chamber *h* ceases as soon as equilibrium is established above and below the delivery valve *j*, at which time the air compressed in the dome *m* on the pressure chamber *h* will begin to push back the water. But only a small portion of the water having entered the chamber *h* will flow back through the valve *j* before the latter closes and arrests further loss. The water which remains in the pressure chamber *h*, after the delivery-valve *j* is closed, is forced up through the delivery-pipe *l* by the compressed air until equilibrium is restored between the pressure within and without the pressure chamber.

When a large volume of drive-water is available the pendulum should be so adjusted as to give the waste-valve a longer interval of opening, thus causing the water to reach its maximum speed before closing the waste-valve. This condition permits a maximum quantity of water to be lifted and discharged, through the delivery-valve *j* and pipe *l*, and is the proper adjustment of the ram when it is desired to lift a maximum quantity of water without regard to economy in the waste of the drive-water. On the other hand, when only a small volume of water is available the pendulum is to be so adjusted as to make the opening of the waste-valve as short and quick as possible. This reduces the duration of the flow and the resultant friction of the water in the drive-pipe, causing a greater number of impulses in a given unit of time. By this adjustment a large quantity of water is lifted in proportion to the quantity wasted. The proper adjustment of the pendulum is also essential to enable the ram to meet the conditions of a high or a low head of water. For example, when having to deal with a high head the pendulum weight would be lowered and in case of a low head, said weight would be raised on its rod.

It is to be noted that the bottom of the body *a* is made with a declivity toward the waste-outlet *e*, and that the latter is located

close to the bottom of the declivity, whereby the effluent waste-water is caused to take a downward direction, leaving an air space in the upper portion of the body *a*. The body of the ram is vertically enlarged or bell-shaped in the direction of the waste-valve opening, and the throat *i* of the delivery-valve constitutes a chamber in which is held a portion of the air admitted through the waste-valve while open; and the air so imprisoned in the throat of the delivery valve will enter the pressure chamber *h* upon the next opening of the former. This construction maintains a constant supply of air in the air-chamber, but eliminates the sniffer valve which, because of its necessarily small size, so frequently gets out of order, and then causes the danger due to insufficient air feed to the air-chamber. The body of air held in the chambered throat *i* of the delivery-valve also minimizes the shock to which the latter is subjected, for, obviously, the air so confined acts as a cushion and materially mitigates the impact which the delivery-valve has to sustain when the flow of the drive-water is suddenly arrested by the closing of the waste-valve. It is further to be noted that the construction of the ram-body is designed to provide easy and gradual curves for the diversion of the drive-water from its flow through the waste-valve to the throat of the delivery-valve. The ram-body is furthermore designed to be in accord with the well known law—that the seat of the maximum energy of a moving column of water is at its forward end; and for this reason I have located the delivery-valve as near as possible to the waste-valve and avoid transmitting the pressure of the impact through a column of “dead water.” The oblique position of the waste-valve when opened reduces the shock incident to its closing. The arc like motion of the valve facilitates its opening, that is, it makes a larger opening for the same length of movement against the now of drive-water; in short, the waste-valve has a sort of semi-sliding movement. The waste-valve is so suspended that a line connecting the center thereof with the center of its point of suspension or spindle *p* makes an angle with the vertical line of the face of the valve-seat. The greater this angle, the greater the opening of the waste-valve for the same distance of recession of the latter against the flow of the drive-water; but, for practical purposes, such point of suspension is to be located approximately as shown in Fig. 4. The degree of the shock which the delivery-valve sustains in the operation of my ram is regulable by the spring *j*<sup>2</sup>, and the latter also enables the adjustment of the delivery-valve to the conditions under which the ram is to be operated.

My ram may be operated with a compara- 130

tively short length of drive-pipe, which, obviously, cheapens its installation, since the length of the drive-pipe usually represents a considerable part of the expense of installation. The arrangement of the waste-valve is such that it facilitates the renewal of valve packing when required, for the entire waste-valve mechanism may be readily removed.

In case the admission of air be found excessive so as to cause a condition known as "air bound", the same may be overcome by setting my ram a little lower in the stream of water.

I claim:

1. In a hydraulic ram, the combination of a body made with a vertical enlargement at the waste outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, a dome like air chamber located in the roof of said enlargement and directly above said waster orifice, the waster orifice being arranged to provide direct communication from the exterior to said air chamber during the periodic opening of the waste valve, a delivery valve in the roof of said air-chamber, an air dome over said delivery valve, said air-chamber serving to store part of the air admitted during each periodic opening of the waste valve, suspending means for the waste valve adapted to partially lift the latter, when opened, into said air chamber, so as to entirely clear the lower part of said waste orifice and shield the upper part of the latter against the outflowing waste stream, and means adapted to periodically open said waste-valve.

2. In a hydraulic ram, the combination of a body made with a declivity at its waste outlet and arranged to provide a vertical enlargement above said outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, a dome like air chamber located in the roof of said enlargement and directly above said waste orifice, the waste orifice being arranged to provide direct communication from the exterior to said air chamber during the periodic opening of the waste valve, a delivery valve in the roof of said air chamber, an air dome over said delivery valve, said air chamber serving to store part of the air admitted during each periodic opening of the waste valve, suspending means for the waste valve adapted to partially lift the latter, when opened, into said air chamber, so as to entirely clear the lower part of said waste orifice and shield the upper part of the latter against the outflowing waste stream, and means adapted to periodically open said waste valve.

3. In a hydraulic ram, the combination of a body made with a vertical enlargement at

the waste outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, a dome like air chamber located in the roof of said enlargement and directly above said waste orifice, the waste orifice being arranged to provide direct communication from the exterior to said air chamber during the periodic opening of the waste valve, suspending means for the waste valve adapted to partially lift the latter when opened, into said air chamber, so as to entirely clear the lower part of the waste orifice and shield the upper part of the same against the outflowing waste stream, a delivery valve in the roof of said air chamber, an air dome over said delivery valve, said air chamber serving to store part of the air admitted during each periodic opening of the waste valve, and means adapted to periodically open said waste valve.

4. In a hydraulic ram, the combination of a body made with a declivity at its waste outlet and arranged to provide a vertical enlargement above said outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, a dome like air chamber located in the roof of said enlargement and directly above said waste orifice, the waste orifice being arranged to provide direct communication from the exterior to said air chamber during the periodic opening of the waste valve, suspending means for the waste valve adapted to partially lift the latter by an arc-like movement, when opened; into said air chamber, so as to entirely clear the lower part of the waste orifice and shield the upper part of the latter against the outflowing waste stream, a delivery valve in the roof of said air chamber, an air dome over said delivery valve, said air chamber serving to store part of the air admitted during each periodic opening of the waste valve and means adapted to periodically open said waste valve.

5. In a hydraulic ram, the combination of a body made with a vertical enlargement at the waste outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, an air-chamber located in the roof of said enlargement and directly above said outlet, a pressure chamber and a delivery valve leading into the same, the throat of said delivery valve being formed in the roof of said air-chamber, a rocker arm on the spindle of the waste valve, a pendulum arranged to impinge against the outer end of said rocker arm and thereby periodically open the waste valve, and means for relatively adjusting the cooperation of the pendulum and rocker arm.

6. In a hydraulic ram, the combination of a body made with a vertical enlargement at



the waste outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, an air-chamber located in the roof of said enlargement and directly above said outlet, suspending means for the waste-valve adapted to cause the same, when opened, to be partially lifted into said air-chamber, above the waste-outlet, whereby the lower part of the waste outlet is entirely cleared, and said waste valve serves as a shield, deflecting the outflowing stream and preventing the same obstructing the air inflow through the upper part of the waste outlet, a pressure chamber and a delivery valve leading into the same, the throat of said delivery valve being formed in the roof of said air-chamber, a rocker arm on the spindle of the waste valve, a pendulum arranged to impinge against the outer end of said rocker arm and thereby periodically open the waste valve, and means for relatively adjusting the cooperation of the pendulum and rocker arm.

7. In a hydraulic ram, the combination of a body made with a vertical enlargement at the waste outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, an air-chamber located in the roof of said enlargement and directly above said outlet, suspending means for the waste-valve adapted to cause the same, when opened, to be partially lifted into said air-chamber, above the waste-outlet, whereby the lower part of the waste outlet is entirely cleared, and said waste valve serves as a shield, deflecting the outflowing stream and preventing the same obstructing the air inflow through the upper part of the waste outlet; a pressure chamber and a delivery valve leading into the same, the throat of said delivery valve being formed in the roof of said air-chamber, a rocker arm on the spindle of the waste valve, a pendulum arranged to impinge against the outer end of said rocker arm and thereby periodically open the waste valve, a concaved cam path on the rod of the pendulum, and a contact point on the extremity of the rocker arm impinging upon said cam path.

8. In a hydraulic ram, the combination of a body made with a vertical enlargement at the waste outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste

outlet, an air-chamber located in the roof of said enlargement and directly above said outlet, suspending means for the waste-valve adapted to cause the same, when opened, to be partially lifted into said air-chamber, above the waste-outlet, whereby the lower part of the waste outlet is entirely cleared, and said waste valve serves as a shield, deflecting the outflowing stream and preventing the same obstructing the air inflow through the upper part of the waste outlet, a pressure chamber and a delivery valve leading into the same, the throat of said delivery valve being formed in the roof of said air-chamber, a rocker arm on the spindle of the waste valve, a pendulum arranged to impinge against the outer end of said rocker arm and thereby periodically open the waste valve, said pendulum comprising a movable weight, a concaved cam path on the rod of the pendulum, and a contact point on the extremity of the rocker arm impinging upon said cam path.

9. In a hydraulic ram, the combination of a body made with a vertical enlargement at the waste outlet, the latter being located in the lower part of said enlargement, a waste valve constituting a closure for said waste outlet, an air-chamber located in the roof of said enlargement and directly above said outlet, suspending means for the waste valve adapted to cause the same, when opened, to be partially lifted into said air-chamber, above the waste outlet, whereby the lower part of the waste outlet is entirely cleared, and said waste valve serves as a shield, deflecting the outflowing stream and preventing the same obstructing the air inflow through the upper part of the waste outlet, a pressure chamber and a delivery valve leading into the same, the throat of said delivery valve being formed in the roof of said air-chamber, a rocker arm on the spindle of the waste valve, a pendulum arranged to impinge against the outer end of said rocker arm and thereby periodically open the waste valve, said pendulum comprising a movable weight, a concaved cam path on the rod of the pendulum, and an adjustable contact point on the extremity of the rocker arm impinging upon said cam path.

FREDERICK HESSE.

Witnesses:

T. J. GEISLER,  
CECIL LONG.

J. E. LESTER.  
HYDRAULIC RAM.

APPLICATION FILED MAY 13, 1908.

946,607.

Patented Jan. 18, 1910.

3 SHEETS—SHEET 1.

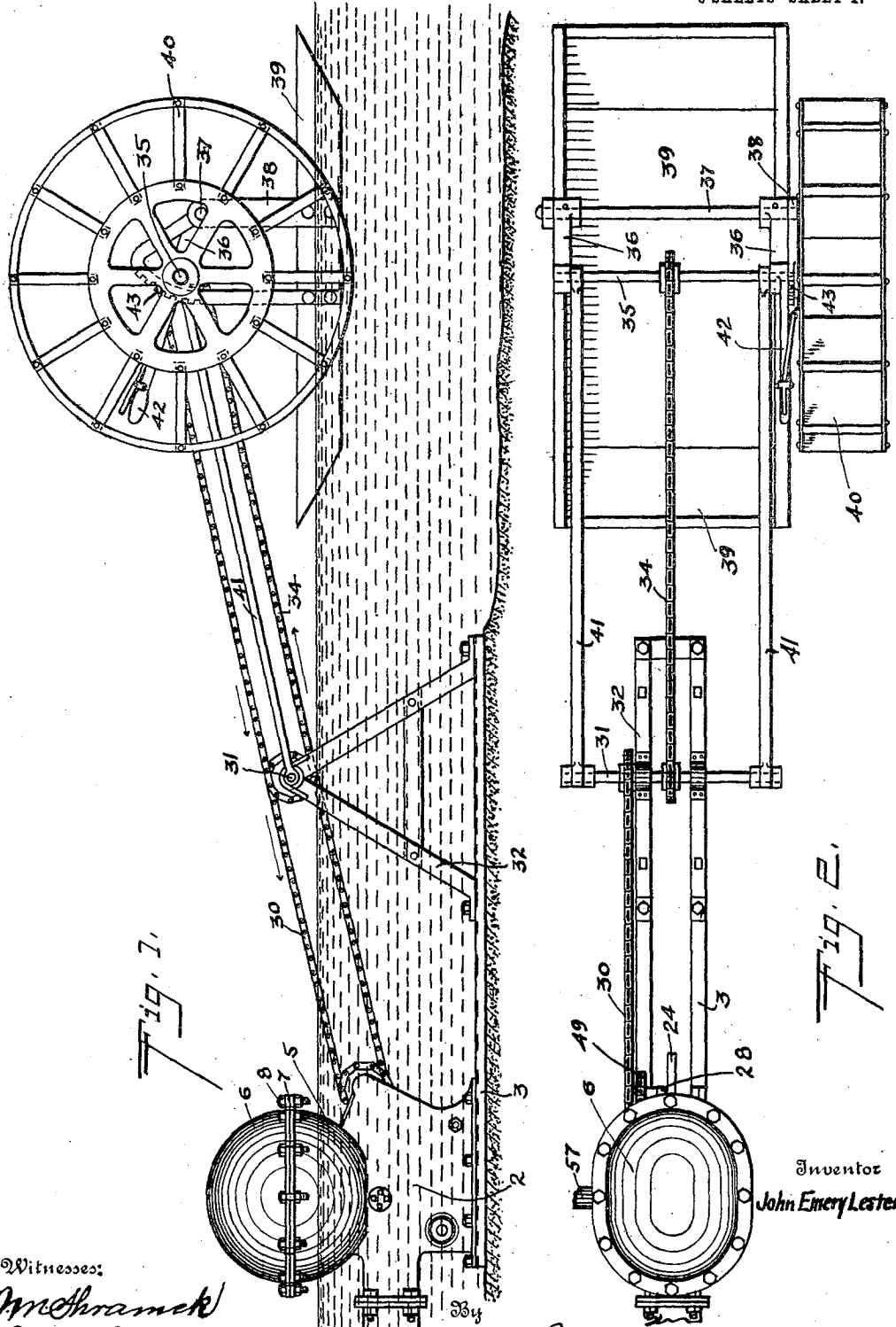


Fig. 1.

Fig. 2.

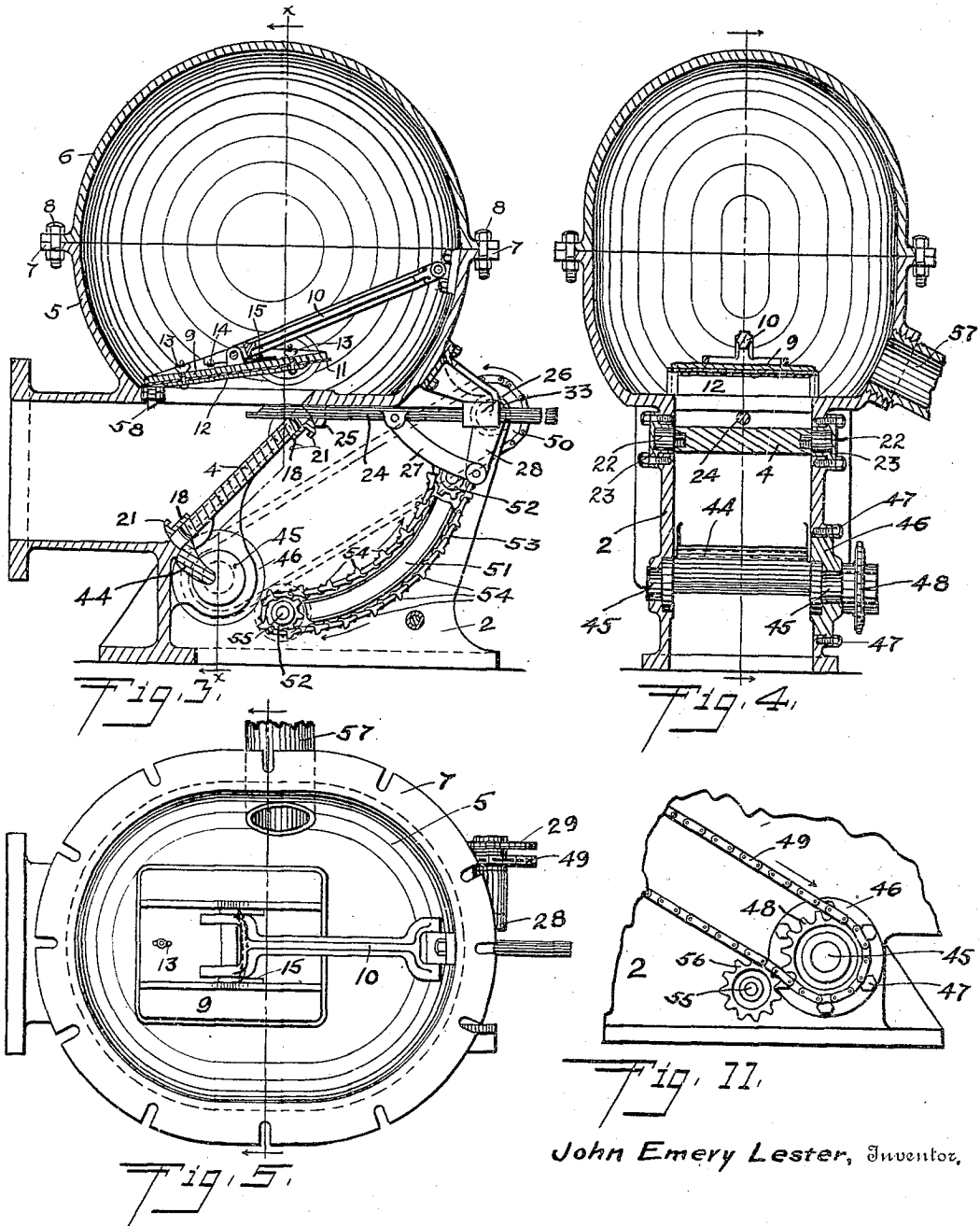
Witnesses:  
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Inventor  
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 APPLICATION FILED MAY 13, 1908.

946,607.

Patented Jan. 18, 1910.  
 3 SHEETS—SHEET 2.



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Witnesses:  
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*Roy G. Kraz*

By *David O. Barnell,*

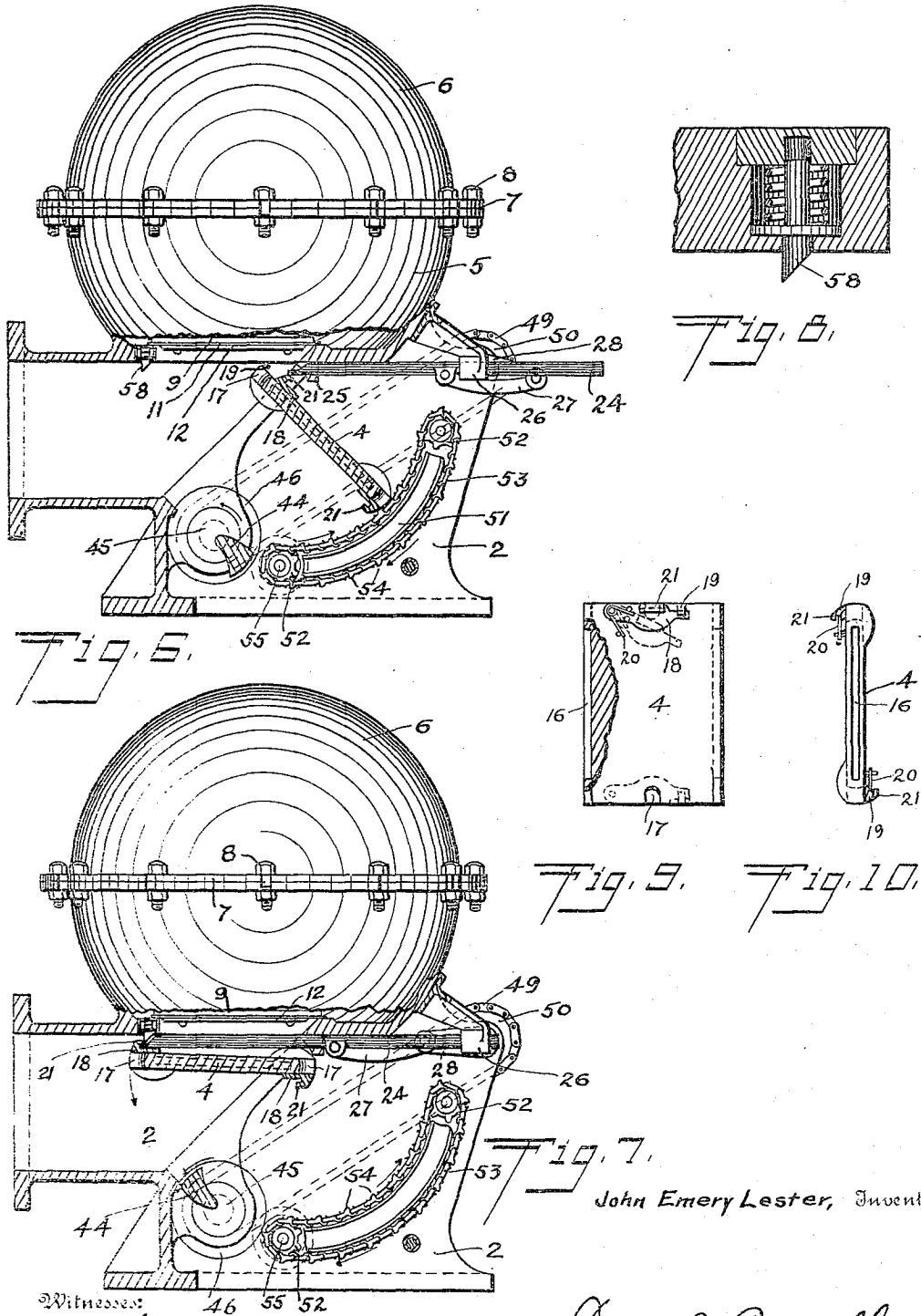
Attorney.

J. E. LESTER.  
 HYDRAULIC RAM.  
 APPLICATION FILED MAY 13, 1908.

946,607.

Patented Jan. 18, 1910.

3 SHEETS—SHEET 3.



Witnesses:  
*John H. Mearns*  
*Roy L. Kratz*

By *David O. Barnell*,  
 Attorney.

# UNITED STATES PATENT OFFICE.

JOHN EMERY LESTER, OF PORTLAND, OREGON, ASSIGNOR TO LESTER HYDRAULIC RAM & IRRIGATION COMPANY, OF PORTLAND, OREGON, A CORPORATION OF OREGON.

## HYDRAULIC RAM.

946,607.

Specification of Letters Patent. Patented Jan. 18, 1910.

Application filed May 13, 1908. Serial No. 432,733.

To all whom it may concern:

Be it known that I, JOHN EMERY LESTER, a citizen of the United States, and a resident of Portland, in the county of Multnomah and State of Oregon, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

My invention relates to hydraulic rams, more particularly to rams of the type shown in United States Letters Patent No. 868,194, issued to me October 15, 1907, in which the waste valve is formed by a slidably and pivotally hung gate, mechanically controlled and arranged to swing toward the waste outlet both in the opening and closing of the valve.

It is the object of my present invention to provide in a ram of this class means for insuring the steady operation of the swinging gate, for reducing the friction losses due to sudden changes in the direction of flow through the machine, for automatically maintaining a constant speed of operation, to provide an improved form of discharge valve, and to so arrange all parts of the mechanism that the same may be economically manufactured.

Constructions embodying my invention are shown in the accompanying drawings in which—

Figure 1 is a side elevation of the ram, set in operative position, Fig. 2 is a plan view of the same, Fig. 3 is a longitudinal section of the mechanism containing the valves, Fig. 4 is a transverse section on the line  $x-x$  of Fig. 3, Fig. 5 is a plan view with the cover of the air-chamber removed, Figs. 6 and 7 are longitudinal sectional views, showing different positions of the swinging gate, Fig. 8 is a detail showing the spring-stop for preventing rearward sliding movement of the gate, Fig. 9 is a detail elevation of the gate, Fig. 10 is a detail side elevation of the same, and Fig. 11 is a detail side elevation of the gate-casing showing the arrangement of the driving sprockets for the rotary gate-stop and gate-lifting chain.

In the arrangement shown in Fig. 1 the supply pipe 1 is supported in the current of a running stream, as in my former patent No. 868,194, above referred to. The supply pipe 1 is secured by a flange connection with the gate-casing 2 which has a suitable base formed integrally therewith, which base

may be secured to timbers 3 placed on the bed of the stream. The gate 4 is so arranged within the casing that when in closed position it stands at an incline of about  $45^\circ$ , as shown in Fig. 3. In the upper part of the casing in front of the upper edge of the gate is the discharge opening which communicates with the air-chamber, the said chamber being formed by a globular casing, the lower part thereof 5 being integral with the casing 2 and the upper part 6 being secured to the portion 5 by means of the slotted flanges 7 and the bolts 8. The discharge-valve-plate 9 is pivotally connected with a forked arm 10 which is, in turn, pivotally connected with the rearward side of the air-chamber casing 5. The portion of the valve which contacts with the seat is formed by a sheet 11 of leather or other suitable material which is held between the plates 9 and 12, the plate 12 being removably connected with the plate 9 by means of the screws and thumb-nuts 13. The forward ends of the forked arm 10 are extended beyond the pivot pin connecting the same with the plate 9, and the said extended portions are provided with stop-pins 14 against which the forward portion of the plate 9 is normally held by the tension of a spring 15 which is coiled around the pivot pin, the ends thereof engaging the arm 10 and valve-plate 9. The said stop-pins 14 are so arranged that when the valve-plate 9 is in contact therewith it will also be in such position as to rest squarely upon the valve-seat.

By the described method of hanging the discharge valve the same may open in two substantially different ways. In the first, the entire valve is lifted, swinging up on an arc from the pivot center of the rearward end of the arm 10, thus fully uncovering the discharge opening and permitting a large volume of water to pass rapidly into the air-chamber, as is necessary when working against low pressure. When working against higher pressures, where smaller quantities of water are being forced into the air-chamber, the valve may be opened sufficiently by tilting up the rearward side thereof, as shown in Figs. 3 and 4, the valve closing by the pressure of the spring 15 when the upward water pressure becomes less than the air-chamber pressure.

The gate 4 consists of a rectangular metal

plate having slots 16 in the longitudinal edges thereof, and rounded notches 17 in the ends thereof, as shown in Figs. 9 and 10. On opposite sides and ends of the gate, plates 18 are pivotally connected therewith, said plates being adapted to swing over and cover the notches 17 in the ends of the gate. Adjoining the notches 17 hooks 19 are formed on the gate, with which hooks the ends of the plates 18 are normally held in engagement by the springs 20 arranged as shown in Fig. 9, the plates being swingable on the pivots thereof to the position shown in dotted lines in said figure, thereby uncovering the notches 17 when necessary to permit the push-rod to pass through the same. On the plates 18 over the notches, hooks 21 are formed for engagement by the end of the push-rod as hereinafter described. The gate is slidably and swingably held within the casing 2 by means of the pins 22 which have flattened ends thereon entering the slots 16 in the sides of the gate, the said pins being revolvably held in bearings 23 which are removably secured in the sides of the casing, as shown in Fig. 4. At the center and upper end of the casing 2 is arranged the push-rod 24 which is longitudinally slidable through the bearing 25 on the casing, and the bearing 26 formed at the end of a bracket secured to the air-chamber casing 5. A longitudinal reciprocating motion is imparted to the rod 24 by the following means: On the rod 24 between the bearings 25 and 26 is formed a lug to which is connected the rod 27. The rearward end of the said rod 27 is connected with a crank 28 carried on the inner end of a transverse shaft 33 which is journaled in a bearing formed at the rearward end of the casing 2. On the outer end of the crank-shaft 33 is a sprocket 29 from which a chain 30 extends to a sprocket carried on a shaft 31 which is journaled in a frame 32 secured to the base-timbers 3. On said shaft 31 is a second sprocket from which a chain 34 extends to a sprocket carried on the wheel-shaft 35. The said shaft is journaled in bearings formed at the ends of radius rods 36 which connect with a shaft 37 supported in standards 38 which are carried by a float 39. On the end of the shaft 35 is carried a paddle- or current- wheel 40 of the ordinary under-shot type. A uniform distance is maintained between the centers of the shafts 31 and 35 by means of radius rods 41 having the ends thereof connected with the respective shafts. The speed of rotation of the paddle-wheel, relative to the speed of the current in which it is placed, may be varied by raising and lowering of the wheel relative to the float 39. The said raising and lowering of the wheel is accomplished by means of a ratchet-lever 42 which is connected with one of the radius rods 36 and is adapted to engage a notched segment 43 ar-

ranged concentrically to the shaft 37 and supported by the standards 38. It may be noted that by the use of the float to carry the paddle-wheel, the same is automatically maintained at a uniform "dip" regardless of the height of water in the stream in which the ram is placed. The gate-stop 44 is formed integrally with short shouldered shafts 45 which are journaled in bearings arranged in the casing 2 near the lower side thereof, as shown in Figs. 3 and 4. One of said bearings for the shafts 45 is formed in a plate 46 which is removably secured to the casing by bolts 47, the opening in the casing in which the plate is held being sufficiently large to permit the gate-stop to pass through the same in assembling the machine. On the outer end of the shaft 45 passing through the plate 46 is a sprocket 48 from which a chain 49 extends diagonally upward to a sprocket 50 carried on the crank-shaft 33. The sprockets 48 and 50 are of equal size so that the crank-shaft and gate-stop are driven synchronously.

On the inside of the casing 2, behind and below the gate, is formed an arcuate guide 51, the curvature of which is concentric to the gate-pivot pins 22. Near the upper and lower ends of said arcuate guide are sprockets 52, and a chain 53 passes around said sprockets and guide. The said chain is provided at regular intervals with outwardly extending lugs 54, as shown. The lower of the sprockets 52 is carried on a shaft 55 which extends through a bearing formed in the casing 2, and is provided at its outer end with a sprocket 56 adapted to engage the chain 49, as shown in Fig. 11, and be driven thereby. The chain 53 is thus driven in the direction indicated by the arrows in Figs. 3, 6 and 7.

The operation of the mechanism will be apparent by reference to Figs. 3, 6 and 7. The parts being in the position shown in Fig. 3, rotation of the gate-stop will release the lower end of the gate, permitting the same to fall by gravity to a vertical position. At this position it is engaged by the lugs 54 on the chain 53 and is thereby swung upwardly, as indicated in Fig. 6, to a substantially horizontal position. Having reached the horizontal position and the push-rod 24 being at the rearward end of its stroke, as the rod starts forward the flat pointed end thereof engages the hook 21 on the plate 18 and the gate is thereby pushed forwardly to the position shown in Fig. 7, sliding upon the flattened end portions of the pins 22 which enter the slots 16 in the sides of the gate. Upon reaching the position shown in Fig. 7, the spring-actuated latch 58, shown in detail in Fig. 8, engages the hook 21 and prevents the possibility of rearward sliding movement of the gate. As the push-rod begins its rearward stroke it disengages

from the hook 21 and the gate then falls to the closed position shown in Fig. 3, where it is stopped momentarily by engagement with the stop 44, and then the cycle of movements is repeated. During the time that the gate is open a rapid flow of water is established through the supply pipe and casing, which flow is, by the closing of the gate, interrupted and diverted so that a quantity of water passes up through the discharge valve into the air-chamber. The opening of the valve is automatically varied to suit the quantity of water delivered, for small quantities the valve simply tilting upon its seat, as shown in Fig. 3, while for larger quantities the entire valve may be lifted from the seat and swung upwardly around the pivoted rear end of the arm 10.

It will be noted that by having the gate at an inclined position when closed, the flow of water from the drive pipe in striking upon the gate is diverted thereby upwardly through the discharge valve with but slight loss of momentum, on account of the slight change in the direction of flow. It will also be noted that there are no pockets, corners or recesses, or other dead space in front of the gate which would cause eddies or other disturbing counter-currents tending to retard the flow of water into the air-chamber.

The discharge pipe 57 is preferably connected with the lower part of the air-chamber, being directed downwardly to the bed of the stream, and thence to any point desired.

By suitable adjustment of the actuating mechanism the action of the gate may be so regulated that the flow of water through the supply pipe is never entirely stopped. In other words, the action may be so timed that after the gate is closed and the flow diverted into the air-chamber, at the instant when the velocity and momentum of the water in the supply pipe has fallen to a point where it will no longer overcome the pressure in the air-chamber, and before the velocity has fallen to zero, the gate may be opened so that the flow will continue, increasing in velocity until reaching the maximum just before the gate is again closed. The result of the above described action is a marked increase in efficiency over an action in which the flow is permitted to be entirely stopped.

It will be obvious to those skilled in the art, that the herein described type of gate and actuating mechanism therefor may be employed in a ram for compressing air, by combining the same with an air-chamber arranged as shown in Fig. 8 of my Patent No. 868,194, hereinbefore referred to.

Now, having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a hydraulic ram, a supply pipe, a

gate casing connected therewith, there being a waste outlet to said casing in substantially horizontal alinement with the supply pipe, a gate slidably and pivotally hung within the casing and adapted to close the waste outlet thereto, there being a valved discharge opening in the casing adjoining the gate, and a rotary stop arranged in the casing to interrupt the swinging movement of the gate in such a position that the same will close the waste outlet, and the gate when in such closed position being at a substantially equal incline to the lines of flow through both the waste outlet and discharge opening.

2. In a hydraulic ram, a casing having a valved discharge opening and provided with a supply pipe and a waste outlet, a gate slidably and swingably hung adjacent to said discharge opening and within the waste outlet, a rotary body disposed adjacent to the waste outlet, means for swinging the gate to a substantially horizontal position, means for sliding the gate longitudinally to a position from which it may swing against the rotary body, the said body being so disposed that when the gate engages the same it will close the waste outlet, and means for driving synchronously the said rotary body and the gate actuating mechanism.

3. In a hydraulic ram, a casing having a valved discharge opening and provided with a supply pipe and a waste outlet, a gate pivotally and slidably mounted in said casing and adapted to swing from a horizontal position past a position at which it will close the waste outlet to a second horizontal position, a rotary stop adapted to engage the gate momentarily when it is at the position closing the waste outlet, means for sliding the gate from the second horizontal position to the first horizontal position, and motor-driven actuating means for the gate and rotary stop.

4. In a hydraulic ram for use in a running stream of water, a waste valve, mechanism for actuating and controlling said valve, a float, a paddle-wheel carried by said float, means for adjusting the position of the paddle-wheel relative to the float, a driving shaft connected with said valve actuating and controlling mechanism, driving means connecting said driving shaft with the paddle-wheel, and means for maintaining a spaced relation between the driving shaft and paddle-wheel whereby the float may automatically maintain the paddle-wheel at a constant relation to the surface of the stream without changing the relation of the same and the driving shaft.

5. In a hydraulic ram, a casing forming an air-chamber and a gate-chamber, there being a discharge opening connecting said chambers, a valve-plate for closing said discharge opening, an arm having one end

pivotally connected with the casing and the other end pivotally connected with the valve-plate, a stop for limiting movement of the valve-plate relative to the arm, and a  
5 spring normally holding the plate in engagement with the stop.

6. In a hydraulic ram, a supply pipe, a gate chamber casing connected therewith, there being a waste outlet to said casing, a  
10 gate pivotally and slidably hung adjacent to said waste outlet, the said gate being adapted to swing from a horizontal position past a position at which it will close the waste outlet to a second horizontal position,  
15 a rotary stop for interrupting the swinging

movement of the gate at the closed position, means for raising the gate from a vertical position to the second horizontal position, a push-rod for sliding the gate from the latter position to the first horizontal position, 20 and driving mechanism for synchronously actuating the stop, push-rod and gate-raising means.

In testimony whereof I have hereunto subscribed my name in the presence of two 25 witnesses.

JOHN EMERY LESTER.

Witnesses:

G. A. JOHNSON,  
CHARLES STOUT.



R. E. STAFFORD & A. F. LOTT.

RAM.

APPLICATION FILED AUG. 4, 1909.

964,128.

Patented July 12, 1910.

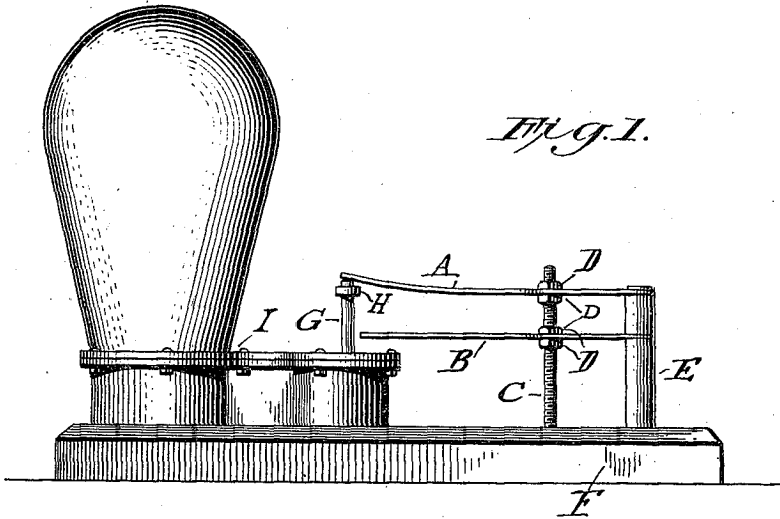
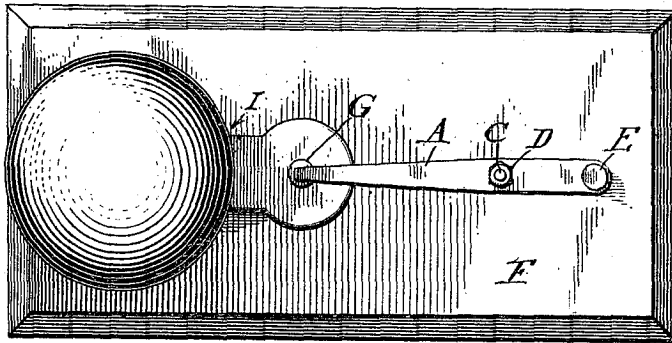


Fig. 2.



Witnesses.

*M. A. Stafford*  
*N. G. Blalock*

Inventors.

*R. E. Stafford*  
*A. F. Lott*

# UNITED STATES PATENT OFFICE.

RICHARD EMBERSON STAFFORD AND ALBERT FRANKLIN LOTT, OF WALLA WALLA, WASHINGTON.

RAM.

964,128.

Specification of Letters Patent. Patented July 12, 1910.

Application filed August 4, 1909. Serial No. 511,260.

To all whom it may concern:

Be it known that we, RICHARD EMBERSON STAFFORD and ALBERT FRANKLIN LOTT, citizens of the United States, residing at Walla Walla, in the county of Walla Walla and State of Washington, have invented a new and useful Attachment for a Ram, of which the following is a specification.

Our invention relates to improvements in rams in which horizontal springs operate in conjunction with a waste valve stem; and the object of our improvement is to provide continuous and uninterrupted action of the waste valve. The failure of a ram to work is generally due to an over amount of pressure on the waste valve or to insufficient pressure on said waste valve; the waste valve failing to rise after the downward stroke or failing to fall after the upward stroke. We attain these objects by the mechanism illustrated in the accompanying drawing, in which—

Figure 1. is a view in perspective of the ram together with our attachment; the several parts of said attachment being designated by the letters A B C D E F; the waste valve stem of said ram being designated by the letter G. Fig. 2. is a top view of the ram together with a top view of our attachments, showing parts A C D E.

Similar letters refer to similar parts throughout.

The adjuster C and the support E are firmly attached to the base F; the base F, in turn, being firmly attached to the ram I. Spring A and the spring B are firmly attached to the support E and supported at the adjuster C by means of four lock-nuts

D D D D as shown in the drawing. The adjustment of the springs A and B is effected by the manipulation of the four lock-nuts D D D D. When the waste valve stem G is set in motion the springs A and B are so adjusted by means of the four lock-nuts D D D D as to aid in forcing the waste valve stem either down or up as the lack of pressure or over amount of pressure may otherwise retard or stop the action of the waste valve stem G. When the collar H on the downward stroke comes in contact with the spring B the waste valve stem G is started on the upward stroke.

We claim—

1. In a ram, the combination of a waste valve stem, a collar on the stem, two spaced substantially flat springs, the said collar being located between the adjacent ends of the springs, a support for the springs located at their opposite ends, and an adjusting means located between the valve stem and the support.

2. In a ram, the combination of a waste valve stem, a collar on the stem, two spaced substantially flat springs, the said collar being located between the adjacent ends of the springs, a support for the springs located at their opposite ends, and a vertical threaded member located between the valve stem and the support and provided with lock nuts for adjusting the springs.

R. E. STAFFORD.  
A. F. LOTT.

Witnesses:

R. G. LYNN,  
M. A. STAFFORD.

S. M. STEVENS.  
 APPARATUS FOR PUMPING WATER.  
 APPLICATION FILED APR. 27, 1910.

973,230.

Patented Oct. 18, 1910.

Fig. 1

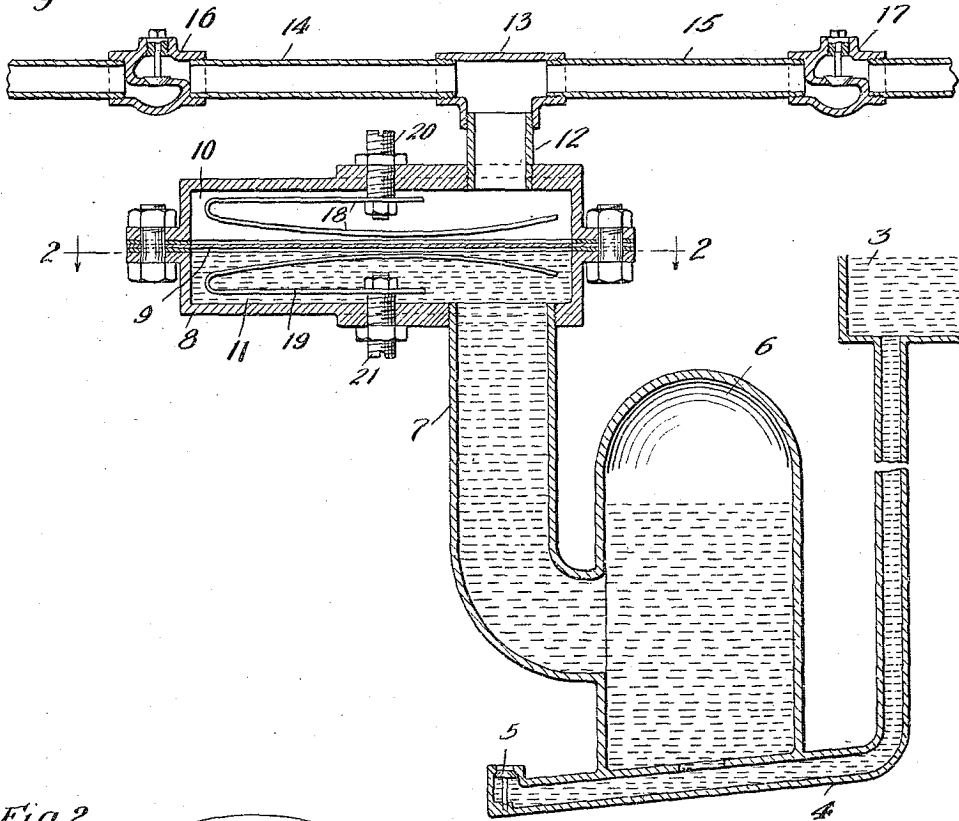
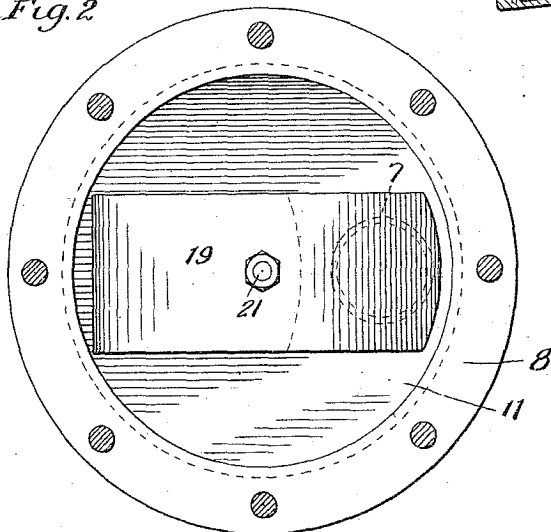


Fig. 2



Witnesses:

Wm. Geiger  
 Pearl Abrams.

Inventor

Sidney M. Stevens  
 BY Munday Evans Adcock & Clarke  
 Attorneys

# UNITED STATES PATENT OFFICE.

SIDNEY M. STEVENS, OF PRINCE GEORGE, VIRGINIA, ASSIGNOR OF ONE-HALF TO  
GRANT CHASE, OF PRINCE GEORGE, VIRGINIA.

## APPARATUS FOR PUMPING WATER.

973,230.

Specification of Letters Patent. Patented Oct. 18, 1910.

Application filed April 27, 1910. Serial No. 557,983.

To all whom it may concern:

Be it known that I, SIDNEY M. STEVENS, a citizen of the United States, residing in Prince George, in the county of Prince George and State of Virginia, have invented a new and useful Improvement in Apparatus for Pumping Water, of which the following is a specification.

This invention relates to the construction of apparatus for raising water, and its object has been to provide an inexpensive construction of automatic apparatus adapted to raise the water in cases where only limited volume is needed.

The invention is fully described below, and also illustrated in the accompanying drawing in which,

Figure 1 is a vertical section of the apparatus and Fig. 2 a section on the line 2—2 of Fig. 1.

In said drawing I show a novel construction of pumping apparatus in combination with a hydraulic ram for operating the same. This hydraulic ram may be of any known construction, and the one shown is a form illustrated in *Knight's Mechanical Dictionary*. In it the water passes from a reservoir or source of supply 3, through the pipe 4 at the lower end of which is a check valve 5, serving as a waste valve to the apparatus. When the water closes this valve, it spends its energy in forcing a portion of itself into the air chamber 6, thus relieving some of the pressure at the valve so that it drops and causes a resumption of the movement through pipe 4 until the valve is again lifted, when the same operations are repeated. The chamber 6 communicates by pipe 7 with a casing 8 in which is located the pumping apparatus now to be described. This casing is horizontally arranged as shown and is divided by a horizontal diaphragm 9 into upper and lower chambers 10 and 11. Of these the lower chamber receives the water from pipe 7, and the upper one receives the water which is to be pumped through a pipe 12. The pipe 12 is joined to a tee 13, one end of which connects with a pipe 14 leading from a spring or other source of supply, and the other end of the tee is joined to a pipe 15 leading to the point at which the water from the spring is to be used or delivered. The pipe 14 is provided with a check valve 16 adapted to admit the water freely to the pipe but also adapted to prevent any return of

the water, and pipe 15 is likewise provided with a check valve 17 adapted to permit the passage of the water to the point of destination, but also adapted to prevent the water after it has moved beyond said valve from returning.

The diaphragm 9 is flexible and adapted to yield to the pressure of the water upon its flat faces and it is accompanied upon both faces with assisting springs. The spring above the diaphragm is indicated at 18 and the one below it is indicated at 19. Both are made from flat metal bent into U shape, and the former is secured to the top of the casing by the screw 20 passing through the shorter limb of the spring, and the lower spring 19 is secured in like manner to the bottom of the casing by the screw 21 also passing through the shorter limb of the spring.

With the construction described, the operation is substantially as follows: The water from the spring enters through valve 16 and fills pipe 14 and the upper chamber 10 of the pumping casing, depressing the diaphragm to a greater or less extent, and forcing it against the spring 19. The ram now acts by creating superior pressure on the underside of the diaphragm and raising it. In so doing the water above the diaphragm is lifted, compelling the closing of the valve 16 so that no more water can enter. At the same time the greater or less part of the water then accumulated above the diaphragm is expelled through valve 17, and sent on its way to the point of delivery. As soon as the ram reacts, the pressure from the water caused by it ceases and the diaphragm falls to its normal position, thereby permitting the water to again enter at valve 16, and to fill the space just vacated by that which was expelled. These operations are repeated as long as the ram is continued in action.

It will be noted that the screws 20 and 21 which support the springs 18 and 19, are adapted to position said springs at different distances from the diaphragm, so that the action of the springs may be lessened or increased as occasion requires. This enables me to regulate these springs, so as to adapt the apparatus to use in cases not only where the spring water is under considerable pressure as it enters but also in cases where there is no pressure upon it. If there is pressure upon it, the springs are adjusted so as to

put greater tension upon the lower spring and slacken that upon the upper one. It will also be noted that the spring water which is pumped, does not become mixed with or adulterated by the water used in the ram. Indeed the latter may be very much inferior to the former.

The apparatus described is adapted to exert a suction force on the water being pumped, so that it is adapted not only to draw the water into itself in the absence of any pressure upon the water, but also to raise the water from a well or other source lower than itself.

15 I claim:—

1. The apparatus for pumping water consisting of a water holding casing, a flexible diaphragm dividing said casing into two compartments, a water supplying and discharging pipe communicating with one of said compartments, a hydraulic ram communicating with the other of said compartments and serving to actuate said diaphragm, and assisting springs at each side of said diaphragm.

25 2. The apparatus for pumping water con-

sisting of a water holding casing, a flexible diaphragm dividing said casing into two compartments, a water supplying and discharging pipe communicating with one of said compartments, a hydraulic ram communicating with the other of said compartments and serving to actuate said diaphragm, and assisting springs at each side of said diaphragm, said assisting springs being adjustable.

3. The apparatus for pumping water consisting of a water holding casing, a flexible diaphragm dividing the casing into two compartments, a water supply pipe opening into one of said compartments, a hydraulic ram communicating with the other compartment and supplying power to operate the diaphragm, and adjusting springs at each side of said diaphragm, said springs being independently adjustable in both directions.

SIDNEY M. STEVENS.

Witnesses:

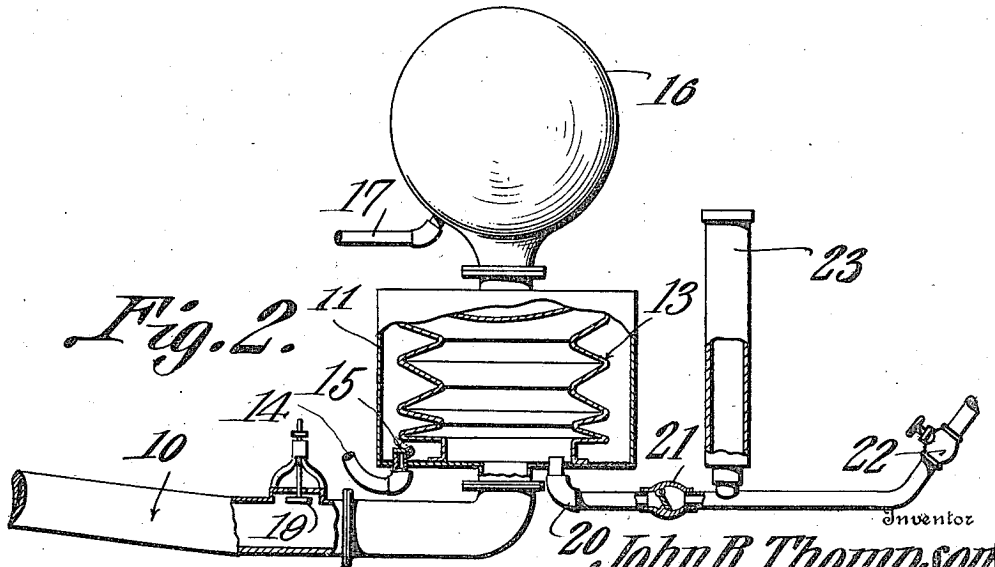
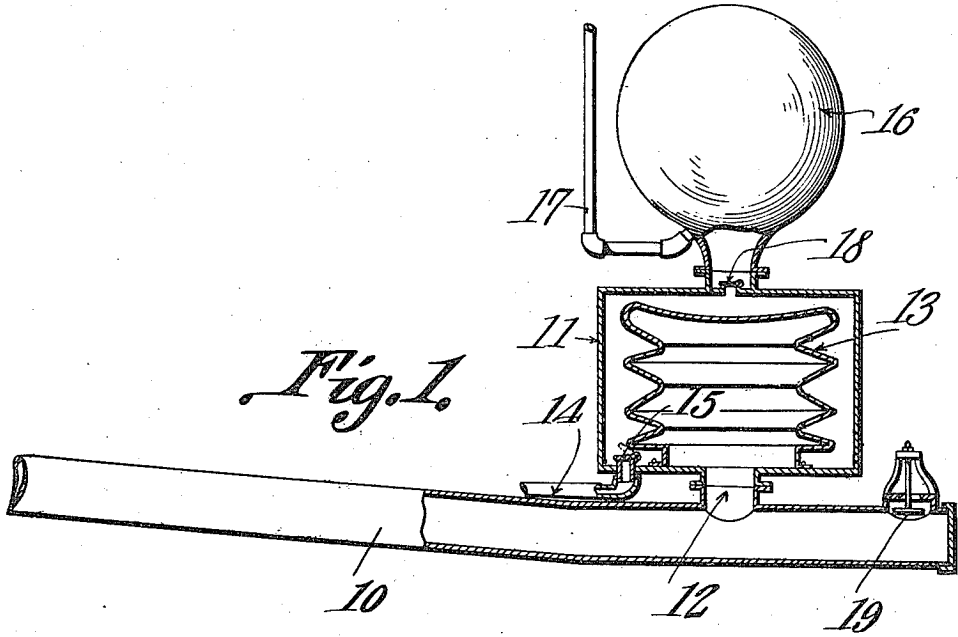
W. E. ARMSTRONG,  
V. M. CAMPBELL.

J. R. THOMPSON.  
HYDRAULIC RAM.  
APPLICATION FILED FEB. 23, 1910.

974,724.

Patented Nov. 1, 1910.

2 SHEETS—SHEET 1.



Witnesses  
*E. J. ...*  
*M. A. Schmitt*

Inventor  
*John R. Thompson*

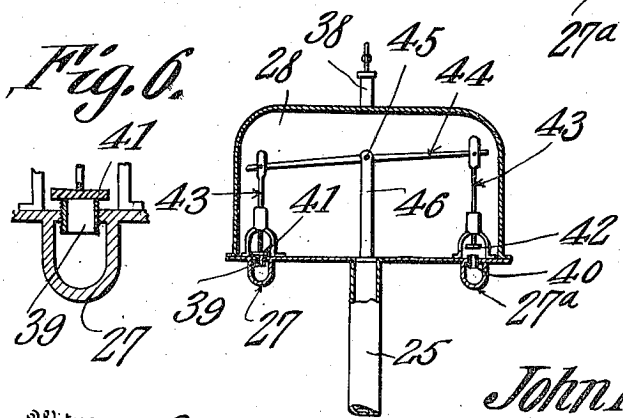
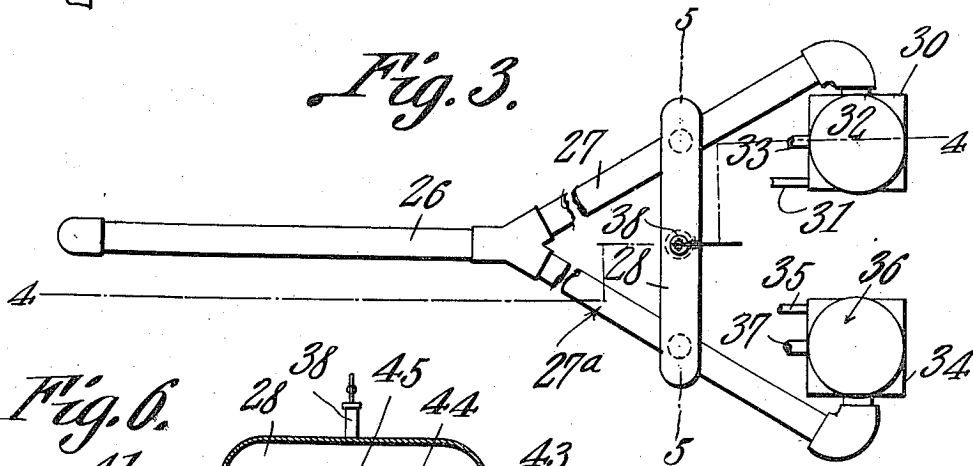
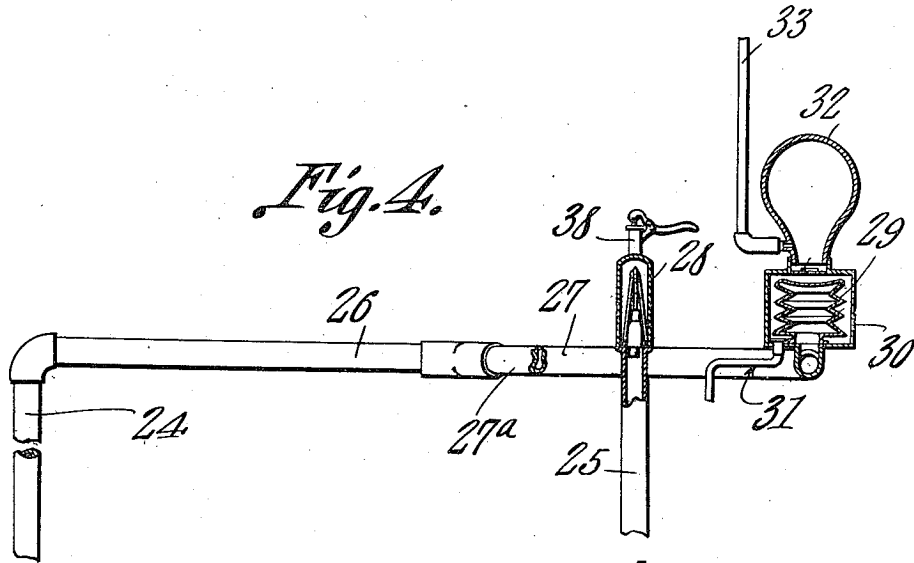
By *Cadnow & Co.*  
Attorneys

J. R. THOMPSON.  
 HYDRAULIC RAM.  
 APPLICATION FILED FEB. 23, 1910.

974,724.

Patented Nov. 1, 1910.

2 SHEETS—SHEET 2.



Inventor

John R. Thompson.

Witnesses

*E. P. Stewart*  
*M. Schmidt*

By *C. A. Snowles*  
 Attorney

# UNITED STATES PATENT OFFICE.

JOHN R. THOMPSON, OF FLOMATON, ALABAMA.

## HYDRAULIC RAM.

974,724.

Specification of Letters Patent.

Patented Nov. 1, 1910.

Application filed February 23, 1910. Serial No. 545,460.

### *To all whom it may concern:*

Be it known that I, JOHN R. THOMPSON, a citizen of the United States, residing at Flomaton, in the county of Escambia and State of Alabama, have invented a new and useful Hydraulic Ram, of which the following is a specification.

This invention relates to a hydraulic ram designed more particularly for elevating water from a source different from that of the water employed for driving the ram, in order that water which is unfit for use may be employed to elevate pure water from another source.

The invention consists, essentially, in a ram of peculiar construction which is connected to a flexible bag or the like mounted in a closed chamber connected to a source of pure water supply. The operation of the ram serves to alternately distend and contract the bag, thereby causing water to be drawn into and expelled from the chamber.

The invention also has for its object to provide an improved form of waste valve, together with a structure which enables the ram to be connected to a siphon.

With the herein stated objects in view, the invention consists in a novel construction and arrangement of parts to be hereinafter described and claimed, reference being had to the accompanying drawings, in which—

Figures 1 and 2 are vertical sectional views of two slightly different forms of the invention. Fig. 3 is a plan view of another form of ram. Fig. 4 is a section on the line 4—4 of Fig. 3. Fig. 5 is a cross section on the line 5—5 of Fig. 3. Fig. 6 is an enlarged section of one of the valves shown in Fig. 5.

Referring more particularly to Figs. 1 and 2 of the drawings, 10 denotes, in each instance, the drive pipe of the ram. In the apparatus shown in Fig. 1, a closed chamber 11 is connected to the drive pipe by a short branch pipe 12. Within the chamber 11 is located a flexible bag 13, the mouth of which is firmly secured to the bottom of the chamber over the branch 12 so that the water flowing in the drive pipe may enter the bag. A fluid tight joint is provided between the bag and the chamber, in order that none of the water of the ram may enter the chamber.

The chamber 11 is entered by a pipe 14 leading to a spring or other source of pure water supply. The discharge end of this pipe is provided with a check valve 15.

The discharge from the chamber 11 is

through the top thereof into an air chamber 16, from which a pipe 17 leads to the place of use of the water. Return flow of the water from the air chamber is prevented by an ordinary check valve 18 as usual.

The drive pipe 10 is provided with the usual waste valve 19 located adjacent to the chamber 11.

In operation, the pipe 14 will be connected to a spring or other source of pure water supply as already stated. The drive pipe 10 may be connected to any other source of supply having a suitable head to insure the proper operation of the ram. The water for operating the ram proper need not be pure water as no part of it enters the chamber 11. It is therefore possible to operate the ram with dirty water.

The operation is as follows: When the valve 19 is closed, the water in the drive pipe 10 backs up in the bag 13 and distends the same, which forces the water out of the chamber 11 into the air chamber 16, from which it flows through the pipe 17 to the place of use. When the valve 19 opens, the water flows out of the bag 13, and the latter therefore contracts, which produces suction in the chamber 11, whereupon the valve 15 opens, and lets water from the pipe 14 into the chamber.

If it is desired to use some of the dirty ram water, the arrangement illustrated in Fig. 2 is provided. The structure is the same as the one already described, with the exception that a pipe 20 enters the mouth of the bag 13, this pipe extending through the bottom of the chamber 11. A fluid tight joint is provided in order that none of the water in the bag 13 may escape into the chamber 11. The pipe 20 leads to the place of use of the water, and is provided with a check valve 21 for preventing the water from flowing back into the bag 13. The pipe 20 is also provided with a valve 22 for shutting off the water when not needed. To the pipe 20, between the check valve 21 and the valve 22, is connected a stand pipe 23, which serves as an air chamber to maintain a steady and uniform flow in the pipe 20.

The operation of the form of apparatus just described, is the same as the apparatus shown in Fig. 1, with the exception that some of the water from the ram entering the bag 13, is also elevated to a place of use.

In the form of apparatus illustrated in Figs. 3 to 5, the ram is interposed in the



apex of a siphon, the flow through the siphon serving to operate the ram. The short leg of the siphon is indicated at 24, and the long leg at 25, these two legs being  
 5 connected by a pipe 26 connected by two branches 27 and 27<sup>a</sup> respectively, to a chamber 28. The long leg 25 of the siphon leads from this casing. The pipe 27 is also continued so as to discharge into a flexible bag  
 10 29 located in a chamber 30 which is entered by a pipe 31 leading to a source of pure water supply, the arrangement being the same as in Figs. 1 and 2. The chamber 30 discharges into an air chamber 32, from  
 15 which a pipe 33 leads the water to the place of use, as before. The pipe 27<sup>a</sup> is also continued so as to enter a flexible bag mounted in a chamber 34 connected by a pipe 35 to a  
 20 source of pure water supply, and discharging into an air chamber 36, from which a pipe 37 leads to the place of use of the water. The chamber 28 is made air tight, and a pump 38 is connected thereto for exhausting the air, to start the siphon.  
 25 In the bottom of the chamber 28 are openings in which are screwed sleeves 39 and 40 respectively, communicating with the pipes 27 and 27<sup>a</sup>. The upper end of the sleeve 39 forms the seat of a valve 41, and the corresponding end of the sleeve 40 forms the seat  
 30 of a valve 42. These valves operate alternately, they being connected by stems 43 to an oscillating beam 44 pivoted intermediate its ends as indicated at 45 to a standard 46  
 35 mounted in the chamber 28, the stems 43 being connected to the respective ends of the beam. It will be evident that by this connection between the valves they will be caused to operate alternately, one of said  
 40 valves closing, while the other is opening. The water therefore flows into the chamber 28 from the pipes 27 and 27<sup>a</sup> alternately. The sleeves are adjustable to regulate the strokes of the valves.  
 45 In operation, the chamber 28 is exhausted to start the siphon. As already stated the valves 41 and 42 operate alternately, and the water flows from the short leg 24 of the siphon into the long leg 25 by the way of  
 50 the chamber 28, the water being conducted

into the chamber by the branch pipes 27 and 27<sup>a</sup>, these pipes discharging into the chamber alternately. When the valve 41 is closed, the water in the branch pipe 27 flows  
 55 into the flexible bag 29 and distends the same, thus expelling the water from the chamber 30. When the valve 41 opens, the water in the pipe 27 flows into the chamber 28, and the bag 29 also empties, thereby  
 60 creating suction in the chamber 30 and causing the latter to fill through the pipe 31. The same action takes place in the mechanism connected to the branch pipe 27<sup>a</sup>.

By the arrangement last described, a double acting ram and pump is had which delivers a large supply of water in a steady  
 65 stream.

What is claimed is:

1. The combination with a ram having a branched drive pipe, of flexible bags into  
 70 which said branches discharge, a chamber inclosing each of said bags, and connected to a source of water supply, and each of said chambers having an outlet, a second chamber with which the branch pipes com-  
 75 municate, said chamber having an outlet, and alternately operating valves for controlling the flow from the branch pipes into the last mentioned chamber.

2. The combination with a ram having a branched drive pipe, of a flexible bag con-  
 80 nected to each of said branches, a chamber inclosing each bag, and connected to a source of water supply, and each of said chambers having an outlet, a second chamber in com-  
 85 munication with the branches of the drive pipe, said chamber having an outlet, a standard mounted in the last mentioned chamber, an oscillating beam pivoted to the standard, and valves carried by the respective ends  
 90 of the beam for alternately opening the branches of the drive pipe to the last mentioned chamber.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature  
 95 in the presence of two witnesses.

JOHN R. THOMPSON.

Witnesses:

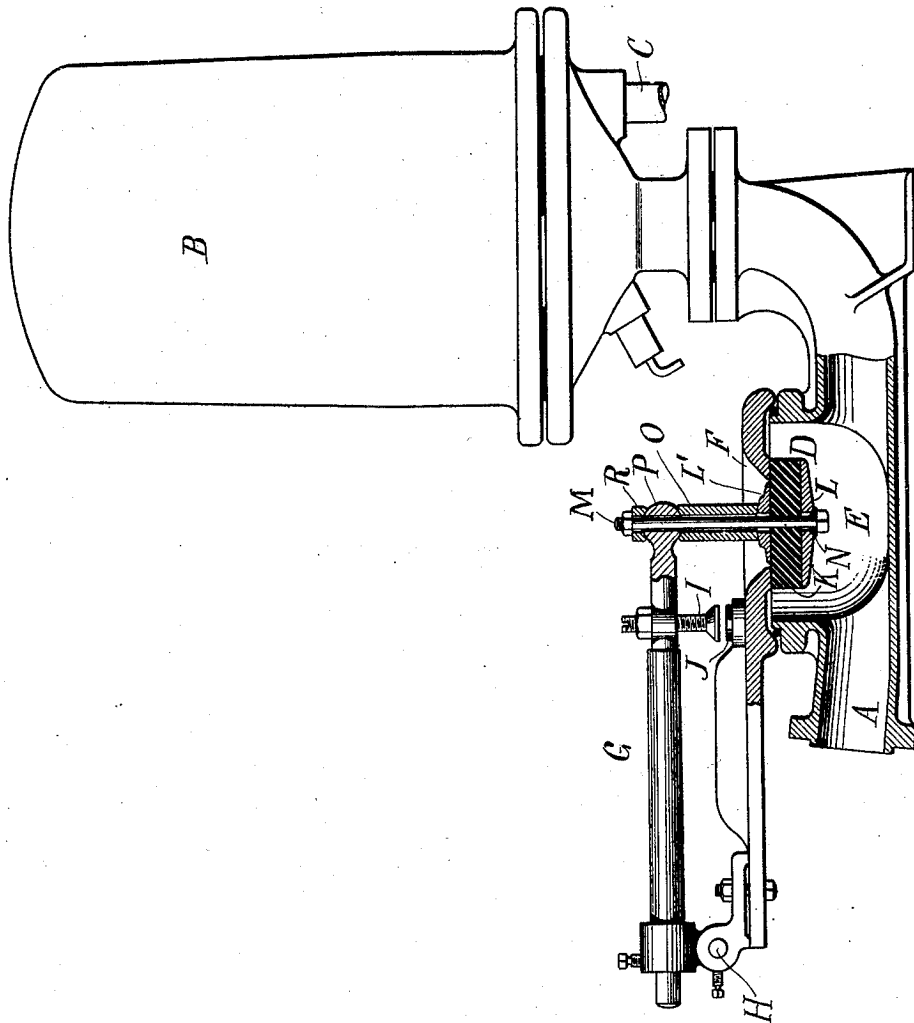
J. N. JOHNSON,

JAMES A. THORNTON.

B. J. CARROLL.  
HYDRAULIC RAM.  
APPLICATION FILED DEC. 30, 1909.

976,546.

Patented Nov. 22, 1910.



Bradish J. Carroll  
Inventor,

Witnesses:  
L. J. Schilling.  
Ed. Davenport.

By his Attorneys  
Kerr, Page, Cooper & Hayward

# UNITED STATES PATENT OFFICE.

BRADISH J. CARROLL, OF NEW YORK, N. Y., ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

## HYDRAULIC RAM.

976,546.

Specification of Letters Patent.

Patented Nov. 22, 1910.

Application filed December 30, 1909. Serial No. 535,630.

*To all whom it may concern:*

Be it known that I, BRADISH J. CARROLL, a citizen of the United States, residing at New York, in the county and State of New York, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a full, clear, and exact description.

This invention relates to hydraulic rams, more particularly to the mounting of the "waste" or "working" valve which enables the fluid to acquire the momentum necessary to drive it into the air chamber. It is of course important that the working valve be tightly seated when closed, as leakage at that time would impair the efficiency of the ram. Considerable difficulty has been experienced in securing this desired close fit of the valve and its seat, particularly after the apparatus has been in use for some time, as wear of the moving parts, or catching of the valve on a piece of wood, pebble, or other foreign object, tends to displace the valve and so cause it to seat improperly.

My present invention is designed to obviate this difficulty by means of a novel form of mounting, of such character that not only the original positioning of the valve may be readily and accurately effected but also that the repeated engagement of the valve with its seat will restore the valve to its proper adjustment in case it should happen to be disturbed.

To this and other ends the invention which I desire to cover consists in the novel features and combinations of elements hereinafter described.

A convenient and effective embodiment of the invention is illustrated in the annexed drawing, in which the apparatus is shown partly in section.

The drive pipe A is connected with the usual air chamber B, provided with a suitable check valve, not shown, constructed to prevent the water from flowing back into the drive pipe. The air chamber also has a delivery pipe C for conveying the water to the point of utilization. The waste or working valve D works in a chamber E, and is arranged to bear on a seat F at the top of the valve chamber. For this purpose the valve is mounted on a horizontal lever or arm G, pivotally supported at H and provided with an adjustable stop I arranged to strike a resilient or yielding base J and

so limit the downward movement of the lever. The drive pipe being connected with a suitable elevated source or "head" of water and the working valve depressed (by gravity), the water pours out past the valve, through the seat, thereby acquiring a certain amount of momentum, sufficient to carry the valve upward against its seat. The water, thus diverted, is carried by its momentum up into the air chamber, relieving the pressure on the working valve and permitting the same to fall again, whereupon the operation described is repeated. In this way the air in the air chamber is compressed, and the water therein forced to the point of utilization by the air pressure.

It is clear that the working valve in closing should fit tightly on its seat, since, as before stated, leakage would impair the efficiency of the ram. My present invention is designed to provide a mounting for the working valve which will enable this desired close fit to be secured and maintained.

In the embodiment illustrated in the drawing the body, K, of the valve, is mounted between a lower supporting disk L and an upper clamping disk L', and extending upwardly through these three parts is a binding bolt or tie rod M, the apertures through which the bolt passes being somewhat larger than the latter, as shown. Between the head of the bolt and the lower disk is a washer N, the upper surface of which is spherically convex, cooperating with a correspondingly concave seat on the disk L around the aperture through which the bolt passes. The top of the upper disk L' is also spherically convex, cooperating with the similarly concave lower end of a short tubular member or stem O loosely encircling the bolt. The upper end of this member is likewise spherically concave, to fit the spherical lower face of the end of lever G, which end is preferably in the form of a ball, as shown at P. Between the lever-end and the bolt nut is a washer R concave on its lower face to fit the upper side of the ball, and the apertures in the ball and washer are larger than the bolt so as to allow more or less play of the latter.

The spherical engaging surfaces described permit adjustment of each part in every direction. In assembling the device, the parts are arranged as shown, but the nut on the bolt M is not set up, so as to leave all the

parts loose. Hence when the lever is raised the valve disk K will seat itself accurately on the seat F. The nut is now tightened, binding all the parts firmly together and leaving the valve in proper adjustment. If in the operation of the ram this adjustment should be disturbed the subsequent impacts in closing will cause the valve to right itself, and even if the parts should work loose their universal adjustability will permit the valve to close properly. In any event mere tightening of the binding nut while the valve is held closely to its seat will restore the original adjustment.

From the foregoing it will be seen that my invention provides a self-adjusting working or waste valve, which has no tendency to get out of adjustment but on the contrary always tends to keep itself in the proper relation to its seat.

The embodiment specifically described herein is simple and thoroughly effective for its purpose, but it is to be understood that the invention is capable of being embodied in other forms without departure from its proper spirit and scope.

I claim:

1. In a hydraulic ram, the combination with a drive pipe, and a valve seat, of a working valve cooperating with said seat, a movable support for the valve, and means for attaching the valve to its support, comprising a plurality of universally adjustable members and means for binding said parts, valve, and support rigidly together in adjusted position.

2. In a hydraulic ram, the combination of a movable support, a working valve, a universally adjustable member between the valve and the support, and a binding bolt for securing the parts rigidly together in adjusted position.

3. In a hydraulic ram, in combination, a movable support having a convex face, a working valve having a stem provided with a concave face fitting said convex face, a binding bolt serving to bind said parts rigidly together in adjusted position, and a seat for the valve.

4. In a hydraulic ram, in combination, a movable support having opposite convex faces, a working valve having a stem provided with a concave face fitting one of the convex faces on the support, a concave washer fitting the other convex face on the support, and a binding bolt extending through the stem, support, and washer.

5. In a hydraulic ram, in combination, a movable support, a working valve provided with a concave seat, a binding bolt extending through the valve and the support, and a convex washer between the head of the bolt and the valve and fitting the said concave seat.

6. In a hydraulic ram, in combination, a working valve comprising a disk of yielding material, a lower supporting disk having a central aperture and a concave seat around the aperture, a convex washer fitting said seat, an upper clamping disk having a central aperture and a convex face around the aperture, an upwardly extending tubular stem having concave ends the lower of which engages said convex face on the upper disk, a movable support having a lower convex face fitting the upper concave end of the tubular stem, and having an upper convex face, a concave washer fitting the upper convex face of the support, and a binding bolt extending through the valve disks, the stem, washers, and supports, and binding the same firmly together.

7. In a hydraulic ram, a horizontal supporting lever having a ball end provided with a vertical aperture, an apertured washer having a concave face fitting the upper side of said ball end, a tubular stem having an upper concave face fitting the under side of said ball end, a working valve, and a binding bolt extending from the valve through the stem, ball end and washer.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

BRADISH J. CARROLL.

Witnesses:

M. LAWSON DYER,  
S. S. DUNHAM.

G. W. WALTERS.  
 HYDRAULIC RAM.  
 APPLICATION FILED SEPT. 21, 1910.

992,524.

Patented May 16, 1911.

FIG. 1

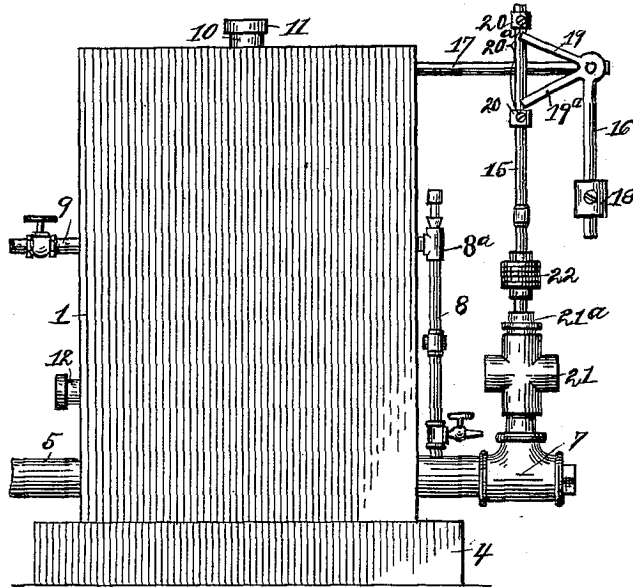


FIG. 2

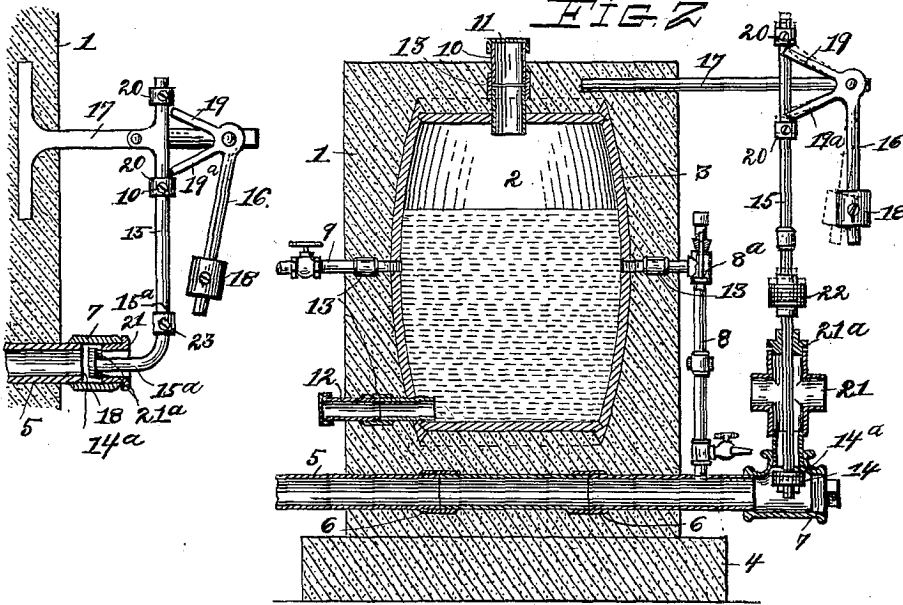
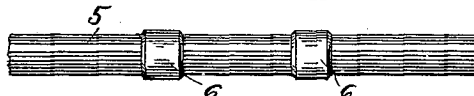


FIG. 4



Witnesses.

J. C. Turner  
 A. C. Otter

Inventor.

Ges. W. Walters  
 by

Obel & Willman, Attorney.

# UNITED STATES PATENT OFFICE.

GEORGE WILLIAM WALTERS, OF SHARON, PENNSYLVANIA.

## HYDRAULIC RAM.

992,524.

Specification of Letters Patent. Patented May 16, 1911.

Application filed September 21, 1910. Serial No. 583,013.

*To all whom it may concern:*

Be it known that I, GEORGE W. WALTERS, a citizen of the United States, residing at Sharon, in the county of Mercer and State of Pennsylvania, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

My invention relates to improvements in hydraulic rams, the primary object being to provide a generally improved hydraulic ram of simple, cheap, and efficient construction, better adapted to its intended purposes than any other device of the same class with which I am acquainted.

The invention relates more particularly to improved mechanism for operating the impact or escape valve and means for regulating the sensitiveness as well as the frequency and length of stroke of the latter.

The improved impact valve is provided with pendulum mechanism adapted to perform the following functions: (1) To more quickly close the impact valve, thus preventing an unnecessary waste of the operating fluid. (2) To more quickly open the impact valve after the necessary impact or impetus has been given, thus giving the valve action greater speed, and (3) To provide a more rapid stroke or pulsation of the impact valve and regulate the same through the medium of an adjustable pendulum weight, thus enabling the ram to work faster in pumping water, and to perform its functions with less loss of the operating fluid.

With the above mentioned ends in view, the invention consists in the novel construction, arrangement and combination of parts, hereinafter described, illustrated in one of its embodiments in the accompanying drawings, and particularly pointed out in the appended claims.

Referring to the drawings, forming a part of this specification, Figure 1 is a side elevation of a hydraulic ram constructed in accordance with my invention, the improved impact valve and pendulum mechanism being shown in an intermediate position. Fig. 2, a central vertical sectional view of the same. Fig. 3, a side elevation of a modified form of impact valve and pendulum mechanism. Fig. 4, a side view of the improved drive or impact pipe.

Similar numerals of reference designate

like parts throughout all the figures of the drawings.

The parts of the improved hydraulic ram are particularly designed and adapted for use in connection with a concrete body 1, of any suitable and convenient form or configuration for containing the air chamber 2, of the improved ram. The concrete may be molded about a barrel 3, or other suitable vessel to form the air chamber and mounted upon a suitable foundation 4, and suitably submerged in the earth to protect it from sudden changes in temperature.

The drive pipe 5, is mounted in the lower portion of the concrete body and connected to a suitable source of supply, said drive pipe being anchored in the concrete body by means of annular shoulders 6. These retaining shoulders may either take the form of pipe coupling members as shown in Fig. 2, or may be cast integral with the drive pipe 5, as shown in Fig. 4.

The drive pipe 5, is provided at one end with an impact valve-body 7, and is intersected by means of a conduit pipe 8, leading upwardly and entering into the air chamber 2.

The barrel or vessel 3, forming the air chamber is provided with a valved delivery pipe 9, adapted to conduct the water to any suitable place desired; said barrel or vessel being also provided with a vertical pipe 10, at its top having the cap 11, and a horizontally extending drain-pipe 12, at its bottom to be used in cleaning out the barrel or receptacle 3, when desired. The pipes 8, 9, 10 and 12, are likewise provided with anchoring shoulders or sleeves 13, for securing the respective pipes in the concrete body. The conduit pipe 8, is provided with a check valve 8<sup>a</sup>, operating in a well known and understood manner.

The impact valve-body 7, is provided with an impact valve 14, said impact valve being carried upon a movable or reciprocatory valve-stem 15, adapted to cooperate with and to be actuated by the pendulum mechanism hereinafter described.

A pendulum member 16, is mounted upon a supporting arm 17, embedded in and extending from the concrete body 1, said pendulum member having its depending portion provided with an adjustably mounted pendulum weight 18. The pendulum mem-

ber is provided with a pair of laterally extending arms or fingers 19 and 19<sup>a</sup>, interposed between and adapted to alternately engage and clear a pair of adjustably mounted stop blocks 20.

The impact valve 14, when closed is adapted to be seated upon a valve seat 14<sup>a</sup>, in the valve-body 7, and in the form of reciprocatory or vertically movable valve stem shown in Figs. 1 and 2, said valve-stem may be mounted in an overflow or waste housing 21, and as a means for cushioning the valve and stem when moved to its open position, a resilient block 22, of rubber or other suitable material may be mounted upon the valve-stem so as to impinge upon the bearing member 21<sup>a</sup>, of the housing 21, as the valve is moved to its extreme open position.

The operation of the impact valve and the pendulum mechanism is as follows: When the impact valve is in its extreme open position and below the intermediate position shown in Figs. 1 and 2 of the drawings, and is wasting water through the valve and waste housing, the upper arm or finger 19, upon the return of the pendulum, will strike the upper stop block 20, and thus start the valve toward its seat, and the valve thus started is forced by the rush or impetus of the water upwardly with such force that the lower stop 20, will strike the lower arm or finger 19<sup>a</sup>, of the pendulum, carrying the depending portion of the pendulum with its weight to a position to the extreme left, and the upper stop block 20, will be carried upwardly to a position sufficiently high to clear the free ends of the arms or fingers 19 and 19<sup>a</sup>, as the pendulum swings. On the return swing of the pendulum, the lower arm or finger 19<sup>a</sup>, will strike the lower stop block 20, and thus start the valve downwardly off of its seat, and when in its extreme open position, the lower stop block is in a position to clear the ends of the arms or fingers 19 and 19<sup>a</sup>, as the pendulum swings or returns to its full stroke at the extreme right, after which the return motion above described again takes place and the action is repeated, the waste of the water from the impact valve taking place while the pendulum swings to the right and returns to the left. By adjusting the stop blocks 20, through the medium of the set screws 20<sup>a</sup>, the sensitiveness of the valve and the length of its throw or stroke may be regulated as well as regulating the swing of the pendulum. By varying the adjustment

of the pendulum weight, the speed of the valve action may be likewise regulated.

In the modified form of pendulum mechanism shown in Fig. 3, the valve-stem 15, receives an oscillatory motion by being pivoted upon the supporting arm 17, opposite the-pivoted portion of the pendulum member 18, the action of the lower or free end 15<sup>a</sup>, of the valve-stem carrying the valve 14, with respect to the vibratory movements of the pendulum member being opposite to that shown in Figs. 1 and 2, as is obvious. If desired, a weight 23, may be adjustably mounted upon the lower or free end 15<sup>a</sup>, to regulate the sensitiveness of the valve 14, the latter being adapted in its open position to abut or impinge upon small stop members 21<sup>a</sup>, of the waste housing to permit the outflow of the water or operating fluid.

From the foregoing description, taken in connection with the accompanying drawings, the operation and advantages of my invention will be readily understood.

Having thus described an embodiment of my invention, what I claim and desire to secure by Letters Patent is,—

1. In a hydraulic ram, an impact valve provided with a stem, stop blocks adjustably mounted thereon, and a pendulum member provided with laterally extending arms adapted to alternately engage and clear said stop blocks.

2. In a hydraulic ram, a drive pipe and impact valve having a valve stem, stop blocks adjustably mounted on said valve stem, a pendulum member provided with laterally extending arms adapted to alternately engage said stop blocks, and a weight adjustably mounted on said pendulum member.

3. In a hydraulic ram, a drive pipe provided at its end with an open valve body, a supporting arm, a vibratory valve stem pivoted on said arm and having its free end extending into said open valve body and provided with a valve, stop blocks adjustably mounted on said valve stem, and a pendulum member pivoted on said supporting arm and provided with arms adapted to alternately engage said stop blocks.

In testimony whereof I have affixed my signature, in presence of two witnesses.

GEORGE WILLIAM WALTERS.

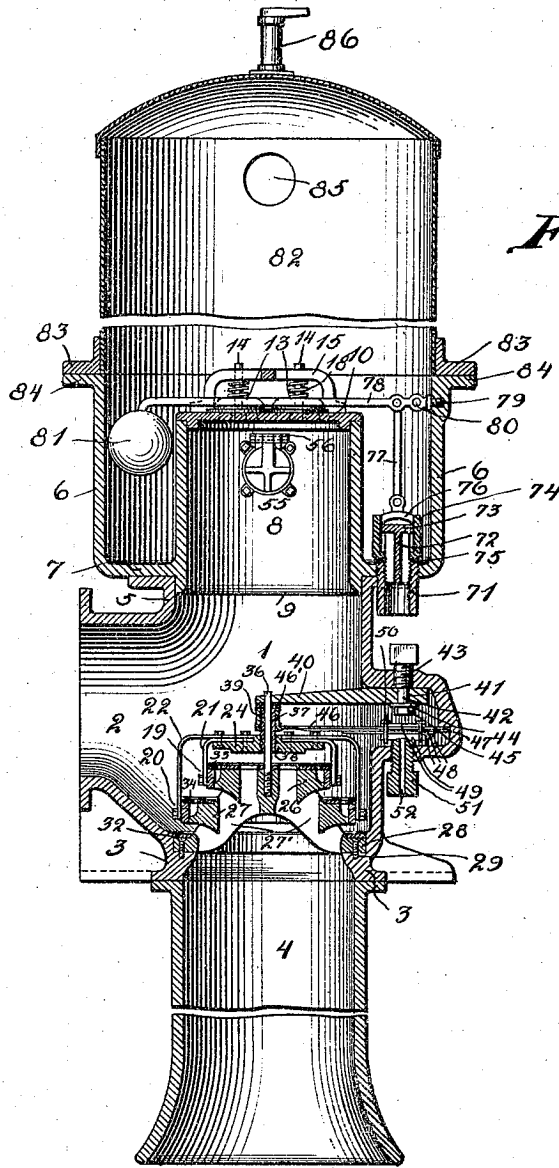
Witnesses:

CHARLES FREDRICK WALTERS,  
THOMAS T. PETRINI.

S. B., C. E. & W. R. HILL.  
 AIR COMPRESSOR.  
 APPLICATION FILED FEB. 11, 1911.

1,005,212.

Patented Oct. 10, 1911.  
 2 SHEETS—SHEET 1.



*Fig. 1.*

Witnesses

*J. Milton Jester*  
*R. P. Schurme*

By

Inventors  
*Stirling B. Hill*  
*Climie E. Hill*  
*William R. Hill*

*C. L. Parker*  
 Attorney



1,005,212.

Patented Oct. 10, 1911.

2 SHEETS—SHEET 2.

Fig. 2.

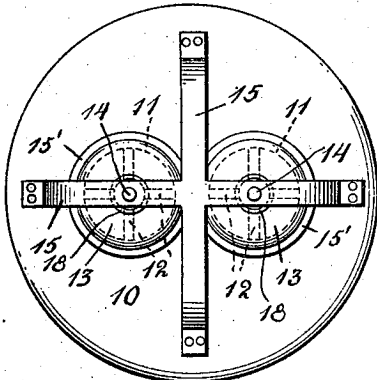


Fig. 4.

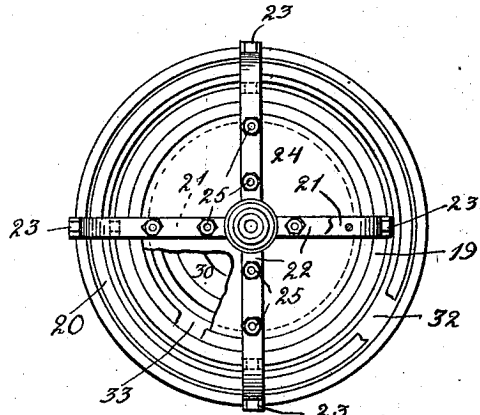


Fig. 3.

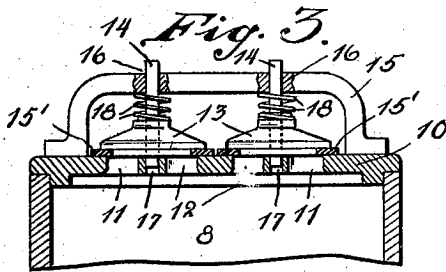


Fig. 5.

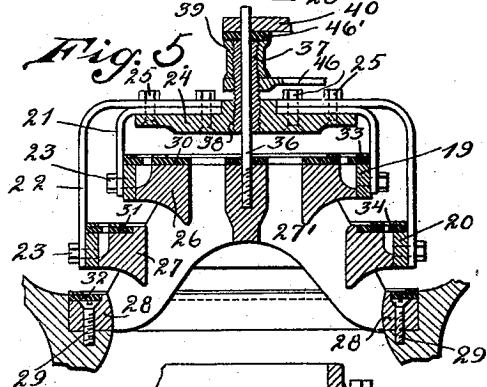
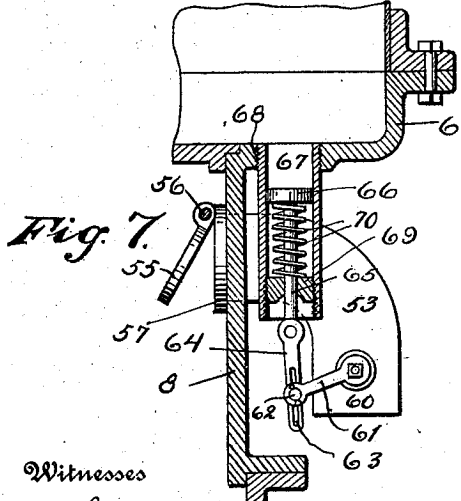
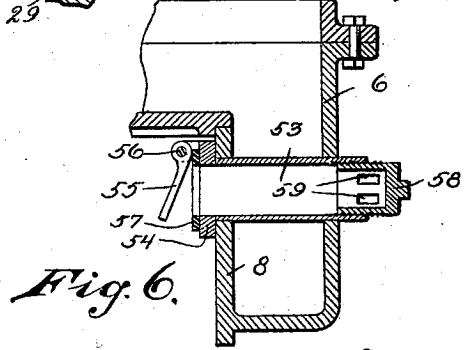


Fig. 7.



Witnesses  
 J. Milton Jester  
 R. M. Hillman

Fig. 6.



Inventors:  
 Stirling B. Hill  
 Climie E. Hill  
 William R. Hill  
 C. L. Parker  
 Attorney

# UNITED STATES PATENT OFFICE.

STIRLING B. HILL, CLIMIE E. HILL, AND WILLIAM R. HILL, OF SEATTLE, WASHINGTON.

AIR-COMPRESSOR.

1,005,212.

Specification of Letters Patent. Patented Oct. 10, 1911.

Application filed February 11, 1911. Serial No. 608,076.

*To all whom it may concern:*

Be it known that we, STIRLING B. HILL, CLIMIE E. HILL, and WILLIAM R. HILL, citizens of the United States, residing at Seattle, in the county of King and State of Washington, have invented certain new and useful Improvements in Air-Compressors, of which the following is a specification.

Our invention relates to air compressors and particularly to such a device employing air compressing means in the embodiment of a hydraulic ram.

An important object of this invention is to provide means whereby the hydraulic ram principle may be employed to compress air.

A further object of this invention is to provide an air compressor of the above character, which is positive, continuous, and automatic in operation.

A further object of this invention is to provide an air compressor including a hydraulic ram, and means for automatically varying the amount of air conducted to the ram to be compressed, whereby as the pressure fails in the air storage tank said means is operated to admit a larger amount of air into the ram.

Other objects and advantages of this invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same, Figure 1 is a central vertical sectional view taken through a device illustrating our invention. Fig. 2 is an enlarged plan view of the air discharge valves; Fig. 3 is a side view of the same, and its associated members shown in section, Fig. 4 is a plan view of the waste valve structure, Fig. 5 is a central vertical sectional view taken through the same, Fig. 6 is a longitudinal sectional view taken through the air supply pipe, and Fig. 7 is a side view of a different form of air supply pipe, together with automatic means for controlling the outer valve, said means being shown partly in section and partly in elevation.

In the drawings wherein is illustrated a preferred embodiment of our invention, a hydraulic ram is shown, comprising a central body casing 1, having one side thereof provided with a flanged nipple 2, which is adapted for connection with a drive pipe,

(not shown). The lower end of this body casing is provided with a flanged nipple 3, which is suitably connected with a waste pipe 4. The upper end of the body casing 1 is provided with a flanged nipple 5, upon which is mounted a preferably cylindrical water-collecting receptacle 6, which is secured thereto by any suitable means. The lower end of this water-collecting receptacle is partially closed by an annular bottom 7, centrally upon which is formed an upstanding preferably cylindrical casing 8. This casing 8 is concentrically arranged with relation to the casing 6, and extends downwardly below the annular bottom 7 to form an annular flange 9, which snugly fits within the nipple 5. The casing 8 forms in effect a continuation of the nipple 5. The casing 8 has its upper end closed by a head 10, secured thereto by any suitable means. This head is provided with a suitable number of openings 11 formed therethrough, within which openings are disposed spiders 12, having suitable connection with said head 10. The passage of material through the openings 11 is controlled by upwardly opening valves 13, which are rigidly mounted upon stems 14. Rigidly mounted upon the upper surface of the head 10, is a large spider 15, having openings 16 formed therethrough to slidably receive the stems 14. The lower ends of these stems are movably mounted within openings 17, which are formed through the spiders 12, as clearly shown in Fig. 3. Disposed upon the upper surface of the head 10 are packing rings 15', surrounding the openings 11 and engaged by the valves 13. The valves 13 are urged into engagement with the packing rings by compressible coil springs 18, as shown.

The discharge of water through the nipple 3 is controlled by a waste valve structure, comprising a plurality of annular valves 19 and 20, the valve 19 being disposed above the valve 20 and spaced therefrom in concentric relation. The annular valves 19 and 20 are rigidly connected with preferably diametrically disposed pairs of curved rods 21 and 22 respectively, as shown at 23. The pairs of curved rods 21 and 22 are bolted together and with a vertically movable disk-valve 24, as shown at 25. The valves 19 and 20 are disposed outwardly of and have slidable engagement with annular

superposed spaced valve-seats 26 and 27, respectively. The annular valve-seats are preferably cast integral with a spider 27, the lower ends of the diametrically arranged arms of which have connection with a ring 28, which ring is connected with the nipple 3 by means of screws 29, or the like. The ring 28 serves as a valve-seat for the valve 20. The valve-seats 26, 27 and 28 have respectively, packing rings 30, 31, and 32, suitably secured upon the upper faces thereof, as shown. The annular valves 19 and 20 have packing rings 33 and 34 respectively, which packing rings extend inwardly beyond such valves for engagement with reduced outer portions of the valve-seats 26 and 27. The spider 27 has rigid connection at its upper central portion with a vertical rod 36, and a sleeve 37 is slidably mounted upon this rod, as shown. The sleeve 37 has screw threaded engagement with the disk-valve, as shown at 38. Disposed above the disk-valve 24 is a spool 39 which has screw threaded engagement with the sleeve 37, as shown. The upper end of the vertical rod 36 is slidably mounted within an opening formed through the inner end of a stop-arm 40, which has its outer end provided with an opening 41 formed therethrough, for rotatably receiving a cylindrical end portion 42 of a bolt 43. The lower end of the portion 42 is provided with a washer and nut 44 and 45, respectively. The bolt 43 is screw threaded through the body casing 1 and may be rotated to raise and lower the stop-arm 40. The spool 39 carries shock absorbing material 46 upon its upper end and such material is also secured upon the spider 27 adjacent the rod 36. The limit of upward movement of the disk-valve 24 is regulated by the relative position of the stop-arm 40. Disposed adjacent the lower end of the spool 39 is a leaf-spring 46, the inner end of which has slotted engagement with the sleeve 37. The leaf-spring is formed of a plurality of spring leaves. The outer end of the leaf-spring 46 is disposed under a shoulder 47 formed upon the casing 1. The leaf-spring 46 is formed of a plurality of spring leaves 48, as above stated, which carry plates 49, said plates being secured together by clamps 50. The lower plate 49 is provided with a curved recess to receive the upper curved end of a bolt 51, having screw-threaded engagement with the casing 1, and provided with an axial opening 52, formed therethrough. The leaf-spring is tensioned to hold the disk-valve 24 in its uppermost position. The tension of the leaf-spring may be changed by manipulating the bolt 51, or by raising said leaf-spring by inserting a tool through the opening 52.

As shown in Fig. 6, an air supply pipe 53 is provided, the same passing through the

collecting receptacle 6 and the cylindrical casing 8. The inner end of the pipe 53 discharges through a ring 54, to which is pivotally connected an inwardly opening check valve 55, as shown at 56. This check valve engages a packing ring 57. The amount of air supplied through the pipe 53 is regulated by a rotatable valve 58, having screw-threaded engagement with the outer end of the pipe 53. This valve is provided with openings 59 formed therethrough. By rotating the valve 58 the openings 59 may be partially closed or opened to regulate the amount of air passing through the pipe 53.

In Fig. 7, we have shown automatic means for regulating the amount of air supplied through the pipe 53. In this form of the invention the pipe 53 may preferably be curved and has communication with the interior of the upper end of the cylindrical casing 8. The collecting receptacle 6 is slightly modified to afford a space for the pipe 53. The passage of air through the pipe 53 is controlled by a valve structure 60, which is operated by a crank 61. This crank carries a pin 62 operating in a slot 63, which is formed through a link 64. This link has its upper end pivotally connected with a rod 65, having connection with a piston 66, which is slidably mounted within a cylinder 67. The cylinder 67 has its upper open end screw-threaded into the collecting receptacle 6, as shown at 68. The rod 65 operates through a nut 69, which is externally screw-threaded for engagement with the internally screw-threaded lower portion of the cylinder 67. The downward movement of the piston 66 is opposed by a compressible coil spring 70, having engagement with the nut 69. It will thus be seen that the tension of this coil spring may be varied by rotating the nut 69. From the construction of the above referred to parts, it is obvious that when the air pressure in the collecting receptacle 6 reaches a certain degree, the piston 66 will be forced downwardly to oscillate the valve structure 60, whereby the air supply through the pipe 53 is reduced proportionally. As the pressure falls in the collecting receptacle 6, the piston 66 is raised by the spring 70 and a larger amount of air is supplied through the pipe 53.

The lower closed end of the collecting receptacle 6 (see Fig. 1) is provided with a screw-threaded opening for receiving a section of pipe 71, which has its upper end internally screw-threaded for engagement with a stationary guide 72, which is approximately X-shaped in cross-section. This guide carries a circular head 73 about which is slidably mounted an annular valve 74. The valve 74 engages a packing ring 75. The valve 74 is pressure balanced. The upper end of the annular valve 74 is connected with an arch 76, having pivotal con-

nection with a link 77. This link has its upper end pivotally connected with a horizontal swinging rod 78, which in turn is pivotally connected with a stationary bolt 5 79, as shown at 80. The swinging rod 78 extends across the head 10 and the free end thereof is connected with a float 81, which is disposed within the annular space of the collecting receptacle 6. An air pressure storage 10 tank 82 is disposed above the collecting receptacle 6 and has free communication therewith. The lower end of the receptacle 82 carries an annular flange 83, which is suitably secured to a corresponding flange 84 15 carried by the upper end of the collecting receptacle 6. The compressed air is discharged through an opening 85 into a suitable pipe (not shown). The opening 85 is disposed near the upper end of the receptacle 20 82. The upper closed end of the receptacle 82 is provided with a pressure equalizer or safety valve 86 of any well known or preferred type.

In the operation of the device, assuming 25 that the waste valve is open, as shown in Fig. 1, the water in the drive pipe will begin to travel and flow through said waste valve to discharge into the pipe 4. As the water increases in velocity, the same by impinging 30 against the disk-valve 24, will close the waste valve. The pressure then rises in the casing 1 and said waste valve is retained in its closed position. As the water is discharging through the waste valve, as above described, 35 the same creates a partial vacuum in the casing 8, whereby the check valve 55 is unseated and said casing 8 filled with air. As soon as the pressure begins to increase in the casing 8, caused by the waste valve being 40 closed, as above described, the check valve 55 will be closed. As the water rises in the casing 8 the air contained therein is compressed and forced past the normally closed upwardly opening valves 13. This compressed 45 air is collected within the receptacles 8 and 82. Should the water also pass the valves 13, the same will be collected in the lower portion of the receptacle 8. When a certain amount of water is collected within 50 the receptacle 8, the float 81 is raised and the valve 74 raised, to discharge the water from the receptacle 6. It will thus be seen that automatic means are provided to prevent the amount of water held by the receptacle 8 55 from exceeding a certain amount. As soon as the velocity of the water in the drive pipe falls off, the pressure in the casing 1 is accordingly reduced so that the leaf-spring may return the waste valve to its open position. The operation is then repeated, as 60 above described. The amount of air supplied into the upper end of the casing 8, may be regulated by the operation of the valve 58 (see Fig. 6). This supply of air may be 65 automatically controlled according to the

increase or decrease of pressure in the tank 82, by the device shown in Fig. 7, and hereinabove described.

We wish it understood that the form of our invention herewith shown and described 70 is to be taken as a preferred example of the same and that certain changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of our invention or the scope of the sub- 75 joined claims.

Having thus described our invention, we claim:—

1. In an air compressor, the combination with a hydraulic ram structure including a 80 casing and a waste valve for controlling the passage of water from one end of the casing, of a shell connected with the casing and comprising a smaller inner shell where- 85 by an approximately annular space is provided between the inner and outer shells, the inner shell forming in effect a continuation of said casing, means for supplying air within the inner shell, means for controlling the passage of material from the 90 inner shell to the outer shell, means for discharging water from the lower end of the outer shell, a valve for controlling the passage of the water through the last named means, and means to move the last named 95 valve, including a lever having one end thereof pivotally connected with one side of the outer shell and extending across the inner shell and provided at its free end with a float. 100

2. In an air compressor, the combination with a hydraulic ram structure, of an air pressure storage tank having communication therewith, a pipe to supply air to the upper portion of said hydraulic ram structure, 105 a check valve to control one end of said pipe, and a valve to regulate the amount of air passing through said pipe when the check valve is open.

3. In an air compressor, the combination 110 with a hydraulic ram structure, of a receptacle having communication therewith, means for supplying air within said hydraulic ram structure, and means actuated 115 by the pressure within said receptacle to regulate the amount of air passing through the first named means.

4. In an air compressor, the combination with a hydraulic ram structure, of a receptacle having communication therewith, 120 means for supplying air within said hydraulic ram structure, a valve to regulate the amount of air passing through said means, a cylinder connected to and having communication with said receptacle, a piston 125 to operate within said cylinder, and means connecting said piston and valve.

5. In an air compressor, the combination with a hydraulic ram structure, of a receptacle having communication therewith, 130

- a pipe for supplying air to the hydraulic ram structure, a valve to regulate the amount of air passing through said pipe, a cylinder connected to and having communication with said receptacle, a piston to operate within said cylinder, means connecting said piston and valve, and a spring to oppose the movement of said piston caused by pressure in said receptacle.
6. In an air compressor, the combination with a hydraulic ram structure, of a receptacle having communication therewith, a pipe for supplying air within said hydraulic ram structure, a valve to regulate the amount of air passing through said pipe, a cylinder connected to and having communication with said receptacle, a piston to operate within said cylinder, means connecting said piston and valve, a spring to oppose the movement of said piston, and means to change the tension of said spring.
7. In an air compressor, the combination with a hydraulic ram structure, of a receptacle having communication therewith, a pipe for supplying air to said hydraulic ram structure, means for regulating the amount of air passing through said pipe, a valve for controlling the discharge of water from said receptacle, and means to move said valve.
8. In an air compressor, the combination with a hydraulic ram structure, of a receptacle having communication therewith, a pipe for supplying air to said hydraulic ram structure, means actuated by the pressure within said receptacle to vary the amount of air passing through said pipe, a

valve to control the discharge of water from said receptacle, and a float to move said valve.

9. In an air compressor, the combination with a hydraulic ram structure, of a receptacle connected therewith, comprising inner and outer walls, the inner wall forming in effect a continuation of said hydraulic ram structure, a head for closing the opening of the inner wall, valves for controlling the passage of air through said head, means to supply air to the interior of said inner wall, a valve to control the discharge of water from the space formed between the inner and outer walls of said receptacle, and a float disposed within said space to move said valve.

10. In an air compressor, the combination with a tank, of a second tank disposed therein, means for controlling the communication between the first and second named tanks, a pipe for supplying air within the second named tank, a valve to control the amount of air passing through said pipe, means actuated by the pressure within the first named tank to move said valve, and means to compress air within the second named tank.

In testimony whereof we affix our signatures in presence of two witnesses.

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CLIMIE E. HILL.  
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 AUTOMATIC RAM STARTER.  
 APPLICATION FILED JULY 6, 1911.

1,006,352.

Patented Oct. 17, 1911.

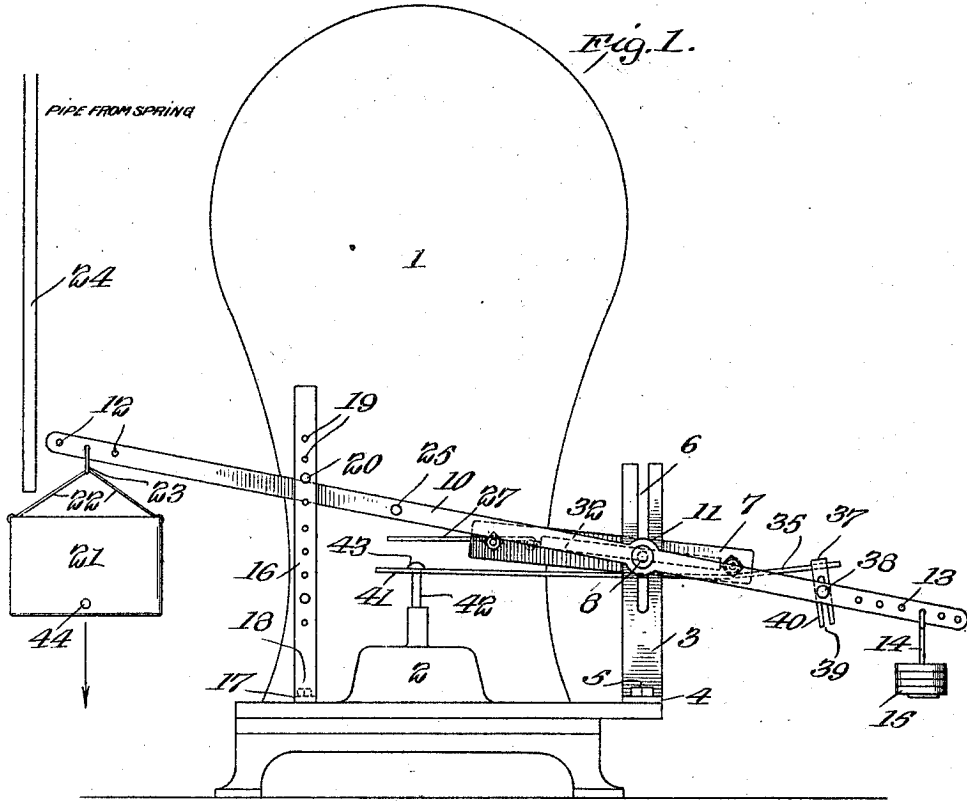
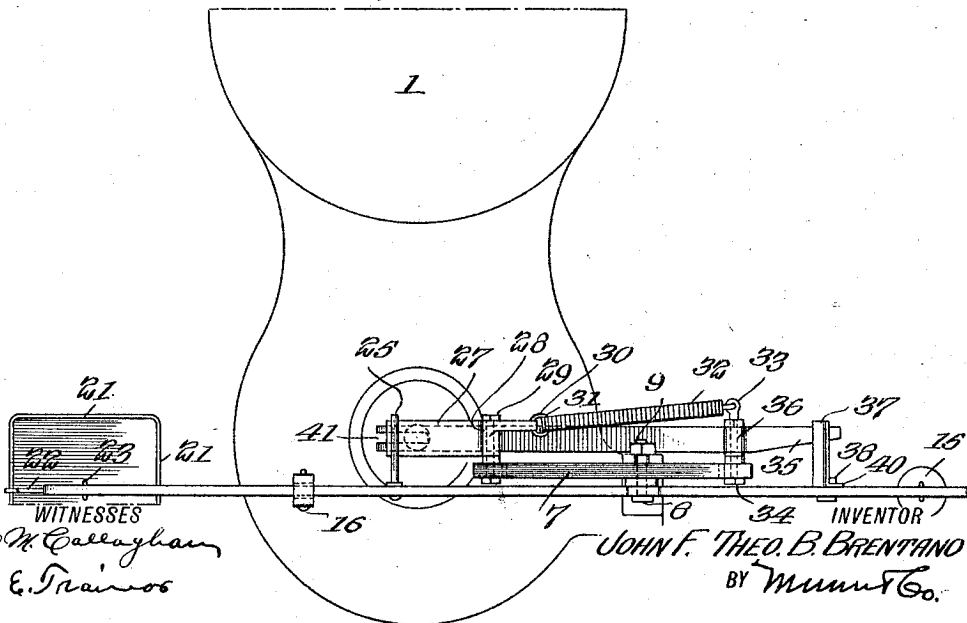


Fig. 2.



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# UNITED STATES PATENT OFFICE.

JOHN F. THEO B. BRENTANO, OF ST. PAUL, OREGON.

## AUTOMATIC RAM-STARTER.

1,006,352.

Specification of Letters Patent.

Patented Oct. 17, 1911.

Application filed July 5, 1911. Serial No. 636,819.

*To all whom it may concern:*

Be it known that I, JOHN F. THEO B. BRENTANO, a citizen of the United States, and a resident of St. Paul, in the county of Marion and State of Oregon, have invented a new and Improved Automatic Ram-  
5 Starter, of which the following is a full, clear, and exact description.

My invention is an improvement in ram  
10 starters, and has for its object, the provision of means in connection with the ram for opening and closing the impetus valve to stop and start the same in accordance with the head of the water, stopping the ram  
15 when the water falls below a predetermined point, and starting it when the water has a sufficient head.

In the drawings:—Figure 1 is a side view of the improvement, and Fig. 2 is a plan  
20 view.

In the present embodiment of the invention, the ram 1 is of any usual or desired construction, and the impetus valve thereof is contained in the chamber 2 of the ram. A  
25 standard 3 is provided with a foot 4, for receiving one of the holding bolts 5 of the ram, and the said standard is longitudinally slotted at its upper end, as indicated at 6. A cross bar 7 is adjustably held on the stand-  
30 ard, by means of a bolt 8, which passes through an opening in the cross bar and the slot 6, and is engaged by a nut 9, to hold the parts together. The opening of the cross bar is somewhat nearer its outer end than  
35 the inner.

A lever 10 is provided with a bearing 11 nearer one end than the other, and with a longitudinal series 12—13 of openings at each end. The bearing engages the bolt 8,  
40 and a pea, poise, or counter-poise 14 is provided with means for engaging one opening of the series 13, and weights 15 are arranged on the counter-poise. The opposite end of the lever moves in a vertical slot in a guide  
45 bar 16 which is provided with a foot 17, having an opening for receiving one of the holding bolts 18 of the ram. The bar 16 is provided with a longitudinal series of spaced openings 19 transverse to the slot, and pins  
50 20 are arranged in sundry of the said openings for limiting the movement of the adjacent end of the lever.

A container 21 is provided with a bail 22, having a hook 23, for engaging one of the  
55 openings of the series 12, and the said container is held in position to receive the dis-

charge from a pipe 24, which leads from the reservoir of the ram. The pipe 24 is so arranged with respect to the reservoir, that water will not flow from the pipe until the  
60 reservoir is full. Whenever the water flows through the pipe 24, the water has sufficient head to run the ram. The receptacle or container when full, counterbalances the opposite end of the lever and the weights 15, and  
65 swings the lever on the bolt 8.

A pin 25 extends laterally from the lever 10, between the bolt 8 and the container 21, and the said pin is in position to engage one end of a lever 27 having a central bearing 28  
70 journaled on a bolt 29 passing through an opening in the adjacent end of the cross bar 7. The other end of the lever is provided with a hook 30 engaging an eye 31, in one end of a spring 32, whose other end engages  
75 an eye bolt 33 engaging an opening in the other end of the cross bar 7, and held in place by a nut 34.

A lever 35 is provided with a bearing 36 near one end, and the bearing is journaled  
80 on the eye bolt 33 before mentioned. The outer end of the lever 35 is in position for engagement by a laterally extending arm 37, adjustably connected to the lever 10 by means of a bolt 38, passing through an open-  
85 ing in the lever, and a slot 39 in an angular extension 40 of the arm. By loosening the bolt 38, the arm may be adjusted vertically on the lever 10 to engage the adjacent end of the lever 35, at a predetermined height of  
90 the lever 10. The opposite end of the lever 35 is provided with a fork 41, which is engaged by a stem 42, connected with the impetus valve of the ram, and having a head 43 above the lever.  
95

In operation, when the water in the reservoir is insufficient to run the ram, water ceases to flow from the pipe 24 into the container 21, and the water already in the container flows out of the same, through a plu-  
100 rality of openings 44, in the container near its bottom, and having a smaller aggregate capacity than the pipe 24. The weight 15 then counterbalances the lever 10, lifting the empty container. The arm 37 engages the  
105 adjacent end of the lever 35, depressing the said end, and elevating the fork 41, which engages the head 43 and lifts and shuts the impetus valve of the ram stopping the same. As soon as the water begins to flow through  
110 pipe 24, the container begins to fill and when a sufficient amount of water has entered to

counterbalance the weights 15, the lever 10 is swung in the opposite direction. By the engagement of pin 25 with lever 27, the lever 27 of the rock shaft moves downward, engages the head 43 of stem 41, depresses it, opens the impetus valve and starts the ram in operation. The pin 25 now allows lever 27 to escape, and lever 27 is drawn to its normal position by spring 32. The waste water is now thrown from the impetus valve into the container 21 and will keep container 21 down until the ram ceases to run, when the container will run empty.

I claim:—

1. In combination with the ram and the impetus valve thereof, of a stem for the valve provided with a head at its upper end, a plate for attachment to the ram having at one end a longitudinally slotted standard and at the other a longitudinally slotted guide provided with spaced openings transverse to the slot, a cross bar, a bolt engaging the cross bar intermediate its ends and the slot of the standard, a nut engaging the bolt, a lever pivoted intermediate its ends on the slotted standard 3 and provided at each end with a longitudinal series of spaced openings, a receptacle having means for engaging an opening of the series at one end, a counter-poise having means for engaging an opening of the series at the other end, a bar pivoted on one end of the cross bar and provided at one end with a fork engaging the stem of the impetus valve, an arm adjustable vertically on the first named lever for engaging the opposite end of the last named lever, a rock shaft journaled on the cross bar and provided with oppositely extending arms, one arm extending above the head of the valve stem, a pin extending laterally from the first named lever for engaging the end of the arm, and a spring engaging the other arm of the rock shaft for returning it to position when released by the lever, said receptacle having openings at its bottom, and a pipe for leading water from the reservoir of the ram and delivering it into the receptacle, said pipe having a greater capacity than the aggregate capacity of the openings of the receptacle, said first named bar moving within the slot of the guide, and pins passed through the openings of the guide above and below the lever.
2. In combination with the ram and the impetus valve thereof, of a stem connected with the valve and provided with a head at its upper end, a plate having means for attaching it to the ram and provided with a standard, a cross bar adjustable vertically on the standard, a lever pivoted to the standard, a receptacle adjustably connected with one end of the lever, a weight adjustably connected with the other end, a pin extending laterally from the lever between the receptacle and the standard and above the
- head of the valve stem, an arm adjustable vertically on the lever between the standard and the weight, a lever pivoted on the cross bar and provided at one end with a fork engaging the valve stem, the other end of the said lever extending beneath the arm, a rock shaft on the cross bar having an arm extending between the head of the stem and the pin, a spring normally pressing said arm upwardly, a guide for the first named lever for preventing lateral swinging thereof, means on the guide for limiting the vertical movement of the lever, and a pipe leading from the reservoir of the ram and delivering to the receptacle, said receptacle having outlet openings of smaller aggregate capacity than the pipe.
3. In combination with the ram and the impetus valve thereof, of a stem connected with the valve and provided with a head at its upper end, a plate having means for attaching it to the ram and provided with a standard, a cross bar adjustable vertically on the standard, a lever pivoted to the standard, a receptacle adjustably connected with one end of the lever, a weight adjustably connected with the other end, a pin extending laterally from the lever between the receptacle and the standard and above the head of the stem, an arm adjustable vertically on the lever between the cross bar and the weight, a lever pivoted on the cross bar and provided at one end with a fork engaging the valve stem, the other end of the said lever extending beneath the arm, a rock shaft on the cross bar having an arm extending between the head of the stem and the pin, a spring normally pressing said arm upwardly, and a pipe leading from the reservoir of the ram to the receptacle, said receptacle having a discharge opening of less capacity than the pipe.
4. The combination with the ram and the impetus valve thereof, of a pipe leading from the reservoir of the ram at a higher level than the connection of the ram, a stem on the valve provided with a head, a standard for connection to the ram, a cross bar adjustable on the standard, a lever pivoted on the cross bar and provided at one end with a fork for engaging the stem, an arm pivoted on the cross bar at one end and extending above the head, a lever pivoted on the standard and provided with a lateral pin intermediate its ends, an arm adjustable on the last named lever for engaging the other end of the first named lever, a weight adjustable on one end of the last named lever, and a receptacle adjustable on the other end of the said last named lever and arranged beneath the outlet of the pipe, and having discharge openings of less aggregate capacity than the pipe, and a spring for lifting the arm out of contact with the head.
5. The combination with the ram and the



impetus valve thereof, of a pipe leading from the reservoir of the ram at a higher level than the connection of the ram, a standard for attachment to the ram, a cross bar adjustable on the standard, means on the cross bar for closing the valve, means on the cross bar for opening the valve, a lever pivoted intermediate its ends on the standard, a weight adjustable on one end of the lever, a receptacle adjustable on the other end and into which the pipe delivers, said receptacle having a discharge opening of smaller capacity than the pipe, means on the lever for operating the valve opening means, when the end having the weight moves downward, and means on the lever for operating the closing means when the end having the receptacle moves downward.

6. The combination with the ram, and the impetus valve thereof, of a pipe leading from the reservoir of the ram at a higher level than the connection of the ram, a support for attachment to the ram, means on the support for opening the valve, a lever mounted for swinging movement intermediate its ends in the support, a weight adjustable on one end of the lever, a receptacle adjustable on the other end into which the pipe delivers, said receptacle having a discharge opening of smaller capacity than the pipe, means on the lever for operating the valve opening means, when the end having the receptacle moves downward, means on the lever for operating the closing means when the end having the weight moves downward, and means for adjusting the said last named means vertically on the lever.

7. The combination with the ram, and the impetus valve thereof, of a pipe leading from the reservoir of the ram at a higher level than the connection of the ram, a support for attachment to the ram, means on the support for opening the valve, means on the support for closing the valve a lever mounted for swinging movement intermediate its ends on the support, a weight adjustable on one end of the lever, a receptacle adjustable on the other end and into which the pipe delivers, said receptacle having a discharge opening of smaller capacity than the pipe, means on the lever for operating the valve opening means, when the end having the receptacle moves downward, and means on the lever for operating the closing means when the end having the weight moves downward.

8. The combination with the ram, and the impetus valve thereof, of a support for attachment to the ram, a lever mounted for swinging movement on the support, a weight on one end of the lever, a receptacle on the other end of the lever, a pipe leading from the reservoir of the ram at a higher level than the connection of the ram and delivering to the receptacle, said receptacle having discharge openings of smaller capacity than the pipes, and means operated by the swinging movement of the lever for opening and closing the valve.

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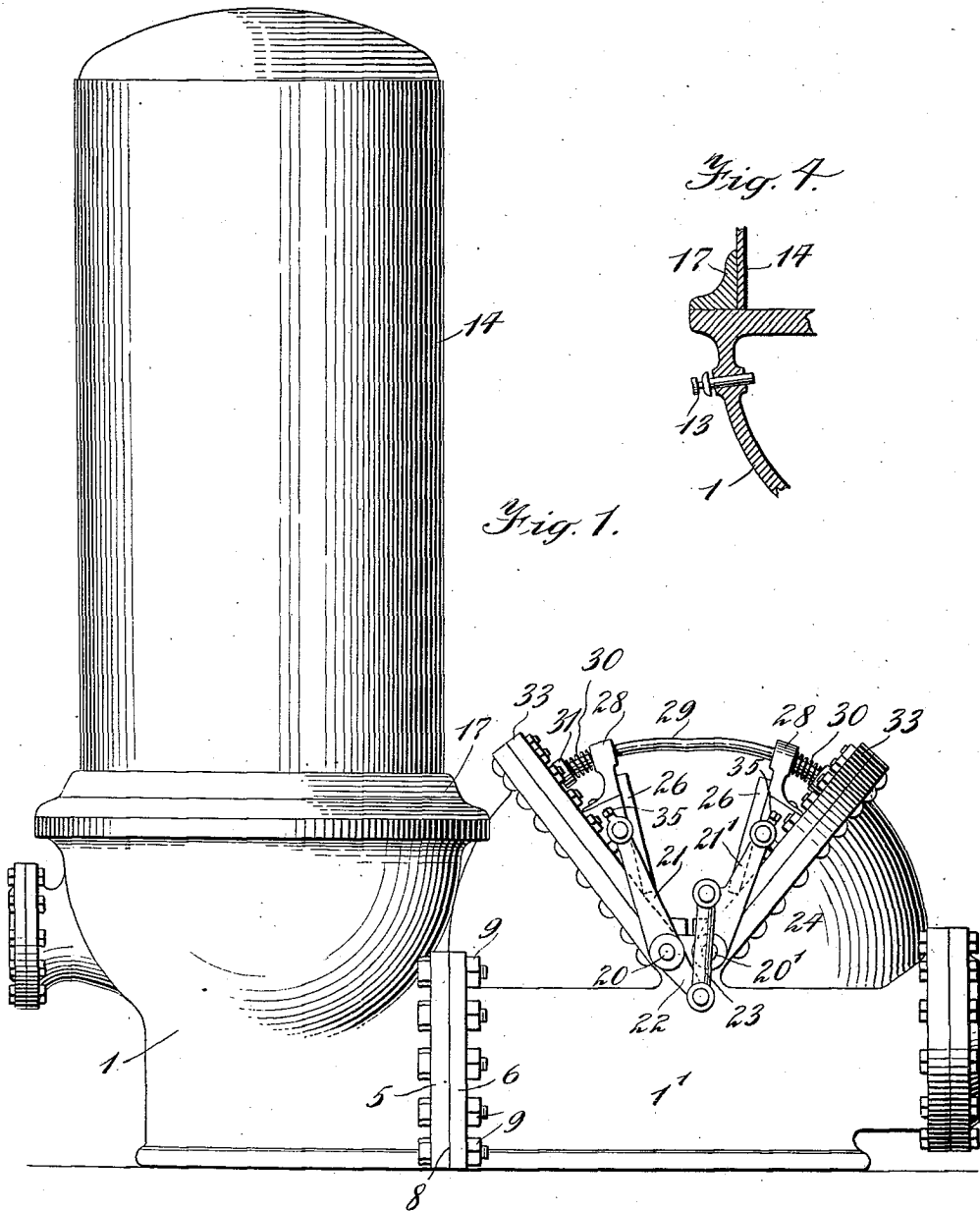
HYDRAULIC RAM.

APPLICATION FILED MAR. 6, 1911.

1,015,949.

Patented Jan. 30, 1912.

2 SHEETS—SHEET 1.



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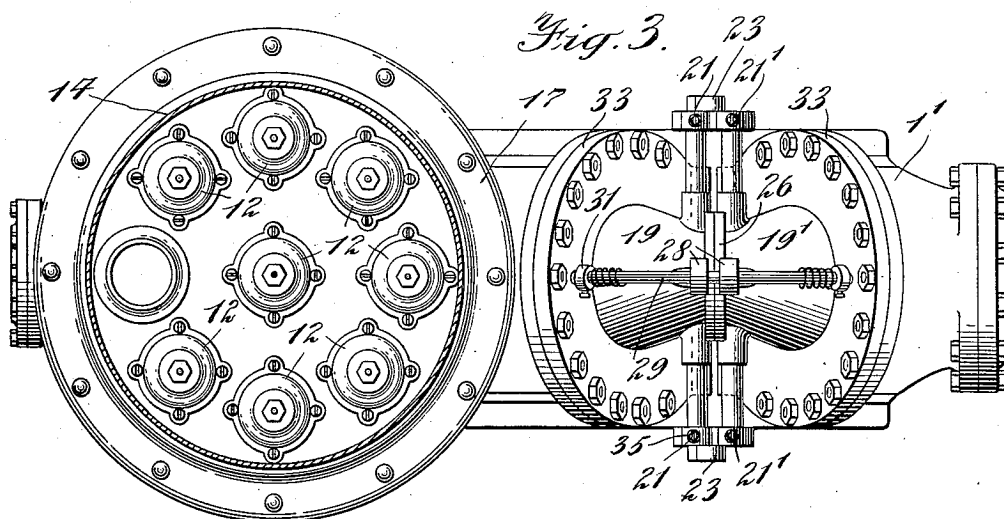
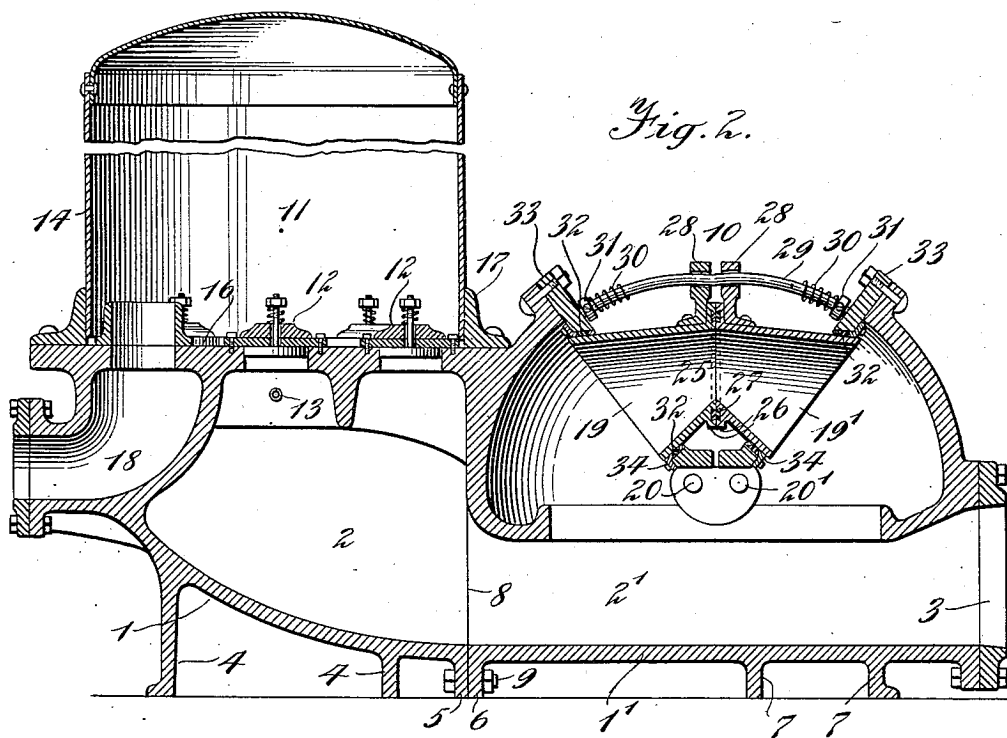
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 HYDRAULIC RAM.  
 APPLICATION FILED MAR. 6, 1911.

1,015,949.

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2 SHEETS—SHEET 2.



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## HYDRAULIC RAM.

1,015,949.

Specification of Letters Patent.

Patented Jan. 30, 1912.

Application filed March 6, 1911. Serial No. 612,673.

*To all whom it may concern:*

Be it known that I, ALFRED H. FRANCFORT, a citizen of the United States, residing at Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a full, clear, and exact description.

This invention relates to hydraulic rams, and has for its object an improved construction of the main valve or gate of such devices, whereby greater efficiency of the device as a whole may be obtained, while minimizing the shock or jar incident to the operation of devices of this character.

A further object of the invention is to devise a form of valve adapted for use in connection with apparatus of this character in which the parts while being very light in construction, nevertheless possess practically a maximum of strength; being of a novel construction heretofore never employed to the best of applicant's knowledge in any device of this or a similar character.

A still further object of the invention is to provide a valve which shall operate more quickly and abruptly than those heretofore used in ram constructions, whereby to check the flow of fluid in the ram with a maximum degree of suddenness.

These and other objects of my invention will be hereinafter described and more particularly set forth in the appended claims.

In the drawings which form a part hereof and in which like reference characters designate like parts throughout the several views: Figure 1 is a side elevation of a hydraulic ram constructed in accordance with the principles of my invention. Fig. 2 is a vertical longitudinal section of said ram. Fig. 3 is a plan of said ram; and Fig. 4 is a detail of an air vent used therein.

In general it may be stated that the efficiency of a hydraulic ram is largely dependent upon the abruptness with which the main valve thereof is closed, and since the closure of this valve is effected by the fluid pressure, the suddenness with which it closes can be increased by enlarging the total effective area of the operative part or parts acted upon by such pressure and by diminishing the weight of the individual movable parts and thereby correspondingly reducing the inertia thereof. In my Patent No. 845,402, issued Feb. 26, 1907, I disclosed a valve construction, such that a considerable

increase in efficiency in rams embodying the same was obtained over rams in use up to that time. I have now discovered that it is possible to still more markedly increase the efficiency of these devices by means of the novel valve to be hereinafter described, in which in place of having a stationary seat as in all other devices of this character as heretofore constructed, I employ what is in effect a movable seat, or, preferably, the seat may be substantially a duplicate of the valve so that said parts actually constitute a valve consisting of a plurality of elements which are adapted to approach and recede from each other, the closure of the valve being preferably effected by the juxtaposition of the seating faces of the movable elements.

Referring now to Fig. 1, wherein is exemplified one form of my device, the ram casing which is preferably in two sections 1, 1', has therein the usual main central chamber, the respective portions of which have been designated 2, 2', and an inlet pipe 3, through which the fluid is admitted from the drive pipe. The casing is adapted to be firmly supported in an upright or any desired position, the base thereof being preferably stiffened with flanges 4, 5, 6 and 7. The casing is divided as at 8 to facilitate the construction thereof, flanges 5 and 6 extending around the abutting ends of the respective portions 1, 1' of the casing and being secured together by means of bolts 9, or the like. Communicating with the portion 2' of the central chamber is the main valve or gate broadly designated 10.

An equalizing chamber 11 is in communication with that portion of the chamber designated 2 by means of a series of check valves 12, which serve to prevent the return of liquid impelled therethrough into said equalizing chamber. The usual air valve 13 which is employed in this class of apparatus to supply a small quantity of air to the fluid so as to compensate for that absorbed by the water in the equalizing chamber 11, is preferably disposed in one side of the casing section 1 as shown in Figs. 1 and 2. The equalizing chamber may be formed of a sheet metal cylinder 14, the upper extremity of which is closed by a dome secured thereto in any suitable manner, the cylinder being held in place upon the table-like surface 16, provided at the upper portion of casing section 1, by means of an annulus 17. The table 16 affords a seat for

the valves 12, which latter may be of any suitable or known construction. The exhaust conduit 18 from the equalizing chamber is preferably formed integrally with the casing 1. The main valve 10 consists of two valve elements 19, 19', which are respectively pivotally connected to the casing at 20, 20', by means of levers 21, 21'. The lever 21 is substantially straight and is of the first-class, the long arm thereof being adjustably secured to the valve element 19, while the short arm 22 of said lever projects below the pivotal point 20, and has the extremity thereof pivotally connected to a link 23. Lever 21' however is of the second-class and preferably has a protuberance or lug 24 thereon which is in turn pivotally connected to the other end of link 23; the points of connection being such that the valve elements will tend to move in unison into valve opening or closing relationship. These valve elements may each have somewhat the form of a truncated cone; the truncated portions of the respective cones being preferably adapted to abut against each other substantially on the median line of the valve. Each of the elements may be provided with flanges 25 which may be grooved as at 26 for the reception of packing rings of rubber, or the like, so that when the respective elements are in juxtaposition, a liquid tight closure is effected therebetween. Buffer brackets 28 are carried by each of these valve elements and are adapted to engage the respective arcuate portions of a rod 29; this rod being preferably round and bent as shown in Fig. 2. Brackets 28 are adapted to engage springs 30 when the elements are in open valve position, these springs serving to take up the shock due to the falling of the said elements into such relationship. The amount of opening between the elements is adjustable by means of collars 31, which may be provided with set screws 32', said collars being movable along the rod 30; the set screws affording means for locking said collars in any position desired. When the valve elements are in closed position, the enlarged ends thereof are adapted to effect a substantially liquid tight closure by engaging suitable packing rings 32 which are disposed within substantially circular apertures provided in plates 33, which may be secured to the casing in any suitable manner; the packing rings 32 being held in position by means of glands 34, or the like.

The operation of the device is as follows: Water flows through the inlet pipe connection 3 into the portion 2' of the main chamber, and since the valves 12 are normally held closed under moderate pressure, the liquid will flow upward through the casing and out through the respective conical valve elements upon both sides of the median line

of the valve; valve elements 19, 19', being in open position, which they tend normally to assume by reason of the fact that their respective centers of gravity are beyond the perpendiculars passing through the respective pivotal points 20, 20'. Water will of course also escape around the base of the respective conical elements, and out through the opening between said elements and the plates 33. When the water has attained a sufficient velocity, the pressure which it exerts upon the respective valve elements will be sufficient to force the latter upwardly and toward each other into valve closing relationship. By reason of the fact that these elements are coned interiorly, the effective closing pressure exerted upon said elements is considerable; and the total area subjected to this pressure is that of not merely one valve element, but of both. It should further be noted that when in open position the valve elements in effect constitute a pair of nozzles which are angularly disposed with respect to each other so that the streams of water issuing from said nozzles impinge against each other substantially on the median line of the valve, but since the impinging streams are angularly disposed with respect to each other, this impingement does not materially interfere with the issuance of fluid through the respective nozzles, but merely forms a sheet of water which is disposed substantially in the vertical plane passing through the said median line. When the valve elements start to move upwardly into closed relationship, the angle between these streams gradually becomes more oblique, but the velocity which the elements will acquire when moving upwardly is such that they will be thrown together with great abruptness, the shock of impact being cushioned, however, by reason of sheet of water formed by the, at such time, diametrically opposing streams. This action is of very material importance in that it conserves the life of the mechanism and the operative parts thereof. At the same instant that closure is effected on the median line of the valve, the enlarged outer ends of the elements thereof correspondingly seal the openings in the plates 33. It will be observed that, when in open position, flow of water is permitted through virtually four openings, to wit, through the respective nozzles and around the outsides thereof, which openings are all simultaneously and very abruptly closed, affording the requisite suddenness of action whereby to obtain a maximum of efficiency. The flow of water through the valve having been thus abruptly checked, the momentum acquired by the bulk of the fluid in the central chamber causes such fluid to exert considerable pressure against and to thereby force open the valves 12; injecting fluid under relatively high pressure

into the equalizing chamber 11 from whence it flows through the conduit 18. When the momentum of the water in the central chamber has thus been utilized to force water into the equalizing chamber, the up-lifting pressure exerted by the water against the valve elements 19, 19' decreases to a point where such elements may drop under the influence of gravity; the said elements swinging apart in guided relationship and at substantially equal rates until the brackets 28 impinge upon the buffer springs 30; the shock of the falling valves being taken up by said springs. It will thus be seen that I have not only devised a valve mechanism in which a very large opening is closed in a minimum of time, but also one in which the operation of the movable parts are cushioned most effectively against the shock of operation, and the mechanism herein presented hence meets the requirements with a maximum of efficiency, in every particular.

While I have shown and described one form of apparatus adapted for the purpose in question, I do not wish to be limited to such specific form since it is obvious that various changes may be made in and to the several parts without departing from the spirit of the invention herein set forth. The breadth of the invention is hence to be deemed as being limited only by the scope of the appended claims.

In conclusion it may be pointed out that the valve elements 19, 19', are adjustably but preferably quite firmly secured to the respective levers 21, 21' by means of set screws 35, or the like. This feature permits of properly abutting the valve elements before clamping or otherwise securing the same to their supporting levers.

Having described my invention, what I claim, is:

1. In a hydraulic ram, a valve comprising a movable element having a passage therein through which liquid may flow, said element having a sloping wall, and a member having an aperture therein in which said element is adapted to move, said member being adapted to co-act with said sloping wall to form a substantially liquid tight closure, and separate, auxiliary means for stopping the flow of fluid through the passage in said movable element.

2. In a hydraulic ram, a valve comprising a plurality of pivotally mounted juxtaposable elements adapted to be swung toward and from each other, one at least of said elements having a fluid passage therein, flow of fluid through said passage being substantially prevented when said elements are in juxtaposition.

3. In a hydraulic ram, a valve comprising a plurality of juxtaposable elements adapted to be moved toward and from each other, one at least of said elements having a fluid

passage therein, flow of fluid through said passage being substantially prevented when said elements are in juxtaposition.

4. In a hydraulic ram, a valve comprising a pivotally mounted element having a passage therein through which fluid may flow, and co-acting means for shutting off the flow of fluid through said passage, said means comprising a second pivotally mounted element.

5. In a hydraulic ram, a valve comprising a pivotally mounted element having a passage therein through which fluid may flow, co-acting means for shutting off the flow of fluid through said passage, said means comprising a second pivotally mounted element, and means for substantially preventing shock when said elements are in operation.

6. In a hydraulic ram, a valve comprising a pivotally mounted element having a passage therein through which fluid may flow, co-acting means for shutting off the flow of fluid through said passage, said means comprising a second pivotally mounted element, and means for substantially preventing shock when said elements are in operation, said shock preventing means comprising resilient buffers.

7. In a hydraulic ram, two substantially similar co-acting hollow valve elements, through which fluid may flow, and movable by the pressure of fluid thereagainst, said elements permitting of the flow of said fluid through said valve when in open position and substantially preventing the flow of said fluid when in valve closing relationship, said elements being simultaneously movable in opposite directions with respect to each other.

8. In a hydraulic ram, two elements adapted to be moved toward each other by fluid pressure, said elements having passages therein through which the fluid may flow when said elements are in retracted position, the flow of said fluid being substantially prevented when the elements have been moved toward each other the limit of their respective travels.

9. In a hydraulic ram, two elements adapted to be moved toward each other by fluid pressure, said elements having passages therein through which the fluid may flow when said elements are in retracted position, the flow of said fluid being substantially prevented when the elements have been moved toward each other the limit of their respective travels, and means for preventing the flow of water around said elements when so positioned.

10. In a hydraulic ram, a valve comprising a hollow element having flaring inner walls and formed to permit the passage of fluid therethrough, said element being movable by fluid pressure into valve closing position and movable by gravity into valve

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opening position, and movable means co-acting with said element when in valve closing position to prevent the flow of fluid therethrough.

5 11. In a hydraulic ram, a plurality of movable apertured valve elements mounted to permit the flow of fluid therethrough when in open valve position, said elements being displaceable with respect to each  
10 other by fluid pressure, and means co-acting with said elements when the latter are in closed valve position for preventing the flow of fluid therethrough.

12. In a hydraulic ram, a plurality of  
15 movable apertured valve elements mounted to permit the flow of fluid therearound and therethrough when in open valve position, said elements being displaceable with respect to each other by fluid pressure, and  
20 means co-acting with said elements when the

latter are in closed valve position for preventing the flow of fluid therethrough and therearound.

13. In a hydraulic ram, a valve comprising an element movable by the pressure  
25 fluid used in said ram, said element having a relatively large passage therein, as compared to the size of said element, through which said fluid may flow, and co-acting  
30 means for shutting off the flow of fluid through said passage, said means comprising a second element, also movable by said pressure fluid.

In witness whereof, I subscribe my signature, in the presence of two witnesses.

ALFRED H. FRANCFORT.

Witnesses:

WALDO M. CHAPIN,  
JAMES DE ANTONIO.

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

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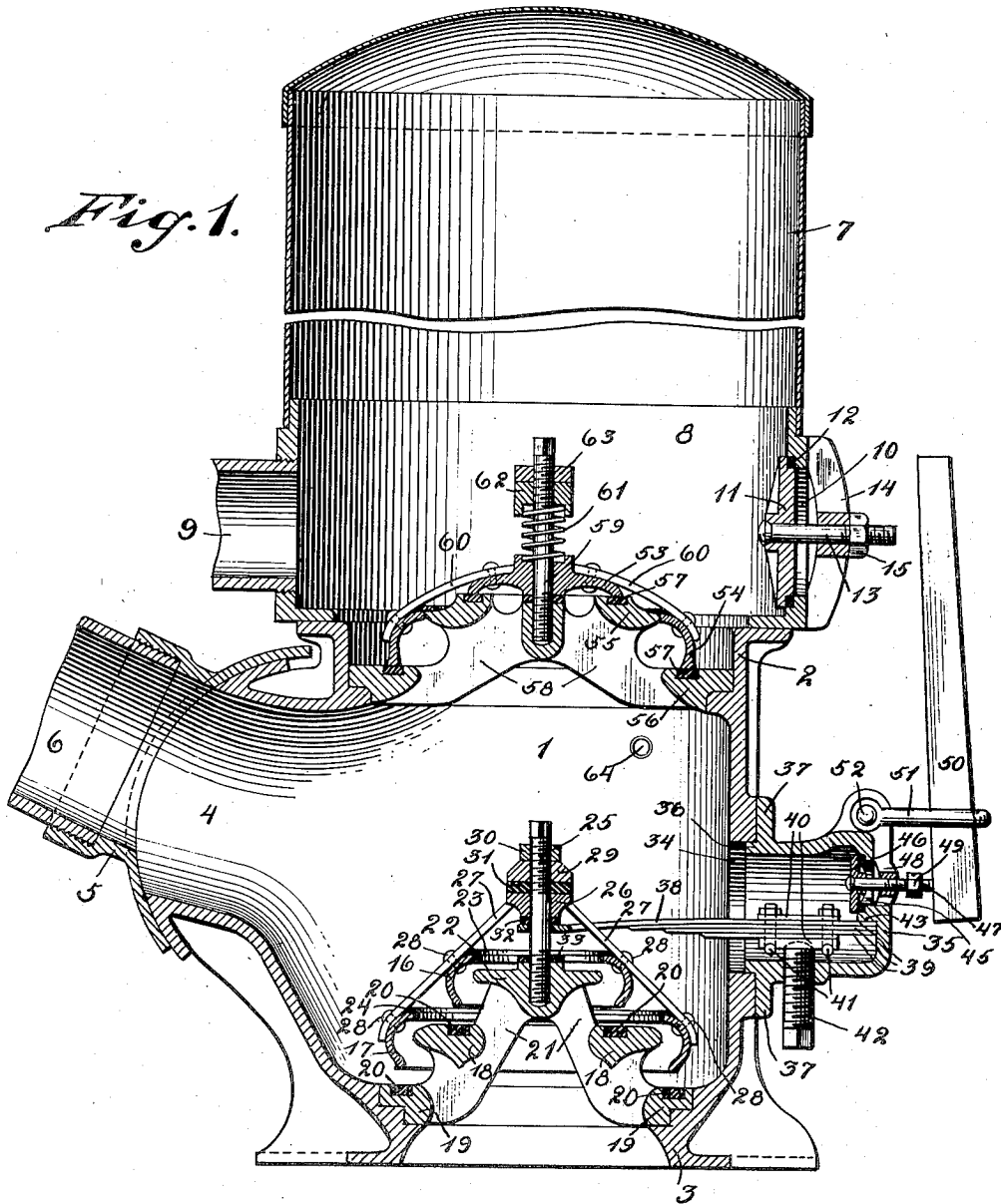
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HYDRAULIC RAM.

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3 SHEETS—SHEET 1.



*Fig. 1.*

Witnesses  
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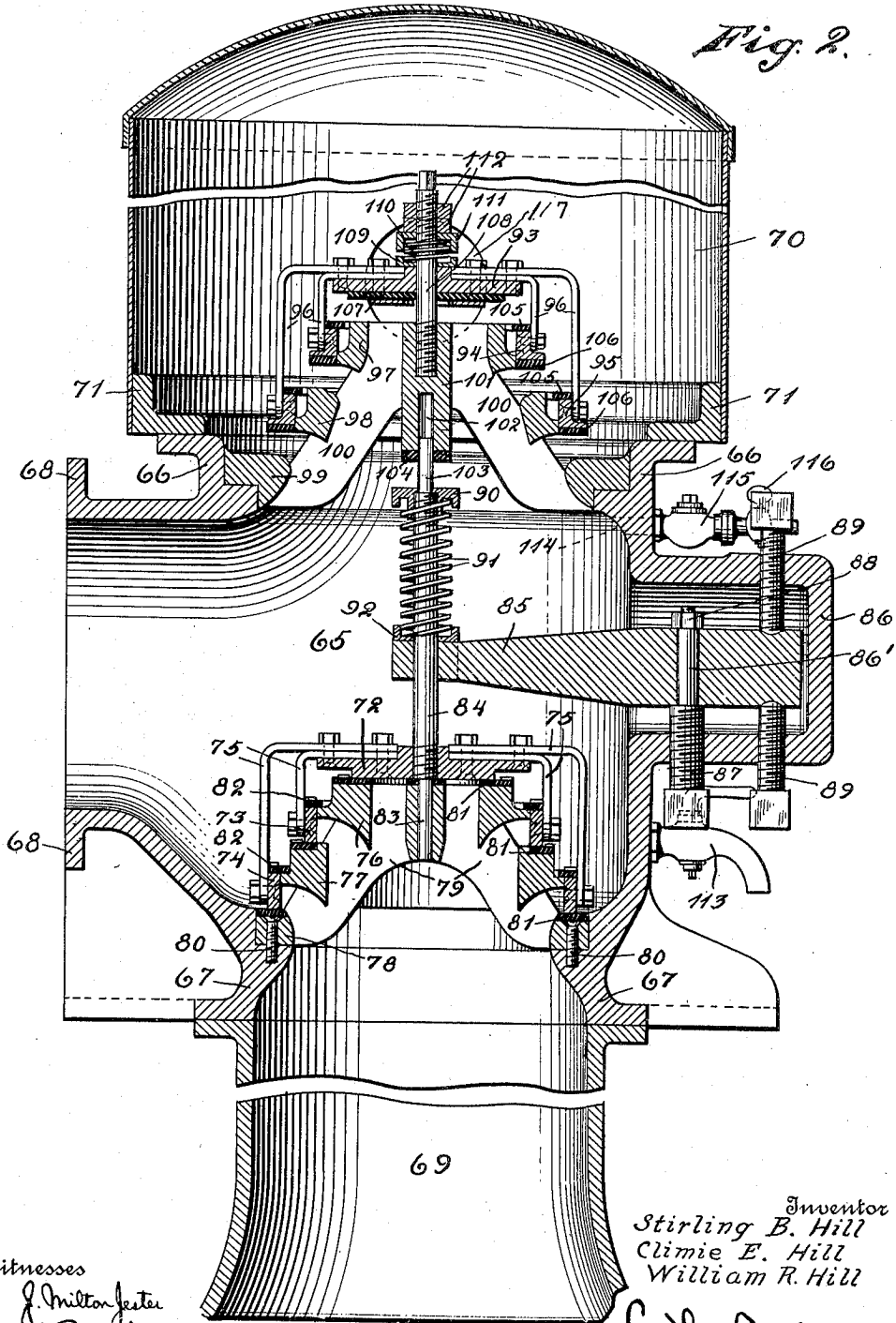
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3 SHEETS—SHEET 2.

Fig. 2.



Witnesses

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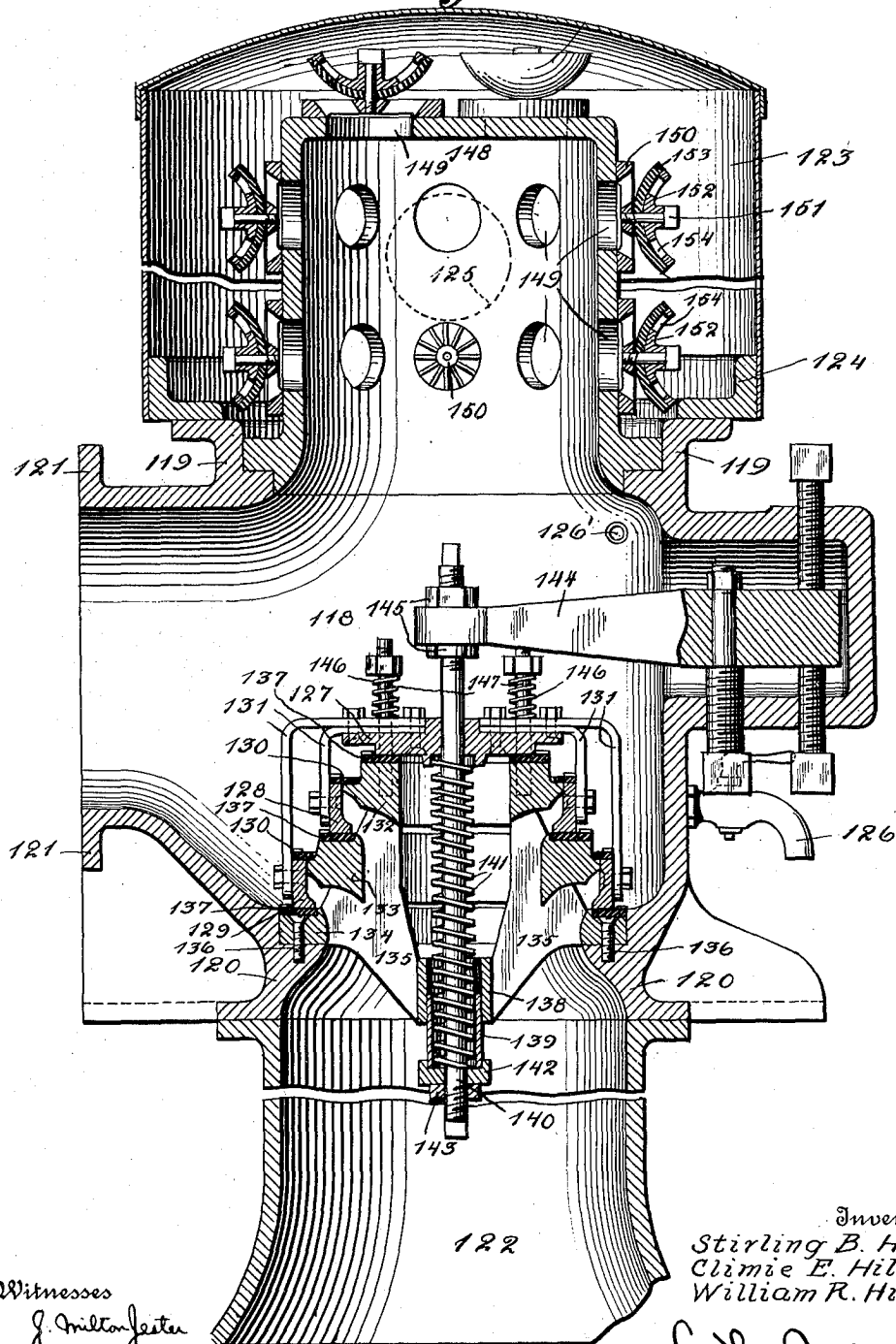
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3 SHEETS—SHEET 3.

Fig. 3.



Witnesses

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# UNITED STATES PATENT OFFICE.

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## HYDRAULIC RAM.

1,016,409.

Specification of Letters Patent.

Patented Feb. 6, 1912.

Application filed February 11, 1911, Serial No. 608,077. Renewed December 23, 1911. Serial No. 667,548.

*To all whom it may concern:*

Be it known that we, STIRLING B. HILL, CLIMIE E. HILL, and WILLIAM R. HILL, citizens of the United States, residing at Seattle, in the county of King and State of Washington, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

10 Our invention relates to hydraulic rams.

An important object of this invention is to provide a valve in a hydraulic ram which with a small weight and movement will produce a maximum area for the passage of water.

15 A further object of this invention is to furnish valves in the hydraulic ram so shaped that the pressure thereon will be as nearly as practicable, balanced thus greatly reducing the jar of closing.

20 A further object of this invention is to provide a hydraulic ram which is efficient, expeditious and continuous in its operation.

25 A further object of this invention is to provide a hydraulic ram of simple and compact construction, having its waste valve discharging downwardly so that the water does not go upwardly to fall back upon the ram.

30 A further object of this invention is to provide a hydraulic ram comprising valves so constructed that the least amount of resistance is offered to the water when passing therethrough.

35 Other objects and advantages of this invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification, and in which like numerals are employed to designate like parts throughout the same, Figure 1 is a central vertical sectional view taken through our improved hydraulic ram, Fig. 2 is a similar view taken through a slightly different form of ram, and, Fig. 3 is a similar view taken through a third different form of ram.

In the drawings wherein is illustrated a preferred embodiment of our invention, attention being called to Fig. 1, the numeral 1 designates a preferably approximately cylindrical casing, provided at its upper and lower ends with flanged nipples 2 and 3. The casing 1 is further provided with a laterally extending nipple 4, having suitable connection with a coupling 5, which in turn

is connected with a drive pipe 6. The lower nipple 3 is designed for connection with a waste pipe (not shown). Disposed above the nipple 2 is a pressure storage tank, which may preferably be formed in two sections 7 and 8, secured together by any suitable means. The lower tank section 8 is disposed upon and suitably secured to the flanged nipple 2. The lower end of the tank section 8 is formed open, as shown, whereby communication may be established between the casing 1 and said storage tank. The tank section 8 is provided with a discharge pipe 9, adapted to conduct the fluid under pressure to the device which is to be operated thereby. The tank section 8 is provided preferably at a point diametrically with relation to the pipe 9 with a man-hole 10, which is normally closed by a head 11. This head engages packing 12 disposed between the head 11 and the tank section 8, as shown. The head 11 has rigid connection with a stem 13, which is slidably mounted through a spider 14 formed upon the tank section 8. The stem 13 is screw-threaded for engagement with a nut 15, by the means of which the head 11 may be clamped in its closed position.

The passage of water through the nipple 3 is controlled by a waste valve structure, comprising a plurality of annular valves 16 and 17. These valves are formed curved in cross-section, as shown, to conduct the water by the same with the least possible amount of friction. The valves 16 and 17 have their lower ends adapted to be moved into and out of engagement with valve seats 18 and 19, respectively. These valve seats comprise packing rings 20. The annular valve seat 19 is positioned upon the nipple 3 and attached thereto by any suitable means. The annular valve seats 18 and 19 are rigidly connected by preferably diametrically arranged sections of material or webs 21, which extend upwardly for engagement with a circular valve seat 22. The upper ends of the annular valves 16 and 17 are adapted to engage the valve seats 22 and 18, respectively, said annular valves being provided with packing rings 23 and 24 to make these engagements air tight. The circular valve seat 22 has rigid connection with a vertically disposed stem 25, upon which is slidably mounted a collar 26, having depending preferably diametrically arranged rods 27 connected therewith. These rods are suitably

connected with the annular valves 16 and 17, as shown at 28. The upward movement of the collar 26 is limited by a nut 29 engaging the upper screw threaded portion of the stem 25, said nut 29 being locked in adjustment at different positions by a second nut 30. A section of packing 31 is disposed between the collar 26 and the nut 29 and secured to said nut by any suitable means. A section of packing 32 is slidably connected with the lower end of the collar 26. A lock nut 33 is screw threaded onto bolt 25 and engages the circular valve seat 22 to hold 25 firmly in place.

The casing 1 is provided opposite the nipple 4 with an opening 34, adjacent which is disposed an auxiliary casing 35, having flanges 36 and 37, as shown. The flange 36 extends within the opening 34 while the flange 37 is rigidly connected with the casing 1 by any suitable means. Disposed within the auxiliary casing 35 is a leaf-spring 38, formed of a plurality of spring-leaves 39, carrying plates 40, which are held together by clamps 41. The lower plate 40 is provided with a recess for receiving the upper end of a bolt 42, operating through a screw-threaded opening formed in the casing 35. The outer end of the leaf-spring 38 is disposed below a shoulder 43 formed in the casing 35, while the inner end of this leaf-spring is provided with an opening for receiving the stem 25. The leaf-spring 38 is so tensioned that the same tends to hold the annular valves 16 and 17 in their open or raised position. By rotating the bolt 42 the tension of the leaf-spring 38 may be varied. The auxiliary casing 35 is provided with a discharge opening 45, which is normally closed by a valve 46, having rigid connection with a stem 47, which in turn operates through an opening formed in a spider 48. The stem 47 is screw-threaded for receiving a nut 49, whereby the valve 46 may be locked in its closed position. After the nut 49 has been moved away from the spider 48, the valve 46 may be unseated by oscillating a lever 50, carried by a link 51, which is pivotally connected with the auxiliary casing 35, as shown at 52.

The passage of water into the storage tank from the casing 1 is controlled by a discharge valve structure, comprising spaced superposed circular and annular valves 53 and 54, respectively. These valves are adapted to engage and disengage annular valve seats 55 and 56, provided with packing 57, as shown. The lower valve seat 56 is disposed within and suitably secured to the nipple 2. The valve seats 55 and 56 are rigidly connected in their spaced relation by preferably diametrically arranged sections of material or webs 58, to the upper ends of which is rigidly connected a vertically disposed stem 59. This stem 59

serves as a guide for the vertically movable valve 53. The annular valve 54 is connected with the valve 53 by means of preferably diametrically arranged rods 60. The valve 53 is normally held in its lowermost position by a compressible coil spring 61, which is engaged by a nut 62, which in turn is clamped in adjustment in different positions by a second nut 63. The casing 1 is provided near its upper end with an opening 64 formed therethrough, which is adapted to supply air within said casing. A check valve (not shown) is to be provided to allow the air to enter the casing 1 but to close upon a reverse movement of the air.

In the operation of this form of ram, assuming that the waste valve structure is in its open position, as shown in Fig. 1, the water will begin to run in the drive pipe 6 and discharge through the waste valve structure. When the flow of the water increases sufficiently in velocity, the same by impinging against the annular valves 16 and 17 causes the same to be seated and the flow of water through the nipple 3 cut off. When the water is flowing through the nipple 3, as above described, a partial vacuum is created within the casing 1, whereby air is drawn into this casing through the opening 64. As soon as the waste valve structure is closed the pressure increases in the casing 1 and closes the check valve (not shown) controlling the opening 64. The water under pressure and the small amount of air which entered the valve 64 now rises in the casing 1 and by opening or unseating the valves 53 and 54, enters the storage pressure tank. The operation continues until the energy in the moving column of water in the drive pipe is dissipated at which instant the flow of water through 53 and 54 stops and the valves close. The pressure continues to rapidly fall in the casing 1 whereby the spring 38 unseats the valves 16 and 17 and the operation as described above is repeated. The object of having a small amount of air enter at each stroke is to maintain the air supply in the storage pressure tank as this would be otherwise slowly dissolved by the flowing water. The valve 45 is employed when starting the device, the same being opened or unseated to reduce the pressure, within the casing 1.

When starting the device, the valve 45 is unseated, whereby the water may more freely pass from the casing 1 and hence the velocity of the water in the drive pipe will be materially increased. The valve 45 may also be employed to quicken the action of the device, for assuming that the water in the drive pipe has gained in velocity sufficiently to seat or close the waste valve structure, such velocity of the water will then begin to decrease. The waste valve structure is retained seated by the pressure in

the casing 1, so when the valve 45 is unseated this pressure is reduced which causes the waste valve structure to be at once unseated and hence allow the water in the drive pipe 6 to continue its movement and increase in velocity. It will thus be seen that by unseating the valve 45 the stroke of the hydraulic ram may be shortened and made quicker.

Referring now to Fig. 2, the form of the hydraulic ram shown therein, comprises a casing 65, provided at its upper and lower ends with flanged nipples 66 and 67. The casing 65 is provided upon one side thereof with a flanged nipple 68, for connection with a drive pipe (not shown). The lower nipple 67 has suitable connection with a waste pipe 69. Disposed above the casing 65 is a pressure storage tank 70, having its open lower end provided with an annular flange 71, which is suitably connected with the flanged nipple 66. The flow of water from the casing 65 into the waste pipe 69 is controlled by a waste valve structure, comprising spaced superposed circular and annular valves 72, 73 and 74. These valves are disposed in superposed relation and are connected by pairs of preferably diametrically arranged rods 75. The valves 72, 73 and 74 cooperate with spaced superposed annular valve seats 76, 77 and 78, having their lower ends concaved, as shown. These valve seats are rigidly connected by sections of material or webs 79, which are preferably diametrically arranged. The lower valve seat 78 is connected with the nipple 67, by means of screws 80 or the like. The valve seats 76, 77 and 78 carry packing rings 81 upon their upper ends, as shown. The annular valves 73 and 74 carry packing rings 82 upon their upper ends. The webs 79 have their adjacent upper ends provided with an opening formed therethrough for slidably receiving a reduced end 83 of a vertically disposed stem 84. This stem has screw threaded engagement with the valve 72, as shown. The stem 84 is slidably mounted through an opening formed through the inner end of a horizontal arm 85. This arm extends within an auxiliary casing 86 formed upon one side of the casing 65. The arm 85 is provided intermediate its ends with a cylindrical opening formed therethrough for rotatably receiving a reduced cylindrical portion 86' of an adjusting bolt 87. This bolt carries a nut 88. The bolt 87 operates through a screw-threaded opening formed through the auxiliary casing 86. The arm 85 is engaged by a pair of clamping bolts 89, operating in screw-threaded openings formed through the auxiliary casing 86. The upper end of the stem 84 is screw-threaded for engagement with a cap 90, which engages a compressible coil spring 91, having engagement with a cap 92 surround-

ing stem 84 and disposed upon the horizontal arm 85. The function of the spring 91 is to normally hold the valves 72, 73 and 74 in their unseated positions. By adjusting the arm 85 the tension of the coil spring 91 may be varied. The discharge of water from the casing 65 into the pressure storage tank is controlled by a discharge valve structure, comprising spaced superposed circular and annular valves 93, 94 and 95. These valves are rigidly connected by means of pairs of preferably diametrically arranged rods 96, as shown. These valves cooperate with spaced superposed annular valve seats 97, 98 and 99, which are rigidly connected by sections of material or webs 100, disposed preferably in diametrical relation. The lower valve seat 99 is disposed within and has suitable connection with the upper nipple 66. The upper ends of the webs 100 are connected with a cylinder 101, having an opening 102 formed through its lower end, for receiving a reduced extension 103 formed upon the stem 84. The cylinder 101 carries packing 104 upon the lower end thereof. The annular valves 94 and 95 carry packing rings 105 and 106 at their upper and lower ends, as shown. The circular valve 93 carries packing 107 at its lower end. The circular valve is slidably mounted upon a vertically disposed stem 108, having screw-threaded engagement with the cylinder 101. The circular valve 93 is engaged by a socket 109, receiving one end of a compressible coil spring 110, having its upper end disposed within the socket 111. The upper end of the stem 108 is screw-threaded for the reception of nuts 112. The lower end of the casing 65 is provided with a spigot 113, which may be operated to discharge the water from said casing. The casing 65 is provided at its upper end with an air inlet 114, controlled by a check valve 115 and a cut-off valve 116. It is to be understood that all three forms of our invention are provided with the cooperating check valve and cut-off valve. The storage tank 70 is provided with a discharge opening 117, which leads into a pipe (not shown) for conducting the fluid to any desired place.

In the operation of this form of our invention, when the valve structures are in the positions shown in Fig. 2, the water from the drive pipe is being discharged into the storage tank 70. As soon as the water decreases in velocity sufficiently, the pressure in the casing 65 is reduced and the spring 91 will open the waste valve structure. The discharge valve structure is closed prior to the opening of the waste valve structure. The column of water now increases in velocity and impinges against the circular valve 72 to close the waste valve structure. The operation is then repeated. Air is drawn into the casing 65 through the

opening 114, for a purpose as explained in connection with Fig. 1.

In Fig. 3, we have shown a third different form of hydraulic ram, the same comprising  
 5 a casing 118, provided at its upper and lower ends with flanged nipples 119 and 120. The casing 118 is provided upon one side thereof with a flanged nipple 121 for connection with a drive pipe (not shown).  
 10 The lower nipple 120 has suitable connection with a waste pipe 122. Disposed above the upper nipple 119 is a pressure storage tank 123, having its lower open end provided with an annular flange 124, which is  
 15 disposed upon and suitably connected with said upper nipple. The tank 123 is provided with a discharge opening 125, which leads into a pipe (not shown) having communication with the device to be operated.  
 20 The casing 118 is provided near its lower end with a spigot 126, whereby water may be discharged from the casing 118. The casing 118 is further provided at its upper end with an air inlet 126', which is controlled by a check valve and cut-off valve,  
 25 in the same manner as described in connection with Fig. 2. The passage of water through the waste pipe 122 is controlled by a waste valve structure, comprising a plurality of spaced superposed circular and annular valves 127, 128 and 129. The annular valves 128 and 129 carry packing rings 130,  
 30 secured upon the upper ends thereof. The annular valves are rigidly connected with the circular valve 127 by pairs of preferably diametrically arranged rods 131. The valves cooperate with spaced superposed annular valve seats 132, 133 and 134, which are rigidly connected by diametrically  
 40 arranged sections of material or webs 135. The valve seat 134 is disposed within and connected with the lower nipple 120 by means of screws 136. The annular valve seats have packing rings 137 suitably secured to the upper ends thereof. The webs  
 45 135 extend downwardly for connection with a tube section 138, within which is mounted a tube 139. A vertically disposed stem 140 extends through an opening formed through the circular valve 127 and is disposed within the tubes 138 and 139. A compressible coil spring 141 surrounds the stem 140 and has engagement with the valve 127 below the same. This spring has its lower end  
 50 disposed within the tube 139 and engages a cap 142, which is held in place by a nut 143. The stem 140 is held in its requisite position by a horizontal arm 144, said stem being provided with nuts 145 to clamp the  
 55 inner end of the arm upon opposite sides thereof. The arm 144 is supported in a like manner to the corresponding arm shown and described in connection with Fig. 2. The function of the spring 141 is to retain  
 60 the waste valve structure open. The up-

ward movement of the valve 127 is opposed by compressible coil springs 146, carried by vertically disposed bolts 147, which extend through suitable openings formed in said valve 127 and are rigidly connected with the uppermost annular valve seat, as shown.  
 70 The discharge of the water into the storage tank 123 from the casing 118, is controlled by a discharge valve structure, comprising an inverted cup-shaped receptacle 148, having its lower open end disposed within and suitably connected with the upper nipple 119. This casing is provided upon its top and side walls with a plurality of openings 149 formed therethrough. Each of these openings has a spider 150 disposed therein and suitably connected with said receptacle. These spiders have screw-threaded engagement with bolts 151, which carry curved plates 152. Disposed between the curved plate and the spider is a suitably flexible valve 153. Each of the valves 153 is capable of allowing the water to flow through the opening 149 into the tank 123, but such valve will close upon a reverse movement of the water, the curved plate being provided with openings 154 formed therethrough.  
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The operation of this form of our invention is very similar to the operation recited in connection with Figs. 1 and 2 and therefore need not be again given.  
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We wish it understood that the forms of our invention herewith shown and described, are to be taken as preferred examples of the same, and that certain changes in the shapes, sizes, and arrangements of parts may be resorted to without departing from the spirit of the invention or the scope of the sub-joined claims.  
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Having thus fully described our invention, we claim:—  
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1. In a hydraulic ram, a casing provided with upper and lower oppositely arranged discharge and waste openings, a valve for controlling the discharge opening, a valve for controlling the waste opening, a spring tending to unseat the second named valve, and means disposed in the line of flow of supply and adapted for discharging material from said casing in addition to the discharge and waste openings for the purpose of starting the ram.  
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2. In a hydraulic ram, a casing provided with discharge and waste openings, valves for controlling the passage of material through such openings, and a valve disposed in the line of flow of supply and adapted when unseated to discharge material from said casing in addition to the discharge passing through the two named openings.  
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3. In a hydraulic ram, a casing provided with discharge and waste openings, a valve for controlling the discharge opening, a valve for controlling the waste opening,  
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said casing being provided with a third opening in addition to the two named openings and disposed in the line of flow of supply, a valve for controlling the third named opening, and manually operated means to move the last named valve.

4. In a hydraulic ram, a casing provided with discharge and waste openings, a valve for controlling the discharge opening, a valve for controlling the waste opening, an auxiliary casing having communication and connected with said casing, a leaf-spring disposed within the auxiliary casing and extending into the first named casing for engagement with the waste valve for normally holding the same unseated, and movable means engaging the wall of the auxiliary casing for changing the tension of the leaf-spring.

5. In a hydraulic ram, a casing provided with discharge and waste openings, a valve for controlling the discharge opening, a valve for controlling the waste opening, an

auxiliary casing having communication and connected with said casing, said auxiliary casing being provided internally thereof with a shoulder, a leaf-spring disposed within the auxiliary casing and extending therefrom to be positioned in the first named casing to have connection with the waste valve, said leaf-spring having one end thereof disposed below and in engagement with said shoulder, and a bolt longitudinally movably mounted through the auxiliary casing to engage the leaf-spring for changing the tension thereof upon the rotation of said bolt.

In testimony whereof we affix our signatures in presence of two witnesses.

STIRLING B. HILL.  
CLIMIE E. HILL.  
WILLIAM R. HILL.

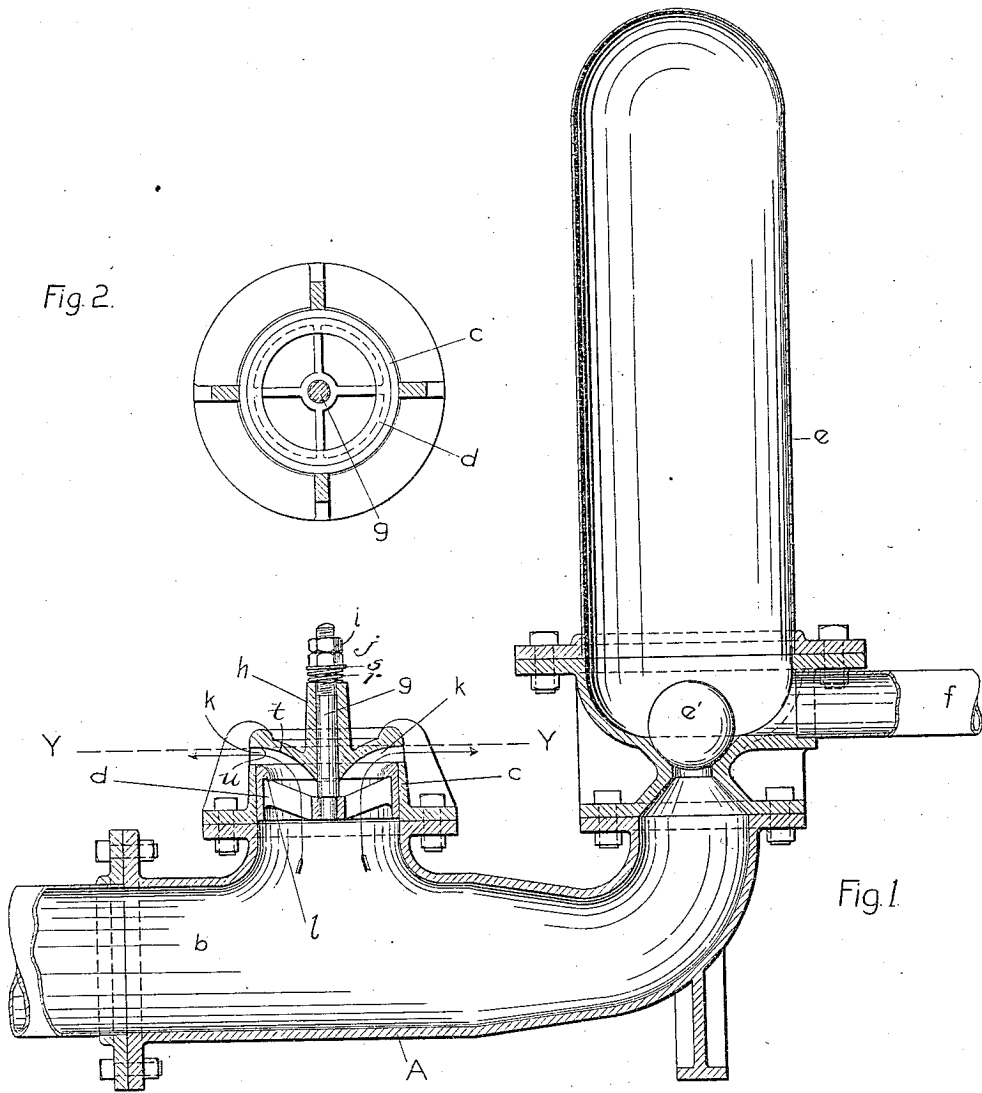
Witnesses:

O. B. POND,  
H. C. APPLGATE.

W. R. PHILLIPS.  
 HYDRAULIC RAM.  
 APPLICATION FILED OCT. 18, 1910.

1,069,285.

Patented Aug. 5, 1913.  
 2 SHEETS—SHEET 1.



WITNESSES:  
 C. B. Long  
 Martin.

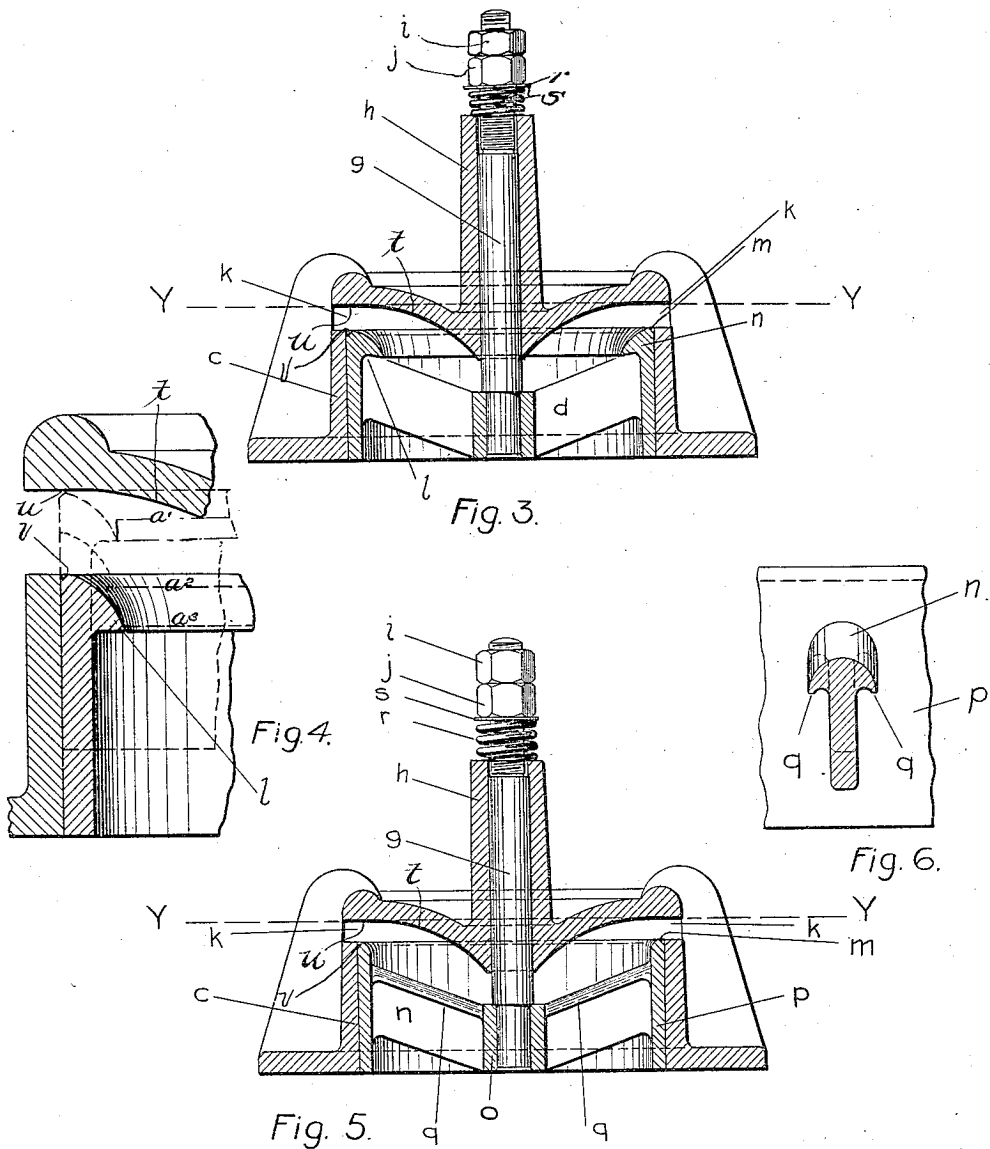
INVENTOR  
 William R. Phillips.  
 BY  
 T. J. Geisler  
 ATTORNEY



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 HYDRAULIC RAM.  
 APPLICATION FILED OCT. 18, 1910.

1,069,285.

Patented Aug. 5, 1913.  
 2 SHEETS—SHEET 2.



WITNESSES:  
 C. B. Long  
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INVENTOR  
 William R. Phillips.  
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 ATTORNEY

# UNITED STATES PATENT OFFICE.

WILLIAM R. PHILLIPS, OF PORTLAND, OREGON.

HYDRAULIC RAM.

1,069,285.

Specification of Letters Patent.

Patented Aug. 5, 1913.

Application filed October 18, 1910. Serial No. 587,772.

To all whom it may concern:

Be it known that I, WILLIAM R. PHILLIPS, a citizen of the United States, and a resident of Portland, county of Multnomah, and State of Oregon, have invented a new and useful Improvement in Hydraulic Rams, of which the following is a specification.

My invention relates to hydraulic rams, more particularly to the type employing a vertical waste-valve, and the object of my invention is:

First.—To obtain a waste-valve which shall be adapted to cause the impact thereof of the drive stream flowing through the ram to automatically close it, periodically in its cycle of motion. This result I obtain by constructing the body of the waste valve in the form of an annulus, and providing such body with a surface, opposed to the direction of travel of said stream, and of such area as to cause said out-flowing stream to drag said waste valve along and in so doing start it to close, the closure being completed by the ordinary, and continuing, impact of the drive water. My valve construction, however, is such as to minimize the force due to the pressure of the water against the under surface of the valve, for I depend upon the dragging action of the water flowing through the valve for the closing force.

Second.—To so construct the waste-valve that it presents the smallest practical, unbalanced area to the action of the stream of drive water at the instant of closure, in order to minimize undue wear upon the waste valve and its seat, as heretofore experienced in rams of the type referred to. In other words I have so constructed the top rim or face of my waste valve that there will be exposed sufficient area on the interior to balance the pressure against the under side of the waste valve, except to the degree required to obtain the dragging effect, described. I also very slightly bevel the exterior of the valve face so as to provide an exterior area for atmospheric pressure to act upon in re-opening the waste valve at the proper instant in the cycle of motion. This bevel is obtained by providing a chamfer, *v*, on the outer edge of the seated surface of the valve. This chamfer also prevents the upsetting of the metal at such surface.

These and other beneficial results which I obtain are fully stated in the body of this specification.

In the accompanying drawings: Figure 1 is an elevation in section of my improved ram; Fig. 2 is a horizontal section on line *y-y* of Fig. 1; Fig. 3 is a larger-scale section through the waste-valve and its casing; Fig. 4 is a sectional detail, on a still larger scale, relating to Fig. 3; Fig. 5 is a section similar to Fig. 3, but embodying certain modifications and additional features which are more conveniently described in the body of the specification; and Fig. 6 is a vertical cross-section through one of the arms connecting the center of the waste-valve with its outer portion, and related to the type of waste-valve illustrated in Fig. 5.

The apparatus is mounted on a tubular base *A*, a part of which is the supply pipe *b*. On the base is mounted a casing *c* of the waste-valve *d*, and the air chamber *e*, which is provided with a check-valve *e'* and a delivery pipe *f*, as usual. The details of construction of the waste-valve may be more readily seen in Fig. 3. The waste-valve *d* slides freely in its cylindrical casing *c* and is partly guided by its central stem *g*, which passes through a sleeve *h*, an integral part of the valve casing *c*. The guiding means comprising the stem *g* and the sleeve *h*, however, are merely used as a matter of convenience and are not essential to the action of the waste-valve, for it may be made of sufficient length to guide itself. The nuts *i*, *j*, shown on the upper part of the valve stem *g*, are provided as convenient means for adjusting the length of travel of the waste valve, and in so doing regulating the number of impulses, per unit of time, and, consequently, the quantity of water used. By means of the nuts *i*, *j*, the valve *d* may be raised so as to partly cover the escape-ways *h*. However, any other suitable means for accomplishing said adjustment will answer.

The waste-valve *d* is a hollow cylinder through which the stream of drive water flows on its way toward the escape-way *h*. The outer and inner surfaces of the valve are substantially parallel, so as to expose no avoidable surfaces to the pressure of the flow of water, also so as to minimize said pressure in the direction of travel of the valve and the force of impact of the valve against its seat in closing. The waste-valve is adapted to be periodically lifted to closed position by the dragging action of the stream of water flowing through it; and it is

such dragging action alone upon which I depend for the closing of my valve, the latter being especially adapted and constructed to present no unbalanced surfaces not required to produce said dragging action. To obtain such dragging action, the combined area of the surfaces of the base and the web of the waste-valve body, exposed and opposed to the direction of travel of the stream of drive water, must be sufficient for the outflowing water to seize and act upon and in so doing produce said closing effect. In other words, the construction of the waste-valve in the particulars referred to must be such as to cause a dragging of the water flowing through it against said surfaces to such degree as to periodically lift the waste-valve toward its closed position. If deemed preferable, the described effect may be promoted by providing the waste-valve with additional surface area; for example, with an interior annular projection or shoulder *l*, so as to obtain a surface of greater area, for the purpose stated; and in my judgment the provision of such additional surface area materially increases the efficiency of the waste-valve in its described action.

The operation of my waste valve, briefly stated, is as follows: Supposing the waste-valve *d* to have just been placed in its open position, as shown in Figs. 1 and 3, and that the water in the supply pipe *b* is beginning to flow through the waste-valve on its way toward escape-ways *k*. The velocity of the water so escaping will rapidly increase and cause it to exert a force upon said opposed surfaces of the waste-valve sufficient to start to lift the latter and the continued impact of the drive water will then close it. The curve, *t*, at top of interior of casing, as shown in Figs. 3 and 4, reduces the area of passage through which the water flows, at the instant the valve is in the act of closing. The effect of this is an increase in the velocity of the water past the lip and a consequent acceleration in the movement of the valve toward its seat *u*. In the action of a hydraulic ram, any escape through the waste valve after the water has reached its maximum velocity, results in a loss of efficiency. It follows then, that the ideal waste valve will stop the flow without loss, at that instant; and a waste valve that can by acceleration, as in this one, shorten the time of closing, will approach the ideal and be an important improvement over a valve in which such acceleration did not take place. Said lifting action ceases the instant the outflowing water is arrested by the closing of the waste-valve, and then the same conditions exist, and the same action takes place, as in any hydraulic ram at the same instant in the cycle of operation; in other words, causing a discharge of the water into the air chamber *e*. The energy of the water in

the supply pipe having been expended, the waste-valve *d* is permitted to return to its open or initial position, being moved to such initial position by the combined agencies of its own weight and regurgitation, and thereupon another cycle begins. Furthermore, to facilitate the reopening of the waste-valve after closure, I prefer to make the top rim thereof with a bevel *v*, more clearly seen in Fig. 4, so that when the waste-valve abuts against its seat in the roof of its casing, as occurs at the instant of closure, it will expose ample surface to exterior atmospheric pressure, and permit the latter to contribute its potency in causing the return movement of the waste-valve.

The waste-valve shown in Fig. 5 differs from that shown in the preceding views only in the following respects: Instead of providing the waste-valve with an interior annular shoulder like *l*, as shown in Figs. 1, 3 and 4, the arms *n*, connecting the central part, *o*, with the outer portion *p*, are provided on both faces with projections or shoulders *q*, *q*, as more clearly illustrated in the cross-section of the arm *n*, shown in Fig. 6. Furthermore, in Fig. 5 I have shown the valve stem *g* to be lengthened sufficiently to permit the introduction of a coil-spring *r* and washer *s* under the nuts *i*, *j*. The purpose of the coil-spring *r* is to relieve a condition where, by reason of the head of water being too low, the impact of the outflowing drive stream against said resisting surfaces of the valve body would be insufficient in itself to effectively overcome the inertia of the waste-valve, and in consequence render its closing movement too sluggish. The tension of the coil-spring *r* is just sufficient to place the waste-valve in a state of equilibrium.

I claim:

1. In a hydraulic ram, a waste valve comprising a cylindrical casing provided with a valve-seat lying in a plane at right angles to its axis, said casing having a portion under said valve-seat cut away to provide a waste outlet, a cylindrical hollow valve whose outer and inner surfaces are substantially parallel to the axis of the cylinder, the opposed surfaces of the valve-seat and of the valve, in contact at the instant of closure, being adapted to expose, at such instant, adjacent the seated surface of the valve an interior area approximately equal to that of the opposite or rear surface of the valve, whereby the latter is placed substantially in balance at the instant of closure.

2. In a hydraulic ram, a waste valve comprising a cylindrical casing provided with a valve-seat lying in a plane at right angles to its axis, said casing having a portion under said valve-seat cut away to provide a waste outlet, a cylindrical hollow valve whose outer and inner surfaces are substan-

tially parallel to the axis of the cylinder, the surface of the valve seated against the valve seat being made with an interior bevel adapted to expose at the instant of closure 5 of the valve an area approximately equal to that of the opposite or rear surface of the valve, whereby the latter is placed substantially in balance at the instant of closure.

3. In a hydraulic ram, a waste valve comprising a cylindrical casing provided with a valve seat lying in a plane at right angles under said valve seat cut away to provide a waste outlet, a cylindrical hollow valve 10 whose outer and inner surfaces are substantially parallel to the axis of the cylinder, the opposed surfaces of the valve seat and of the valve, in contact at the instant of closure, being adapted to expose, at such instant, adjacent the seated surface of the valve an interior area approximately equal to that of the opposite or rear surface of the valve, whereby the latter is placed substantially in balance at the instant of closure, and said valve made with a projecting surface perpendicular to its line of motion constantly exposed to the water flowing through the valve.

4. In a hydraulic ram a waste-valve comprising a cylindrical casing provided with a valve-seat lying in a plane at right-angles to its axis, said casing having a portion under said valve-seat cut away to provide a waste outlet; a cylindrical hollow valve 35 whose outer and inner surfaces are substantially parallel so as to minimize the pressure of the outflowing water upon the valve in the direction of its travel; said valve formed with a surface projecting from it in a plane perpendicular to the interior surface of the valve, whereby the outflow of the water through the valve is opposed, and such outflowing water in escaping over such lip is caused to drag the valve into its 45 closed position, the opposed surfaces of the valve seat and of the valve, in contact at the instant of closure, being adapted to expose, at such instant, adjacent the seated surface of the valve an interior area approximately equal to that of the opposite or rear surface of the valve; and means for

holding the valve in a state of poise when in its open position.

5. In a hydraulic ram, a waste valve comprising a cylindrical casing provided with 55 a valve seat lying in a plane at right angles to its axis, said casing having a portion under said valve seat cut away to provide a waste outlet, a cylindrical hollow valve whose outer and inner surfaces are substantially parallel to the axis of the cylinder; said valve seat made with an interiorly projecting concaved conical surface adapted to reduce the area of passage through which the water flows at the instant the valve is in 65 the act of closing; and the opposed surfaces of the valve seat and of the valve, in contact at the instant of closure, being adapted to expose, at such instant, adjacent the seated surface of the valve an interior area approximately equal to that of the opposite or rear surface of the valve, whereby the latter is placed substantially in balance at the instant of closure.

6. In a hydraulic ram, a waste valve comprising a cylindrical casing provided with 75 a valve seat lying in a plane at right angles to its axis, said casing having a portion under said valve seat cut away to provide a waste outlet, a cylindrical hollow valve 80 whose outer and inner surfaces are substantially parallel to the axis of the cylinder; said valve seat made with an interiorly projecting concaved conical surface adapted to reduce the area of passage through which 85 the water flows at the instant the valve is in the act of closing; the opposed surfaces of the valve seat and of the valve, in contact at the instant of closure, being adapted to expose, at such instant, adjacent the seated 90 surface of the valve an interior area approximately equal to that of the opposite or rear surface of the valve, whereby the latter is placed substantially in balance at the instant of closure; and said valve made 95 with a projecting surface perpendicular to its line of motion constantly exposed to the water flowing through the valve.

WILLIAM R. PHILLIPS.

Witnesses:

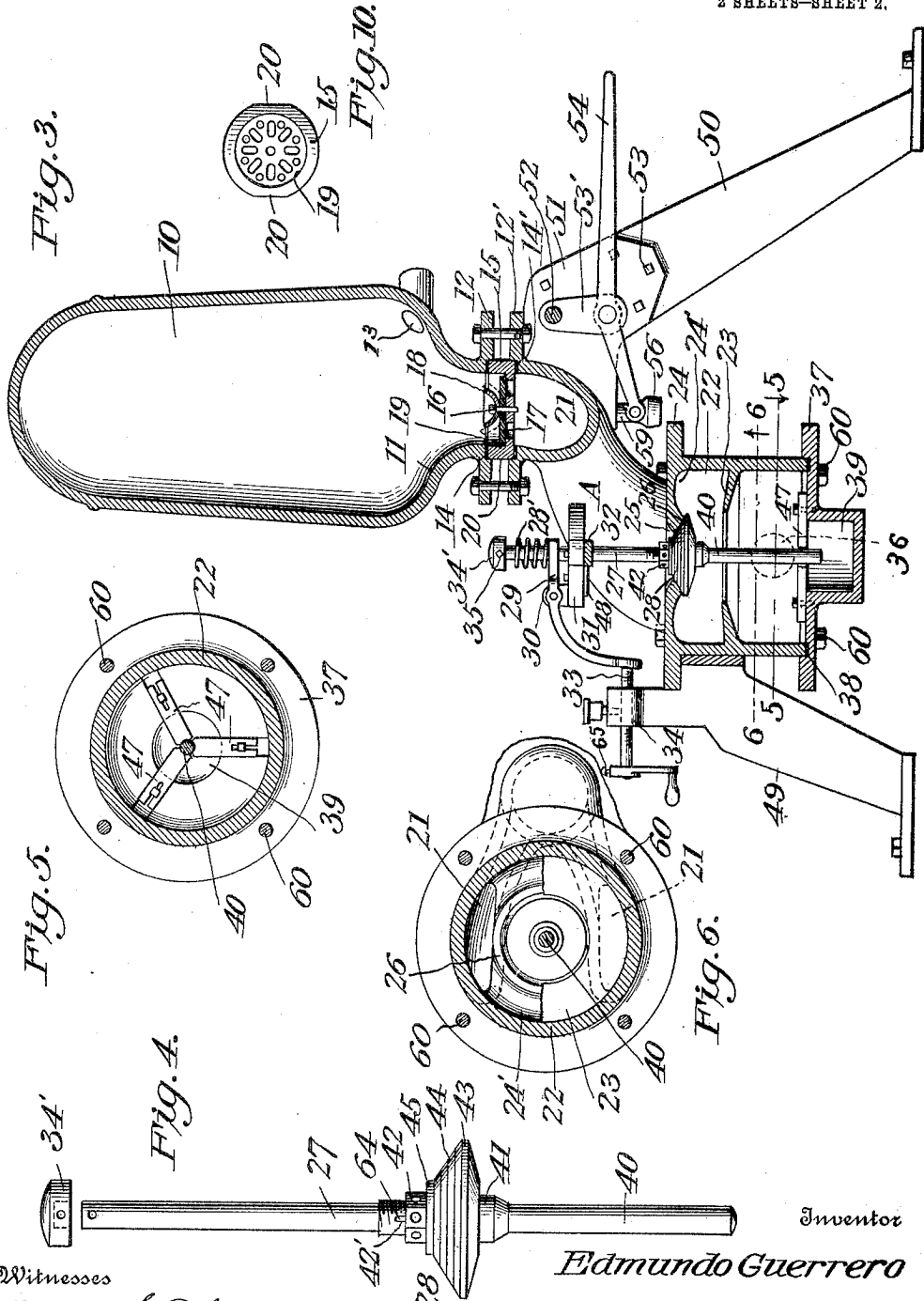
O. O. MARTIN,  
C. B. LONG.

E. GUERRERO.  
 HYDRAULIC RAM.  
 APPLICATION FILED JUNE 10, 1913.

1,098,720.

Patented June 2, 1914.

2 SHEETS—SHEET 2.



Witnesses  
*Fenton St. Belt*  
*Chas. R. Nielsen.*

Inventor  
*Eduardo Guerrero*

By *H. S. Woodward*  
 Attorney

# UNITED STATES PATENT OFFICE.

EDMUNDO GUERRERO, OF ANTIGUA, GUATEMALA.

## HYDRAULIC RAM.

1,098,720.

Specification of Letters Patent.

Patented June 2, 1914.

Application filed June 10, 1913. Serial No. 772,773.

*To all whom it may concern:*

Be it known that I, EDMUNDO GUERRERO, a citizen of Guatemala, residing at Antigua, in the Province of Sacatepequez and Republic of Guatemala, have invented new and useful Improvements in Hydraulic Rams, of which the following is a specification.

The invention has for an object to improve the mounting of the impetus valve in such devices so that the passage from the impetus valve chamber to the air chamber or the delivery line may be more directly in line with the direction of movement of the water in flowing past the impetus valve and developing the momentum required for the blow to be struck.

Another very important object is to so construct the device that air will be fed to the air chamber through the impetus valve port under the normal operation of the device without requiring separate mechanical parts, and operable in connection with an ordinary form of valve.

A further aim is to improve the construction of valves in such devices.

An additional object is to simplify the removal of the impetus valve.

It has been the common experience in such devices that after the impetus valve has been adjusted to act properly, it soon gets out of adjustment because of wear of parts, or for other reasons, and it is also necessary to stop the operation of the device while a new adjustment is made, which then is rather difficult and apt to be inaccurately made except by skilled artisans.

It is therefore an important aim of my invention to provide a valve adjustment, liable in the minimum degree to variation through wear, to enable the adjustment of the stroke without stopping the action and to permit an accurate adjustment to be maintained without requiring skill in manipulating implements or parts of the machine.

It has also frequently happened that when used to elevate water to considerable heights gaskets or packings are very difficult to retain in place, and become loosened and blown out under the combined vibration and pressure exerted.

It is a valuable attainment of my invention that the parts are so constructed as to insure the gaskets remaining in place with a moderate compression.

Another object of great importance in

such devices is to enable the renewal of the main valve between the feed and the air chamber without entirely removing the air chamber, or disconnecting the delivery pipe although the latter be connected to the bell portion of the chamber direct, thus permitting simplification of the form of the castings required.

A further object is to provide an improved means for accurately centering a puppet valve of the mushroom type.

An additional object attained is an increased durability in the impetus valve and the main valve.

An important end attained is the provision of means for releasing and exposing the main valve within the air-chamber.

Additional objects and advantages will be apparent, some of which will appear from the following description, and from the drawings, representing one possible embodiment of the invention, in which,

Figure 1 is a side view of the device, Fig. 2 is a front view thereof, Fig. 3 is a vertical sectional view, Fig. 4 is a detail view of the impetus valve, Fig. 5 is a section on the line 5—5 of Fig. 3, Fig. 6 is a section on the line 6—6 of Fig. 3, Fig. 7 is a detail of the cross-head, Fig. 8 is a detail of the starting lever, Fig. 9 is a detail of the upper valve guide, Fig. 10 is a detail of the main valve seat, Fig. 11 is a fragmentary detail of the air chamber adjustment.

The ram comprises an air chamber 10 substantially in the form of an inverted bottle having a reduced neck 11 at its lower or receiving end, the neck having a flange 12, whereby it may be mounted upon a supporting portion to be described. A delivery terminal 13 is formed on the air chamber casting in the bilge portion and the fastenings for the chamber permit its adjustment of the supporting portion with the terminal 13 at any of four sides, in order that the feed connections may be made at that side most convenient. The lower face of the flange 12 is provided with a shallow groove 14, in which a gasket may be set, and in which the upper portion of a circular bronze plate 15 may be set upon the gasket, the plate being foraminated and having a headed bolt 16 screwed downwardly thereinto, confining a circular flap valve 17, of ordinary form checked against upward flexure beyond a proper limit by means of

recessed to coengage snugly around the stem portion 40, to allow vertical reciprocation thereof and to hold the stem properly centered. Similar guide blocks 48 are secured upon the upper side of the plate 31 by which the lever 29 is supported. In the operation of the device it will be seen that there is no binding of the stem of the valve as would be the case in ordinary forms where the valve is guided only at one end.

After the blow is delivered by the ram during operation, the opening of the valve serves to allow ingress of a number of small bubbles into the grooves 24 through the port 25, the groove serving as a trap to prevent escape of the air and to guide it to the duct branches, which are inclined continuously upwardly to the main valve, through which they are carried by the successive blows of the ram.

Projecting forwardly and downwardly from the side of the chamber 22 there is a leg 49, and legs 50 are attached to the rear of the duct, secured in a manner which will be subsequently described. Three legs are preferably provided, the two rear ones adjusted at the rear of the duct, and the device is preferably supported at such a height that when the bottom 37 is removed from the chamber 22, and the top 34' removed from the valve stem, the valve may be readily drawn downwardly and removed.

Two laterally spaced rearwardly projected ears 51 are formed on the upper part of the duct 21 and the legs are secured respectively to the ears 51, one of the securing means being a bolt or shaft 52 extending between the legs and secured in a suitable manner. Pendent upon the shaft 52 there are links 53', pivoted to the lower ends of which is a lever 54 having a suitable handle for its operation projecting rearwardly, the lever being of the first class and having its inner end suitably disposed for vertical movement close to the axis of the air chamber. A cross head 56 is carried pivotally thereby, the outer ends of which are in alignment with guides 57 formed at the sides of the duct. Secured to suitable lugs 58 formed on the side of the air chamber above the flange 12, there are heavy supporting or lifting bolts 59, engaged diagonally through the lugs and extending downwardly to the flange 12, immediately below which they are turned and extended in a vertical direction slidably through the flange 12' and guides. The lower ends of the bolts are rounded and rest in suitable recesses at the outer ends of the cross head 56, the upper ends of the bolts being tenoned in the lugs, whereby, when the lever 54 is operated after the removal of the clamping bolts, the chamber is lifted sufficiently for the removal and replacement of the main valve as before described. The flanges 12 and 12' when in secured position

are spaced apart some distance, the plate 15 being of a sufficient dimension to secure this, so that very slight movement of the chamber 10 gives sufficient space for clearance of, and access to, the plate. The flanges 12 and 12' are suitably apertured for the insertion of clamping bolts in the proper number. There will be a minimum binding of the bolts 59 with the guide portions 57 and the operation of renewal of the main valve or parts may be accomplished with but little effort. The projecting top flange portions of the chamber 22 and the bottom plate 37 are provided with registered apertures through which securing bolts 60 may be engaged.

The starting of a ram of this character is sometimes attended with considerable difficulty, if the valve is closed by the power water before there is proper pressure in the delivery system. The proportions and relation of the valve stem and flanges 12 and 12' are therefore especially calculated to facilitate the application of pressure upon the valve stem; and particularly to enable the use of such an implement as that shown in Fig. 8, which comprises a lever 61 having a lip 62 adapted to be engaged beneath one of the flanges, and also a recess 63 adapted to receive the cap 34' therein, being of such length as to be readily operated manually to depress the valve against the maximum water pressure.

It is apparent that notwithstanding the improvements in function attained by the invention, it is nevertheless constructed of few parts, simple to manufacture, whereby its cost is minimized.

The renewal of the wearing surfaces of the valve 28 may be readily accomplished under the construction provided, and it may be noted that in order to secure the nut 42 in place it is provided with a series of radial apertures, and the threaded portion of the stem has a longitudinal groove 42' therein, by which arrangement a cotter pin 64 may be engaged through one aperture with its extremity in the groove, to hold the nut against casual loosening. The screw 33 may be fitted with a detachable revoluble crank thereon, and secured by a screw 65, the weight of which when pendant holds the screw against change of adjustment; and by means of the screw 65, whenever the valve is adjusted the crank may be disposed in pendant position to hold the device as set.

It is to be observed that the construction enables the obtainance of an automatic air feed directly from the impetus valve port or waste opening, and yet enables the use of a vertically disposed valve which is best adapted for accurate feeding and properly balanced movement with a simple construction. The quantity of air supplied is quite

abundant, entering on each reaction and being forced by the consecutive impacts into the air chamber together with the water. If the quantity of air becomes excessive, it is

5 simply forced into the delivery line as soon as the level of water in the air chamber becomes lower than the delivery terminal 13. The pump is especially designed for lifting water to great elevations, and it will be

10 seen that all of the parts are of such design as to best meet such requirements. It is of course understood that the walls of the air chamber and other parts sustaining stress of the water pressure are of sufficient thick-

15 ness to sustain the maximum pressure to which they are liable.

In order to lessen the pressure necessary to form a water-tight joint between the several castings the grooves for the gaskets may have a medial smaller groove, and those parts engaging in the larger grooves may have a corresponding rib, as shown at 66 in Fig. 11. By this construction the packing material is heavily compressed with but

20 little strain on the clamping bolts, as will be understood. The grooves 24' may be slightly deepened adjacent the lower ends of the arms of the duct 21 so that they will slope continuously upward theretoward, facilitating the movement of air into the duct.

30 What is claimed:

1. In a ram, an impetus valve chamber having a circular waste port in its top part, a circumscribing groove there around within the chamber, an air chamber located above the groove in communication with the delivery line of the ram and duct means leading continuously upward from the groove to the air-chamber.

40 2. In a ram, an impetus valve chamber having a circular waste port in its top part, recesses formed closely adjacent the port and having sides upwardly inclined away from the port, an air chamber above the recesses in communication with the delivery line of the ram and duct means leading continuously upward from the recess to the air-chamber.

50 3. A ram, comprising an impetus chamber member having an upwardly opening port, an impetus valve therefor, integral duct portions extending upwardly from each side of the port being curved laterally in a common direction and inclined upwardly, an air chamber member carried at the upper end thereof in communication with the ducts, the upper parts of the ducts and elements carried thereby being spaced from the axis of the valve, said valve having a stem projecting upward above the lower portions of the ducts, and a check valve between the impetus chamber and air chamber.

65 4. In a ram, an impetus chamber having duct portions leading therefrom, terminating in a ported flange portion, an air cham-

ber thereover having a corresponding flange portion opposed to that first named and adapted to be bolted thereto, a ported valve plate secured between said flanges, a puppet valve carried by the plate opening toward the chamber, securing bolts engaged between the flanges to hold the air chamber in operative position and to secure the said plate, a lever pivoted separately from the air chamber casting, a vertically slidable member carried by the lever for operation thereby, and connected to the air chamber for lifting thereof at times to clear the valve plate, whereby the latter may be removed.

5. In a ram, an impetus chamber having duct portions leading therefrom and terminating in a ported air chamber support, an air chamber thereover having an inlet registering with the port of the support, a valve carrying member removably engaged between the air chamber and support, a puppet valve contained therein opening toward the chamber, means to clamp the valve carrying member between the base of the chamber and the support, a lifting member secured to the chamber and engaged slidably in the support for vertical movement, pendent links carried by the support, a lever intermediately pivoted on the lower ends of the links, and having a major operating arm projected outwardly from the support, and pivotal connections between the minor arm of the lever and said lifting member for lifting the chamber at times and clearance of said valve carrying member for lateral removal.

6. A stroke adjusting means for impetus valves comprising a support, a reciprocating valve stem, a lever on the support having an arm embracing the stem, a head on the stem, a spring on the arm adapted to engage the head to check the valve stem in opening movement and means to adjust the lever in various positions to vary the limit of opening movement of the valve.

7. In a ram of the class described, an air chamber element having a port opening outwardly, a coaxial reciprocating valve adapted to seat inwardly thereof and having stem portions projecting inwardly and outwardly, circumscribing stationary plate portions adjacent the inner and outer stem portions, radially arranged blocks radially slidable on the plates and having recessed end portions adapted to coengage the respective stem portions for guidance thereof, and means to secure the blocks in adjusted positions.

8. A ram comprising an impetus valve chamber casting, a top portion thereon having a concentric port, a valve seat on the inner side of the port therearound, a valve adapted to seat therein having a stem projected outwardly from the port, guide and stroke limiting means engaged with the

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stem above the chamber, duct elements carried by the top of the chamber and having communication with the chamber laterally of said port, the duct elements being inclined laterally and upwardly, away from the axis of the port and terminating in a single flanged member, an air chamber having a flanged inlet portion adapted for co-engagement with the said flanged member, a main valve for the air chamber inlet, and

supply and delivery connections for the impetus valve and air chambers respectively.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

EDMUNDO GUERRERO.

Witnesses:

DAVID NOTHFIELD,  
H. L. WOODWARD.

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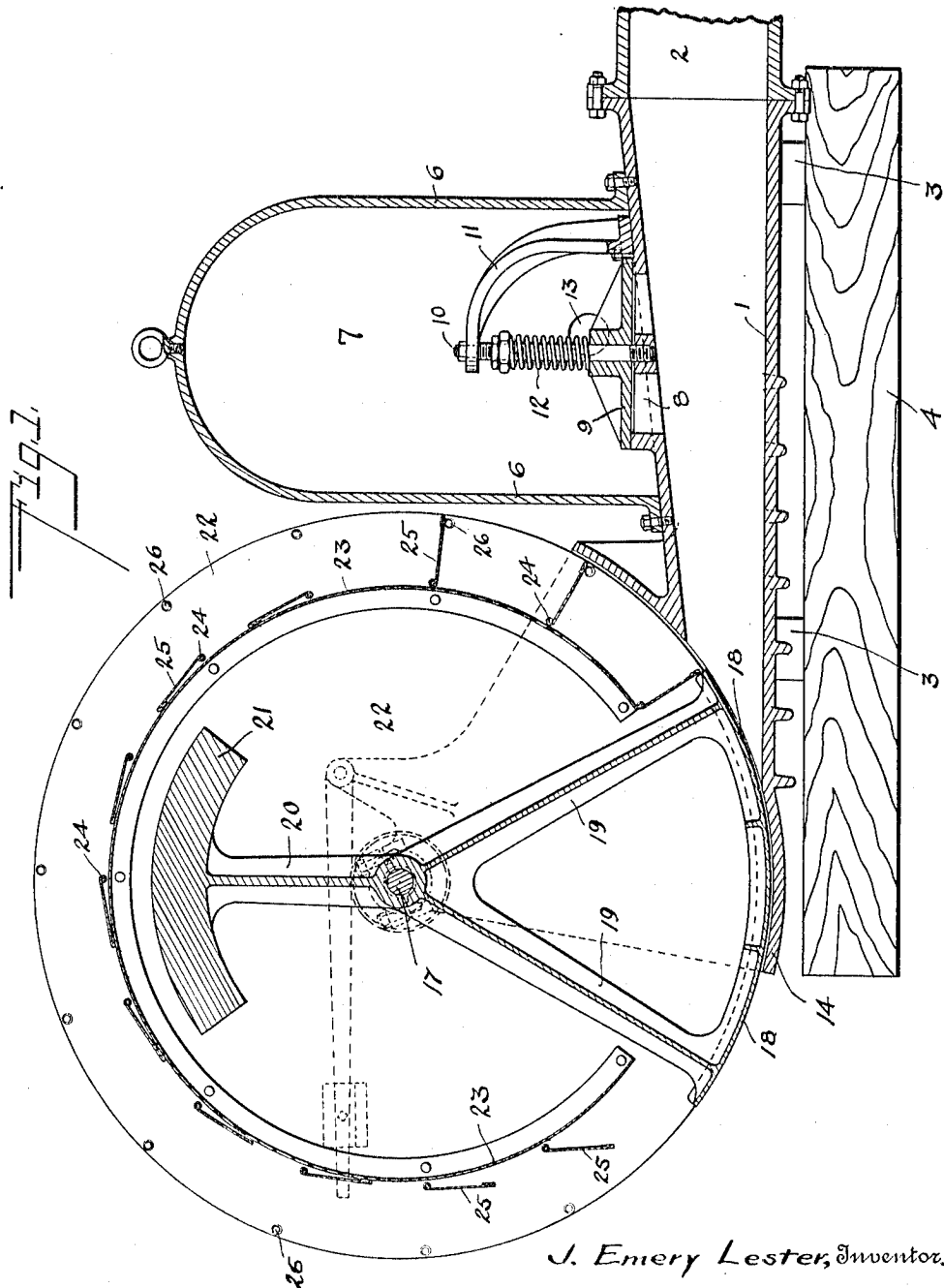
Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

J. E. LESTER.  
 HYDRAULIC RAM.  
 APPLICATION FILED OCT. 11, 1910.

1,102,217.

Patented June 30, 1914.

3 SHEETS-SHEET 1.



J. Emery Lester, Inventor.

Witnesses:  
*Wm. Fisher*  
*Ray L. Spang*

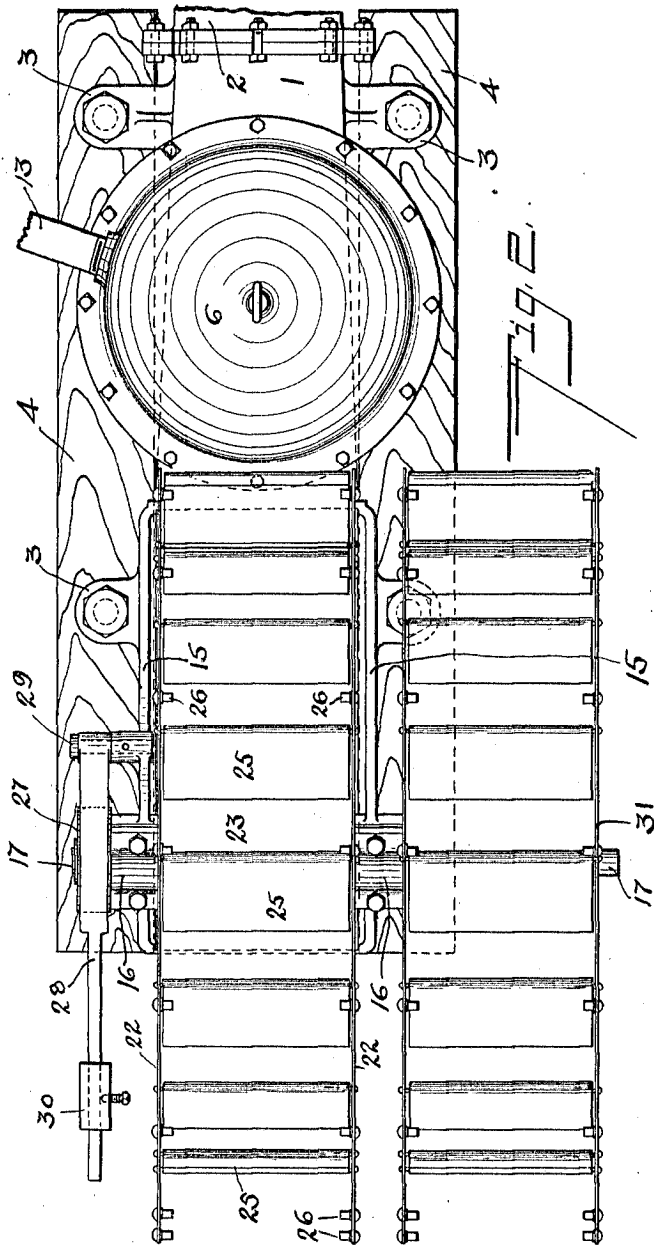
By *David O. Barnell,*  
 Attorney.

J. E. LESTER.  
HYDRAULIC RAM.  
APPLICATION FILED OCT. 11, 1910.

1,102,217.

Patented June 30, 1914.

3 SHEETS—SHEET 2.



J. Emery Lester, Inventor.

Witnesses:  
*Fred Fisher*  
*Roy G. Kratz*

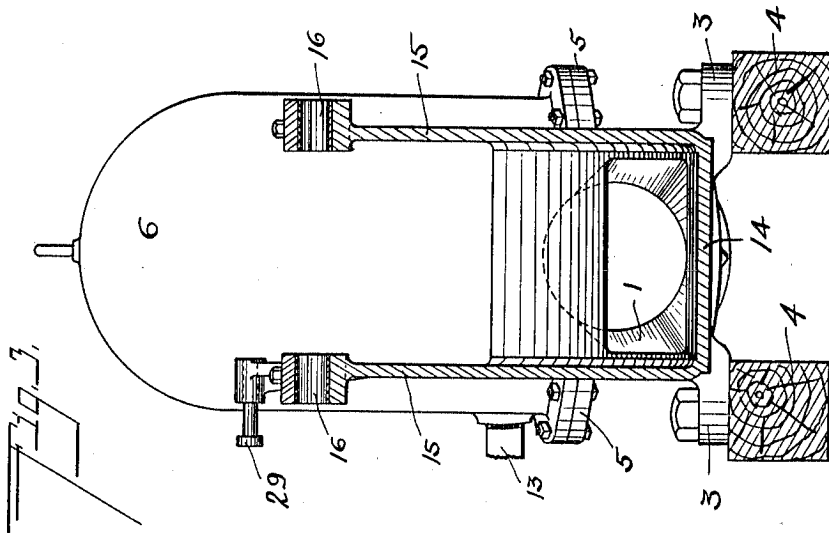
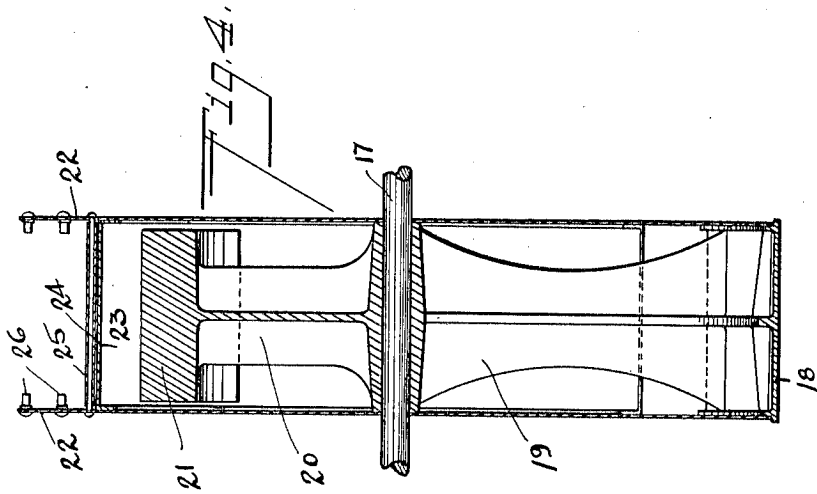
By *David O. Barnell*,  
Attorney.

J. E. LESTER.  
 HYDRAULIC RAM.  
 APPLICATION FILED OCT. 11, 1910.

1,102,217.

Patented June 30, 1914.

3 SHEETS-SHEET 3.



J. Emery Lester, Inventor.

Witnesses  
*Jord Fisher*  
*Roy G. Kratz*

By *David O. Barnell*,  
 Attorney.

# UNITED STATES PATENT OFFICE.

JOHN EMERY LESTER, OF PORTLAND, OREGON, ASSIGNOR, BY MESNE ASSIGNMENTS,  
TO S. J. PHILLIPS, OF PORTLAND, OREGON.

## HYDRAULIC RAM.

1,102,217.

Specification of Letters Patent. Patented June 30, 1914.

Application filed October 11, 1910. Serial No. 586,548.

*To all whom it may concern:*

Be it known that I, JOHN EMERY LESTER, a citizen of the United States, residing at Portland, in the county of Multnomah and State of Oregon, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

My invention relates to hydraulic rams, and more particularly to the structure and operation of waste-valves for such machines.

It is the object of my invention to provide in a hydraulic ram a simple and positive means for periodically closing the waste opening, which closing means shall be actuated by the stream of water which passes from the waste opening when the same is open.

Further objects are to provide means for regulating or controlling the valve action, and means enabling the ram to be operated when set in running streams where the head of water attainable is very low and where the water level varies so that at times the entire ram mechanism may be submerged.

In the accompanying drawings, Figure 1 is a longitudinal vertical sectional view of a hydraulic ram embodying my invention, Fig. 2 is a plan view of the same, Fig. 3 is a transverse vertical section of the casing on the axis of the wheel shaft bearings, and Fig. 4 is an axial section of the gate-wheel.

In the construction shown I provide a casing or shell 1 having at one end a flange adapted for connection with the drive-pipe 2 which is extended to a suitable source of water supply. The passage through the casing is circular at the end connected with the drive pipe, and in traversing the length of the casing is narrowed vertically and widened horizontally so that the waste opening is of the rectangular form indicated in Fig. 3. The lower side of the passage is substantially horizontal, the vertical narrowing of the passage being made by inclination of the upper side of the casing, and the sectional area of the passage is made throughout substantially the same as that of the drive pipe. At the sides of the casing are suitable foot-lugs 3 adapted for connection with base-timbers 4, as shown.

On the upper side of the casing is a flange 5 to which is bolted the bell or dome 6 which

incloses the air-chamber 7. An opening 8 from the passage through the casing 1 to the air-chamber is normally closed by the discharge-valve 9. Said valve is slidably held in position above the opening by the vertical guide-rod 10 which is held at the upper end by a curved standard 11 and at the lower end is screwed into the spider or grating which extends across the valve opening. A coil spring 12 is disposed around the guide-rod and normally holds the valve down upon its seat. Adjusting-nuts are placed on the guide-rod to permit adjustment of the compression of the coil spring. The discharge-pipe 13 is connected at one side of the air-chamber, as shown.

The lower part of the casing 1 is extended beyond the waste-opening as a curved plate 14, and from the sides thereof the cheek-plates 15 extend upwardly and carry the bearings 16 for the wheel-shaft 17. On said shaft between the bearings thereof is mounted the gate-wheel of which a part of the peripheral portion is formed by an arcuate plate 18 which is connected by integral arms 19 with a hub secured to the shaft. An arm extending from the opposite side of the hub carries a counterweight 21 of a size sufficient to balance the plate 18 and the arms carrying the same. The sides of the wheel are formed by circular plates 22, and said side-plates are connected with each other by a cylindrically formed cross-plate 23 which extends around concentrically with the shaft and of which the ends are substantially in radial alinement with the ends of the plate 18. Adjoining the outer side of the cross-plate 23 are equally spaced transverse rods 24 of which the ends are secured in the side-plates 22. On said rods are pivotally mounted the driving-blades 25 which are permitted to swing in one direction to a position tangent to the plate 23. Movement of the driving-blades in the other direction is limited by the studs 26 which are arranged in the side-plates at the positions shown so that the blades extend radially when the same engage said studs.

On one end of the shaft 17 outside the bearing thereof is mounted the brake-disk 27. A lever 28, fulcrumed on a stud 29 on the cheek-plate, extends over the brake-disk and has a weight 30 slidably secured thereon so that by adjusting the position thereof the

braking pressure of the lever on the disk may be varied.

In the operation of the ram, the water issuing from the waste-opening strikes the driving-blades 25 and thereby causes rotation of the wheel. During a part of each revolution of the wheel the waste-opening is closed by the plate 18, and during such time the wheel continues its movement by the momentum acquired during the remainder of the revolution. During the time that the waste opening is closed the momentum of the water in the drive-pipe forces a part of the same through the discharge-valve into the air-chamber 7, in the usual manner. There is more or less variation in the speed of the wheel at different phases of its movement, the motion being slowest when the plate 18 is passing away from and thus uncovering the waste-opening, and from this time increasing in velocity so that the maximum speed is reached during the covering of the waste-opening by the plate 18. It will be noted that as the closing of the waste-opening is commenced and the area thereof is reduced, the water will pass with increased velocity through the opening, and that the jet of water issuing from the reduced opening, being confined by the plate 14, will impinge upon one of the driving-blades and assist in moving the wheel. For controlling the speed of the wheel the braking device formed by the disk 27 and lever 28 is employed, and when operating under conditions where a brake is not required, the lever may be turned back so as not to engage the disk.

When operating with low heads of water an additional driving wheel 31 may be mounted on the end of the shaft 17 opposite to the brake device, as indicated in Fig. 2, the structure of said wheel being the same

throughout as the driving portion of the gate-wheel.

It may be noted with reference to the wheel structure, that by the pivotal mounting of the drive-blades 25 enabling them to turn back to a position tangent to the plate 23, the wheel may be actuated in the proper manner when the ram is completely submerged in a stream.

It may also be noted that the passage through the casing 1, being substantially horizontal, offers practically no resistance to the flow of water through the same, and thus makes the ram especially available for use in running streams where only a very low head of water is attainable.

Now, having described my invention, what I claim and desire to secure by Letters Patent is:

In a hydraulic ram, a water supply pipe having a discharge nozzle with a substantially rectangular opening of greater width than depth and with arcuate marginal portions, an undershot water wheel positioned so as to be engaged tangentially by the stream issuing from the discharge nozzle, and an arcuate plate carried by the wheel and adapted to coact with the marginal portions of the nozzle opening to close said opening, the plate being adapted in passing over the opening to direct the water from the uncovered part thereof onto the wheel so that the propulsive effect thereon will be momentarily increased.

In testimony whereof I have hereunto subscribed my name in the presence of two witnesses.

J. EMERY LESTER.

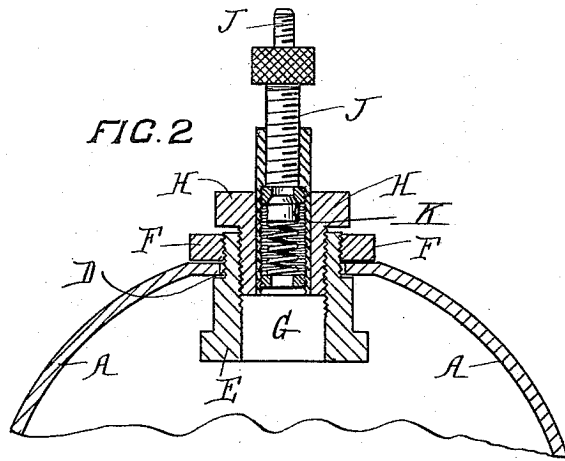
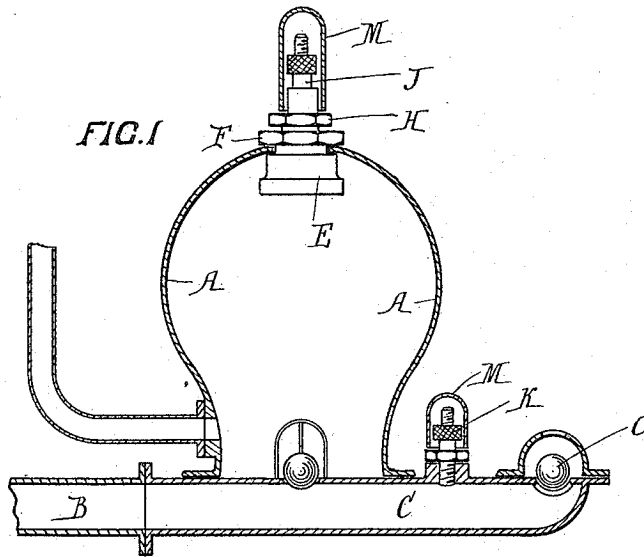
Witnesses:

DAVID O. BARNELL,  
ROY G. KRATZ.

W. NICHOLAS.  
 HYDRAULIC RAM.  
 APPLICATION FILED DEC. 14, 1911.

1,148,982.

Patented Aug. 3, 1915.



WITNESSES  
*F. H. Logan*  
*Alfred R. Anderson*

INVENTOR  
 WILLIAM NICHOLAS  
 BY *Frank Edmund*  
 ATTORNEY

# UNITED STATES PATENT OFFICE.

WILLIAM NICHOLAS, OF HOOK, NEW ZEALAND.

HYDRAULIC RAM.

1,148,982.

Specification of Letters Patent.

Patented Aug. 3, 1915.

Application filed December 14, 1911. Serial No. 665,743.

To all whom it may concern:

Be it known that I, WILLIAM NICHOLAS, subject of the King of Great Britain, residing at Hook, Canterbury, New Zealand, have invented new and useful Improvements in Hydraulic Rams; and I do hereby declare the following to be a full, clear, and exact description of the same.

This invention has been devised for the purpose of providing means whereby hydraulic rams may be cleared from matter choking the delivery pipe and valve, or the air dome and its valve and the waste pipe with a minimum of trouble and without any necessity for disconnecting any of the parts or for stopping the flow of water.

The invention consists in forming the top of the air dome with an opening which is normally kept sealed and providing it with an air inlet valve through which air under pressure may be introduced into the dome. A second air inlet valve is arranged in the waste pipe of the ram through which also, air under pressure, may be introduced into such pipe.

The opening in the top of the dome will allow for the dome being opened and cleared of any dirt or obstructions within it by the rush of the water that would then pass through the dome, and then be reclosed; while the air inlet valve thereon will provide for air being pumped into the top of the dome to force the water level down and to provide the necessary air pressure in the dome for the working of the ram. Likewise the air valve upon the waste pipe will provide for air being forced into such pipe to clear it of any dirt or other obstructions preventing the proper working of its out-flow valve.

The invention is illustrated in the accompanying drawings, in which:—

Figure 1 is a sectional elevation of a ram constructed according to this invention, the valves and valve fittings being shown in elevation. Fig. 2 is an enlarged sectional elevation of the top of the air dome and the valve in position therein.

A is the air dome; B the main flow pipe and C the waste pipe having the outlet gravity valve *c* all arranged in the usual relative and operative positions.

In this invention the air dome A is formed with the opening D in its top into which opening a bush E is secured by means of the nut F.

A passage G into the dome is thus provided. This passage is sealed by the hollow screw plug H which plug is provided with the air valve J opening through it. This valve is of any approved construction and preferably such as will normally keep closed and will open when air is forced into it so as to allow the air to pass through. In the drawings the valve represented is of the ordinary pneumatic tire type of valve adapted to receive the flexible union of an air pump.

K is the second air valve of similar construction which is fitted into the waste pipe C at a point close to the dome A in order that air may be forced through it into such pipe.

In operation, the air dome may be opened by unscrewing the plug H and removing it and the valve. The inside of the dome may then be inspected and any matter removed or stirred up by inserting a tool through the opening in the bush E. The water flowing through the main B will then flow up through the dome and carry the dirt and other matters out through the top of the dome or along the waste pipe. The opening may then be closed and sealed by reinserting the screw plug H, after which air may be pumped in through the valve J to provide the required air pressure in the dome.

When the valves J and K are not being used, they may each be covered and protected by a cap M placed thereon.

The construction and fitting of the valves may be varied in a number of ways without departing from the spirit of this invention and it is to be understood that I do not wish to confine myself exclusively to the means for carrying out the invention described herein and shown in the drawings.

What I do claim as my invention and sire to secure by Letters Patent is:—

1. In a hydraulic ram, the combination of a waste pipe having an outlet valve; an air dome communicating therewith at a distance from said valve, and having an opening at the upper part thereof; an inwardly and outwardly threaded hollow bush in said opening and having a shoulder engaging the inner face of the dome; a nut screwed to the outer threads of the bush and engaging the outer face of the dome and clamping the plug in said opening; a hollow screw plug screwed in the hollow bush; and an inwardly opening normally closed valve in



said plug and having a threaded end for the reception of a pump connection.

2. In a hydraulic ram, the combination of a waste pipe having an outlet valve; an air dome communicating therewith at a distance from said valve, and having an opening at the upper part thereof; an inwardly and outwardly threaded hollow bush in said opening and having a shoulder engaging the inner face of the dome; a nut screwed to the outer threads of the bush and engaging the outer face of the dome and clamping the plug in said opening; a hollow screw plug

screwed in the hollow bush; an inwardly opening normally closed valve in said plug and having a threaded end for the reception of a pump connection; and a protecting cap placed over said valve and resting on the hollow screw plug. 15

In testimony whereof, I have signed this specification in the presence of two subscribing witnesses. 20

WILLIAM NICHOLAS.

Witnesses:

ALPHO RICHARD VON HOLOSUF,  
CYRIL HASTO-STRONYER.

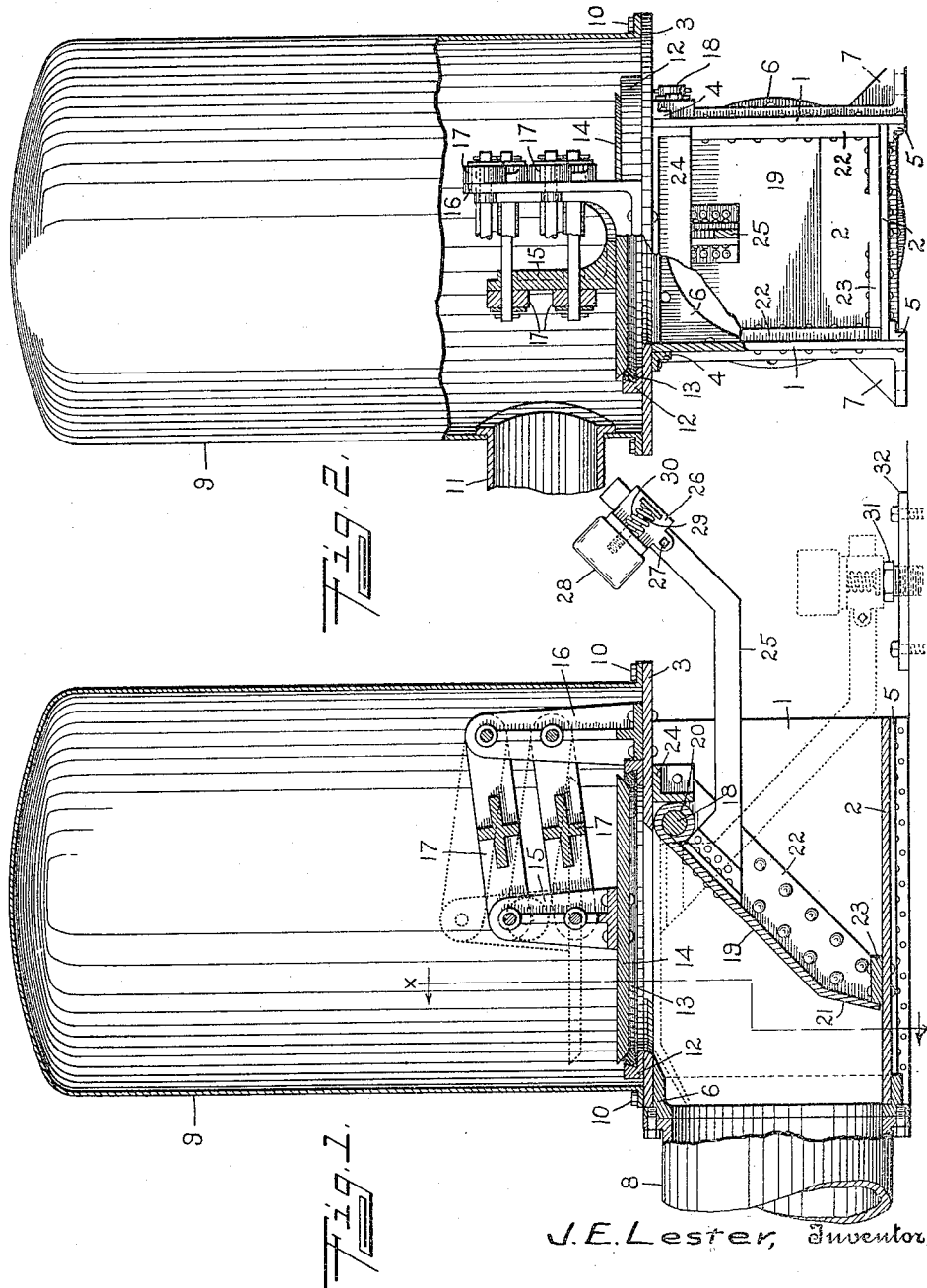
Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

1,214,192.

J. E. LESTER.  
HYDRAULIC RAM.  
APPLICATION FILED SEPT. 13, 1915.

Patented Jan. 30, 1917

2 SHEETS—SHEET 1.



J. E. Lester, Inventor.

Witness:

*A. W. Jamieson*

*By David O. Parrell,*

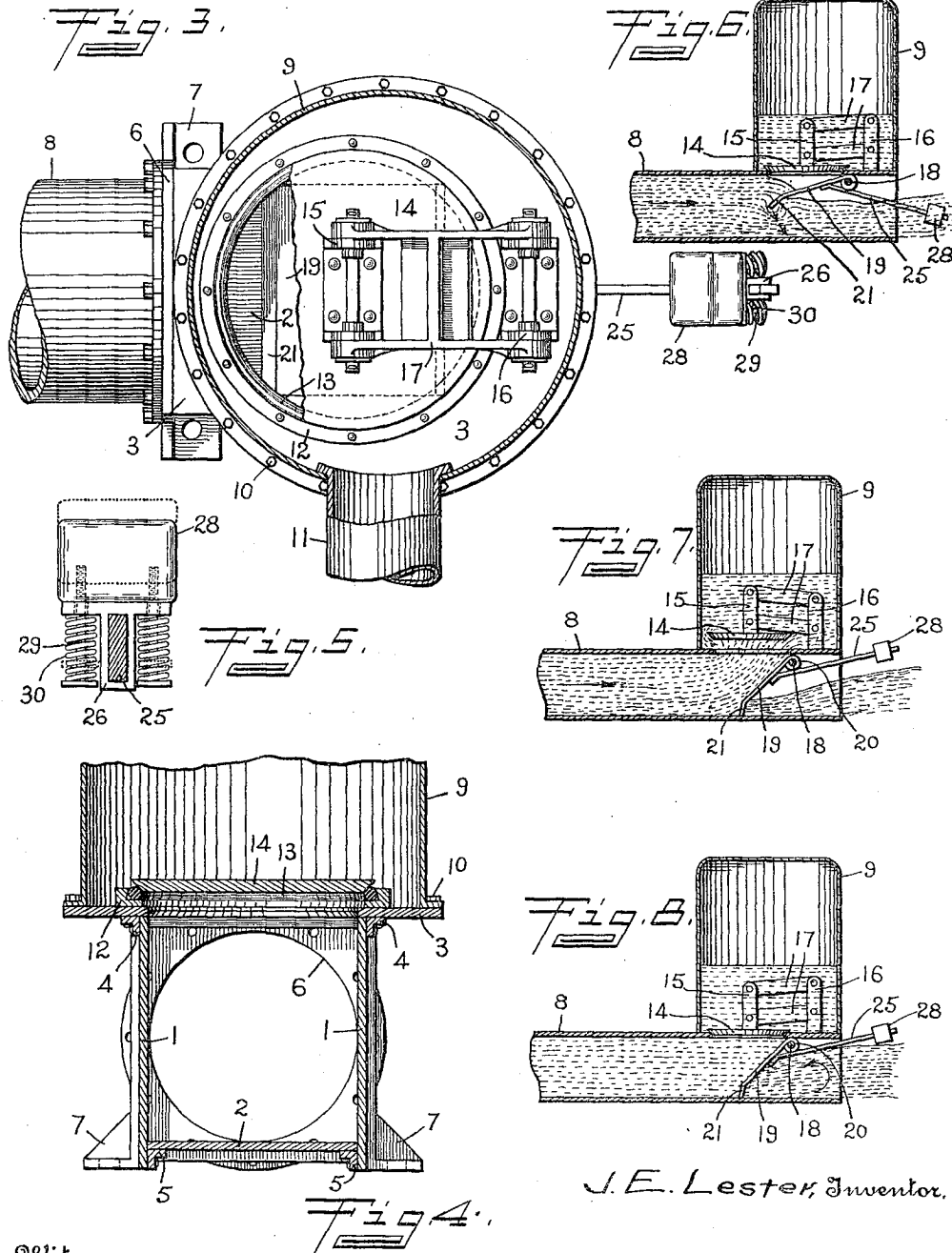
Attorney.

J. E. LESTER.  
 HYDRAULIC RAM.  
 APPLICATION FILED SEPT. 13, 1915.

1,214,192.

Patented Jan. 30, 1917.

2 SHEETS—SHEET 2.



J. E. Lester, Inventor.

Witness:

*A. W. Jamieson*

By *David O. Barnell*  
 Attorney.

# UNITED STATES PATENT OFFICE.

JOHN E. LESTER, OF TACOMA, WASHINGTON.

## HYDRAULIC RAM.

1,214,192.

Specification of Letters Patent.

Patented Jan. 30, 1917.

Application filed September 13, 1915. Serial No. 50,486.

*To all whom it may concern:*

Be it known that I, JOHN EMERY LESTER, a citizen of the United States, and a resident of Tacoma, in the county of Pierce and State of Washington, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

My invention relates to hydraulic rams, and it is the object thereof to provide a simple, efficient and durable ram mechanism, particularly adapted for operation under low driving heads, and for elevating large volumes of water to moderate elevations, as for irrigation purposes.

My invention relates particularly to the valve structure of the ram, and provides a waste-valve adapted to close a horizontal passage, and at closed position to deflect the moving current of water toward the delivery-valve with a minimum loss of velocity.

A further object of my invention is to provide means for adjusting the mechanism to vary the rate of operation thereof, and means for cushioning the movement of the valve counterweight at the end of the sudden closing movement.

In the accompanying drawings Figure 1 is a longitudinal vertical section of a mechanism embodying my invention, Fig. 2 is a partial rear end view thereof, portions being in transverse vertical section, Fig. 3 is a horizontal sectional view taken through the air-chamber, Fig. 4 is a detail transverse vertical section on the plane of the line  $x-x$  of Fig. 1, Fig. 5 is a detail end view of the cushioned counterweight, and Figs. 6, 7 and 8 are diagrammatic longitudinal sectional views illustrating the operation of the mechanism.

In the illustrated embodiment of my invention I provide a rectangular valve-casing formed by side-plates 1, a bottom-plate 2 and a top-plate 3, preferably secured together along the corners by connecting angle-bars 4 and 5 riveted thereto, as shown. At the front end of the casing a flanged plate 6 is secured thereto, the same having at its lower edge laterally projecting foot-lugs 7 for attachment to a suitable base or foundation for the ram. The drive-pipe or supply pipe 8, through which water is supplied to the valve-chamber, is connected with the plate 6 by suitable bolts, the diameter of the pipe and of the opening through the plate being the same as the width of the valve-

chamber between the side-plates 1 of the casing.

The top-plate 3 of the valve-casing extends laterally beyond the side-plates, and to said top-plate the dome or air-chamber casing 9 is removably secured by bolts 10. At one side of the dome 9 near the bottom thereof the delivery-pipe 11 is connected therewith as shown in Figs. 2 and 3. On the upper side of the plate 3 within the air-chamber is secured a channel-ring 12 having in the inner edge thereof a V-shaped channel in which is disposed a seat-ring 13 of circular cross-section and made of suitable yieldable material. Said channel-ring surrounds an opening in the plate 3, through which water enters the air-chamber from the valve-chamber, the opening being normally closed by the delivery-valve 14. The delivery-valve comprises a circular plate having beveled edges which rest normally upon the seat-ring 13. On the upper side of the valve-plate 14, at the center thereof, are a pair of standards 15, and a similar pair of standards 16 are mounted on the plate 3 behind the channel-ring 12. A double pair of parallel vertically-spaced arms 17 have their ends pivotally connected with the standards 15 and 16, and said arms by swinging about their pivots on the standards 16, permit the valve 14 to raise freely off its seat, but hold it constantly in a horizontal position, as will appear from the positions thereof indicated in Fig. 1.

Adjacent to the rearward edge of the delivery-valve opening through the plate 3, a shaft 18 extends transversely through the casing, the ends of the shaft being supported by the side-plates 1. Said shaft forms a pivotal support for the waste-valve, which comprises a flat rectangular plate 19 of which one edge-portion 20 is curled around the shaft 18, and the opposite edge is bent to form a transversely-extending angular lip 21. On the side-plates 1 are secured angularly-extending plates 22, and on the bottom-plate 2 is secured a transverse bar 23, said plates and bar forming abutments for the edges of the waste-valve when the same is in closed position. An angle-bar 24 extends transversely beneath the plate 3 behind the valve-shaft 18, contacting with the curled cylindrical portion 20 and forming a joint therewith. To the lower side of the valve-plate 19 is secured the end of an arm 25 which extends rear-

ing to swing the same from the closed position toward the supply pipe to an open position, a lip on the valve adapted to extend partially in front of the supply pipe opening when the valve is in open position, and means for adjusting the open position of the valve to vary the extent to which said lip may intercept the flow of water from the supply pipe.

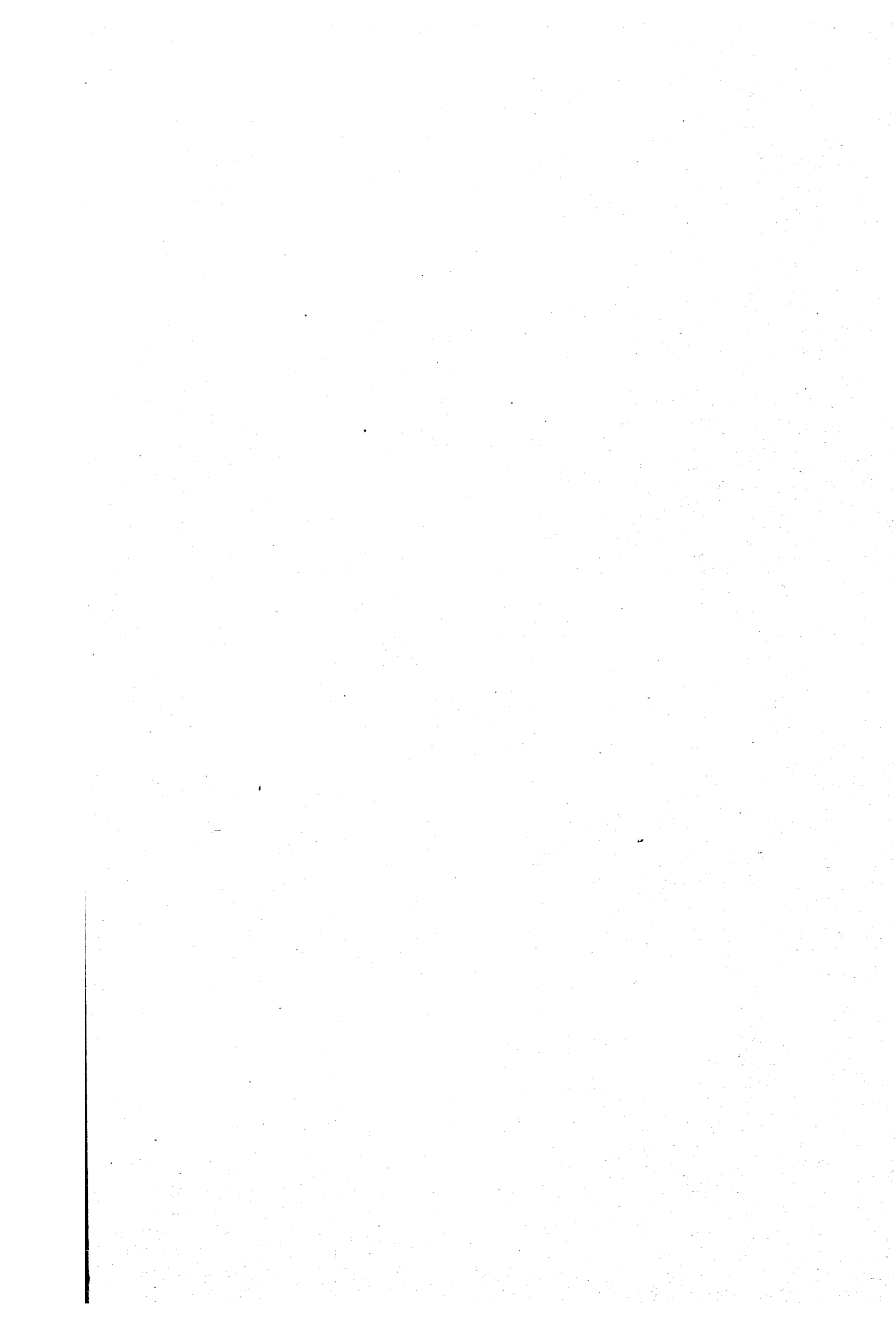
4. In a hydraulic ram, a valve-casing having a horizontal substantially unobstructed passage through the same, a supply pipe connected with the casing at one end of the horizontal passage, the casing having a valved delivery-passage opening laterally from the horizontal passage, a waste-valve pivotally mounted on an axis extending near the edge of the delivery-passage remote from the supply pipe, means normally holding said valve in an open position substantially parallel with the horizontal passage, a lip on the valve adapted for engagement by a water-current flowing through the horizontal passage to swing the valve from the open position to a position intercepting the passage, and abutments on the casing for stopping the valve at a closed position adapted to deflect the water-current

from the supply pipe toward the delivery passage.

5. In a hydraulic ram, a valve-casing having a horizontal substantially unobstructed passage through the same and a valved delivery-passage opening from the upper side of the horizontal passage, a supply pipe connected with the casing at one end of the horizontal passage, a waste-valve pivoted on a transverse horizontal axis near the edge of the delivery-passage remote from the supply pipe, said valve being swingable about said axis from an inclined closed position at which it intercepts the horizontal passage to a horizontal open position adjoining the delivery-passage, a counterweight connected with the valve and adapted to move the same from closed to open position, the valve having an angular lip-portion projecting near the end of the supply pipe when the valve is in open position, and a variable stop for adjusting the open position of the valve to increase and decrease the extent to which the lip projects into the path of a water-current from the supply pipe.

J. E. LESTER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."



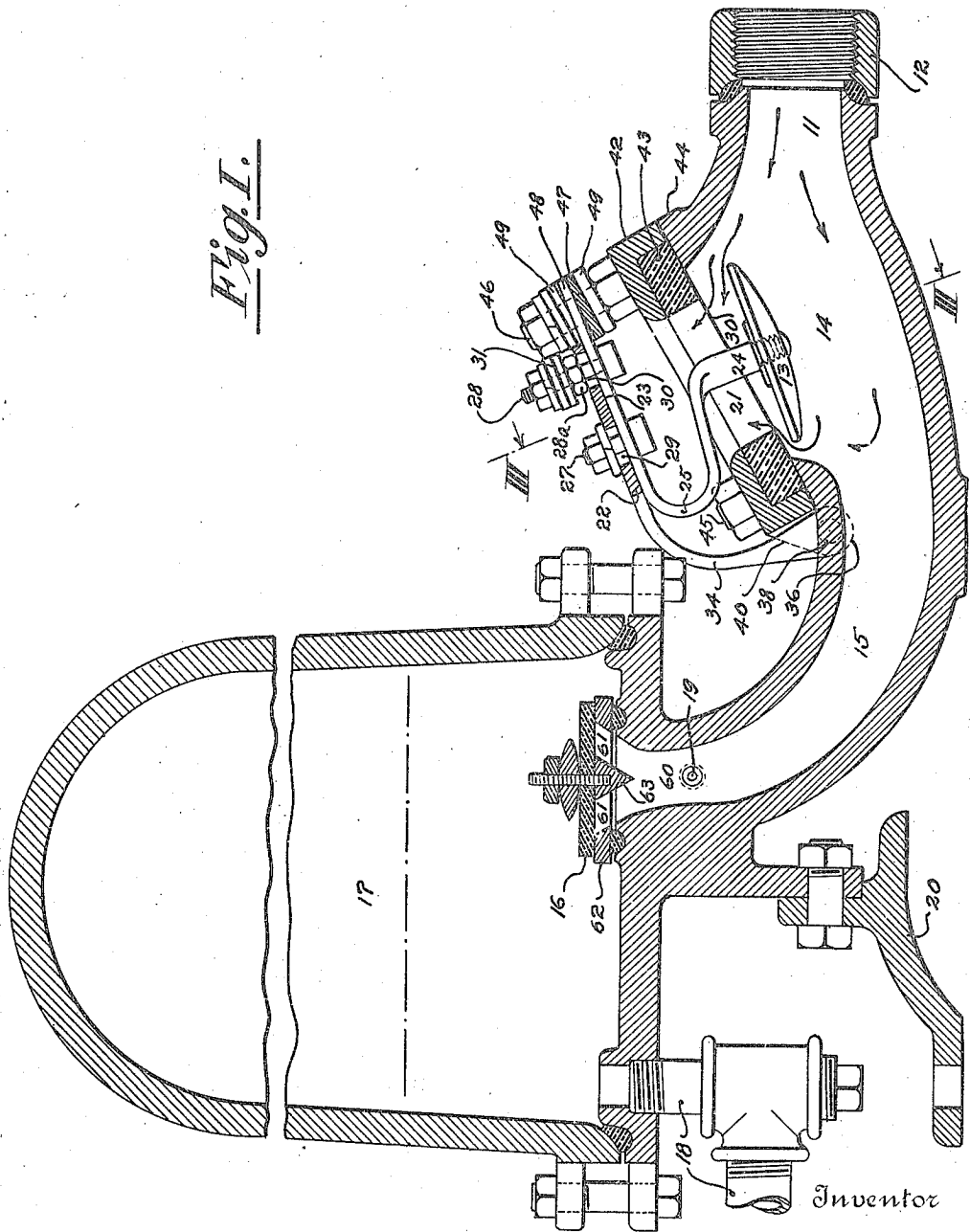
1,249,462.

L. G. NILSON.  
HYDRAULIC RAM.  
APPLICATION FILED JUNE 20, 1916.

Patented Dec. 11, 1917.

2 SHEETS—SHEET 1.

*Fig. 1.*



Inventor  
Lars Gustaf Nilson  
By his Attorney  
H. Carlsson

1,249,462.

L. G. NILSON.  
HYDRAULIC RAM.  
APPLICATION FILED JUNE 20, 1916.

Patented Dec. 11, 1917.  
2 SHEETS—SHEET 2.

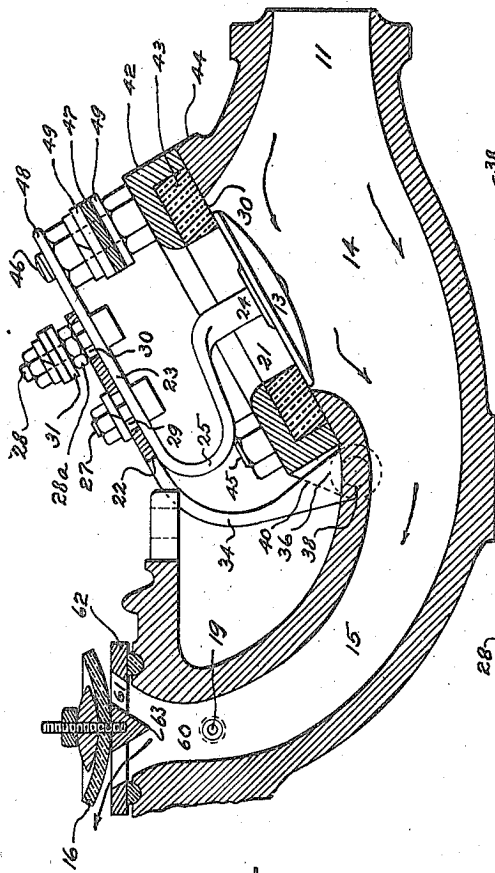


Fig. II.

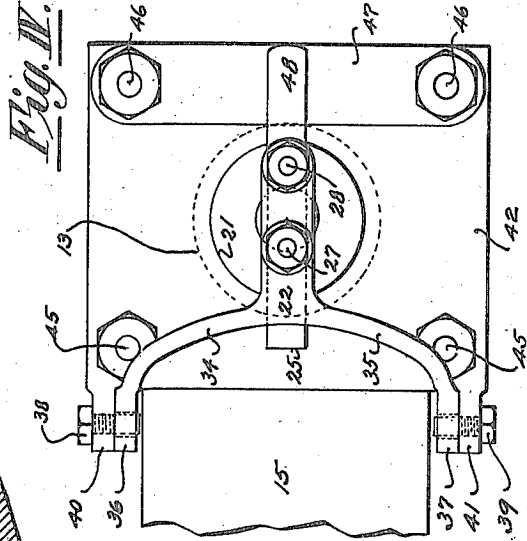


Fig. III.

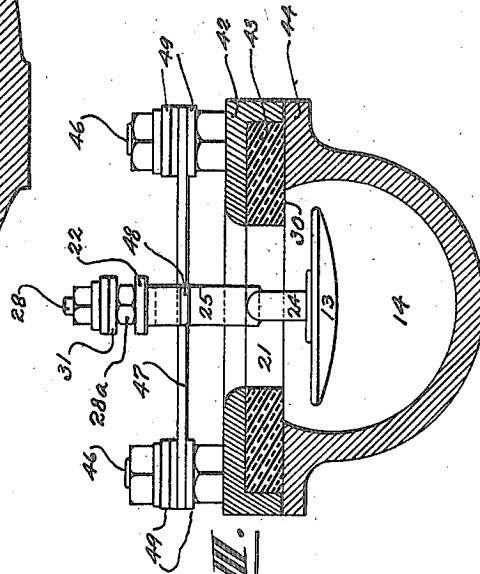


Fig. III.

Inventor

Lars Gustaf Nilson

By his Attorney

H. Carlsson



# UNITED STATES PATENT OFFICE.

LARS GUSTAF NILSON, OF HOBOKEN, NEW JERSEY.

## HYDRAULIC RAM.

1,249,462.

Specification of Letters Patent. Patented Dec. 11, 1917.

Application filed June 20, 1916. Serial No. 104,716.

*To all whom it may concern:*

Be it known that I, LARS GUSTAF NILSON, a citizen of the United States, and resident of Hoboken, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

This invention relates to improvements in hydraulic devices, and it appertains more especially to the structural means for increasing the efficiency and durability of rams in general.

One of the objects of the invention is to produce an improved device of the nature set forth wherein the flow of the water is diverted to the least possible extent so as to reduce the frictional resistance to a minimum.

A further object is the production of a device of the character described including an outlet valve inclined in the direction of the flow of the water, so arranged that the greatest opening thereof will be presented toward the inlet or drive pipe, thereby securing a free escape for the water that goes to waste.

Another object is to provide a device of the species mentioned with an easy and direct path for the water to the pressure chamber, so constructed that the speed of the water is accelerated to the advantage of increased flow and pressure.

Still another object is the provision of a device of the type specified having a resilient support for the outlet valve positively clamped in position, which will not shake loose from any vibrations to which it may be subjected.

A still further object is to afford an apparatus of the kind referred to, which shall have an outlet valve positively loaded by direct application of fixed weights, the amount whereof, is determined once for all when the device is adjusted for operation, thereby lessening the liability of a shiftable load shaking loose or being tampered with by unauthorized or inexperienced persons.

An additional object is to combine the outlet valve with a yielding abutment serving as means for limiting the opening thereof.

A general object is the design of a ram composed of few movable parts which shall

be simple and strong, as well as convenient to assemble and replace, and amenable to low cost of manufacture.

Other objects and advantages will become apparent as the specification proceeds.

With the aforesaid objects in view, the invention consists of the improvements, novel construction, arrangements and combinations of parts hereinafter described, defined in the subjoined claims, and illustrated in their preferred embodiments by the annexed drawings, wherein like elements are designated by the same reference characters throughout.

In the said drawings:—

Figure 1 is a longitudinal sectional elevation of a ram embodying the invention under consideration;

Fig. 2, is a fragmentary view similar to the preceding with some of the elements shown in a changed position;

Fig. 3 is a section of the device taken irregularly on the line 3—3 of Fig. 1, looking in the direction of the arrows; and

Fig. 4, is a fragmentary top plan view of the right hand portion of Fig. 1.

In these several views the numeral "11" denotes an inlet to the ram from the usual drive or supply pipe, of which a coupling flange 12 is shown, and through which pipe the water is led from a suitable source; 13, an outlet valve for controlling the escape or overflow of the water; 14, a housing for the valve 13 standing in communication with the inlet 11 at one end; and 15, a duct leading from the other end of the housing 14, which duct conveys the water past a delivery valve 16, into a pressure chamber 17, whence it is conducted out by means of a delivery pipe 18. Air is admitted into the upper end of the duct 15 through a valve controlled aperture 19. One of the supporting feet for the ram is shown at 20. The operation of the parts above enumerated as belonging to the ram is so well known as not to require any lengthy description herein. Suffice it therefore to say that when the water entering the ram from the inlet pipe has acquired enough impetus it closes the outlet or main valve 13. With the water thus suddenly shut-off, the momentum of the moving column thereof strikes the portion of the water already in the duct 15 beyond the outlet valve, and

forces part of the same by the delivery valve into the pressure chamber. When the impact of the moving water has been absorbed and counteracted by the pressure of the air and water in the chamber 17 which closes the delivery valve 16, the pressure below the outlet valve is also equalized, due to the reaction of the water in the forward part of the duct 15, permitting the said outlet valve to drop on account of its weight. One cycle thus follows another automatically and ceaselessly. The proportion of the water pumped to that which overflows depends upon the difference of the supply and delivery heads.

Although the annexed drawings and description refer specifically to a single acting ram, no limitation in that sense is intended, as both double acting and compound rams incorporating the improvements of the present invention are contemplated as well.

It will be noticed from Figs. 1 and 2 that the main valve 13 coacts with an outlet opening 21 which is located adjacent to the inlet from the drive or supply pipe, in such a position that it is inclined toward the direction of the flow of the water. The latter is thereby diverted in the least possible extent from its natural path, and not forced to make a right angled turn as ordinarily is the case in the prevalent types of rams. To attain still further freedom of escape for the waste water, the main or outlet valve 13 is arranged to present its greatest opening toward the drive pipe, which again is different from the common practice. With this purpose in view a lever 22 is pivoted beyond the opening 21 at the far side thereof with respect to the inlet end of the ram. To this lever is fixed a supporting stem 23 for the valve. Preferably the said stem consists of resilient material, and one end thereof is securely entered into the body of the valve, as by screwing, after which it is riveted over the underside of the latter. The lower portion 24 of the stem is relatively rigid, while its middle portion 25 is flattened to a comparatively thin web to increase its flexibility. The said middle portion is also bent U-shape, in offset formation to one side, rearwardly as shown, which still further enhances its capability of flexure.

The particular advantage of a flexibly or resiliently mounted valve which is still positively maintained in position, is that, should foreign substances of any kind such as slivers or pebbles, carried along with the water from the drive pipe, happen accidentally to become lodged between the valve and its seat, the flexible stem will allow of a certain amount of distortion, without undue strain, and as soon as the obstruction is washed away, the valve will again seat itself normally. This construction dispenses with the use of interengaging convexed and con-

caved surfaces held frictionally together, which may shift and prevent the valve from seating properly.

The upper portion of the stem is maintained flat and constitutes an attachment to the underside of the lever 22. As shown, bolts 27, 28 serve to clamp the last named elements one to the other. These bolts pass through clearance holes 29, 30, provided therefor in the lever 22. By virtue of this construction, a ready and secure means is had for alining and holding the valve against its seat 30 with relation to the opening 21 therein, when the different parts of the ram are assembled. In the accompanying drawings one of the bolts is shown extended up to provide an anchorage for weights 31, which may be in the nature of ordinary metallic washers, impaled upon the bolt 28 for instance. Lock washers of the split spring type may be interposed between the nuts of the bolts 27, 28 and the weights to keep the former from working loose owing to the successive impacts transmitted to them through the stem from the valve 13. The object of having replaceable washers which can be applied directly over the valve, or removed therefrom, is to adjust the frequency of the beats or pulsations of the latter. By reason of the fact that different heads and quantities of water are encountered in practice when installing rams, it becomes necessary at certain times to add weight to the valve to make it work slower, while by removing the washers the valve is caused to operate quicker, which, for other occasions, may be more desirable. An adjustment of this character should be made only once, when the ram is put up and adjusted. Experience has shown that it is better to have a fixed regulation than one susceptible of being altered as may be done with a slidable weight, the latter being too easily tampered with by unauthorized or inexperienced persons.

As before mentioned, the lever 22 is pivoted in rear of the valve 13, but in line with the duct 15 which it straddles on the outside thereof. To this end the rear portion of the lever is bifurcated as at 34, 35 and hubs 36, 37 are formed with the latter. These hubs are journaled upon the ends of trunnion bolts 38, 39 received in ears 40, 41 respectively, which ears project in a rearward direction from a bonnet or housing plate 42. The latter is recessed to receive a body or filler 43, of rubber or other suitable material, which serves as a tightening gasket between the bonnet plate and the upper face of a rim 44 surrounding the outside of the valve housing on top, as well as for a seat against which the valve 13 strikes in its upward position to shut-off the communication through the opening 21 therein. To securely hold the bonnet or housing plate 42 in position,

and tightly force the gasket 43 against the rim 44, two pairs of bolts 45, 46 may be employed. The latter pair which is located at the upper and forward corners of the plate are extended beyond the other pair of bolts, to constitute a support for a bridge or buffer strip 47. This bridge or strip is designed to receive the impact from a projecting end 48 of the flattened valve stem 23 when the valve 13 attached to the other end thereof drops into its lowermost position. Both the end 48 and the bridge 47 may be made resilient to cushion and lessen the force of the blows. Adjustment of the bridge 47 in height relatively to the valve's seat 30, determines the amount that the valve is permitted to drop, it being understood that a heavily weighted valve generally requires a longer stroke or movement, and the reverse for a light valve. The adjustment for the bridge strip 47 may conveniently be effected in a similar manner to the loading of the valve, namely, through the instrumentality of interposed washers 49. The accompanying drawings show that these washers can be placed above the bridge, as fillings under the nuts of the bolts 46. When adjustment is desired the positions of these washers are simply interchanged, the washers being placed either above or below the bridge strip, as the case may be, to elevate or depress the same, for the purposes already described.

It will be noted that the walls which encompass the inlet 11, the valve housing 14, and the duct 15 have all been given curves of smooth and gradual sweep so as to reduce to a minimum the frictional resistance against the water flowing therethrough. Furthermore it will be observed that near the rearward terminal the duct 15, is constricted for a certain distance as at 60. This is to obtain the effect of a Venturi tube, according to which, the speed and the pressure of the fluid at the contracted area is increased, so that the same amount will pass the given point in the same period of time as in other portions of the conduit. The principle mentioned is especially advantageous in the present instance, in that it accelerates the speed of the water entering the pressure chamber 17, through ports 61 in a valve plate 62, underlying the delivery valve 16. The water, in order to reach the said ports 61, first encounters a conical depending deflector 63, which evenly distributes the same between the aforementioned ports, of which there may be two or more according to size and design of the ram.

While a certain preferred embodiment of this device has been shown and described, it will be understood that changes in the form, arrangements, sizes, proportions and details thereof may be made without departing from the scope of the invention as defined by the appended claims.

Having described my invention what I desire to secure by Letters Patent and claim is:—

1. A hydraulic ram including, in combination, a pressure chamber, a valved conduit discharging thereinto, an inlet leading to said conduit, and a waste water valve pivoted intermediate said inlet and conduit in such a manner that its widest opening is inclined toward the inlet.

2. A hydraulic ram including, in combination, a chamber having a self-closing admission, a passage arranged to deliver a stream of water through the latter, a discharge for the overflow water inclined toward the entrance to said passage in advance of said chamber, and a valve for said discharge pivoted between it and said admission above the passage so as to present the wider opening on the side nearest to said entrance.

3. A hydraulic ram including, in combination, an air and fluid chamber, a valved channel leading into the same, a waste water passage lateral to said channel and inclined toward the entrance thereto, and a valve adapted to control said passage pivoted on the far side thereof in proximity to said entrance end of the channel.

4. A hydraulic ram including, in combination, a pressure chamber, a conduit arranged to discharge a stream of water thereinto, an overflow passage in one side of said conduit inclined toward the inlet thereof, a valve controlling said passage, and means for pivotally supporting said valve immediately of the discharge end of the conduit and the side of the overflow passage remote from said inlet so as to enable the valve to present its widest opening to the latter.

5. A hydraulic ram including, in combination, a pressure chamber, a conduit delivering water thereto, a discharge passage for waste water lateral to said conduit, a valve for said discharge, and a lever to which said valve is attached pivotally straddling the conduit intermediate the discharge and the pressure chamber.

6. A hydraulic ram including, in combination, a pressure chamber, a conduit conveying water thereinto, an outlet passage for waste water at one side of said conduit, a valve for said outlet, an apertured cover overlying the latter and having ears straddling the conduit on the far side with relation to the entrance thereto, and a bifurcated lever for said valve having pivotal connections with said ears.

7. A hydraulic ram including, in combination, a water channel, an inlet thereto, a discharge passage for overflow water lateral to said channel, a pressure chamber beyond said discharge, and a duct intermediate of the channel and chamber constructed

and arranged on the principle of a Venturi tube operating to accelerate the flow into the latter.

5 8. A hydraulic ram including, in combination, a water conduit, a discharge passage for waste water adjoining the entrance to the said conduit, a pressure chamber, a duct connecting the conduit with the latter, said duct having a constricted area adjacent to said chamber operating to accelerate the flow of water thereinto on the principle of a Venturi tube, and a valved plate registering with said area.

10 9. A hydraulic ram including, in combination, a pressure chamber, a water conduit leading thereto, a passage affording egress for waste water from said conduit, a valve adapted to control said passage, and a pivotally connected resilient support for said valve.

15 10. A hydraulic ram including, in combination, a pressure chamber, a duct communicating therewith, an outlet for waste water from said duct, a valve positioned to control said outlet, a pivotal lever for said valve, and a resilient connection between the latter and said lever.

20 11. A hydraulic ram including, in combination, a pressure chamber, a duct conveying water to the same, an overflow passage for said duct, a valve controlling said passage, a lever for said valve, a housing for the valve's seat to which said lever is pivoted, members extending up from said housing opposite to the point of attachment of the lever, and a resilient element adjustable on said members transversely to the path

of movement of the lever disposed transversely across the path of said connection, and means for adjusting said member to pre- 40  
determine the travel of the valve.

12. A hydraulic ram including, in combination, a pressure chamber, a channel leading water thereinto, an outlet for waste water from said channel, a valve controlling 45  
said outlet having a projecting stem, a pivotal lever to which said stem is attached, a bridge arranged across the path of oscillation of said lever, supporting means for said bridge, and spacers capable of being trans- 50  
posed for the adjustment of the bridge on said supporting means.

13. A hydraulic ram including, in combination, a pressure chamber, a duct conveying water thereto, a flanged overflow passage for waste water from said duct, an apertured plate overlying said passage and having a recess in its underside, a gasket provided with an opening registering with the aperture in said plate, the outer portion 55  
of the gasket constituting a tightening medium between the flange of the overflow passage and the plate, being lodged in the recess thereof, and a valve controlling the opening in the gasket, the inner portion of 60  
the latter around the opening therein serving as a seat for said valve.

Signed at the borough of Manhattan in the county of New York and State of New York this 17th day of June A. D. 1916.

LARS GUSTAF NILSON.

Witnesses:

H. C. KARLSON,  
W. H. GEE.

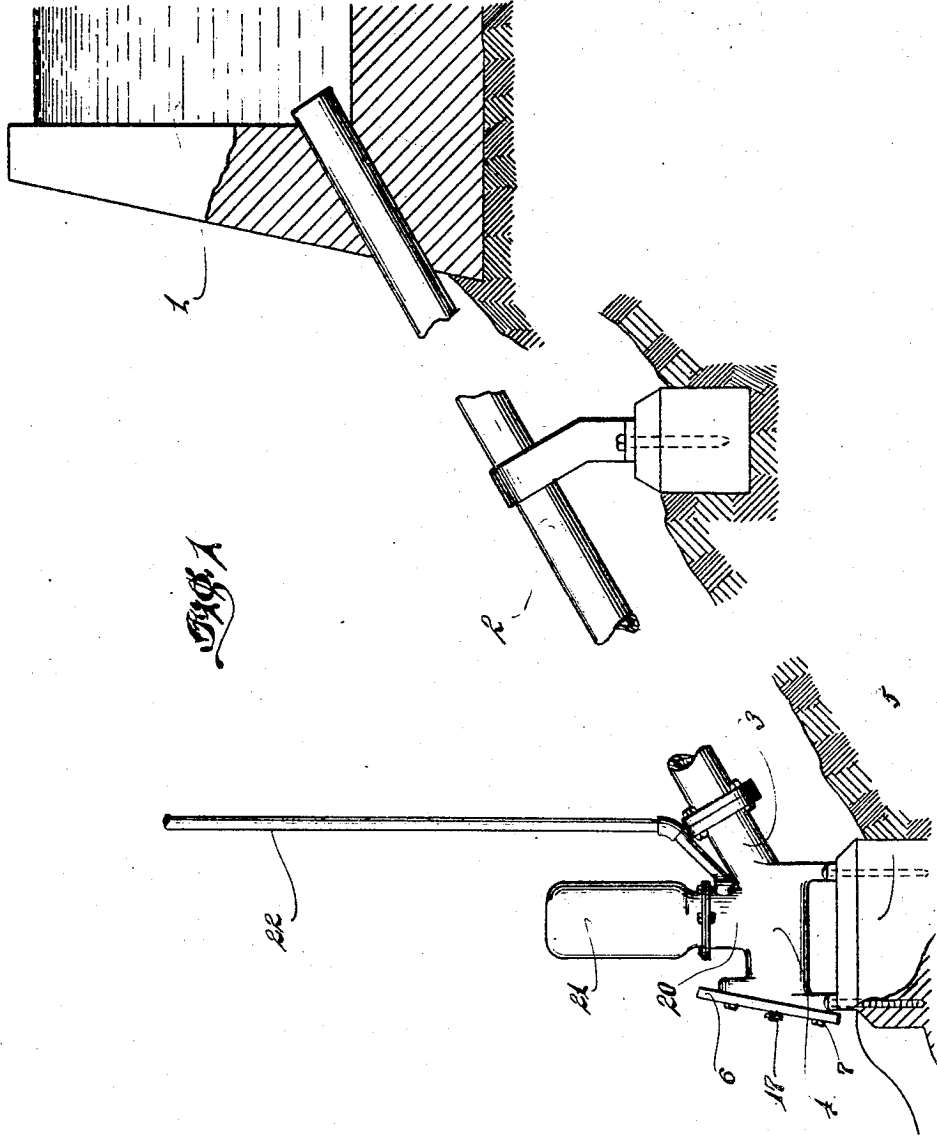
Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

F. C. CROWE.  
HYDRAULIC RAM.  
APPLICATION FILED APR. 30, 1918.

1,285,629.

Patented Nov. 26, 1918.

2 SHEETS—SHEET 1.



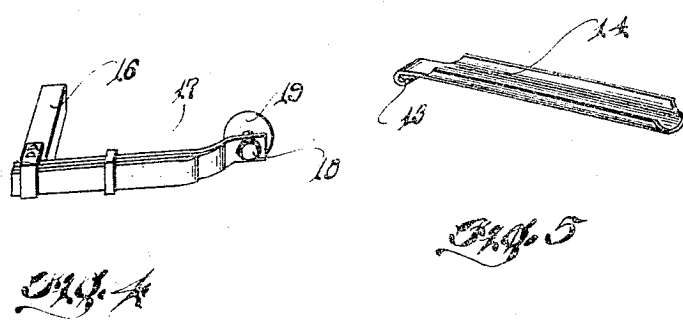
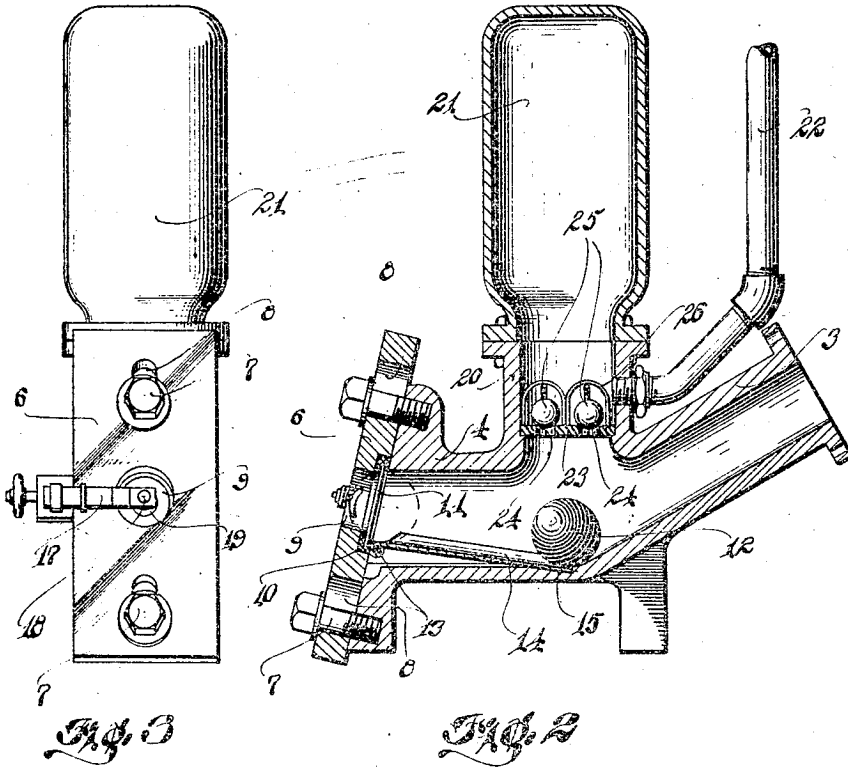
Inventor  
Frederick C. Crowe

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Attorney

F. C. CROWE.  
 HYDRAULIC RAM.  
 APPLICATION FILED APR. 30, 1918.

1,285,629.

Patented Nov. 26, 1918.  
 2 SHEETS—SHEET 2.



Inventor  
 Frederick C. Crowe

Herbert E. Smith  
 Attorney

334

# UNITED STATES PATENT OFFICE.

FREDERICK C. CROWE, OF NORTH YAKIMA, WASHINGTON, ASSIGNOR TO HENRY W. COOLIDGE, OF CHICAGO, ILLINOIS.

## HYDRAULIC RAM.

1,285,629.

Specification of Letters Patent.

Patented Nov. 26, 1918.

Application filed April 30, 1918. Serial No. 231,625.

*To all whom it may concern:*

Be it known that I, FREDERICK C. CROWE, a citizen of the United States, residing at North Yakima, in the county of Yakima and State of Washington, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

This invention relates to new and useful improvements in hydraulic rams and the principal object is to provide a simple and efficient device of this character with an improved valve construction.

A further object of the invention resides in providing an impetus valve operating on an inclined track way which is capable of being adjusted to accommodate various pressures.

A still further object of the invention resides in providing a removable plate at the end of the ram chamber to which the inclined track way is pivotally connected, the plate being adjustable to dispose the track way to various angles, with respect to the bottom wall of the chamber.

With these and other objects in view my invention consists in the novel features of construction, combination and arrangement of parts as will be hereinafter referred to and more particularly pointed out in the specification and claims.

In the accompanying drawings forming a part of this application:—

Figure 1 is a side elevation partly in section showing the application of my invention to use;

Fig. 2 is an enlarged vertical section through the ram chamber and adjunctive parts;

Fig. 3 is a front elevation thereof;

Fig. 4 is a perspective view of the spring member, its support and the buffer carried thereby; and

Fig. 5 is a perspective view of the inclined track way removed.

In describing the invention, I shall refer to the drawings in which similar reference characters designate corresponding parts throughout the several views and in which 1 designates a reservoir, the water from which is adapted to flow downwardly through a downwardly inclined supply pipe 2, the latter connecting with a tubular extension 3 of a casting 4, the latter forming what may be termed the ram chamber proper. This cast-

ing may be mounted on a base or pedestal as shown at 5 in Fig. 1 of the drawings and properly positioned for operation.

The end of the chamber 4 opposite the extension 3 has a removable plate 6 applied thereto and secured by means of the set screws 7, the latter operating through slots 8 in the plate, whereby to adjust said plate with respect to the chamber for a purpose to be hereinafter and more particularly set forth. The plate 6 is provided with a central opening 9 and the inner face of said plate surrounding said opening is provided with a seat 10 in which is positioned a packing 11 which is adapted to receive thereagainst a ball valve 12 which operates in the chamber 4. Pivotaly secured to the inner face of the plate 6 as shown at 13 is a track member 14 which is designed concavo-convex and designed to receive said ball valve therein. The track member is so pivoted with respect to the plate and the bottom wall of the chamber that the same is inclined, as clearly shown in Fig. 2 of the drawings and the lower free end of the same operates in a groove or guide way 15 formed in the bottom wall of said chamber. The ball valve 12 is normally positioned at the lower end of the channel-shaped track 14, but is adapted to be directed upwardly thereon by pressure of water entering the chamber through the supply pipe 2 and thus be directed against the valve seat 10. In order to provide a cushioning means for the ball valve and the seat and also afford means for assisting the ball valve to return to its initial position when pressure is released therefrom, a yielding buffer or the like is provided. To this end an adjustable arm 16 is carried on one side of the chamber 4, the outer end thereof having a leaf-spring member 17 secured thereto. The free end of the leaf-spring member 17 terminates in alinement with the opening 9 in the plate 6 and adjustably secured to the outer end of said leaf-spring member by means of a set screw 18 is a buffer 19 which is designed concavo-convex to conform to the outline of the ball valve 12.

The casting 4 has an upper outlet extension 20 to which is secured an air or equalizing chamber 21 and leading from this extension 20 is a delivery pipe 22.

Positioned in the extension 20 just below the entrance of the delivery pipe 22 thereto is a partition wall or the like 23 which is pro-

vided with valve seats 24. Discharge or check valves 25 of the ball type are positioned on the member 23 to be seated in said valve seats and the cages 26 are provided therefor.

The operation of the machine is as follows:—As the water flows from the reservoir 1 through the pipe 2 to the chamber 4, the same gains considerable velocity and pressure, due to the fact that the valve 12 is normally in its open position with respect to the valve seat 10. As the pressure and velocity increases, the same will become sufficiently great to roll the ball valve 12 up the inclined track 14, seating the ball and thus stopping the flow of water through the opening pipe 6. The water flowing through the pipe and into the chamber with such pressure and momentum seeks another outlet, which it finds through the check or discharge valves positioned in the extension 20. The water flowing through these latter valves enters the air or equalizing chamber and thence through the delivery pipe 22 and it may be here stated that the air in the chamber 21 acts as a cushion to the sudden inflow of water to maintain substantially a constant pressure in the chamber and a steady flow through the delivery pipe.

When all the energy of the moving column of water is used in forcing water into the air chamber, the pressure in the chamber tends to start a back-flow similar to the oscillations in a U-tube. This instantly closes the check valves 25, retaining the water pumped and the tendency to back-flow together with the sudden closing of the check valve causes a momentary reduction of pressure in the ram chamber 4 which allows the ball valve 12 to roll down the inclined track 14 to its initial position, thus opening the waste opening 9. The water is now free to flow as before and the cycle is completed.

From the foregoing it will be seen that I have provided a simple and efficient hydraulic ram which is inexpensive to manufacture, extremely durable in construction and one which will be most efficient in carrying out the purposes for which the same is designed.

While I have particularly described the elements best adapted to perform the functions set forth, it is obvious that various changes in the form, proportion and in the minor details of construction may be resorted to, without departing from the spirit or sacrificing any of the principles of the invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent, is:—

1. In a hydraulic ram, a casting designed to form a chamber and having an inlet and a pair of outlet ports therein, means to supply water to the chamber, check valves in connection with one of the outlets of the

chamber, a ball valve in the chamber for coöperation with the other outlet thereof, and an inclined trackway for the last mentioned valve.

2. In a hydraulic ram, a casting designed to form a chamber and provided with an inlet and a pair of outlet ports, means to supply water to said chamber, valve seats formed in the outlet ports, check valves arranged in the seats of one of said outlet ports, a ball valve disposed in the chamber to coöperate with the valve seat in the other outlet port, and an adjustable inclined track way for said ball valve.

3. In a hydraulic ram, a casting designed to form a chamber and provided with an inlet and a pair of outlet ports, means to supply water to the chamber, said outlet ports being provided with valve seats, check valves arranged in the seats of one outlet port, a ball valve in said chamber adapted to coöperate with the valve seat in the other outlet port, an inclined track way for said ball valve leading to the last-mentioned valve seat, and means for adjusting the degree of inclination of said track way.

4. In a hydraulic ram, a casting designed to form a chamber and provided with an inlet and a pair of outlet ports, check-valves in connection with one of said outlet ports, the other outlet port being provided with a valve seat, a ball valve in said chamber adapted to coöperate with said valve seat, an inclined track way for said ball valve, and a yielding buffer in connection with the valve seat for coöperation with said ball valve.

5. In a hydraulic ram, a casting designed to form a chamber and provided with an inlet and a pair of outlet ports, means to supply water to the inlet port, check valves in connection with one of said outlet ports, a plate secured to the casting and provided with an opening, registering with the other outlet port, a valve seat in connection with said plate, a ball valve in said chamber adapted to coöperate with said valve seat, and an inclined track way for said ball valve leading to said valve seat.

6. In a hydraulic ram, a casting designed to form a chamber and provided with an inlet and a pair of outlet ports, means to supply water to the inlet port, check valves in connection with one of said outlet ports, a plate adjustably secured to the casting and having an opening therein registering with the other outlet port, said plate being provided with a valve seat, adjacent the opening therein, a ball valve in said chamber adapted to coöperate with said valve seat, and a track way pivoted at its one end to said plate and inclined downwardly to rest upon a lower wall of the chamber whereby to guide the ball valve to the valve seat.

7. In a hydraulic ram, a casting designed to form a chamber and provided with an in-



let and a pair of outlet ports, means to supply water to the inlet port, check valves in connection with one of said outlet ports, a plate adjustably secured to the casting and having an opening therein registering with the other outlet port, said plate being provided with a valve seat adjacent the opening therein, a ball valve in said chamber adapted to cooperate with said valve seat, a track way pivoted at its outer end to said plate and inclined downwardly within the chamber to form a guide for the ball valve and a yielding buffer carried by the casting and projecting in the opening of said plate to cooperate with said ball valve.

8. In a hydraulic ram, a casting designed to form a chamber and provided with an in-

let and a pair of outlet ports, means to supply water to an inlet port, an air chamber cooperating with one of said outlet ports, a delivery pipe in connection with the outlet port in advance of the air chamber, check valves also arranged in the aforesaid outlet port, in advance of the delivery pipe, a valve seat arranged at the other outlet port, a ball valve in said chamber for cooperation with said valve seat, and an inclined track way for the ball valve leading from within the chamber to the aforesaid valve seat.

In testimony whereof I affix my signature.

FREDERICK C. CROWE.

Witnesses:

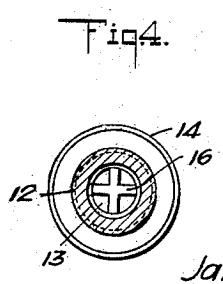
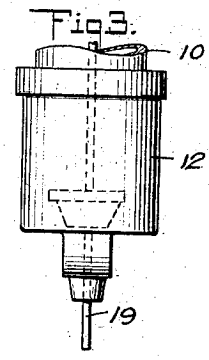
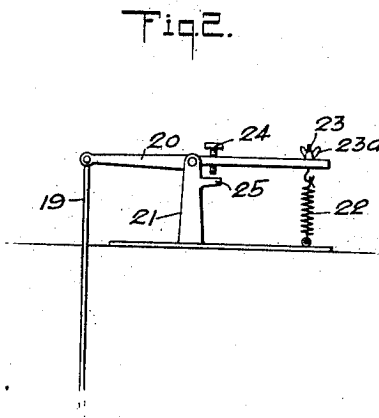
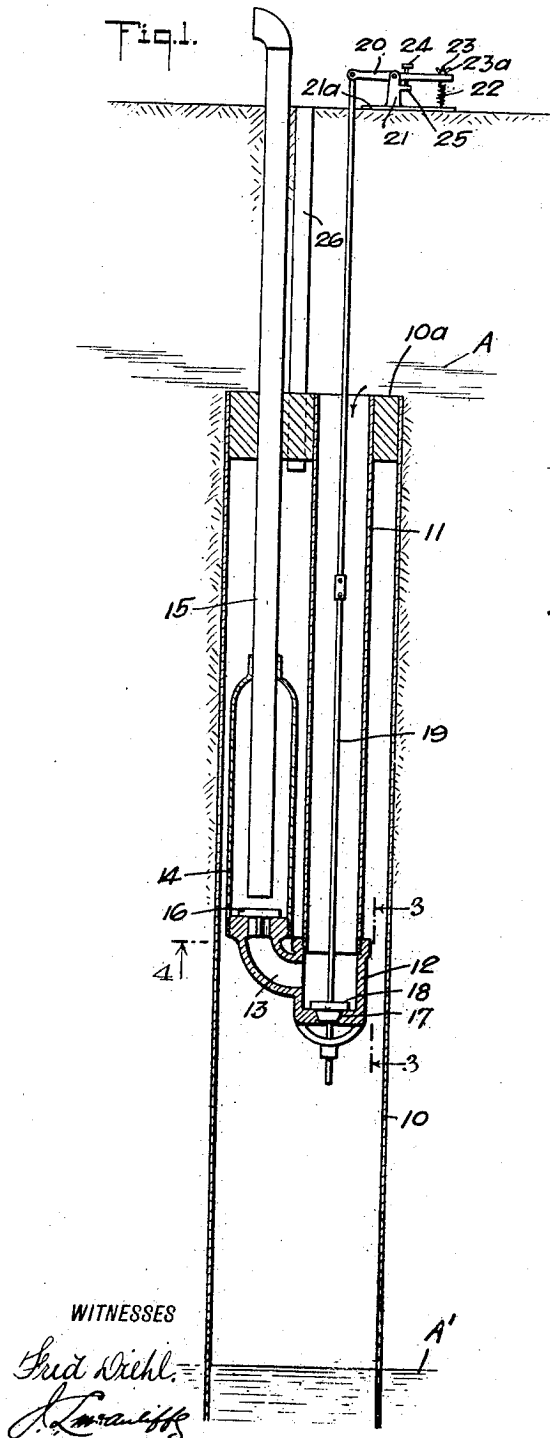
WINIFRED E. HOLMES,  
LEILA TRIVESS.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

J. O. KAFADER.  
 HYDRAULIC RAM.  
 APPLICATION FILED AUG. 16, 1910.

1,383,143.

Patented June 28, 1921.



INVENTOR  
*James O. Kafader*  
 BY *Wm. L. ...*  
 ATTORNEYS

# UNITED STATES PATENT OFFICE.

JAMES OLIVER KAFADER, OF FORT BIDWELL, CALIFORNIA.

## HYDRAULIC RAM.

1,383,143.

Specification of Letters Patent. Patented June 28, 1921.

Application filed August 16, 1918. Serial No. 250,260.

To all whom it may concern:

Be it known that I, JAMES OLIVER KAFADER, a citizen of the United States, and a resident of Fort Bidwell, in the county of Modoc and State of California, have invented a new and Improved Hydraulic Ram, of which the following is a description.

My invention relates to hydraulic rams and although capable of a wider use is more particularly intended for installation in connection with subterranean water stratum at different levels.

The general object of my invention is to provide a hydraulic ram adapted to be installed in a cased well extending between subterranean stratum that is the upper and lower levels of rise of the water in a well.

Another important object of my invention is to provide a hydraulic ram in which the impetus valve will be so controlled as to cause the valve to be positively lifted to effect the intermittent opening thereof for the discharge of the motive column beyond the air chamber of the ram, as well as to provide a lift means for the impetus valve extending to the top of the well in which the ram is installed and adapted to be adjusted to insure the opening and closing of the valve as well as its proper timing with the discharge of the water through the ascension pipe.

Reference is to be had to the accompanying drawings forming a part of this specification, it being understood that the drawings are merely illustrative of one example of the invention.

Figure 1 is a vertical section of a ram installed in a cased well between two indicated subterranean water stratum;

Fig. 2 is an enlarged side elevation of the equalizer controlling the lift for the impetus valve;

Fig. 3 is a fragmentary view showing in side elevation the valved fitting at the lower end of the ram and connecting the drive pipe with the air chamber, the view being taken in a plane indicated by the line 3-3, Fig. 1;

Fig. 4 is a cross section at the base of the air chamber, the section being taken in a plane indicated by the line number 4 in Fig. 1.

In carrying out my invention in accordance with the illustrated example the ram is installed in a well casing 10 extending be-

tween an upper subterranean water stratum A. and a lower stratum A'. The drive pipe 11 of the ram in which the hydrostatic column or motive column is produced is suspended from the closed upper end 10<sup>a</sup> of the well casing; said pipe being open for the inflow of water from the stratum A. The drive pipe 11 is secured at its lower end to a fitting 12 having a branch 13 leading to the air chamber 14 from which the ascension pipe 15 rises, the inlet to the air chamber from the passage 13 being controlled by a check valve 16 in the usual manner. The ascension pipe 15 extends through the top 10<sup>a</sup> of the well casing and rises above the ground level.

The impetus valve 18 in my improved ram instead of opening downwardly as usual in hydraulic rams, lifts in the opening movement and closes by a downward movement. The seat 17 of the impetus valve is in the fitting 12 directly in line with the vertical drive pipe 11 and has a stem 19 extending upwardly through said drive pipe and above the ground level. The upper end of the valve stem 19 is connected with one end of an equalizer bar 20 pivoted between its ends in any suitable manner as on a standard 21 and the opposite end of the lever is subject to a retractile spring 22 secured to the base 21<sup>a</sup> of the standard, the upper end of the spring engaging a threaded hook 23 having a wing nut 23<sup>a</sup> or the like to raise or lower said hook for varying the tension of the spring. A set screw 24 in the equalizer bar 20 is adapted to bear against a stop 25 on the standard 21 to limit the movement of said bar 20 in one direction under the action of the spring 22.

With the described construction in accordance with the principle of hydraulic rams, the impetus valve 18 will be closed by the flow of the motive column in the drive pipe 11 but the tension of the spring 22 will be sufficient to lift the said valve and open the same upon cessation of flow of the motive column following a discharge into the air chamber 14. Thus, upon each period of rest of the motive column, the pressure of the spring will lift the impetus valve permitting discharge of water therefrom beyond the air chamber and cause the intermittent discharge into the air chamber in the well-known manner of hydraulic rams generally. Thus, the positive opening of

the impetus valve is insured and consequently a proper operation of the ram generally, the spring-acted equalizer being readily accessible at the ground level to effect any necessary adjustment. Also, the arrangement lends itself to installation between subterranean water stratum.

A vent pipe 26 extends through the top 10<sup>a</sup> of the well casing 10 for the intake or escape of air due to the rising or falling of water in the well casing by the discharge through the fitting 12 by the opening of the valve 18.

I would state in conclusion that while the illustrated example constitutes a practical embodiment of my invention, I do not limit myself strictly to the mechanical details herein illustrated, since manifestly the same can be considerably varied without departure from the spirit of the invention as defined in the appended claims.

Having thus described my invention, I claim as new, an desire to secure by Letters Patent:

1. A hydraulic ram including a drive pipe having an open upper end and adapted to form a hydrostatic motive column, a valve-controlled air chamber communicating with said drive pipe, an ascension pipe rising from the air chamber, an impetus valve controlling the intermittent discharge of said drive pipe beyond the air chamber and adapted to be closed by the flow of the motive column, said valve opening upwardly, and spring actuated means to positively lift said valve, said lift means being subject to a cessation of flow of the motive column; together with a well casing adapted to be installed between upper and lower subterranean water stratum, said casing having its upper end closed and from which closed end said drive pipe is suspended and through which the

ascension pipe extends, said lift means being arranged above the well casing.

2. A ram including a drive pipe having an open upper end, an air chamber communicating with said drive pipe, an ascension pipe rising from the air chamber, a well casing adapted to be installed between upper and lower subterranean water stratum, said casing having its upper end closed and from which closed end the drive pipe is suspended and through which the ascension pipe extends, an impetus valve controlling the discharge from the drive pipe below the connection of the air chamber, said valve opening upwardly, a stem carrying said valve and extending upwardly through said drive pipe and above the well casing to be located above the ground level, an adjustable spring-pressed equalizer means connected with the valve stem and adapted to lift the valve to open the same upon a cessation of flow of the hydrostatic column in the drive pipe, and a vent pipe extending through the closed upper end of the casing.

3. In a hydraulic ram, a casing having its upper end closed and adapted to be installed between upper and lower subterranean water stratum, a pipe suspended from the closed upper end of the casing and having an open upper end, a valve casing at the lower end of the pipe and having a valve seat and a branch member, an air chamber secured to the branch member, a valve in the bottom of the air chamber, a discharge pipe leading from the air chamber out through the top of the casing, a valve in said valve casing, a spring actuated member at the ground level, and a rod connecting the said member with the last named valve.

JAMES OLIVER KAFADER.

A. O. URBAN.  
STARTING DEVICE FOR HYDRAULIC PUMPS.  
APPLICATION FILED JULY 10, 1920.

1,403,138.

Patented Jan. 10, 1922.

2 SHEETS—SHEET 1.

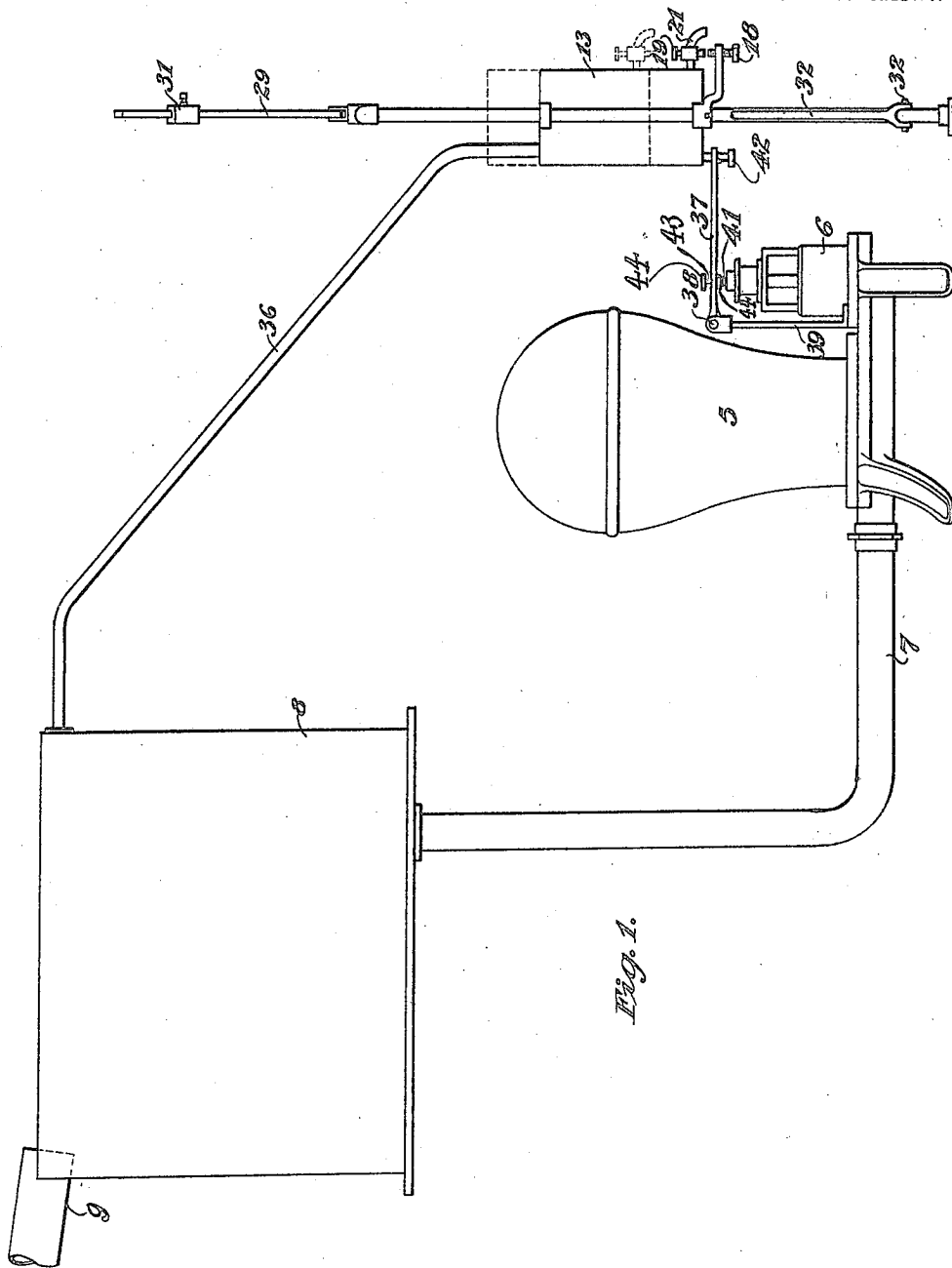


Fig. 1.

INVENTOR.  
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A. O. URBAN.  
STARTING DEVICE FOR HYDRAULIC PUMPS.  
APPLICATION FILED JULY 10, 1920.

1,403,138.

Patented Jan. 10, 1922.  
2 SHEETS—SHEET 2.

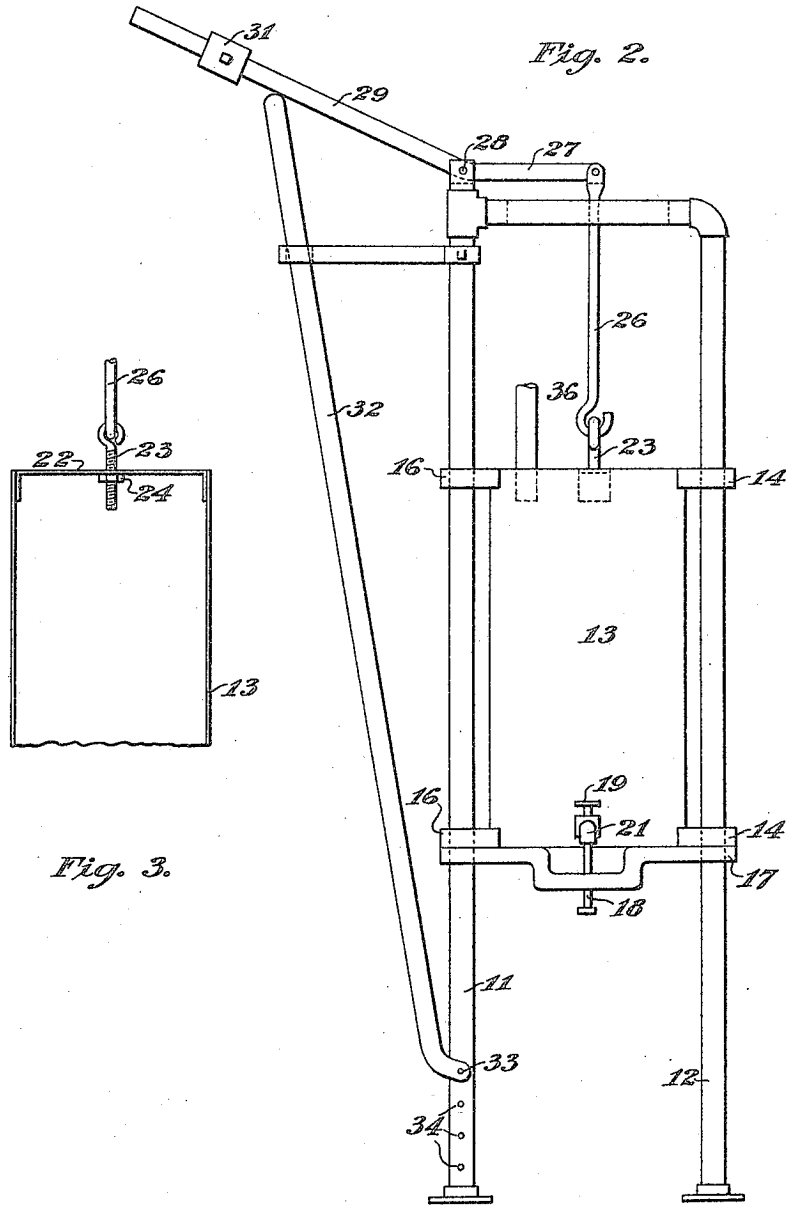


Fig. 3.

Fig. 2.

INVENTOR.  
A. O. Urban.  
BY *Victor J. Evans*  
ATTORNEY.

# UNITED STATES PATENT OFFICE.

ADOLPH OTTO URBAN, OF POINT ARENA, CALIFORNIA.

## STARTING DEVICE FOR HYDRAULIC PUMPS.

1,403,188.

Specification of Letters Patent. Patented Jan. 10, 1922.

Application filed July 10, 1920. Serial No. 395,195.

*To all whom it may concern:*

Be it known that I, ADOLPH O. URBAN, a subject of the Republic of Austria, residing at Point Arena, in the county of Mendocino and State of California, have invented new and useful Improvements in Starting Devices for Hydraulic Pumps, of which the following is a specification.

This invention relates to a new and useful improvement in starting devices for hydraulic pumps and relates in particular to a device for starting a hydraulic ram.

The principal object of this invention is to produce a device of this character which will operate upon a ram in such a manner as to start the same operating when, through lack of water, the ram has ceased to operate.

A further object of this invention is to provide a starting device for pumps which is operated by the overflow from the source of supply and to provide an attachment which will not interfere with the delicate recoil of the pump.

A still further object is to produce a device which is simple in construction, automatic in operation and one which may be attached to rams now in general use.

I propose to accomplish the above results by providing a simple means of automatically opening the interrupter valve of the ram, thereby again starting the ram.

Other objects and advantages of the invention will be apparent during the course of the following description:

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a diagrammatic view of a ram having my starting device attached thereto,

Figure 2 is a side elevation of a portion of my starting device, and

Figure 3 is a cross-sectional fragmentary detail view of a bucket.

The operation of a ram is well known, and is a device which is placed in a running stream, which device serves to lift a portion of the water passing there-through and deliver the same at some elevation above the ram. The lift is secured through the fact that the water flowing there-through is interrupted at intervals, which causes the inertia of the water trapped to be delivered at a distant point.

It is to the interrupter valve that my invention will be attached.

In the drawings wherein for the purpose of illustration is shown a preferred embodiment of my invention, the numeral 5 designates a ram as a whole, and the numeral 6 the interrupter valve as a whole.

The pipe 7 is adapted to receive water from a source of supply here shown as a tank 8. This tank receives its supply through a pipe 9, the pipe 9 representing a brook or any other source of supply.

The numerals 11 and 12 refer to standards positioned adjacent to the ram 5 and serving to support a bucket 13. This bucket is provided with ears 14 and 16 which serve to guide the same upon the standards 11 and 12.

At 17 I provide a brace which forms a stop to limit the downward movement of the bucket 13. This brace also serves to support a valve adjustment screw 18, which screw is adapted to be adjusted so as to contact with a valve 19 formed in a spigot 21 carried upon the bucket 13.

This bucket 13 is provided across its top with a brace 22 to which is attached a screw eye 23 through the medium of a bolt 24. To this screw eye is attached a link 26, which in turn is attached to the end of a lever 27, which lever is fulcrumed at 28 in the top of the standard 11 and is provided with a long arm 29 having a weight 31 movable thereon.

At 32 I have shown a lever adapted to contact with the arm 29 and attached at its lower end to the standard 11, through the medium of a pin 33. This lever 32 may be lowered by moving the pin 33 to any one of the holes 34.

The numeral 36 designates an overflow pipe extending from a point near the top of the receptacle 8 to a point within the top of the bucket 13.

At 37 I have shown an arm pivoted at 38 to a bracket 39 attached to the ram 5. This arm 37 is normally adapted to rest above the stem 41 of the interrupter valve 6 and is adapted to have its free end engaged by a pin 42 passing there-through and secured to the bucket 13. Between the arm 37 and the stem 41 there is a space provided when the arm is in its normal position. The position of the arm 37, as shown in Figure 2, sets forth the position of the bucket when it is down causing the stem of the valve to be depressed. The arm 37, it will be observed, will move upwardly and downwardly with the bucket and will cause an adjustable

screw 43 mounted thereon to contact with the valve stem 41 only after the bucket has in its downward movement acquired a sufficient momentum to overcome the counterweight and the pressure under the valve. 5 The above mentioned screw 43 on which are mounted nuts 44, is provided to allow different adjustments of arm 37 in order to have it disposed on a level from the pivot 10 point 38 to the pin 42 no matter what the height of the valve stem 41 may be.

In operation water flows from the source of supply to the tank 8 through the pipe 7 through the ram 5 and causes the same to 15 operate, it being assumed that the operation has been started.

Now, assuming that the water supply lowers to a point where it is not sufficient to work the ram, the interrupter valve 6 will 20 close, thereby causing the water to accumulate in the tank 8, due to the fact that it can not pass through the ram 5.

This accumulation will result in the water overflowing through the pipe 36 and discharging into the bucket 13, and as the 25 bucket is empty, it will be in its dotted position as shown in Figure 1. As soon as the same is sufficiently filled to overcome the weight 31, the bucket will move downwardly. This will cause the interrupter 30 valve stem 41 to be depressed and at the same time the valve 19 will have been lifted through the action of the valve adjustment screw 18, which will allow the water within 35 the bucket 13 to escape, and will again allow the bucket to return to its normal posi-

tion, which action carries the arm from its contacting position to its normal position. This depression of the valve stem 41 will have started the ram to operate, which operation will continue until the supply in the 40 tank 8 has become exhausted after which the operation just described will be repeated.

It will thus be seen that I have created a device for automatically starting a ram, 45 which will need practically no attention.

It is to be understood that the form of my invention herewith shown and described, is to be taken as a preferred example of the same, and that various changes in the shape, 50 size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claim.

Having thus described my invention, I 55 claim:—

In an automatic starting device for hydraulic rams, the combination of an interrupter valve, a lever adapted to contact and depress said valve, a bucket adapted to actuate 60 said lever, a reservoir, overflow means for conducting fluid from said reservoir to said bucket, an adjustable element for controlling the downward movement of said bucket when full of fluid and to raise said 65 bucket when empty, and adjustable means for emptying said bucket when said bucket has reached the limit of its downward movement.

In testimony whereof I affix my signature. 70

ADOLPH OTTO URBAN.



March 17, 1925.

1,530,182

A. JORDÃO, JR

HYDRAULIC RAM

Filed Nov. 1, 1920

3 Sheets-Sheet 1

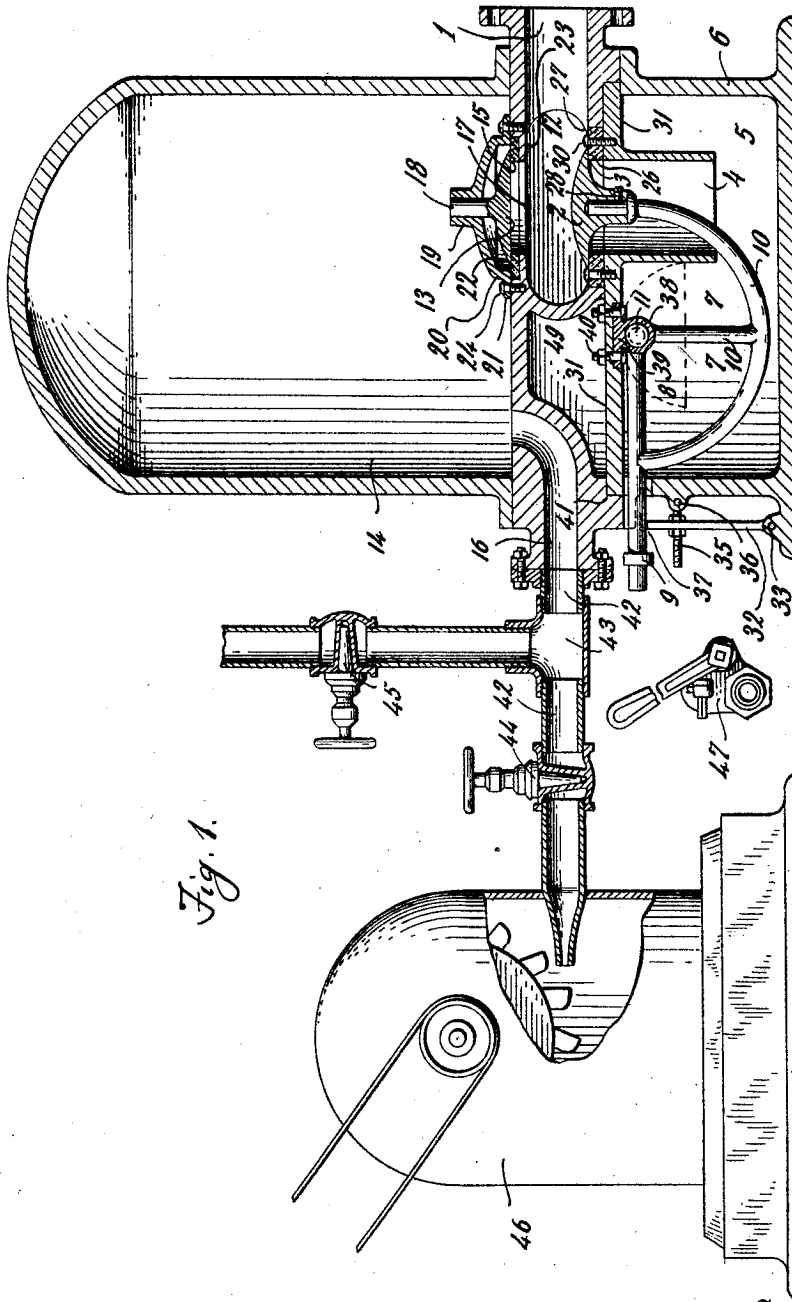


Fig. 1.

Inventor  
*Alfredo Jordão Júnior*  
By his Attorney  
*Alfredo*

March 17, 1925.

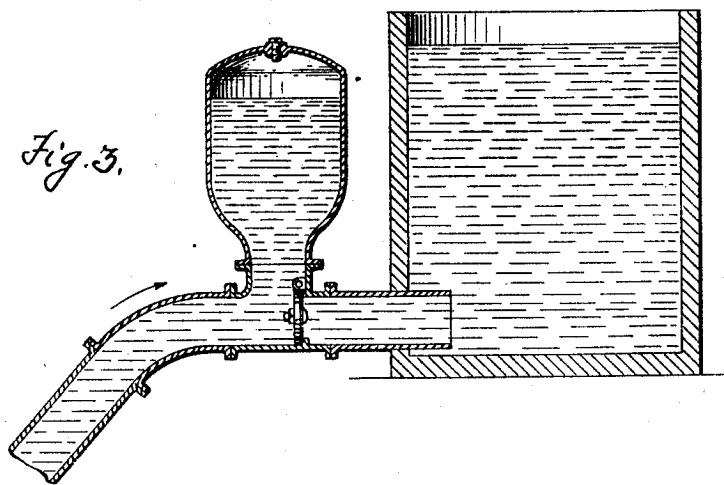
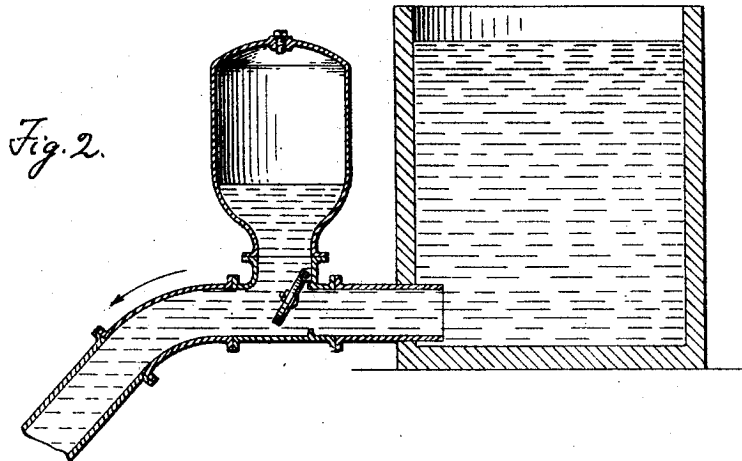
1,530,182

A. JORDÃO, JR

HYDRAULIC RAM

Filed Nov. 1, 1920

3 Sheets-Sheet 2



Inventor  
*Alfredo Jordão Júnior*  
By his Attorneys  
*Alfredo*

March 17, 1925.

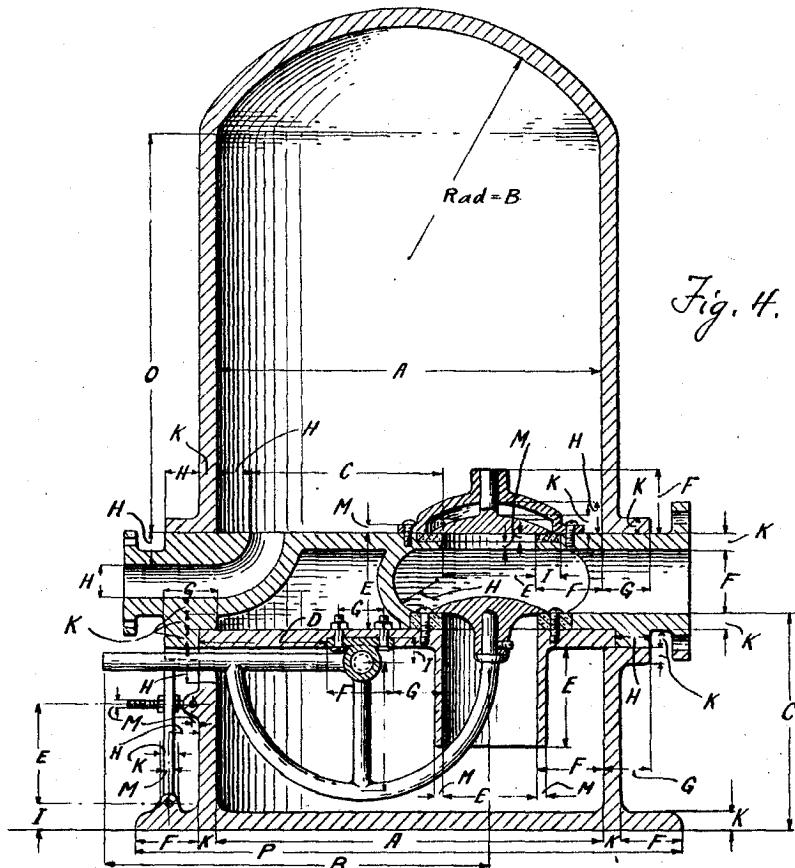
1,530,182

A. JORDÃO, JR

HYDRAULIC RAM

Filed Nov. 1, 1920

3 Sheets-Sheet 3



**Gladstoch-Formula**

Nº	1.	2.	3.	4.	5.	6.
A	6	9	12	18	24	36
B	4	6	8	12	16	24
C	3	4½	6	9	12	18
D	2	3	4	6	8	12
E	1½	2¼	3	4½	6	9
F	1	1½	2	3	4	6
G	¾	1¼	1½	2¼	3	4½
H	½	¾	1	1½	2	3
I	⅓	⅑	¾	1¼	1½	2¼
K	¼	⅜	½	¾	1	1½
L	⅙	⅓	⅔	⅑	¾	1¼
M	⅛	⅙	¼	⅜	½	¾
N	⅙	2⅓	3¾	5⅝	7½	11¼
O	9	13½	18	27	36	54
P	8½	12¾	17	25½	34	51

Fig. 5.

Inventor  
*Alfredo Jordão Junior*  
 By his Attorney  
*Alfredo*

Patented Mar. 17, 1925.

1,530,182

# UNITED STATES PATENT OFFICE.

ALFREDO JORDÃO, JR., OF SAO PAULO, BRAZIL.

HYDRAULIC RAM.

Application filed November 1, 1920. Serial No. 421,064.

*To all whom it may concern:*

Be it known that I, ALFREDO JORDÃO, Junior, citizen of Brazil, residing at Rua Alvares Penteados 39, Sao Paulo, State of Sao Paulo, Brazil, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

My invention relates to hydraulic rams and has for its object to produce a ram of greatly increased efficiency not heretofore obtained and adapted to be used not only to raise water but also to operate a hydraulic motor.

In the drawing herewith, Fig. 1 is a central vertical section through the hydraulic ram, showing in elevation also the hydraulic motor, a portion of its casing being broken away. Figs. 2 and 3 are sectional diagrammatic views; Fig. 4 is a similar view as that shown in Fig. 1 with the hydraulic motor and water-raising pipe omitted.

The water arriving in pipe 1 (Fig. 1) flows, when the valve 2 is open, through the valve-opening 3 and pipe 4 into the tank 7, in which a constant level is maintained, the tank being provided with a semi-circular spill 8. When the velocity of the water current increases sufficiently to close the valve 2 and to overcome the resistance of the counter-weight 9 connected with the valve by means of the balance 10, adapted to oscillate about the pivot 11, there results a violent shock in the chamber 12 of pipe 1 from the flow of water being suddenly interrupted. This shock opens the check valve 13, so that water will now enter the air-chamber 14 through the valve-opening 15, compressing the air in chamber 14. The compressed air forces the water out through pipe 16. After the shock in chamber 12 and pipe 1 has thus been absorbed, the valve 13 is again seated, while the valve 2 under the action of the counter-weight 9 opens again, so that a fresh volume of water can rush in through the valve-opening 3, starting the second cycle.

The check valve 13 consists of a metal cover with a curved upper surface to offer greater resistance to the pressure in chamber 14. From the center of the cover rises a cylindrical rod 18, which is guided in a bushing 19. The latter is carried by four brackets 20, the lower ends of which merge into a circular flange 21, wide enough to hold in place a packing ring 22, forming the

seat for the valve 13. The flange is secured by screws 24. As the valve 13 is lifted from its seat 22 by the pressure in chamber 12, an uniform circumferential opening is formed proportional to the volume of water to be admitted at each cycle into the air-chamber 14.

The valve 2 also consists of a metal cover provided with a curved upper surface and secured to a pin 25 formed at the extremity of the balance 10, on which pin the valve is held by a screw 28. The seat of the valve 2 is formed by a packing disc 26, protected by a metal disc 27 formed by an inwardly projecting portion of the chamber 12. Screws 30 are provided for holding the packing disc 26 in place on the flange 31 of the tube 4.

The valve-opening 3 can be decreased or increased by means of a lever 32 pivoted at 33, on the upper free end of which lever rests the arm of the counter-weight 9. The position of the lever 32 is determined by a screw-spindle 34, pivoted at 36, which screw-spindle carries the nuts 35, between which the lever 32 is held. By an adjustment of the lever the exact size of the valve-opening 3 can be determined as on a micrometric scale, which is of great value for determining the exact consumption of the apparatus.

The distance between the valves 2 and 13 is as small as possible, being exactly equal to the diameter of the pipe 1. This results in a reduction in the capacity of the compression chamber 12 which is at the point where the greatest force is produced at the moment the valve 2 closes. Water being capable of compression, altho to a limited extent depending upon the volume, it is evident that with the dimensions of chamber 12 being reduced as much as possible, the shock produced by the water will exert its maximum effect upon the valve 13, thus resulting in great efficiency. Moreover, the area of the interior surface of the chamber 12 being reduced, the amount of friction is likewise reduced.

The main reason for the high efficiency of the ram as shown lies in the position of the valve 2 and tube 4. The valve 2 being disposed below the pipe 1 and opening directly into the downwardly directed tube 4, the flow of water through the valve opening and the tube 4 is assisted by gravity, a vacuum being produced in the said tube by the outflow of the water from the previous cycle.

As the tube 4 is constantly submerged in water in the tank 7, it is impossible for air to enter the tube.

Also the resistance due to the pressure of the outside air is completely eliminated, whereby the greatly increased efficiency of the ram is obtained.

It should be remembered that the pressure of the atmosphere is 1.033 kg. per square centimeter, i. e. equivalent to a column of mercury of 760 millimeters at zero. My ram being provided with a vacuum tube, the flow of the water has necessarily a greater velocity than under ordinary conditions. Therefore, my ram can be operated in cases where the fall of water is very small. The ram uses only a portion of the water for its own motive force. The remaining portion which is subjected to severe pressure is used to operate the hydraulic motor 46, the latter being, as shown on the drawing, directly connected with the ram through the pipe 42. In the latter is provided a valve 44, whereby the flow of water to the motor can be shut off.

The pipe 42 is made in two pieces, and at the junction thereof is provided a T-piece which carries the water-elevating pipe in which is included a valve 45.

The part marked 47 and shown separately on the drawing is a valve used for the purpose of starting the operation of the ram. This valve is in some suitable manner fitted to the pipe 1. When the valve 2 is closed, especially under a great column of water, it would be obviously impossible, to lift the valve 2 by forcing down the counterweight 9 on the balance 10. Therefore, to start the flow of water, the said valve 47 is used. The lever of this valve is first moved to one side, whereby water is caused to flow into the pipe 1 through an outlet connected to the valve. By moving the valve-lever to the opposite side, the outlet is closed, and at the same instant, one stroke of the ram occurs forcing a certain amount of water into the air-chamber 14 through the opening 15. By oscillating the valve-lever back and forth, the pressure in chamber 14 increases, and when this pressure is sufficient to produce the withdrawal of the water from the pipe 1, the valve 2 will open, and the operation of the ram commences.

In Figs. 2 and 3 I have shown in section a compensating recoil chamber as an auxiliary apparatus to my ram.

The power developed by hydraulic rams decreases in an inverse ratio to the height of the elevating column for any given fall. The cause of the decrease must be looked for in the recoil, being the result of the slight degree of elasticity of water and being in direct proportion to the resistance offered by the column of elevation. In hydraulic rams this recoil is indispensable for

the continuous opening of the escape valve in order to produce a new cycle. Undoubtedly, the quantity of water in the elevation tube principally depends on the number of strokes made by the machine in a given space of time. In the case of great elevations, the water in the motor tube, when thrust back by the violence of the stroke reaches on its recoil a considerable distance from the compression chamber. To avoid the disadvantage of excessive recoil I have introduced, as a further improvement of my ram, the recoil compensation chamber. This chamber as will be seen from Figs. 2 and 3, comprises an air chamber of the kind usually employed in hydraulic machinery. It is placed above the motor tube and as near as possible to the feed box of the ram. In its lower T-shaped extremity, where it connects with the motor tube is a retention valve which opens (Fig. 2) to allow the water to pass from the feed-box of the ram, and closes (Fig. 3) when the recoil occurs, holding up the water on its return and impeding its entrance into the feed box. As the motor tube is in communication with the air chamber at the moment of recoil, the level of the water is raised in the chamber in question and compresses the air in the chamber. The maximum flow therefore of the water on its return is determined by the amount of air existing in the chamber, and this amount is fixed by means of the screw which is provided in its upper part. If the chamber were full of water the ram could not work, its retrograde movement being impeded by the retention valve. By the means already mentioned the amount of air in the chamber can be fixed at the minimum required to allow of the indispensable recoil, it being a matter of certainty that the velocity of the water at the beginning of each cycle will be increased by the super-pressure exercised against the air by the previous recoil. In this manner the machine commences to work without loss of time and will maintain the same number of strokes at great or small elevations, the development of power being thus maintained unchanged for the two extremes.

With reference to Fig. 1, 38 denotes the bearing for the balance 10. The base 39 of this bearing is fastened to the cover 31 of the tank 7 by bolts 40. The free end of the adjusting lever 32 is provided with a suitable lining 37.

I claim as my invention:

1. A hydraulic ram comprising in combination with the flow-pipe and the air-chamber, a constant level tank, a check valve interposed between the said flow-pipe and air-chamber, a discharge-valve in the said flow-pipe opposite the said check valve and in direct communication with the said tank, an oscillating balance enclosed within the said

tank and carrying the said discharge-valve, a central bearing for the said balance, a portion of said balance extending through the wall of the said tank outside thereof, and an adjustable counterweight carried by the said extending portion.

2. A hydraulic ram comprising in combination with the flow-pipe and the air-chamber, a constant level tank, a check valve interposed between the said flow-pipe and air-chamber, a discharge-valve in the said flow-pipe opposite the said check valve and in direct communication with the said tank, an oscillating balance carrying the said discharge valve, a central bearing for said balance, a rearward extension on said balance, and an adjustable counterweight carried by the said extension, an oscillating arm adapted to contact with the said extension for determining the position of said balance, and means for adjusting the said arm on a micrometric scale.

3. A hydraulic ram comprising in combination with the water-pipe and air-chamber, a tank below the said water-pipe, a discharge-valve, the said valve being formed of a metal cover having a curved upper surface, a check-valve between the said water-pipe and the said air-chamber, the said check-valve being also made of a metal cover

having a curved upper surface, means for guiding the said check-valve, a compression chamber being formed between the said two valves, the distance between the same being equal to the diameter of the said water-pipe.

4. A hydraulic ram comprising in combination with the flow-pipe and the air-chamber, a constant level tank, a check valve interposed between the said flow-pipe and air-chamber, a discharge-valve in the said flow-pipe opposite the said check valve and in direct communication with the said tank, a vacuum tube extending into the tank below the said discharge-valve and being immersed in the said tank, an oscillating balance carrying the said discharge valve, a bearing for the said balance, and a means for adjusting the said balance on a micrometric scale,— and a disc carrying the said vacuum tube and the said bearing of the said balance and forming a cover for the said tank.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ALFREDO JORDÃO, JUNIOR.

Witnesses:

JOHN E. MIERS,  
LUIZ SALADAUBRA.

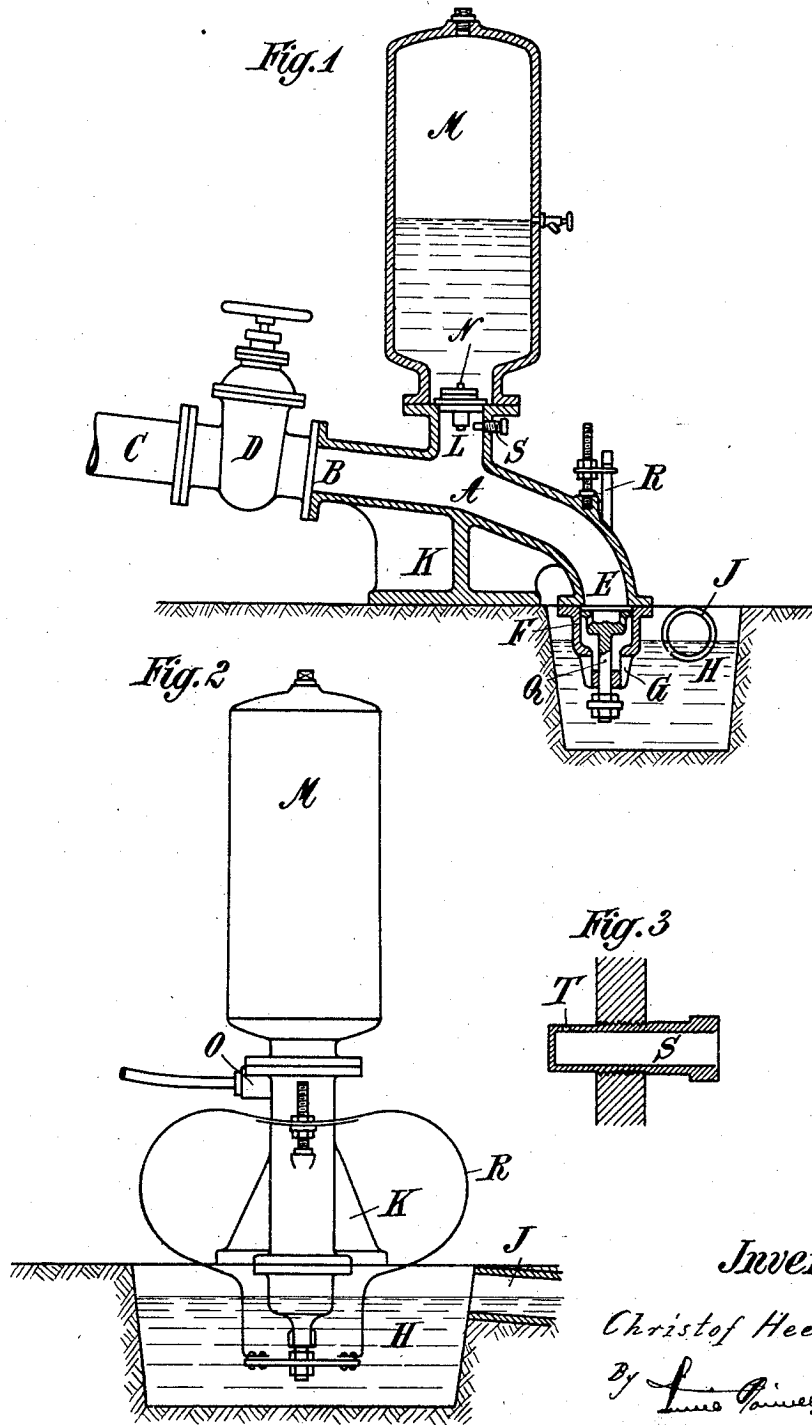
April 20, 1926.

1,581,945

C. HEERLEIN

HYDRAULIC RAM

Filed July 1, 1925



*Inventor:*

*Christof Heerlein*

*By Louis Pinnerke*  
*Attorney*

# UNITED STATES PATENT OFFICE.

CHRISTOF HEERLEIN, OF NUREMBERG, GERMANY, ASSIGNOR TO PFISTER & LANG-  
HANSS AKT.-GES., OF NUREMBERG, GERMANY.

## HYDRAULIC RAM.

Application filed July 1, 1925. Serial No. 40,792.

*To all whom it may concern:*

Be it known that I, CHRISTOF HEERLEIN, engineer, a citizen of the German Republic, residing at Nuremberg, Bavaria, Germany, have invented certain new and useful Improvements in Hydraulic Rams, of which the following is a specification.

The present invention relates to a hydraulic ram, in which the outflow of the driving water is downwardly directed. Hydraulic rams are very well known in many different constructions. Normally these rams are constructed in such a manner that the exhaust of the driving water is effected upwardly or sidewardly. But there are modifications too, in which the exhaust of the water is downwardly directed. In view of utilizing the height of the fall the last named construction is especially favourable. On the other hand a special control of the percussion valve was necessary in constructions of this kind, so that the other advantages became useless thereby.

Now, the present invention consists in employing a percussion valve of known structure instead of a downwardly directed and controlled percussion valve; in this case the percussion valve is compensated and acts perfectly automatically without any controlling or governing device. As compensating device a yielding elastic ribbon or spring is suitably employed, toward which the valve abuts.

In the annexed drawing a practical mode of execution is represented.

Figure 1 shows the entire arrangement in vertical cross-section.

Figure 2 is a side view, and

Figure 3 shows the air suction nozzle in cross-section.

The body of the ram principally consists of a curved pipe A, the back end B of which is not horizontal and has the same inclination as the power conduit C. The latter conduit is connected with the curved pipe A of the ram B by an inserted stop-valve or slide D. The other free end E of the pipe A is downwardly and vertically conducted in a slight curve and carries at its mouth-piece the percussion-valve F. The exit-conduit of the percussion valve is permanently

secured in the lower water H, which is led off by means of the pipe J.

The curved pipe A is secured on the base or support K. The pressure pipe-stud L is vertically arranged, supporting in the well known manner the air-tank M, the pressure-valve N, the branch pipe O for the lift-conduit and the suction pipe S provided with the suction-hole T. The weight of the percussion valve Q is, as usual, balanced by means of a spring R, tending to open the valve Q. This balance-spring is shaped as an elastic continuous band in circular, elliptic or any other similar form, carrying without a hinge directly or by means of a cross-bar the valve-cone of the percussion valve said springs being arranged on the outside of the pipe. In a like simple manner the spring is connected with its adjustable abutment.

The hydraulic ram is started in the well known manner. By balancing the percussion-valve Q by means of an elastic flat spring the valve acts without any control or steering device. The openings in the percussion valve may be made of larger cross-section, so that the power water in its passage meets only a weak resistance. The tension of the flat spring R may be varied within wide limits by altering the point of abutment in a sensitive manner and the action of the hydraulic ram accordingly. The construction of the flat spring obviates any wear and excludes any disturbing supplementary oscillation.

I claim—

A hydraulic ram comprising a curved pipe secured at one end to a power conduit and having a pipe stud intermediate its ends; a percussion valve secured at the other end of said pipe; a vertically disposed air tank secured to said pipe stud; a valve in said pipe stud which is adapted to admit water into the tank; and a double circular spring secured to the outside of said pipe and being adapted to force said percussion valve in its open position, said spring being adjustably mounted at the pipe connection.

In testimony whereof I have affixed my signature.

CHRISTOF HEERLEIN.



Sept. 6, 1927.

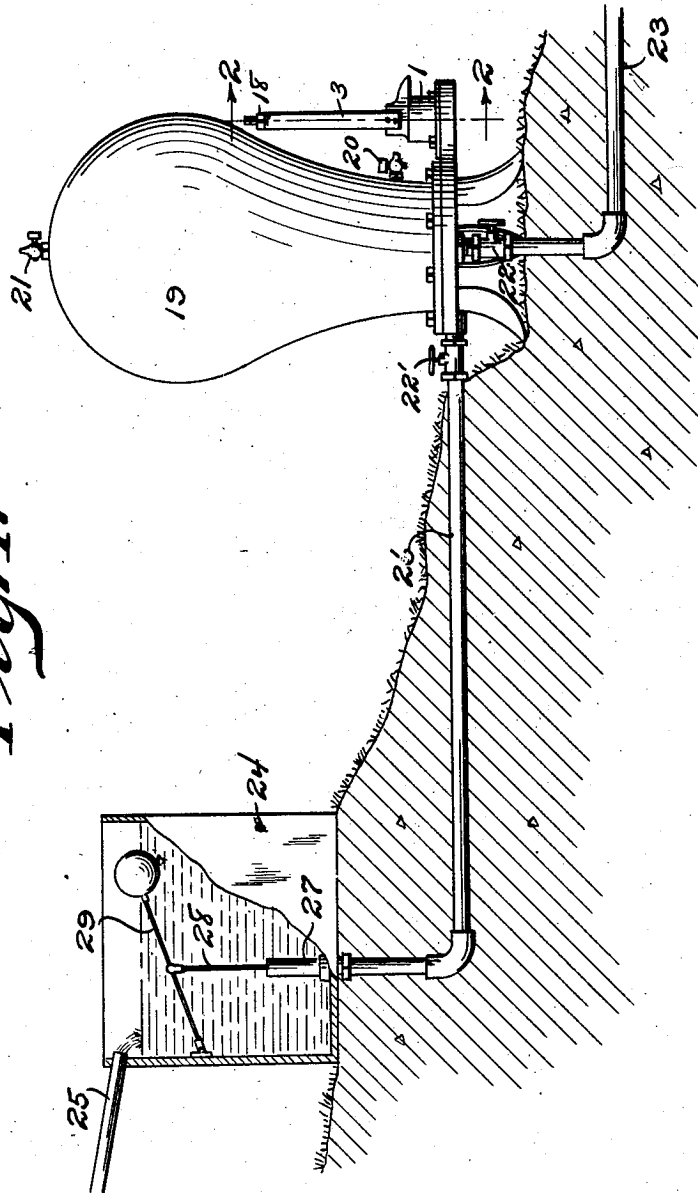
1,641,878

J. L. BOLAND

HYDRAULIC RAM

Original Filed Jan. 8, 1926 2 Sheets-Sheet 1

Fig. 1.



John L. Boland  
INVENTOR

BY Victor J. Evans  
ATTORNEY

WITNESS

*John Moran*

ATTORNEY

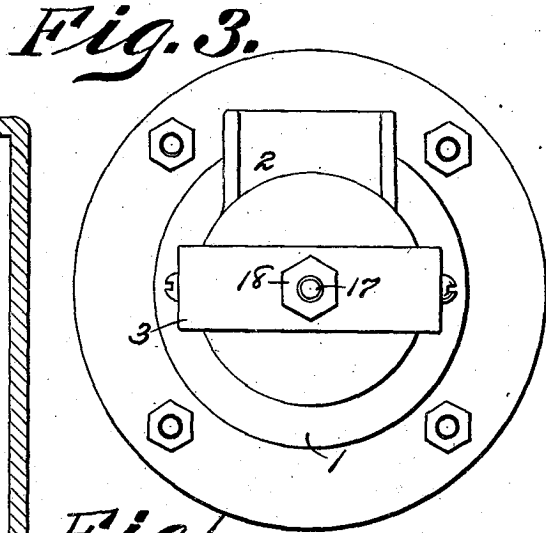
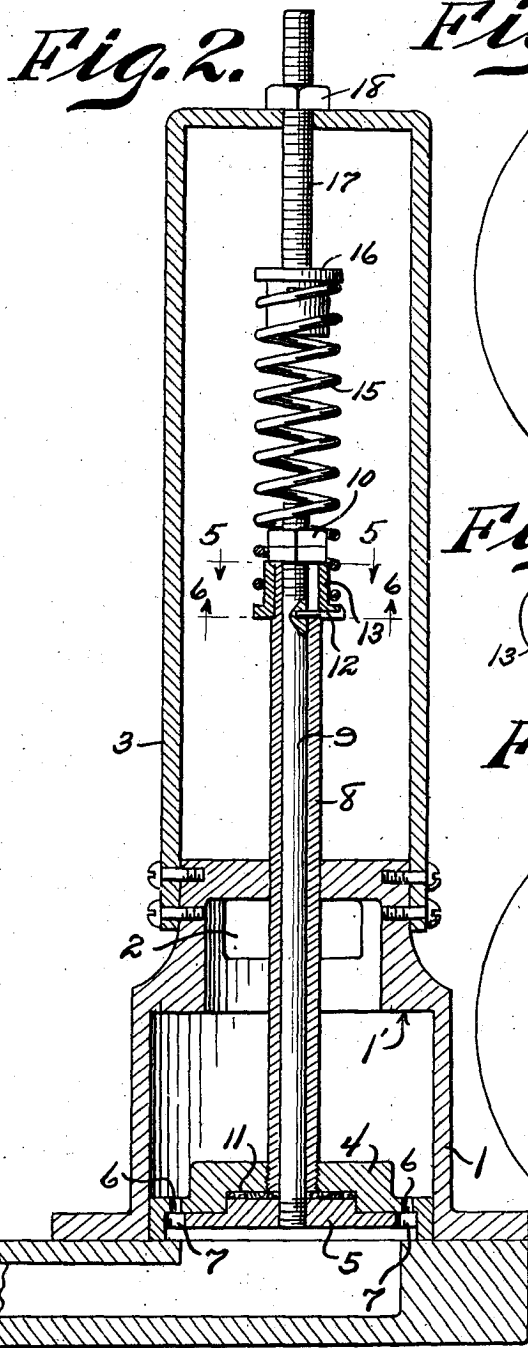
Sept. 6, 1927.

1,641,878

J. L. BOLAND

HYDRAULIC RAM

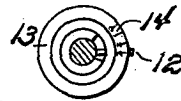
Original Filed Jan. 8, 1926 2 Sheets-Sheet 2



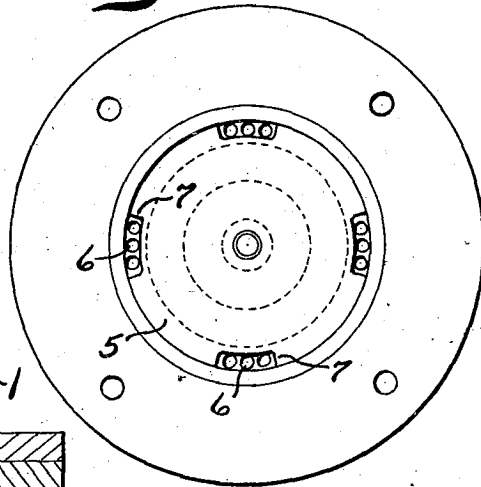
*Fig. 6.*



*Fig. 5.*



*Fig. 4.*



John L. Boland  
INVENTOR

BY Victor J. Evans  
ATTORNEY

WITNESS:

*John Donovan*

ATTORNEY

# UNITED STATES PATENT OFFICE.

JOHN L. BOLAND, OF WILMORE, PENNSYLVANIA.

## HYDRAULIC RAM.

Application filed January 8, 1926, Serial No. 80,092. Renewed June 20, 1927.

This invention relates to improvements in hydraulic rams, the general object of the invention being to provide means for making the ram adjustable for use with varying

5 water volumes so that the ram can be used in situations where the water supply varies from time to time throughout the seasons.

Another object of the invention is to provide an adjustable spring for holding the

10 waste valve off its seat. Another object of the invention is to provide means for renewing the air supply in the air chamber of the ram.

Another object of the invention is to provide a storage tank for furnishing water to the ram which is float controlled and into

15 which the water from the supply pipe discharges. This invention also consists in certain other features of construction and in the combination and arrangement of the several parts,

20 to be hereinafter fully described, illustrated in the accompanying drawings and specifically pointed out in the appended claims.

25 In describing my invention in detail, reference will be had to the accompanying drawings wherein like characters denote like or corresponding parts throughout the several views, and in which:

30 Figure 1 is a view showing the invention in use.

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

35 Figure 3 is a top plan view of Figure 2.

Figure 4 is a bottom plan view of the waste valve and its associated parts.

Figure 5 is a section on line 5—5 of Figure 2.

40 Figure 6 is a section on line 6—6 of Figure 2.

In these views, 1 indicates the housing of the waste valve of the ram which is formed with the discharge 2 and which has a yoke frame 3 attached to its upper end. My improved waste valve comprises the main part 4 and the part 5 which fits in the recessed under portion of the part 4 and is rotatably mounted therein. This part 4 is provided with a number of groups of holes 6, while

45 the part 5 is provided with a number of slots 7, a slot being provided for each group of holes, and these holes and slots are so arranged that by moving the parts 4 and 5 relative to each other, the holes 6 can be

50 covered or uncovered by the solid portions of the member 5 and thus the discharge of

water through the waste valve can be regulated. A hollow stem 8 is attached to the member 4 and is guided through a hole in the top of the casing 1. A solid stem 9 is

60 connected with the part 5 and passes through the stem 8 and has its projecting upper end threaded to receive the nuts 10 which hold the parts of the valve together. Packing 11 may be placed between the parts 4 and 5.

65 A pin 12 is fastened to the stem 9 and extends through a slot in the stem 8 so that the stem 9 and its valve part can be partly rotated to adjust the valve part 5 in relation to the part 4. A collar 13 is held on the stem 8 by the nuts 10 and this collar has a flange which is provided with the graduations 14 which cooperate with the pin 12 for permitting the waste valve parts to be

70 adjusted to any desired extent. The lower end of a coiled spring 15 is seated on the flange of the collar 13, and its upper end engages the head 16 of a screw shaft 17 which passes through the upper end of the yoke frame 3 and has a nut 18 thereon.

75 Thus by adjusting the nut 18, the shaft 17 is moved to adjust the tension of the spring 15. This spring tends to hold the valve in its lowest position, and by properly adjusting the spring, the waste valve can be set to operate under the head of water in the ram pipe and thus eliminate the manual manipulation of the valve now necessary in starting up a ram.

80 From the foregoing, it will be seen that by adjusting the parts 4 and 5 of the waste valve relative to each other, the flow of water through the valve can be adjusted so that the ram can be used with water supplies of different volumes, and with a supply where

85 the volume varies from time to time. With the small number of openings in the valve, the water would hold the valve against its seat 1' and thus prevent operation of the ram and in order to prevent this, I provide the spring which forces the valve off its seat again as this spring is adjusted so that it will permit the valve to close under the pressure of the water but will open it again when the volume of water loses its momentum, so that the water will again pass through the valve until its momentum closes the valve again. The spring also eliminates the manual manipulation of the waste valve now necessary in starting up a ram.

90 I also provide means for renewing the air in the air chamber 19 of the ram. Such

95

100

105

110

means comprises a cock 20 at the lower end of the chamber and a cock 21 in the top thereof. When the air supply is to be renewed, the valve 22 in the lift pipe 23 is closed, and the valves 20 and 21 are opened. Water in the air chamber will escape through the valve 20 and air will flow in the chamber, to take the place of the water, through the valve 21. When enough air has entered the cocks are closed and thus the air will be trapped in the chamber. A valve 22' in the supply line is closed when the air valves are open.

I also provide a storage tank 24 for holding a supply of water for the ram so that the ram can be continued in operation over a dry spell. The water is delivered to this tank from the source of supply through the pipe 25 and its outlet to the ram pipe 26 is controlled by a valve 27. The stem 28 of which is connected to the float rod 29 so that as soon as the tank is full, the valve will be opened by the float so that the water from the tank will pass to the ram. With this tank, the ram can still be used where the supply has dwindled to such a small stream that it would not be sufficient to operate the ram if it passed to the ram direct.

This tank can be used with my improved form of waste valve, as said valve is automatic in operation so that as soon as the water is released from the storage tank by the operation of the valve by the float, the ram will start to work without manual manipulation of the valve. Otherwise the

valve would close under the pressure of the water from the tank and would remain closed unless manually manipulated.

It is thought from the foregoing description that the advantages and novel features of my invention will be readily apparent.

I desire it to be understood that I may make changes in the construction and in the combination and arrangement of the several parts, provided that such changes fall within the scope of the appended claims.

What I claim is:—

1. In a ram, a waste valve, adjustable spring means for holding the same off its seat and adjustable means for regulating the amount of water passing through the valve.
2. In a ram, a waste valve composed of two parts, each having ports therein, a hollow stem connected with the upper part, a stem connected with the lower part and passing through the hollow stem, means connected with one stem for moving it in relation to the other stem and a scale on the other stem for indicating the amount of movement of the first stem.
3. In combination with a ram, a tank connected with the ram pipe, a valve for controlling the flow of water from the tank into said pipe, a float in the tank for opening the valve when the tank is full and means for connecting the tank with a supply of water.

In testimony whereof I affix my signature.

JOHN L. BOLAND.

Aug. 20, 1929.

C. E. HELMICK

1,725,637

SUPERHYDRAULIC RAM

Original Filed Aug. 26, 1927

Fig. 2.

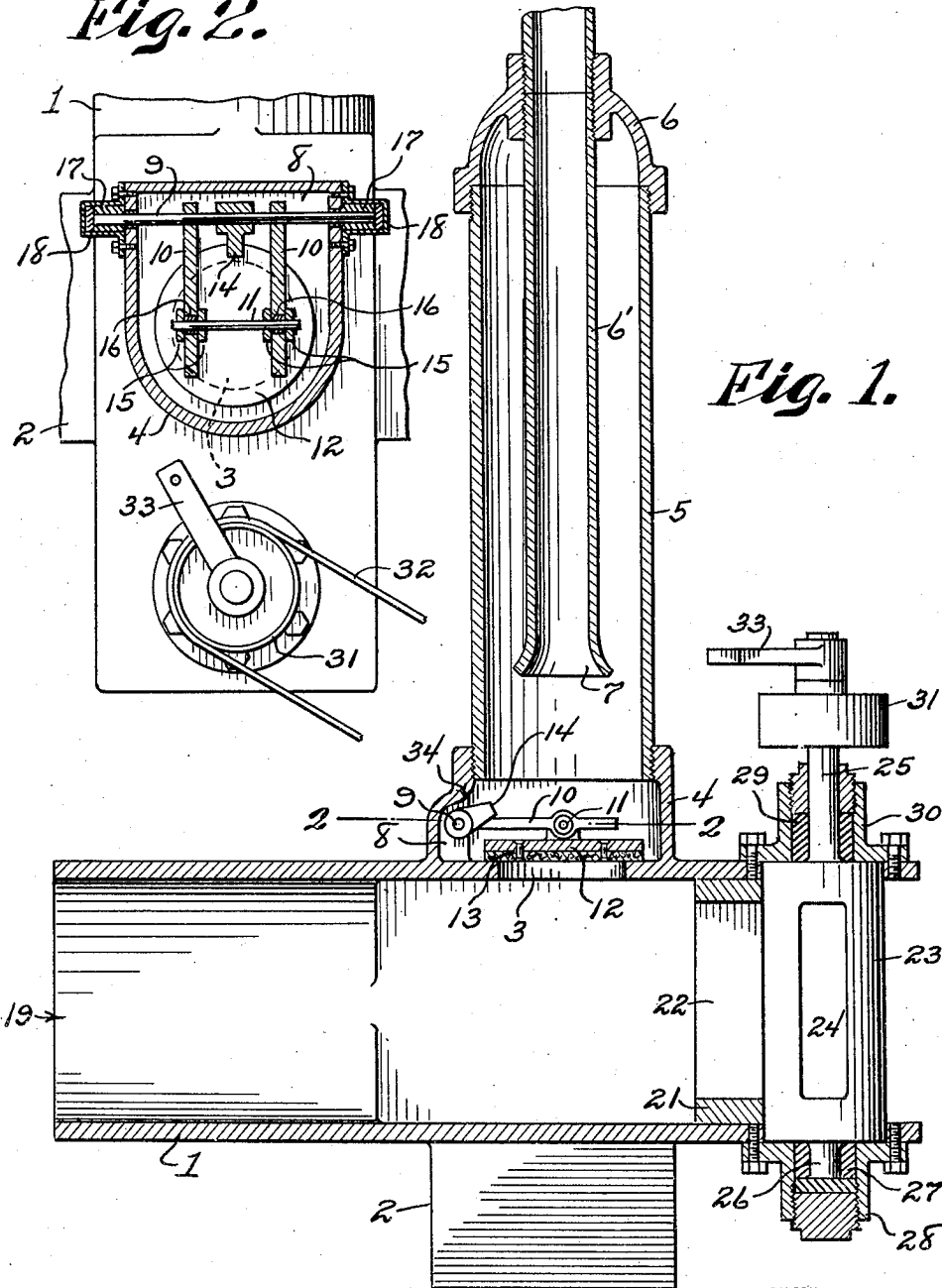


Fig. 1.

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BY Victor J. Evans  
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WITNESS: John D. Moran

ATTORNEY

## UNITED STATES PATENT OFFICE.

CLARENCE E. HELMICK, OF BAKER, OREGON, ASSIGNOR TO HELMICK HYDROSTATIC MOTOR CO., OF BAKER, OREGON.

## SUPERHYDRAULIC RAM.

Application filed August 26, 1927, Serial No. 215,733. Renewed February 8, 1929.

My present invention has reference to a hydraulic ram and my object is the provision of a ram for this purpose which will overcome the deficiencies of hydraulic rams of the usual constructions by overcoming the power of the "water-hammer" which prevents the practicability of the use of a penstock or drive pipe of greater than a comparatively small diameter and which likewise prevents a continuous and constant flow of water and the elevation thereof beyond a certain height.

A further object is the provision of a hydraulic ram in which a discharge valve of an especially and peculiar construction is employed, hinged only at one point to permit of a perfect conformity of the valve face with the valve seat and in which an exhaust valve of either a reciprocatory or rotary type is provided and operated by suitable mechanism so that the ram is not of the automatic type but wherein the construction of the same is such that the closing of the exhaust valve permits of a high intense pressure of water opening the discharge valve and being directed into the compression chamber, where the air is compressed by a series of violent waves of resultant pressure which applies weight to the mass of water, stores up the pressure waves, seats the discharge valve and produces a continuous flow of water through the discharge pipe, and likewise wherein the continuous opening and operation of the exhaust valve produces an alternating impulse of pressure and relax of such pressure in the compression chamber to positively assure a free and constant flow of water through the discharge pipe and the elevating thereof to any desired height.

A still further object is the provision of a hydraulic ram in which the valves employed are seated in bearings of a construction which are lubricated by contact of water therewith.

The invention will be fully and comprehensively understood from a consideration of the following detailed description when read in connection with the accompanying drawings which form part of the application, with the understanding, however, that the improvement is capable of extended application and is not confined to the exact showing of the drawings nor to the precise construction described and, therefore, such changes and modifications may be made therefrom as do not affect the spirit of the invention nor ex-

ceed the scope thereof as expressed in the appended claims.

In the drawings:

Figure 1 is an approximately vertical central longitudinal sectional view through my improved hydraulic ram.

Figure 2 is a sectional view on the line 2—2 of Figure 1.

The ram has its lower portion, of course, arranged in a flowing body of water, the same including a conduit 1, which is preferably mounted upon a suitable base 2 and thereby elevated above the body of water. The pipe member or conduit 1 has on its top a round opening 3 and disposed away from but surrounding this opening the said top is further provided with an upstanding annular flange 4. To this flange, there is screwed or otherwise secured the lower end of the compression chamber 5. The top of the chamber 5 is closed by a dome-like cap 6, and threaded through the center of this cap and entering the compression chamber 5 there is a water outlet pipe 6'. The lower branch of this pipe is flared outwardly, as at 7, and the same is disposed a slight but suitable distance above the conduit 1.

The flange 4 has an inner chambered portion 8 on one of its sides, in which there is mounted a shaft 9 that carries an outstanding arm 10. To this arm there is pivoted, as at 11, the valve 12 that closes the opening 3. This valve 12 is in the nature of a disc and comprises two members. The valve is preferably of a compressible nature and the members constituting the same are riveted or otherwise connected together, as indicated by the numeral 13. On the shaft 9 there is fixed a finger 14 and this finger is in the path of contact with the upper and angle wall provided by the chamber 8 so that the opening of the valve is thus limited. As disclosed by the drawings there is arranged on the shaft 9 two arms 10 which are suitably spaced, and by reference to Figure 6 of the drawings it will be seen that the finger 14 is disposed between these arms. Also it will be noted that the pivot or shaft 11 passes through spaced ears 15 on the valve, and that the said pivot passes through a bearing in the arms. These bearings 16, are of the lignum vitæ type and consequently are lubricated by the water contacting therewith. The bearings for the shaft 9 are also of lignum

vitæ type. These bearings, indicated by the numeral 17, are received in suitable closed caps or housings 18 that are fixed to the sides of the flange 4.

5 For distinction the intake end of the conduit 1 is indicated by the numeral 19. At the outlet end of the said conduit there is received in the conduit and fixed thereto, by means 20, a hollow extension 21. The outer end of the extension 21 is concaved and provides a seat or rest for a rotary valve 23. The valve has an alining transverse port 24 which communicates with the hollow extension 21. The valve has upper and lower stems 25 and 26, respectively, the stem 25 being in the nature of a stop and being received in a bearing of the lignum vitæ type, 27, that is suitably housed in a casing 28 that is fixed on the top and bottom of the conduit that extends beyond the hollow member 21. The sides of the conduit, at the said extending and outlet end are cut-away. The upper stem 25 for the valve 23 is received through a lignum vitæ bearing 29 that is in turn received in a suitable housing 30 fixed in the top of the conduit. The stem 25 may have on its upper end a belt wheel 31 around which a belt 32 is trained, the said belt being connected to any desired source of power which will revolve the valve 23 in proper timed relation to aline with and out of registration with the hollow member 21 of the conduit 19. If desired and as disclosed by the drawings there may be fixed on the stem 25 above the belt wheel 31 an arm 33, and the arm may be connected to any desired source of power which will impart a reciprocatory turning to the valve 23.

With my improvement the outlet or discharge pipes may be of any desired height and preferably decrease in cross sectional diameter from the inner to the outer ends thereof. Also with my improvement it will be noted that the water flowing through the conduit will open the valve 12. The opening of this valve is limited by the contact of the finger 14 with the shoulder 34 in the flange 4, so that the water will partly enter the flared or bell-shaped end of the pipe 8 and compress air thereabove in the chamber 5. The force of this water will close the valve so that air is compressed in uniformity in the said chamber 5. The opening of the valve permits of the free flow of the water through the conduit but the compressed air in the chamber 5 and the volume of water therein will close the valve 12, causing the water from the chamber to pass in an even flow through the outlet pipe 6. With my improvement all of the power developed by what is known as the "water-hammer" in the ordinary rams is utilized in the discharge of the water, and also with my improvement the energy is stored to aid in a

continuity of flow in the discharge pipe so that the water pressure, wasted in the ordinary rams, is thus utilized. Also it is to be noted that the surge pipe within the compression chamber may be modified to properly function under different conditions.

The improvement is of an extremely simple construction and the advantages thereof, will, it is thought, be readily apparent to those skilled in the art.

Having described the invention, I claim:—

1. A hydraulic ram including a water conduit, a chamber on the top thereof having a restricted communication therewith, a bell-shaped cap closing the top of the chamber, an outlet pipe screwed through the cap and having a portion entering the chamber and said portion having a bell-shaped end, a valve comprising two connected compressible discs for closing the passage between the conduit and the chamber, a shaft journaled in water lubricating bearings, arms extending therefrom pivotally connected to the top of the valve, a finger on the shaft for limiting the opening of the valve and a revoluble valve having stems journaled in water lubricating bearings at the outlet end of the conduit, in combination with means for actuating said valve.

2. A hydraulic ram including a conduit through which water passes, said valve having a large opening in the top thereof, an annular flange disposed away but surrounding the opening and having a pocket in one of the walls thereof, a compression chamber fixed to the valve and extending thereabove, a conical cap member closing the outer end of the compression chamber, an outlet pipe screwed through the cap and entering the chamber and having a lower outwardly flared end, a valve comprising two discs for closing the opening in the conduit, a shaft journaled in water lubricating bearings in the ends of the pocket, spaced arms extending from the shaft, pivotally connected to the valve, a finger fixed on the shaft in the path of contact with the upper wall of the pocket for limiting the opening of the valve, a hollow member fixed in the outlet end of the conduit and having its wall concaved, and said conduit, outward of said member, having its sides cutaway, a cylindrical valve having a transverse passage therethrough and having stems on the opposite ends thereof, which latter are journaled in water lubricating bearings in the top and bottom at the cut-away portions of the conduit and said valve designed to be received in the concaved end of the hollow member.

In testimony whereof I affix my signature.

CLARENCE E. HELMICK.

Jan. 29, 1935.

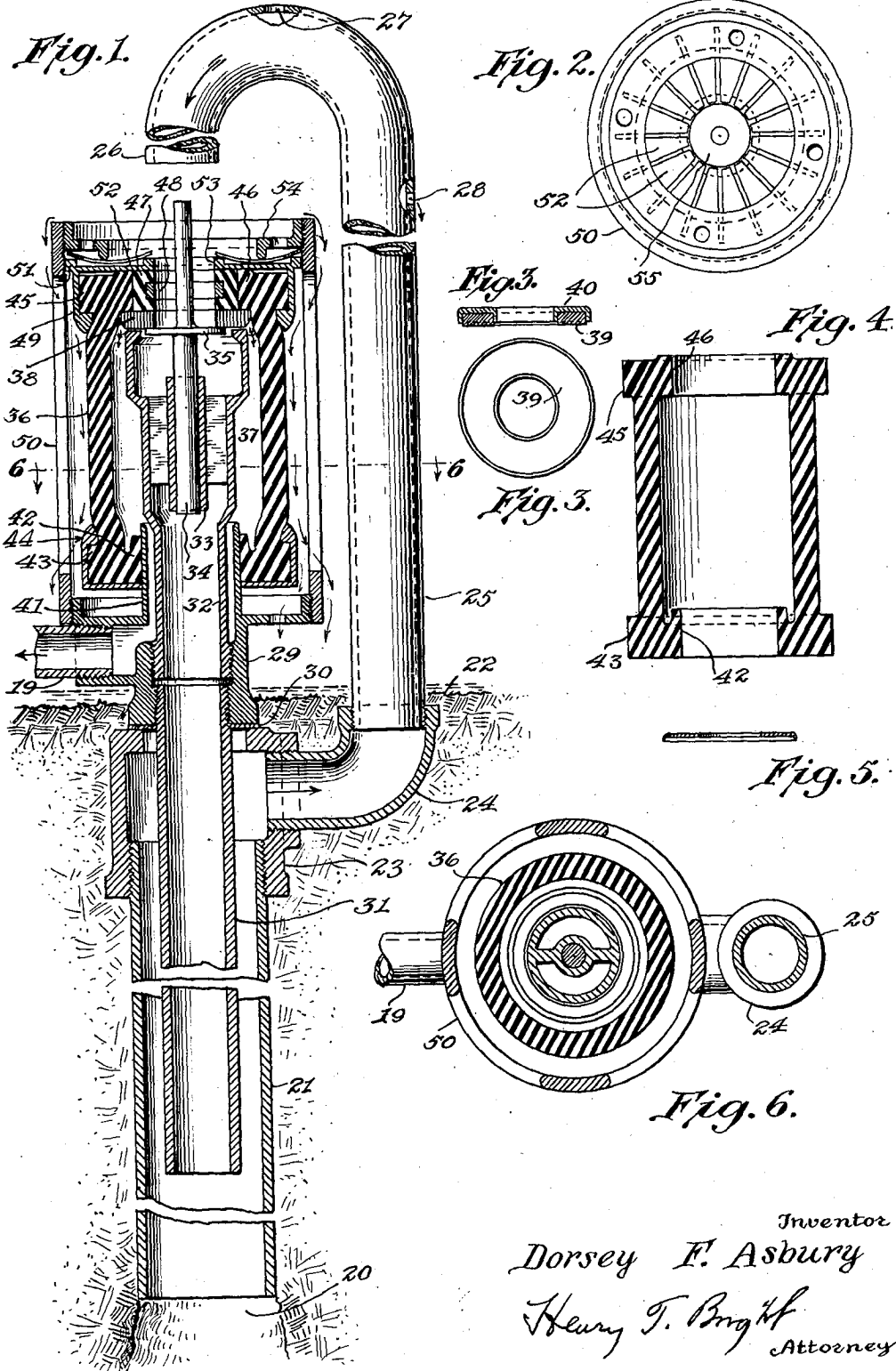
D. F. ASBURY

1,989,580

HYDRAULIC RAM

Filed Feb. 9, 1933

4 Sheets-Sheet 1



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Jan. 29, 1935.

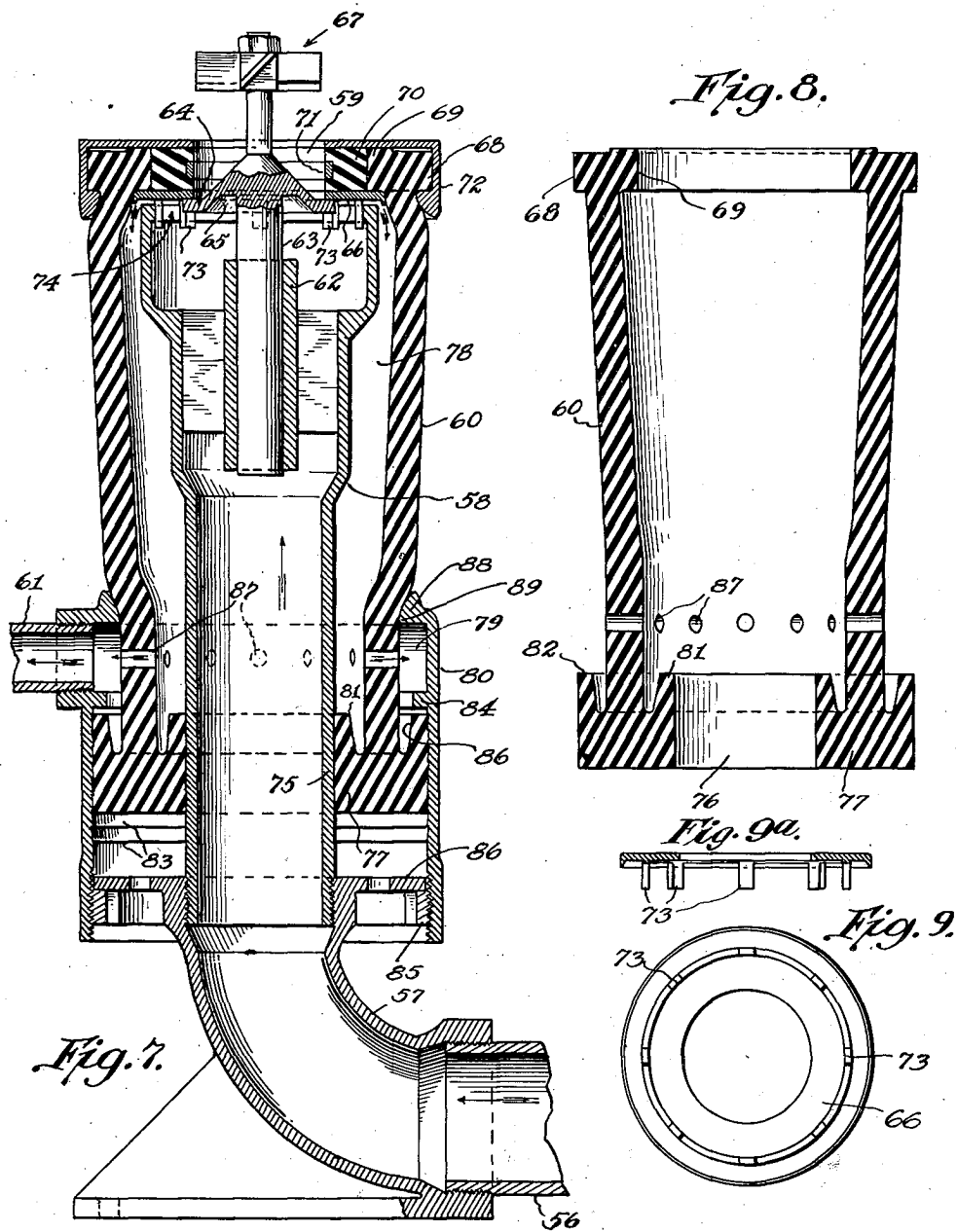
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Filed Feb. 9, 1933

4 Sheets-Sheet 2



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HYDRAULIC RAM

Filed Feb. 9, 1933

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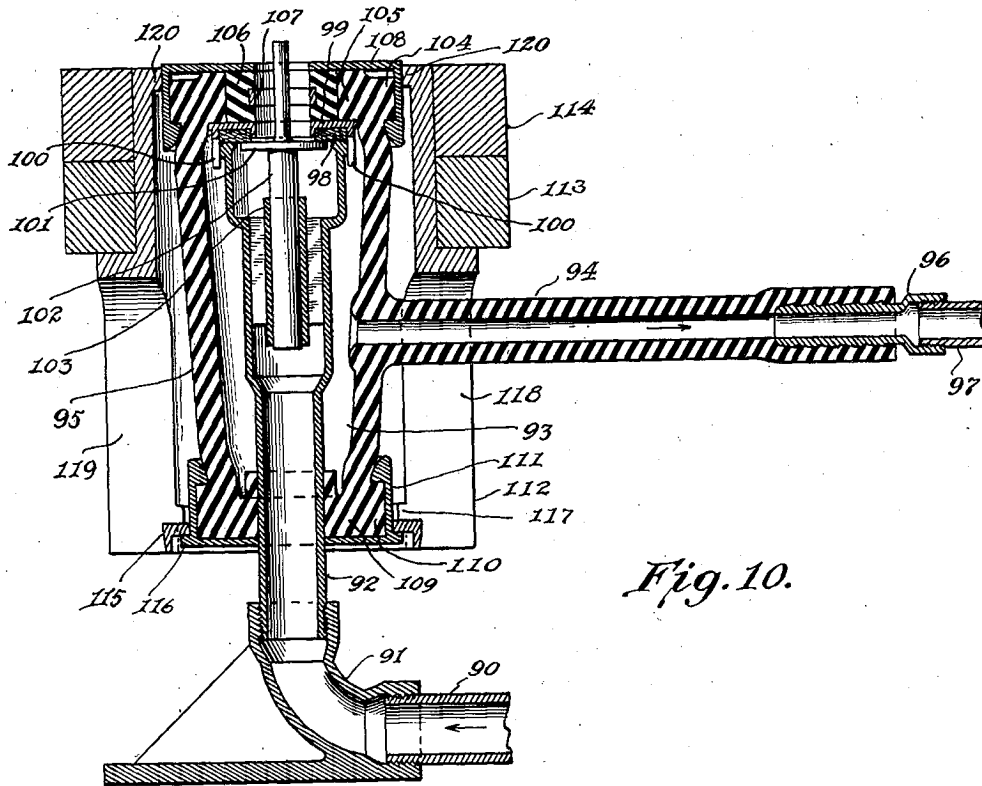


Fig. 10.

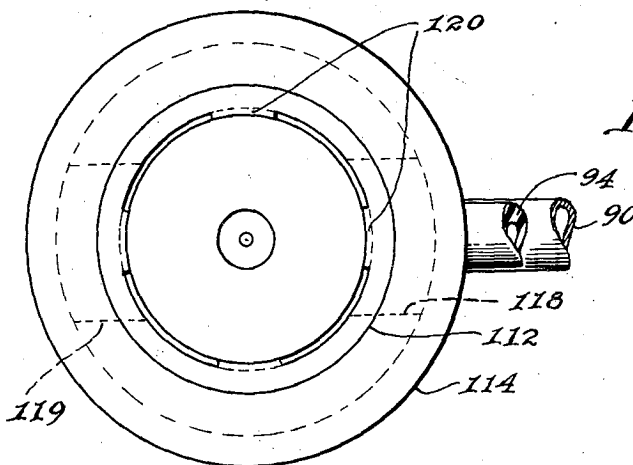


Fig. 11.

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4 Sheets-Sheet 4

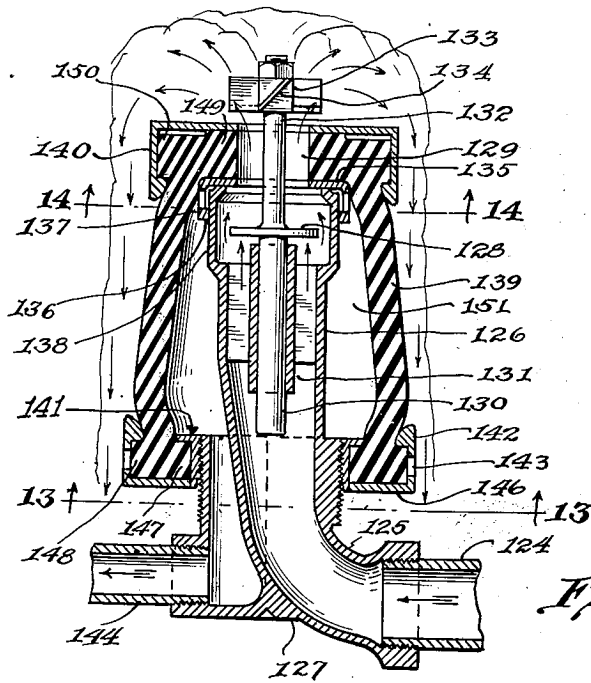


Fig. 12.

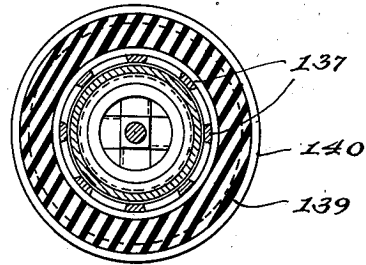


Fig. 14.

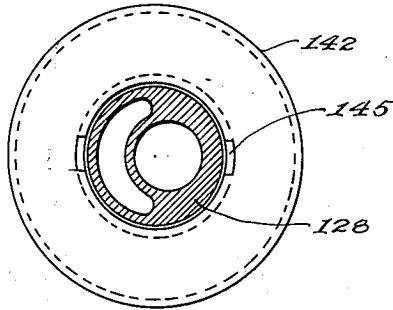


Fig. 13.

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# UNITED STATES PATENT OFFICE

1,989,580

## HYDRAULIC RAM

Dorsey F. Asbury, Broomes Island, Md.

Application February 9, 1933, Serial No. 656,015

26 Claims. (Cl. 103-77)

It is my purpose to produce a very light and compact hydraulic ram which can be manufactured and shipped cheaply.

The following are the structural objects of my invention: to produce a ram in which resilient rubber acts as the pulsating element in order to avoid the use of an air dome which requires frequent replenishing with air to restore maximum efficiency; to make the momentum of the water operate with a quick push against resilient rubber which will store energy and then use it in the other part of the cycle of operation; to cause the momentum of the cut-off valve and the pressure against said valve to help open the expansion chamber valve; to assist gravity in opening the cut-off valve by causing the closing movement of the expansion chamber valve to be moving the cut-off valve downwardly before the said cut-off valve begins to open; to locate the impulse blades that rotate the cut-off valve so that they will be out of the water while the valve is opening thereby permitting the valve to fall open quicker; to provide automatic compensating means to permit permanent set in the longitudinal stretch of the rubber diaphragm without deficiency in the rubber's action; to provide a follow-up spring pressing down on the rubber to compensate for a permanent set in that portion of the rubber which is above the expansion chamber valve and under compression in order to make the ram run a long time without readjusting; to provide either a weight or a secondary expansion chamber outside of the rubber diaphragm to make the downwardly acting force of the diaphragm large enough to overcome the momentum of the water in the drive pipe and then close the expansion chamber valve after the impulse; to locate the expansion chamber valve at the very end of the driving column of water so that 100% of the water column's momentum will be available to open the valve and force water into the expansion chamber; to provide an inside and an outside support to hold the rubber of the diaphragm and to make one of the supports carry the force that is exerted on the other support; to provide a water tight seal between stretched rubber and a sealing member by locating the sealing member where it will prevent the rubber from stretching in a straight line thereby causing the pressure between the rubber and the sealing member to be greater than the pressure in the water confined; to have the waste water leave from the top of the ram and flow downwardly over the outside of the rubber diaphragm to prevent oxidation of the rubber and also to maintain the outside thereof warmer

than the atmosphere in the winter and cooler than the atmosphere in the summer; to provide a light thin ring valve which when pressed on uniformly by rubber it will conform to its mating seat and seal with substantially uniform pressure throughout its sealing surface; to provide means to hold the rubber diaphragm concentric with the expansion chamber valve and to guide the expansion chamber valve concentric with its mating seat; to provide means whereby the expansion chamber valve, which has no stem, is maintained level with its mating seat while the valve is open so that the water forced in the chamber will be distributed equally radially 360°; to make the expansion chamber valve of wood or thin metal and support it by thick rubber so that the closing of the cut-off valve there against will make very little noise; to increase the effectiveness of the drive pipe of rams that are run by water from artesian wells by having the drive pipe hang down in the well's casing in order that its lower end will be in high pressure water where it will fill the pipe faster and thereby permit the water to run through the pipe faster and store more energy; to provide an artesian well's casing with an overflow pipe independent of the ram's drive pipe and to have the water in the overflow pipe spill on the ram to protect the outside of the rubber and also to keep the water in the ram from freezing in case the ram should stop or be stopped during cold weather; to hang the ram's drive pipe down in the artesian well's casing to keep the water in the drive pipe from freezing should the ram stop and also to cause the friction of the water current in the well's casing above the lower end of the drive pipe to add to the water head which runs the ram; to make the rubber thick enough so that its working stretch will be only about 1/80 of its 650% maximum stretch so that the diaphragm will last several years.

In the drawings chosen for the purpose of illustrating my invention

Fig. 1 is a vertical cross section of a hydraulic ram constructed in accordance with my invention and connected to an artesian well;

Fig. 2 is a view looking down on the top of the ram shown in Fig. 1;

Fig. 3 shows a leather seat valve that may be substituted for the valve shown in Fig. 1; Figure 3a is a transverse section of the valve shown in Figure 3;

Fig. 4 is a longitudinal section through the rubber diaphragm shown in Fig. 1;

Fig. 5 is a section through a thin metal valve

that may be substituted for the valve shown in Fig. 1;

Fig. 6 is a transverse section on line 6—6 of Fig. 1;

5 Fig. 7 is a vertical cross section of a modified form of my invention showing a secondary expansion chamber;

Fig. 8 is a longitudinal section through the rubber diaphragm shown in Fig. 7;

10 Fig. 9 shows in detail the valve shown in Fig. 7; Figure 9a is a transverse section of the valve shown in Figure 9;

Fig. 10 is a vertical cross section of a modified form of my invention showing weights holding the rubber diaphragm down;

15 Fig. 11 is a view looking down on the ram shown in Fig. 10;

Fig. 12 is a vertical cross section through the simplest and least expensive form of my invention;

20 Fig. 13 is a transverse section on line 13—13 of Fig. 12; and

Fig. 14 is a transverse section on line 14—14 of Fig. 12.

25 Referring to the drawings, Fig. 1 is a vertical cross section of a hydraulic ram constructed in accordance with my invention and connected to an artesian well 20 having a casing pipe 21 extending fully 60 feet below the surface 22 of the ground. On the upper end of the well's casing pipe is screwed a fitting 23 having a side outlet consisting of an elbow 24 supporting an overflow pipe 25 which extends upwardly about 5 feet to provide a head of water above the ground, this pipe extends back down to within about 2 feet of the ground with the center of the end 26 over the center of the well for purposes that will presently appear. The air hole 27 in the top of the overflow pipe prevents the water flowing through the downward extending portion from siphoning and reducing the water head, small leak holes like 28 in the side of the pipe provide circulation to keep the water from freezing in case there is water in the pipe and no overflow while the ram is operating.

45 The base casting 29 of the ram sits on the washer 30 between it and the fitting 23, the ram's drive pipe 31 is screwed to casting 29 and extends hanging therefrom about 55 feet down inside of the well's casing and the central member 32 is screwed to the base casting to form a continuation of the drive pipe 31. Inside and central with member 32 is a guide bearing 33 in which reciprocates the stem 34 of the cut-off valve 35. The hollow rubber diaphragm 36 forms the outside wall of the ram's expansion chamber 37 and the inside wall thereof is formed by the member 32. The expansion chamber valve 38 is ring shaped and has two sealing surfaces on its lower side, the outside sealing surface mates with the end of member 32 and the inside surface is shown in contact with its mating seat on the cut-off valve. The expansion chamber valve shown in Fig. 1 is made of hard wood concentric with the wood's heart so the end of the cylindrical layers of the wood's growth will form a plurality of circular seals. Either the valve shown by Fig. 3 which is made of leather 39 inlaid in metal 40 or the thin metal valve shown by Fig. 5 may be used instead of the wood valve. The base casting 29 has a cylindrical flange 41 extending upward over which is forced the lower end portion 42 of the rubber diaphragm to form a water tight seal between the expansion chamber and the atmosphere. The lower end of the rubber diaphragm has an out-

wardly projecting flange 43 and surrounding this rubber flange and supported by the same is a metal member 44 having a flange extending inwardly which supports the portion 42 of the diaphragm. The upper end of the rubber diaphragm has an outer flange 45 and an inner flange 46 and inward of the latter is a filling in cylindrical rubber member 47 having a shape supporting metal ring 48. The expansion chamber valve 38 by supporting both the inner flange 46 and the rubber member 47 supports the outer flange 45 through the metal member 49 which surrounds flange 45 and extends inwardly over rubber flange 46 and rubber member 47. The lower end of the outside frame 50 is screwed to the base casting 29 and it extends up to the top of the ram, member 49 has a flange 51 the outside of which is guided by frame 50 and the upper side of which supports the outer ends of a series of radial springs 52 and the inner ends of the springs are supported by the flange 53 on member 49. These springs 52 are joined at their outer end by enough metal to hold them radial while they are simultaneously compressed or adjusted by rotating the member 54 which is threaded to the frame 50. Member 49 guides the upper end of the diaphragm and the diaphragm guides the expansion chamber valve concentric with the drive pipe and cut-off valve.

In Fig. 1 the cut-off valve 35 is shown closed against the expansion chamber valve 38 which is nearly closed, the rubber diaphragm 36 is bulged outwardly by the pressure inside the expansion chamber 37 this pressure being necessary to force water up to a reservoir. The force of the springs 52 and the force in the rubber above the expansion chamber valve 38 moves the valve downwardly to close against its mating seat which is formed by the upper end of member 32. This downward movement moves the cut-off valve downward and also moves the water in the drive pipe slightly downwardly to relieve pressure against the under side of the cut-off valve while said valve opens. This downward movement given to the cut-off valve before it opens assists gravity in opening said valve. When the expansion chamber valve closes the cut-off valve keeps on moving downwardly due to the force of its own momentum and that of gravity until it is stopped by the upper end of the guide bearing 33. Then the water in the drive pipe begins to flow by the cut-off valve's periphery to the atmosphere through the hole 55 in the top of the ram and when the water acquires velocity enough the current acting against the lower surface of the cut-off valve lifts said valve and it closes against the expansion chamber valve, then the momentum in the long straight column of water from the bottom of the drive pipe 31 to the top of member 32 acting against the lower side of both the cut-off valve and the expansion chamber valve opens the latter and forces water radially 360° by this valve into the expansion chamber 37. After the energy in the form of momentum in the driving column of water opens the expansion chamber valve and forces water into the expansion chamber energy stored in the rubber and springs during said action acts to close the expansion chamber valve and help open the cut-off valve. The momentum delivered to the cut-off valve during the closing movement thereof helps open the expansion chamber valve. During the time water is forced into the expansion chamber the stretch or deformation of rubber permits more amount of water to be forced into the expansion chamber than the amount forced

out through the discharge pipe 19 during said time.

The most of the force which opens the expansion chamber valve is delivered through the cut-off valve and stem 34 of the latter is held by guide bearing 33 square to the mating seat of the expansion chamber valve and this is the means that keeps the seat of the expansion chamber valve level with its mating seat while the valve is open.

If there occurs a permanent set in the rubber due to mashing it against the expansion chamber valve the springs 52 pressing down on the member 49 will follow this member and thus compensate for the decrease in the working thickness of the rubber and if there is a permanent set in the rubber diaphragm due to longitudinal stretch the pressure of the water in the expansion chamber will push the lower end of the diaphragm further down over the cylindrical flange 41 and this will compensate for the permanent set.

As water cannot be forced through one end of a drive pipe any faster than it enters the other end the drive pipe 31 which projects about 50 feet down in the artesian well has an advantage for the high pressure at its lower end will cause the water to fill the pipe as fast as the water head which runs the ram can move the water through the pipe.

This ram makes about fifty strokes per minute and while the ram is operating and also if the ram should stop with the cut-off valve open water flowing out through the hole 55 runs down over and maintains a coating of water over the outside of the rubber to prevent oxidation of the rubber by the air and also to maintain the rubber cooler than the atmosphere in the summer and warmer than the atmosphere in the winter. If the ram stops with the cut-off valve closed the water from the well will flow through the overflow pipe 25 and keep the water strata leading to the well open and the water from the overflow pipe will spill on the ram to keep the rubber diaphragm wet and also keep the water in the ram from freezing.

Referring to the disclosure shown by Fig. 7, Fig. 8 and Fig. 9 of the drawings the water which runs this ram enters through a horizontal drive pipe 56, the elbow 57 and the central vertical hollow member 58 forms a continuation of the drive pipe. The waste water from the ram leaves through the hole 59 in the top thereof and flows down over the outside of the rubber diaphragm 60. The water pumped by the ram is forced out through the discharge pipe 61 to a reservoir not shown. Central with and supported by member 58 is a guide bearing 62 in which the stem 63 of the cut-off valve 64 reciprocates. A cavity 65 is made in the under side of the cut-off valve to allow the upper end of the guide bearing 62 to be nearer the plane of the expansion chamber valve 66, this feature becomes more important as the size of the ram is increased. The purpose and action of the wheel 67 shown on top of the cut-off valve will be stated in the description of Fig. 12. At the top of the diaphragm 60 is a rubber flange 68 on the outside and a rubber flange 69 on the inside and inward of the latter is a filling in rubber member 70 having a shape supporting metal ring 71. The metal member 72 surrounds the rubber flange 68 and the downward pull of the outside of the rubber diaphragm is carried and delivered down through the rubber flange 69 and rubber mem-

ber 70 to the expansion chamber valve 66. The upper end of the rubber diaphragm is held concentric with the expansion chamber valve by the periphery of the latter and the expansion chamber valve is guided by a series of prongs 73 projecting downward from the under side of the valve and bearing against the inside surface 74 of the top of member 58. The lower portion 75 of member 58 is forced through the hole 76 in the lower end 77 of the diaphragm 60 and the inside wall of the expansion chamber 78 is formed by the outside of member 58. Expansion chamber 79 is formed between the outside of the rubber diaphragm 60 and the inside of metal member 80. The annular flanges 81 and 82 on the lower end of the diaphragm respectively form water tight seals with the outside of member 58 and inside of member 80. The annular ridges 83 on the inside of member 80 permit downward movement of the lower end 77 and resist upward movement thereof so as to hold the said lower end down after it has once been forced downward by the pressure of the water in the expansion chambers 78 and 79 in order that there will be enough longitudinal stretch in the diaphragm after the ram is stopped to cause the diaphragm to start to function when the ram is again started by pushing the cut-off valve open. While assembling the ram the annular flange 84 on the inside of member 80 acts against the flange 82 to pull the lower end of the diaphragm down far enough to cause the diaphragm to function when the ram is started the first time. Member 80 is pulled down by rotating ring 85 which is threaded with 80 and which bears against the under side of the flange 86 cast with the elbow 57. The series of holes 87 permit the water to flow freely from expansion chamber 78 to expansion chamber 79. At the top of member 80 is formed an annular flange 88 having its least inside diameter slightly less than the outside diameter of the mating portion of the diaphragm and this flange is so located to prevent the rubber of the diaphragm from stretching straight from above said flange to the lower end of the diaphragm thereby causing the rubber to contact against the sealing corner 89 with a greater unit pressure than that of the water confined in expansion chamber 79, also the bending of the rubber around the corner 89 by the bulge in the diaphragm above the sealing member increases the pressure at the corner 89. The water in chamber 78 mashes rubber of the diaphragm against flange 88 and the rubber below said flange is mashed between the water in chambers 78 and 79 and the rubber flanges 81 and 82 are respectively mashed by the water in chambers 78 and 79 and the amount of this mashing of the rubber varies directly with the pressure of the water hence all this mashing of the rubber in the diaphragm forms part of the means whereby more amount of water can be forced into the ram's expansion chambers per a unit of time than that amount discharged therefrom during the same unit of time.

The purposes of the outside expansion chamber 79 are to provide a chamber from which the water may be discharged through a metal pipe 61, to have the hole 76 shown in Fig. 8 as small as the outside diameter of the drive pipe portion 75 and to provide a chamber outside of the rubber diaphragm whereby the water therein reacts from an area much greater than the area of the hole 76 and forces the lower end of the diaphragm downward with force enough to-

gether with the downward acting force produced in expansion chamber 78 to stretch the diaphragm with a force great enough to overcome the momentum of the water in the drive pipe, and close the expansion chamber valve after water is forced into the expansion chamber 78. The above is means to automatically adjust to compensate for a permanent set anywhere in the rubber and it thereby enables the rubber diaphragm to continue to function throughout its effective life without being manually adjusted.

Fig. 10 and Fig. 11 show a modified form of my invention having a horizontal drive pipe 90, an elbow 91 and a central member 92 like respective parts shown in Fig. 7 and already described. The water from the expansion chamber 93 is discharged through a flexible rubber hose 94 one end of which is connected directly to the diaphragm 95 and the other is forced over a hose connection 96 which is screwed to the pipe 97. The expansion chamber valve is formed by a ring 98 of sole leather inlaid in a metal casing 99 and projecting downwardly from the casing is a series of prongs 100 with their inside surface bearing loosely against the outside cylindrical surface at the top of member 92, these prongs 100 guide the valve concentric with its mating seat formed by the top of member 92. The cut-off valve 101 is guided by its stem 102 working in bearing 103. The outside flange 104 and the inside flange 105 made on the upper end of the diaphragm, the filling in rubber member 106, the shape supporting ring 107 and the metal member 108 surrounding the upper end of the diaphragm are like those respective parts already described with Fig. 7. The lower end 109 of the diaphragm fits water tight around the member 92. The outside annular flange 110 on the diaphragm supports the member 111 which surrounds it and this member supports the portion of the rubber which is around the central member 92.

When the ram is running and during the time the momentum of the water in the drive pipe is being overcome there is a greater area acted on by the pressure in the drive pipe and expansion chamber to force the upper end of the diaphragm upward than the area acted on by the pressure in the expansion chamber to force the lower end of the diaphragm downward, to overbalance this excess force acting upwardly I provide cylindrical weights 112, 113 and 114 and support them by the lower end of the diaphragm. The metal ring 115 fits on top of the flange 116 forming a part of member 111 and fits under the flange 117 which is a part of the weight 112. The weight 112 has a recess 118 in one side through which the flexible rubber hose 94 projects and the opposite recess 119 is provided to make the weight symmetrical. Member 108 holds the upper end of the weight 112 central by guiding the inside surface of the lugs 120. To prevent excess heating of the water pumped by the ram only the weight 112 is to be used with the ram forcing water to a low reservoir and the weight 113 is to be added for a medium high reservoir and the weight 114 is to be added when the reservoir is high. The metal ring 115 is so made that it will fit over the top of member 108 where it may be used to support the weights by being under the lugs 120, the recesses 118 and 119 permit the metal ring 115 to be entered by the flange 117 to assemble the ring under the lugs 120.

Fig. 12, Fig. 13 and Fig. 14 of the drawings

show the simplest form of a ram constructed in accordance with my invention. The water which runs the ram flows through the horizontal drive pipe 124 thence through the elbow portion 125 and central vertical portion 126 of the main casting 127 and thence on by the periphery of the cut-off valve 128 out through the hole 129 to the atmosphere. The cut-off valve's stem 130 fits very loosely in the guide bearing 131 and the current of the water in getting by the cut-off valve impinges against the lower side thereof and lifts the valve. Projecting upward from the center of the upper side of the cut-off valve is a stem 132 to which is screwed the hub 133 having four impulse blades 134 projecting radially therefrom against which the current of the water impinges to rotate the cut-off valve and also to help lift the valve to its closed position against the under side of the expansion chamber valve 135. Integral with and below the expansion chamber valve is a ring 136 connected to the valve by the vertical ribs 137, the inside surface of the ring 136 bears loosely against the outside surface 138 to guide the valve concentric with its mating seat on the upper end of casting 127.

To assemble the parts to the rubber diaphragm 139; first collapse its upper end and place it in the member 140, then press the lower end of the diaphragm slightly oval and put the expansion chamber valve 135 and the threaded member 141 inside, then collapse the lower end and place it in the member 142, then push the expansion chamber valve up into its place and the threaded member down into its place, then with the cut-off valve 128 in place lower the rubber diaphragm and parts assembled thereto over the main casting 127 and screw down member 141 by rotating member 142; then screw the hub 133 of the impulse blades 134 to the stem 132. The proper longitudinal stretch in the rubber diaphragm is ascertained while the ram is running by rotating the lower end of the diaphragm with a spanner wrench hooked in one of the holes 143 in the periphery of member 142 and measuring the water forced to the reservoir through the pipe 144. The upper end of the diaphragm and the expansion chamber valve are free to rotate together when the said valve is open and the small twist in the diaphragm produced by rotating the lower end while the valve is closed will untwist while the valve is open.

The rotative force applied to member 142 is transmitted to rotate member 141 by the keys 145 on member 141 projecting down through the flange 146 which formed a part of member 143. For holding the rubber diaphragm the lower end thereof has an inner flange 147 and an outer flange 148 and the member 141 supports the said inner flange and also supports the member 142 which supports the said outer flange, and the upper end of the diaphragm has an inner flange 149 and an outer flange 150 and the expansion chamber valve 135 supports the said inner flange and this flange supports the member 140 which supports the said outer flange.

While the current of the water is moving the cut-off valve 128 in its closing direction there is a fountain of water acting on the impulse blades 134, this fountain of water disappears during the time the said valve stays closed, the cut-off valve opens during the time the water in the drive pipe is still therefore during the opening movement of the cut-off valve there is no water above member 140 to act on the impulse blades to retard the valve's opening movement.

## I claim:

1. In an hydraulic ram, a drive pipe having a cut-off valve, and expansion chamber formed by a rubber diaphragm and the pipe, having a valve, said cut-off valve seating against said expansion chamber valve, and means whereby said cut-off valve prevents said expansion chamber valve from tilting.
2. In an hydraulic ram, a hollow cylindrical member, a rubber diaphragm forming an expansion chamber between itself and the outside of the hollow cylindrical member, a thin round valve between the member and diaphragm seating against the end of said member and closed by the rubber diaphragm, and means maintaining the valve concentric with the member.
3. An hydraulic ram including a drive pipe having a cylindrical end, a rubber diaphragm surrounding said cylindrical end forming a chamber, and a ring valve between the chamber and drive pipe seating against the end of the drive pipe whereby when the valve is open water is discharged radially through an arc of 360° from the drive pipe into the chamber.
4. In an hydraulic ram including a drive pipe, a cut-off valve to stop the water from flowing from the drive pipe to the atmosphere, and means to move the cut-off valve in its opening direction while closed to thereby move the water in the drive pipe slightly backwardly before the initial opening of the cut-off valve occurs.
5. An hydraulic ram having a tubular shaped rubber diaphragm, a drive pipe extending through the lower end of the diaphragm to the upper end thereof thereby forming an expansion chamber around the drive pipe, a valve at the end of the drive pipe carried by the diaphragm permitting water to be forced into the expansion chamber, and a cut-off valve also at the end of the drive pipe permitting water to flow to the atmosphere and then closing said end of the diaphragm, and an extra expansion chamber outside of the rubber diaphragm acting to pull the diaphragm downward to overcome the momentum of the water in the drive pipe and close the expansion chamber valve after the momentum of the water in the drive pipe has forced water into the expansion chamber.
6. An hydraulic ram having a tubular shaped rubber diaphragm, a drive pipe extending through the lower end of the diaphragm to the upper end thereof thereby forming an expansion chamber around the drive pipe, a valve at the end of the drive pipe carried by the diaphragm permitting water to be forced into the expansion chamber, and a cut-off valve also at the end of the drive pipe permitting water to flow to the atmosphere and then closing said end of the diaphragm, and a weight outside of the rubber diaphragm acting to pull the diaphragm downward to overcome the momentum of the water in the drive pipe and close the expansion chamber valve after the momentum of the water in the drive pipe has forced water into the expansion chamber.
7. An hydraulic ram including a rubber diaphragm forming an outside wall of the ram, and means whereby the water operating the ram flows over the outside of the rubber diaphragm and means whereby a flow of water is caused to flow over the outside of the rubber diaphragm while the ram is not operating.
8. In an hydraulic ram, a drive pipe, means forming an expansion chamber, a valve controlling communication between the drive pipe and the expansion chamber, and a second valve con-
- trolling communication between the drive pipe and the atmosphere, said first valve constituting the mating seat of the second valve.
9. In an hydraulic ram, a drive pipe, and two valves opened alternately to allow water to flow from said drive pipe, one of said valves constituting the mating seat for the other.
10. In an hydraulic ram, a drive pipe, means forming an expansion chamber, a valve controlling communication between the drive pipe and the expansion chamber, and a second valve controlling communication between the drive pipe and the atmosphere, said second valve closing against and then moving with the first valve during opening and closing movements of said first valve.
11. In an hydraulic ram, a diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling communication between the pipe and the expansion chamber and normally held closed by the diaphragm, and a second valve controlling communication between the pipe and the atmosphere.
12. In an hydraulic ram, a diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, and a valve between the drive pipe and diaphragm movable with the latter to open and close communication between the drive pipe and the expansion chamber.
13. In an hydraulic ram, a rubber diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, and a flexible valve controlling communication between the drive pipe and expansion chamber, said diaphragm constantly tending to move and hold said valve to and in its closed position.
14. In an hydraulic ram, a diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling communication between the pipe and the expansion chamber, and a second valve controlling communication between the pipe and atmosphere said communication being through the first valve's members and through the diaphragm.
15. In an hydraulic ram, a diaphragm forming at least a part of the wall of an expansion chamber and having an opening therethrough, a drive pipe having its end concentric with the opening in the diaphragm, a ring valve controlling communication between the pipe and the expansion chamber and seating against the end of the drive pipe, and a second valve controlling communication between the pipe and the atmosphere, said second valve seating against the first valve to close communication between the pipe and atmosphere.
16. In an hydraulic ram, a diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, and a valve controlling communication between the pipe and expansion chamber, said valve seating against an end of the drive pipe when in closed position and being constantly urged to said closed position by the diaphragm.
17. In an hydraulic ram, a rubber diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling communication between the pipe and expansion chamber, and means to cause water to flow from the drive pipe to and over the exterior surface of the rubber diaphragm which would otherwise be in contact with the atmosphere.
18. In an hydraulic ram, a rubber diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling



communication between the pipe and expansion chamber, and means effective after the ram stops operating to cause the water which would normally operate the ram to flow to and over the exterior surface of the diaphragm.

19. In an hydraulic ram including a rubber diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling communication between the pipe and expansion chamber, said valve being constantly urged to its closed position by the diaphragm, and means for maintaining the action of the diaphragm to urge the valve to closed position after a permanent set has occurred in the rubber thereof.

20. In an hydraulic ram, a diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, and a valve controlling communication between the pipe and expansion chamber and constantly urged to closed position by the diaphragm.

21. In an hydraulic ram, a rubber diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling communication between the pipe and expansion chamber, said valve being constantly urged to its closed position by the diaphragm, and spring means reinforcing the action of the diaphragm in urging the valve to its closed position.

22. In an hydraulic ram, means having an outside surface and forming an expansion chamber, a drive pipe, a valve between the expansion chamber and drive pipe permitting water to be forced into the expansion chamber, a second valve controlling an intermittent flow of water from the drive pipe to the atmosphere, and means effective when said second valve stops operating in closed position to cause water which would otherwise flow through the drive pipe to flow over the outside surface of said first means to maintain the temperature of the water in the expansion chamber substantially equal to the tem-

perature of the water caused to flow over the said outside surface.

23. In an hydraulic ram, a rubber diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling communication between the drive pipe and chamber and closed by pressure of the diaphragm thereagainst, and manual means operable to vary the pressure exerting force of the diaphragm against the valve.

24. In an hydraulic ram, a drive pipe, a rubber diaphragm having spaced ends and surrounding the drive pipe to form an expansion chamber between itself and the drive pipe, a valve between the drive pipe and expansion chamber, a member surrounding said diaphragm and forming a second expansion chamber between itself and the diaphragm and communicating with the first chamber said member having an annular flange in contact with the outside surface of said diaphragm at a location intermediate the ends thereof.

25. An hydraulic ram having a water chamber, one side of which is formed by a rubber diaphragm to permit water to be forced in said chamber faster than the water leaves said chamber, means holding the rubber diaphragm comprising an enlargement at one end thereof forming inner and outer shoulders, a member supporting one of the shoulders, and a member supporting the other shoulder, said second member being supported by the first member.

26. In an hydraulic ram, a rubber diaphragm forming at least a part of the wall of an expansion chamber, a drive pipe, a valve controlling communication between the pipe and expansion chamber, and means to cause water to flow to and over the exterior surface of the rubber diaphragm which would otherwise be in contact with the atmosphere.

DORSEY F. ASBURY.

March 3, 1936.

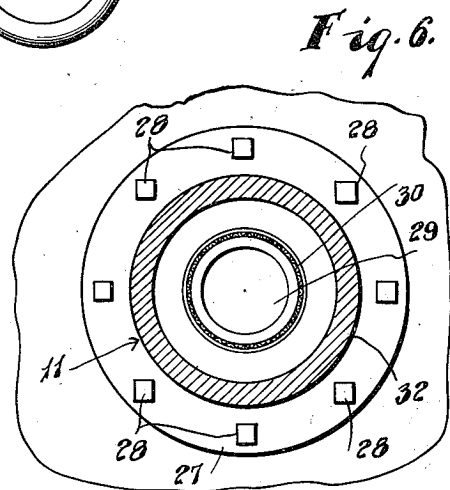
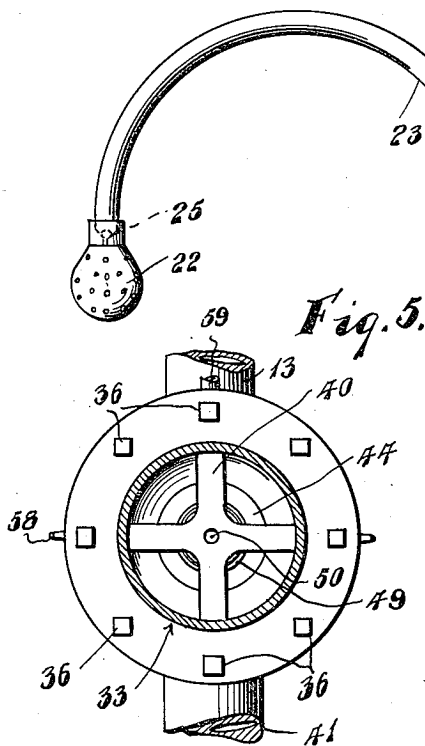
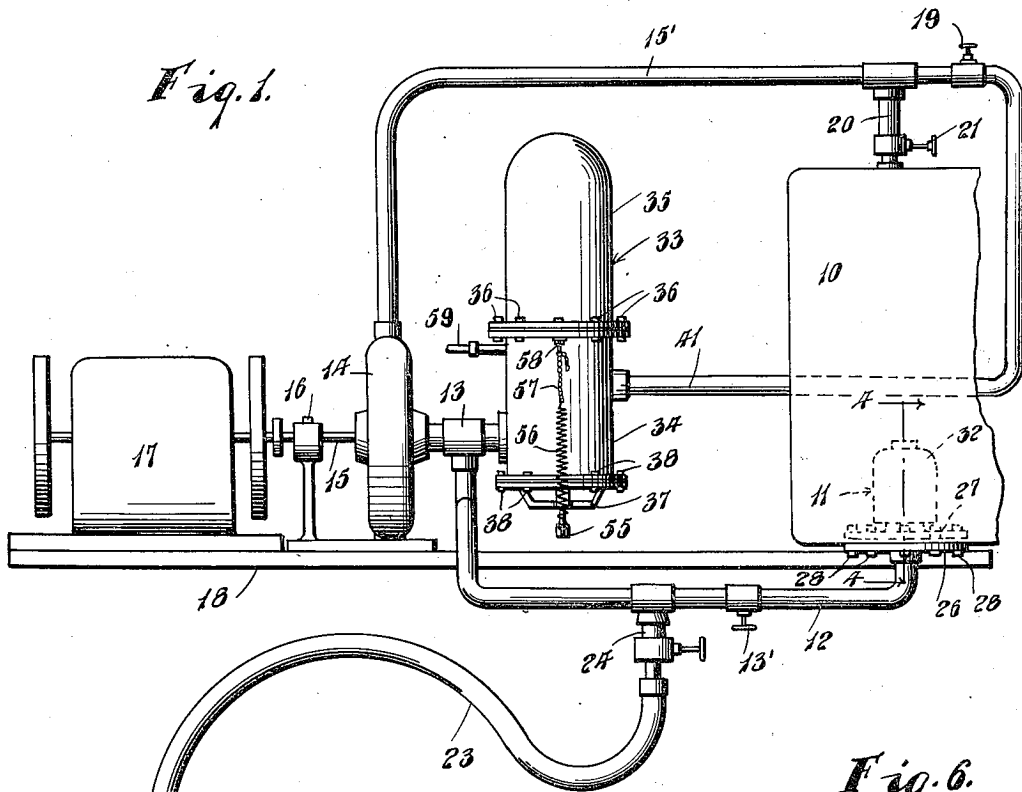
J. P. WATSON

2,033,017

HYDRAULIC RAM APPARATUS

Filed March 8, 1934

2 Sheets-Sheet 1



Inventor  
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March 3, 1936.

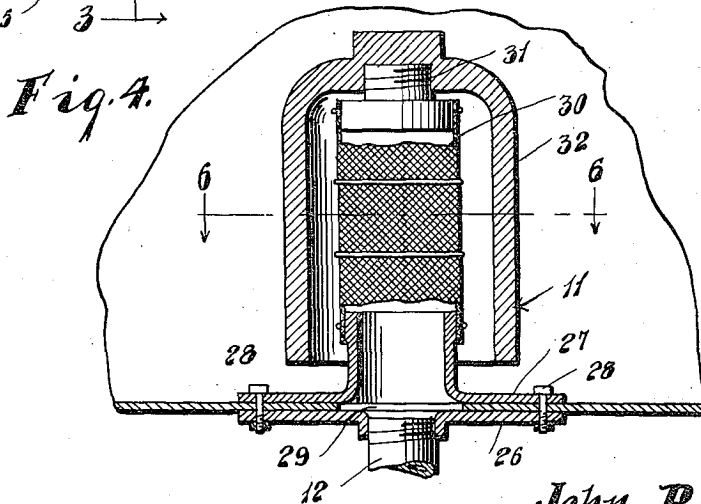
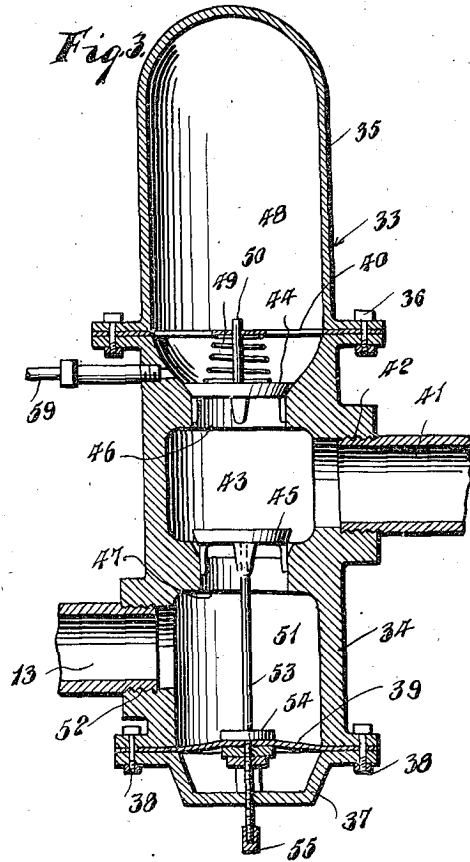
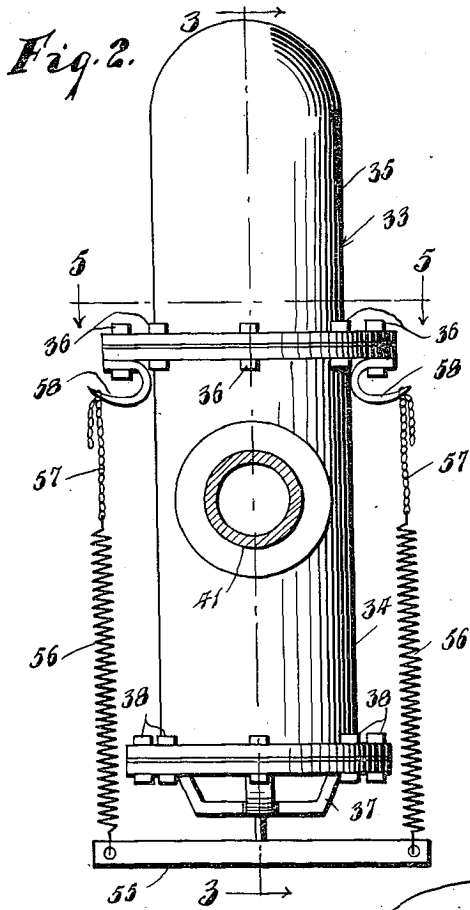
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2,033,017

HYDRAULIC RAM APPARATUS

Filed March 8, 1934

2 Sheets-Sheet 2



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# UNITED STATES PATENT OFFICE

2,033,017

## HYDRAULIC RAM APPARATUS

John P. Watson, Elsa, Tex.

Application March 8, 1934, Serial No. 714,709

7 Claims. (Cl. 103—5)

This invention relates to an hydraulic ram apparatus and it aims to provide a novel mechanism adapting a ram to a wider range of usefulness, increasing the efficiency of the ram and generally providing a more compact organization.

The more specific objects and advantages will in part be pointed out and otherwise become apparent from a consideration of the description following taken in connection with accompanying drawings illustrating an operative embodiment.

In said drawings:—

Figure 1 is a view of the improved apparatus in side elevation;

Figure 2 is an enlarged elevation of the ram taken at a right angle to Figure 1;

Figure 3 is a vertical sectional view taken on the line 3—3 of Figure 2;

Figure 4 is a vertical sectional view taken on the line 4—4 of Figure 1;

Figure 5 is a horizontal sectional view taken on the line 5—5 of Figure 2; and

Figure 6 is a horizontal sectional view taken on the line 6—6 of Figure 4.

Referring specifically to the drawings, 10 designates a tank or reservoir for containing a liquid material adapted to be sprayed, for instance a lime and water solution. Such solution is withdrawn through an outlet means 11, pipe or conduit 12, a pipe or conduit 13 located at the suction end of a centrifugal pump 14, the impeller of which is rotated by a shaft 15 suitably journaled as at 16 and driven by any suitable prime mover at 17. All of the parts are preferably mounted on a common support 18. The outlet or discharge pipe from the centrifugal pump 14 is shown at 15' leading to pipe 41 hereinafter described, and which discharge pipe has a cut off valve 19 therein.

Pipe 15' has a branch 20 leading to the reservoir 10 which is equipped with a cut off valve 21.

In the pipe 12 a cut off valve 13' is provided which may be closed when desired, to enable replenishing of water in the reservoir through an inlet nozzle 22 of a hose 23 connected to a pipe 24 communicating with the pipe 12 and which contains a normally closed check valve 25, capable of being opened by upward suction to enable the water to pass the same into the pipe 12, pipe 13, pump 14, pipe 15 and pipe 20 into the reservoir 10 when the valve 21 is opened. When valve 21 is opened, valve 19 will be closed and vice versa.

Said inlet means 11 comprises outer and inner

couplings 26 and 27, bolted at 28 to the bottom wall of reservoir 10 in a leak-proof manner, in line with an opening 29 therethrough. Connected to the section 27, is a cylindrical screen 30 carrying a screw-threaded stud 31 to which a bell 32 is detachably screwed or otherwise fastened.

The ram is shown at 33 and consists of a body section 34, head section 35 bolted thereto as at 36 in a leak-proof manner, and a base section 37 bolted to the body section as at 38, in a leak-proof manner, which bolts 38 secure a flexible diaphragm 39 in place. Bolts 36 secure a spider 40 in place.

Water flowing through conduit 15' is adapted to enter the body section 34 through a drive or supply pipe 41 connected thereto and screwed to that section as at 42. The receiving chamber of the body 34 is designated 43 and has therein vertically alined or opposed check valve 44 and obstruction valve 45, said valves respectively, coacting with seats in passages 46 and 47. Passage 46 leads to the head 35 which primarily forms a compression chamber 48. Valve 44 is normally in closed position and urged to its seat through the expansion of a coil spring 49 engaging the same and the spider 40 and the valve being guided in movement by a stem 50 thereon passing loosely through said spider 40. Passage 47 communicates with the low pressure chamber 51 in the lower part of the valve body or cage 34, and the pipe 13 is screw-threaded to such body or cage 34 as at 52 in communication with the chamber 51.

Normally valve 45 is in open position, raised from its seat. The valve 45 has a stem 53 depending through the diaphragm 39 and base 37, being secured in a water-tight manner as at 54 to the diaphragm. Below the base 37, stem 53 is screw-threaded to a cross bar 55 which is curved upwardly under adjustable spring tension, as by means of coil springs 56 connected thereto and in turn connected to chains 57, and whose links are selectively attachable to hooks 58 secured in place by certain of the bolts 36.

The water which enters the compression chamber 48, is led therefrom through a suitable conduit 59 to any suitable place of use.

Referring now more particularly to the operation of the ram 33, the water flows thereto through the pipe 41 from pipe 15' so that it will enter the chamber 43 under considerable velocity. Such water will flow downward past valve 45 through passage 47 into pipe 13. When the flow of such water is sufficiently great, said obstruction

valve 45 will be forced downward, that is closed, overcoming the resistance offered by the coil spring 56. When said valve 45 seats, the column of flowing water possesses enough kinetic energy to force a portion of the water upwardly past the check valve 44 and into the compression chamber 48. This produces a ramming effect and upon completion thereof there is a back surge of the water in the supply pipe 41 conduit 15' which is connected thereto, which permits the springs 56 to raise the valve 45 from its seat. The flow of the water again begins through the ram at pipe 41, until the process described is repeated. The chains 57 as described enable the springs to be secured with the desired tension. The water under pressure in the compression tank 48 is led to the desired place through the outlet pipe 59. During the operation the flexible diaphragm 39 makes the valve 45 and stem 53 to reciprocate freely without leakage of water under the ram.

The position of the check valve 44 and obstructing valve 45 and their arrangement to open and close together provides means whereby the ramming effect of the liquid is both downward and upward on the ram unit simultaneously. As a result the efficiency is increased in the operation of the ram through reduction in vibration and friction.

The purpose of tank 10 in the combination is to contain a supply of liquid as of spray material, to be sprayed out under high pressure, and also to cause the material to be continuously agitated by the back surge of the liquid through pipes 41, 15', 11, and 12 and directed laterally by part 32.

Referring to the operation of the apparatus as a whole, prime mover 17 through the shaft 15 rotates the impeller in the centrifugal pump 14. The liquid thus set to flowing through the conduit or drive pipe 41 enters the ram and forces obstructing valve 45 to its seat. The kinetic energy which the column of liquid possesses now forces a portion of the liquid past the valve 44 and into the compression chamber 48. Upon completing the ramming effect, there is a back surge of the liquid through the pipes 41, 15', and 12 and into the reservoir or tank 10 through the inlet means 11. The surging liquid is directed against the bottom of the tank through contact with the interior wall of the bell 32 and forced to move laterally, serving to agitate the liquid so as to keep the mixture thoroughly stirred, as in the case of lime in water as previously referred to. Upon completion of the back surge, the impeller pump 14 again imparts a rapid flow through the drive pipe 41 and valve 45 is again forced to its seat and the result previously described repeats, making it possible to obtain considerable liquid from the compression chamber under high pressure, the ram operating entirely automatically to effect such result.

Said pump 14 continually maintains a head of liquid which causes the liquid to circulate through the pipes 15' and 41 so long as valve 45 is open. When the velocity of this circulation becomes great enough, valve 45 is carried to its seat, or closed. When the rapidly moving column of liquid is brought to a stop very quickly, as is the case, even though a portion of the liquid enters the compression chamber, there is sufficient pressure on that part of the column of liquid nearest the ram and entering it to cause it to slightly decrease in volume. When the force of the blow is spent, the portion of the liquid which has been compressed to a smaller volume now expands but the rapidity of the expansion and elasticity of

the liquid causes the liquid to expand to a volume greater than the normal volume of the liquid; thus it can be seen that a small portion of the liquid will be forced backward through the pump very quickly. Now since the liquid has expanded to a volume which is greater than normal, it will again contract. This time a vacuum will be created in conduit 41 and valve 45 will be jerked open, and circulation will begin again through the endless conduit. It is known that liquids are elastic and that great pressure on liquids reduces the volume slightly. To explain the phenomenon of how a vacuum can occur in the pipe which the pump is attempting to keep filled, the contraction of the liquid occurs so very rapidly that the vacuum occurs in spite of the action of the pump. These back surges can be felt by placing the hand near the end of pipe 12 while the unit is operating.

Pump 14 sucks through pipe 12 only one time each stroke. There may be some oscillation of the liquid in and out but only one real suction takes place each stroke. When valve 45 closes and a portion of the liquid enters the compression chamber, if pipe 12 were closed so as not to admit more liquid there would be a vacuum in the conduit 41 whose volume would be exactly equal to the volume of the liquid which entered the compression chamber, but since it is open and connected to a supply of liquid the liquid will rush in. This suction of the liquid through pipe 12 is very easy to feel by placing the hand near the end of the pipe. In fact the action is so positive that there is danger of hurting the hand if it is put over the end of a large suction pipe while the machine is operating.

It will be realized that by reason of the invention, the hydraulic ram is combined with a driven impeller pump to form a pumping unit which is at the same time or simultaneously a low pressure large volume pump and a high pressure smaller volume pump. This combination is very useful, for instance, on a power spraying unit in connection with which it has been described. This arrangement permits the supply tank or reservoir 10 to be quickly filled while operating at low pressure. It will be realized that the invention provides for the location of the diaphragm in the ram so as not to be subjected to the high pressure of the liquid hammer. The invention also eliminates the water hammering due to separation of an obstructing valve and check valve laterally.

Various changes may be resorted to provided they fall within the spirit and scope of the invention.

I claim as my invention:

1. A hydraulic ram, a body having a chamber to receive fluid and a compression chamber, a check valve normally cutting off supply fluid through the body to said chamber, an obstructing valve below said check valve disposed in open position when the check valve is closed, the arrangement of said valves causing the ramming effect of the liquid to be both downward and upward simultaneously, a chamber, the entrance to which is controlled by said obstructing valve, a diaphragm to which said valve is connected arranged out of the high pressure zone of the liquid hammer, and means urging opening of the obstructing valve.

2. A hydraulic ram according to claim 1 wherein the last mentioned means has spring action.

3. A hydraulic ram, a body having a chamber to receive fluid and a compression chamber, a

check valve normally cutting off supply fluid through the body to said chamber, an obstructing valve below said check valve disposed in open position when the check valve is closed, the arrangement of said valves causing the ramming effect of the liquid to be both downward and upward simultaneously, a chamber, the entrance to which is controlled by said obstructing valve, a diaphragm to which said valve is connected arranged out of the high pressure zone of the liquid hammer, and means urging opening of the obstructing valve comprising a bar removable with said diaphragm and obstructing valve, contractile spring means connected to the bar, chain means connected to the spring means, and hook means on the ram engageable selectively by links of said chain means.

4. A hydraulic ram, a body having a chamber to receive fluid and a compression chamber, a check valve normally cutting off supply fluid through the body to said chamber, an obstructing valve below said check valve disposed in open position when the check valve is closed, the arrangement of said valves causing the ramming effect of the liquid to be both downward and upward simultaneously, a chamber, the entrance to which is controlled by said obstructing valve, a diaphragm to which said valve is connected arranged out of the high pressure zone of the liquid hammer, means urging opening of the obstructing valve, and means whereby the last mentioned means may be adjusted to vary the resistance offered to the liquid flow past the obstructing valve.

5. A hydraulic ram, a body having a chamber to receive fluid and a compression chamber, a check valve normally cutting off supply fluid through the body to said chamber, an obstructing valve below said check valve disposed in open position when the check valve is closed, the arrangement of said valves causing the ramming effect of the liquid to be both downward and upward simultaneously, an impeller pump means for fluid independently of that to operate the ram having a pipe in communication with the ram below the obstructing valve, and means for

securing said obstructing valve closed against its seat so that the impeller pump may operate without passing liquid through the ram.

6. A hydraulic ram, a body having a chamber to receive fluid and a compression chamber, a check valve normally cutting off supply fluid through the body to said chamber, an obstructing valve below said check valve disposed in open position when the check valve is closed, the arrangement of said valves causing the ramming effect of the liquid to be both downward and upward simultaneously, an impeller pump means for fluid independently of that to operate the ram having a pipe in communication with the ram below the obstructing valve, means for securing said obstructing valve closed against its seat so that the impeller pump may operate without passing liquid through the ram, a reservoir with which said pipe is connected to receive its liquid supply, a coupling securing the pipe to the reservoir, a strainer rising from the coupling, and a bell supported by the strainer for the purpose specified.

7. A hydraulic ram, a body having a chamber to receive fluid and a compression chamber, a check valve normally cutting off supply fluid through the body to said chamber, an obstructing valve below said check valve disposed in open position when the check valve is closed, the arrangement of said valves causing the ramming effect of the liquid to be both downward and upward simultaneously, an impeller pump means for fluid independently of that to operate the ram having a pipe in communication with the ram below the obstructing valve, means for securing said obstructing valve closed against its seat so that the impeller pump may operate without passing liquid through the ram, said impeller pump having a valve checked pipe in return communication with the reservoir, a valve inlet pipe in communication with the impeller pump between the same and reservoir, and a cut off valve in the conduit between the reservoir and said last mentioned valve pipe.

JOHN P. WATSON.

Jan. 19, 1943.

A. H. FRANCFORT

2,309,058

HYDRAULIC RAM

Filed Dec. 1, 1941

Fig. 1

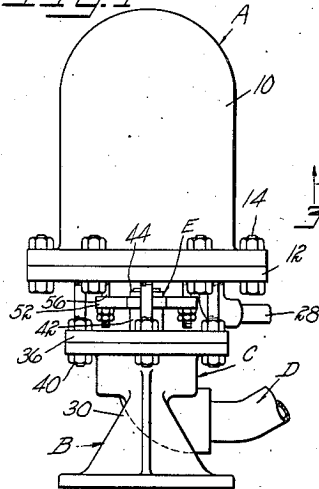


Fig. 2

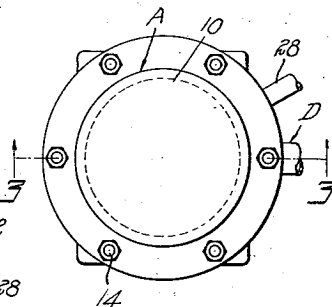


Fig. 4

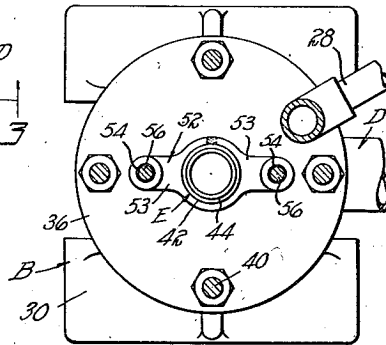


Fig. 3

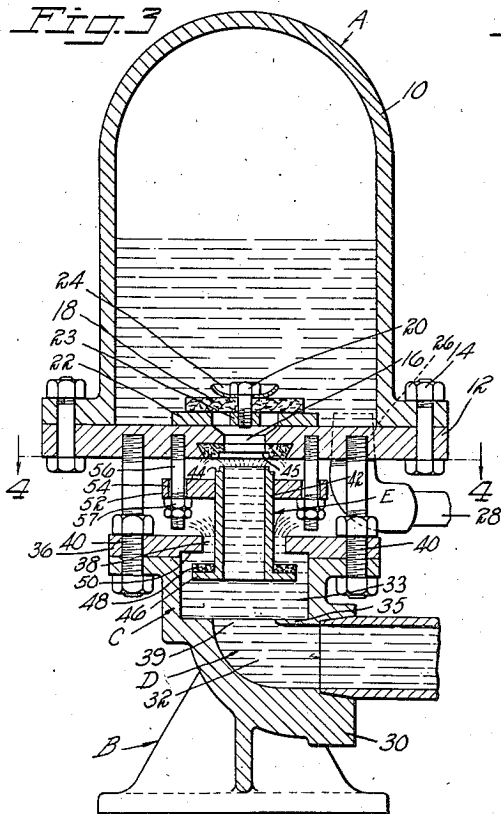
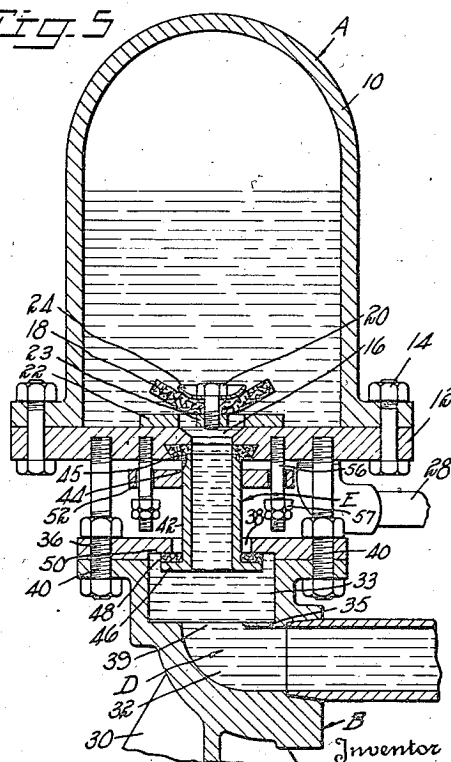


Fig. 5



Inventor  
ALFRED H. FRANCFORT

Ludney & Shellard

Attorneys

# UNITED STATES PATENT OFFICE

2,309,058

## HYDRAULIC RAM

Alfred H. Francfort, Middle Haddam, Conn., assignor of one-half to Arthur B. Calef, Middle Haddam, Conn.

Application December 1, 1941, Serial No. 421,146

5 Claims. (Cl. 103-77)

The present invention relates to hydraulic rams and more particularly to a ram wherein the flow of water is periodically directed into the air chamber through a connector or impulse valve intermittently operated by the flow of water, and is a continuation-in-part of application, Serial No. 365,626, filed November 14, 1940.

So far as applicant is aware, the only ram of the above-indicated type which has heretofore been suggested is that shown in the Italian Patent No. 177 of 1869. However, due to the construction of the impulse valve or connector shown in that patent, a ram constructed in accordance with the showing therein would be inoperative due to the fact that the valve is of cylindrical type and is slidably mounted in a cylinder without sufficient area being provided to lift the valve upon the water coming in contact therewith. Apparently in an effort to overcome this objectionable feature the Italian patent suggests the use of a Venturi tube connected to the intake of the ram in order to obtain sufficient pressure to lift the valve. The use of a Venturi tube not only increases the cost of the ram, but, in addition, necessitates the construction of a ram for each set of conditions in order to obtain the velocities for which the Venturi tube was designed. Because of this, it would be necessary to design each individual ram to meet the particular set of conditions at the point of installation.

Assuming, however, that the ram could be made operative in the sense that the impulse valve could be moved from open to closed position, it would further be subjected to the fault that upon the kickback the valve would fall by gravity between its closed and open positions without any means whatsoever to cushion the shock thereof, and thus in a short time the valve, if not the entire ram, due to this constant hammering would be rendered inoperative. Moreover, as the valve is slidably mounted in a cylinder, it necessitates the accurate manufacture of these parts, which, even when accurately manufactured, offer considerable frictional resistance to movement and greatly increase the wear.

Applicant is also aware of the fact that rams have been shown wherein the impulse valve is operated by a flow of water directly contacting the lower face thereof and wherein the impulse valve is so constructed that there is substantially no frictional resistance offered to the lifting of the valve. Such a type of ram is shown in applicant's United States Patent No. 845,402 issued in 1907. However, this type of ram was also subjected to the faults of the ram shown in the Ital-

ian patent in that upon the valve moving from closed to open position it would drop by gravity, subjecting the entire structure to considerable shock. In view of this, it was found necessary to reconstruct the rams of the type shown in said applicant's patent to include mechanical means for cushioning the valve upon its movement from closed to open position. This could be accomplished in rams of the type shown in applicant's patent, but it could not be accomplished in rams of the type shown in the above-noted Italian patent, for, due to the arrangement of the ram of the latter patent, mechanical means could not be fitted between the air chamber and the valve.

The object of the present invention is to provide a ram of the type wherein the air chamber and impulse valve or connector are arranged in vertical alignment and wherein the impulse valve always operates in a liquid medium, which medium provides cushioning means for the valve.

A still further object is to provide a ram of the aforementioned type wherein the valve is so suspended as to have substantially no frictional contact with any of the other parts of the ram, thus obtaining free and easy operation and also permitting ready adjustment of the stroke of the valve.

A still further object is to provide a ram of the above-indicated type which is extremely simple and inexpensive to manufacture in that there is little or no machining of the parts and which is particularly efficient in the results obtained in that the wastage of water is reduced to a minimum.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements, and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In the accompanying drawing:

Figure 1 is a side view of a ram embodying the invention herein;

Fig. 2 is a top view of the ram shown in Fig. 1;

Fig. 3 is a vertical section taken on the line 3-3 of Fig. 2 and with the connector or impulse valve in open position;

Fig. 4 is a view taken on the line 4-4 of Fig. 3; and

Fig. 5 is a view similar to Fig. 3 with the impulse valve or connector in closed position.

Referring to the drawing, the ram comprises generally an air chamber A vertically spaced



from a base B in which there is located a cylindrical impact chamber C connecting to a drive pipe inlet D, and a connector E for intermittently interconnecting the impact chamber C with the air chamber A.

More specifically, the air chamber A comprises a dome-shaped member 10 secured to a horizontal base plate 12 in any suitable manner, such as by the bolts 14. Centrally of the base plate there is provided an inlet 16 for the admission of water and air into the air chamber. Concentric with inlet 16 and positioned in the air chamber is a valve seat 22 adapted to cooperate with an automatically operated opening and closing inlet valve 18. The valve 18 is in the shape of a disk and may be made of any suitable flexible material secured in position by a stud 20 extending through an opening in the center of the valve and threaded into a crossbar 23 carried by the valve seat 22. To reduce wear on the valve 18, there may be positioned between the head of the stud 20 and the valve a concave member 24, thereby providing a smooth surface against which the valve will contact when flexed to open position. To complete the air chamber, there is further provided a discharge opening 26 located in the base plate 12 and into which there is connected a discharge pipe 28, which pipe will lead to the point at which the water is to be delivered.

Referring now to the base B, it comprises a casting 30 and a top plate 36 secured to the casting as by studs 40; these studs also carrying on their upper ends the base plate 12 of the air chamber A, thus vertically spacing the latter above the base B. The casting 30 further includes an enlarged cylindrical portion 33 arranged in axial alignment with the air chamber inlet 16, which portion, together with the top plate, forms the cylindrical impact chamber C. As indicated, the top plate 36 has a central opening constituting a discharge outlet 38 from the impact chamber, and the base of the chamber has an inlet opening 39; these openings being arranged in axial alignment with the air chamber opening 16. Beneath the impact chamber C the casting 30 is formed to provide the drive pipe inlet D which includes a portion 32 which, in effect, is substantially a continuation of the drive pipe, and a baffle 35 for directing the flow of the water upwardly and into the impact chamber. With this construction, it will be seen that the inlet opening 39 of the impact chamber connects to the drive pipe at a point of greatest foot fall, for reasons hereinafter made apparent.

Referring now to the connector E, it comprises a tubular member 42 of slightly smaller diameter than the impact chamber outlet 38, and is of such length that when its upper end engages the air chamber base plate its lower end projects into the impact chamber. The lower end of the member 42 further carries a flange 46 of greater diameter than both the inlet and outlet of the impact chamber 33; this flange having its upper face covered with any suitable type of packing material to provide a valve face 48 adapted to engage the under face of the top plate 36, which face functions as a valve seat 50. At its upper end the tubular member terminates in a valve face 44 adapted to close on a suitable valve seat 45 also formed of a suitable packing material provided in the base plate 12 of the air chamber concentrically with the opening 16.

With this construction, when the upper valve face 44 engages the valve seat 45, the lower valve

face 48 engages the valve seat 50, thus simultaneously closing the outlet 38 from the impact chamber and directly connecting the air chamber inlet 16 to the impact chamber. It will also be noted that inasmuch as the valve face 48 and valve seat 45 are made from material which has a certain degree of resiliency, accurate machining of the cooperating engaging parts is not required as resilient material will, under pressure, provide a water-tight seal.

In order to assure proper alignment of the connector D with the air chamber inlet, the connector carries a guide plate 52 secured to the tubular member 42 intermediate of the air chamber and the base. The guide plate 52 includes diametrically opposed arms 53, each of which is provided with a vertical opening 54 for slidably mounting the guide plate on a pair of studs 56 depending from the base plate of the air chamber. The studs 56 are threaded at their lower end, whereby the securing nuts 57 may be raised or lowered, thereby lengthening or shortening the stroke of the connector.

With the ram so constructed, upon its being connected to a source of water supply the water will initially fill the impact chamber C and the connector E and overflow both through the impact chamber outlet 38 and out of the top of the connector. As the velocity of the water increases, the connector will be moved towards closed position. Inasmuch as the connector is freely suspended, there is no friction to be overcome, thus greatly reducing the force required to move the connector to closed position. As the connector rises, the clearance between the valve face 48 and seat 50 and valve face 44 and seat 45 will be reduced, but until actual contact is made, water will flow between the respective valve faces and seats, thus cushioning them and reducing the shock occurring upon the closing of the connector.

When the connector has reached closed position, the water flowing through the connector will then force open the valve 18 (see Fig. 5) and water will flow directly into the air chamber. This flow will continue until the air in the chamber is compressed to a point where it equalizes the footfall, whereupon the flow will be suddenly checked and a reaction or kickback will result.

When the water is driven back by the kickback, the valve 18 will automatically close, and likewise the force acting to maintain the connector closed will be released. When this force is released, the connector will be free to drop to open position. However, in the ram disclosed, the lower end of the connector will always move through a liquid medium which acts as a cushion, thus assuring a smooth and easy operation and eliminating the necessity of the provision of any mechanical parts for absorbing the shock resulting from the falling of the valve.

To obtain the aforeindicated cushioning effect, it is necessary that the level of the water in the impact chamber always be maintained so that the lower end of the connector always moves through a liquid medium. This result is obtained in the present construction by correlating the size of the impact chamber, drive pipe, and connector whereby any water driven from the impact chamber into the drive pipe inlet will be substantially equalized by water driven from the connector into the impact chamber. To obtain this, the connector is made of such size that when a kickback occurs the water contained in the connector will be driven into the impact chamber

and thus replenish any water driven from the impact chamber into the drive pipe. However, to assure the maintaining of a high enough level, the impact chamber is made of such size that the fall of the level of water within the impact chamber upon the displacement of any given volume therein will be substantially less than the fall within the drive pipe and connector upon the displacement of an equivalent volume.

To accomplish the foregoing, the diameters of the drive pipe and of the connector D are made substantially equivalent, whereas the diameter of the impact chamber is at least one and one-half times that of the drive pipe. In other words, the diameters of the drive pipe, connector, and impact chamber will bear a ratio of substantially 1:1:1.5. Obviously, inasmuch as the area of a circle increases as the square of the radius, it will be seen that the capacity of the impact chamber in any given plane will be substantially greater than that of either the drive pipe or the connector in any given plane.

For example, in actual practice a ram which has been built to be used with a twelve inch drive pipe has an impact chamber of twenty and one-quarter inches, whereas the connector has a ten inch diameter. The maximum stroke of this type of ram is approximately one-half of the drive pipe diameter—namely, six inches. Therefore, the depth of the impact chamber must be slightly greater than this six inches in order to prevent the flange 46 from seating on the bottom of the impact chamber when the connector is in lowest position. The overall length of the connector is approximately twelve inches, whereby when a maximum stroke is utilized, six inches of the connector will be immersed at the bottom of the stroke.

With a ram utilizing a twelve inch drive pipe, under actual operating conditions the kickback or drop in water is found to be approximately four inches. As a result, when the water is driven back four inches within the drive pipe inlet, the fall of water within the impact chamber will only be about one-quarter as much, or one inch. However, as the water entering the impact chamber from the connector equalizes that leaving the impact chamber and entering the drive pipe, the impact chamber will at all times remain substantially filled, whereby the lower end of the impact valve or connector will operate in a liquid medium. In this way, the connector in effect floats between open and closed positions, and a relatively small force is required to operate it. Moreover, inasmuch as the drive pipe connects to the impact chamber inlet at the point of maximum fall of the drive pipe, there is no head of water to be overcome following the reaction of the kickback, and rapid flooding of the impact chamber and connector will almost instantaneously follow.

From the foregoing it will be seen that the ram operates with maximum efficiency and with substantially little loss of water. Moreover, inasmuch as the impact valve operates in a liquid medium, the ram is subjected to substantially no shock either on its closing or opening movements.

It will also be seen that inasmuch as the means for suspending the impact valve are located between the air chamber and the base of the ram, the stroke of the connector may be readily changed to compensate for its speed of operation, which compensation may be necessary due to changes in conditions following the installation of the ram.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim as my invention:

1. A hydraulic ram of the character described including an air chamber having a normally closed inlet, an impact chamber spaced beneath said air chamber and having an inlet and an outlet arranged in vertical alignment with the air chamber inlet, a connector including a tubular portion extending through said outlet and having a valve seat on its lower end positioned in said impact chamber, said connector being movable by water flowing through said impact chamber to a position where it connects said air chamber to said impact chamber and closes said impact chamber outlet, the diameter of said impact chamber being substantially greater than said connector tubular portion, and the diameter of said impact chamber inlet being substantially the same as said tubular portion, whereby upon a reaction following the closing of the connector the water driven from the connector into the impact chamber will substantially equalize the water driven from the impact chamber through said impact chamber outlet.

2. A hydraulic ram of the character described including an air chamber having a normally closed inlet, an impact chamber spaced beneath the air chamber and having an inlet and an outlet arranged in vertical alignment with the air chamber inlet, a tubular connector for intermittently connecting said impact chamber to said air chamber, means between said air chamber and impact chamber for suspending said tubular connector whereby the lower end of said connector is positioned within that impact chamber, a valve portion carried on the lower end of said tubular connector, said tubular connector being so suspended that it does not have any contact with said impact chamber except when in connecting position when said valve face closes said impact chamber outlet, a drive pipe inlet connected to said impact chamber inlet, said drive pipe inlet being of substantially lesser diameter than said impact chamber.

3. A hydraulic ram of the character described including an air chamber having a normally closed inlet, an impact chamber spaced beneath said air chamber, a tubular connector for intermittently connecting the impact chamber to the air chamber, means positioned between said air chamber and impact chamber for slidably supporting said tubular connector with its lower end located in the impact chamber, a drive pipe inlet connected to the base of said impact chamber, the respective diameters of said tubular connector, drive pipe inlet, and impact chamber being substantially in the ratio of 1:1:1.5 and the depth of said impact chamber being greater than the maximum stroke of said connector.

4. A hydraulic ram of the character described including an air chamber having a normally closed inlet, an impact chamber spaced beneath

said air chamber and having an inlet and an outlet, a slidable connector for connecting said impact chamber to said air chamber and closing said impact chamber outlet, said connector having its lower end arranged in said impact chamber and its upper end extending through the outlet and slidably supported exterior of the air chamber, a drive pipe inlet connected to the inlet of said impact chamber, said impact chamber diameter being substantially greater than said drive pipe inlet diameter whereby upon a fall of water following a kickback the drop of level within the impact chamber will vary as the square of the drop within the drive pipe inlet.

5. A hydraulic ram including an air chamber having an inlet opening, an automatically actuating opening and closing valve to permit entrance of liquid and air thru said opening and to prevent outflow therefrom, an outlet for free discharge from said chamber, an impact chamber

located underneath said opening and having an inlet for gravity flow of liquid thereto and an outlet opening in line with the opening to said air chamber, an automatically actuated movable connector to control flow of liquid from said impact chamber thru said outlet opening, said connector including a flange located in the impact chamber and a tubular extension extending upwardly from said flange with its end opposite said flange adapted to make contact with the under side of said air chamber in alignment with the air chamber inlet, a guide plate secured to said extension exterior of the impact chamber, guide rods projecting from the under side of said air chamber and thru said guide plate, and means for adjusting the movement of the guide plate on the guide rods to vary the movement of the connector.

ALFRED H. FRANCFORT.

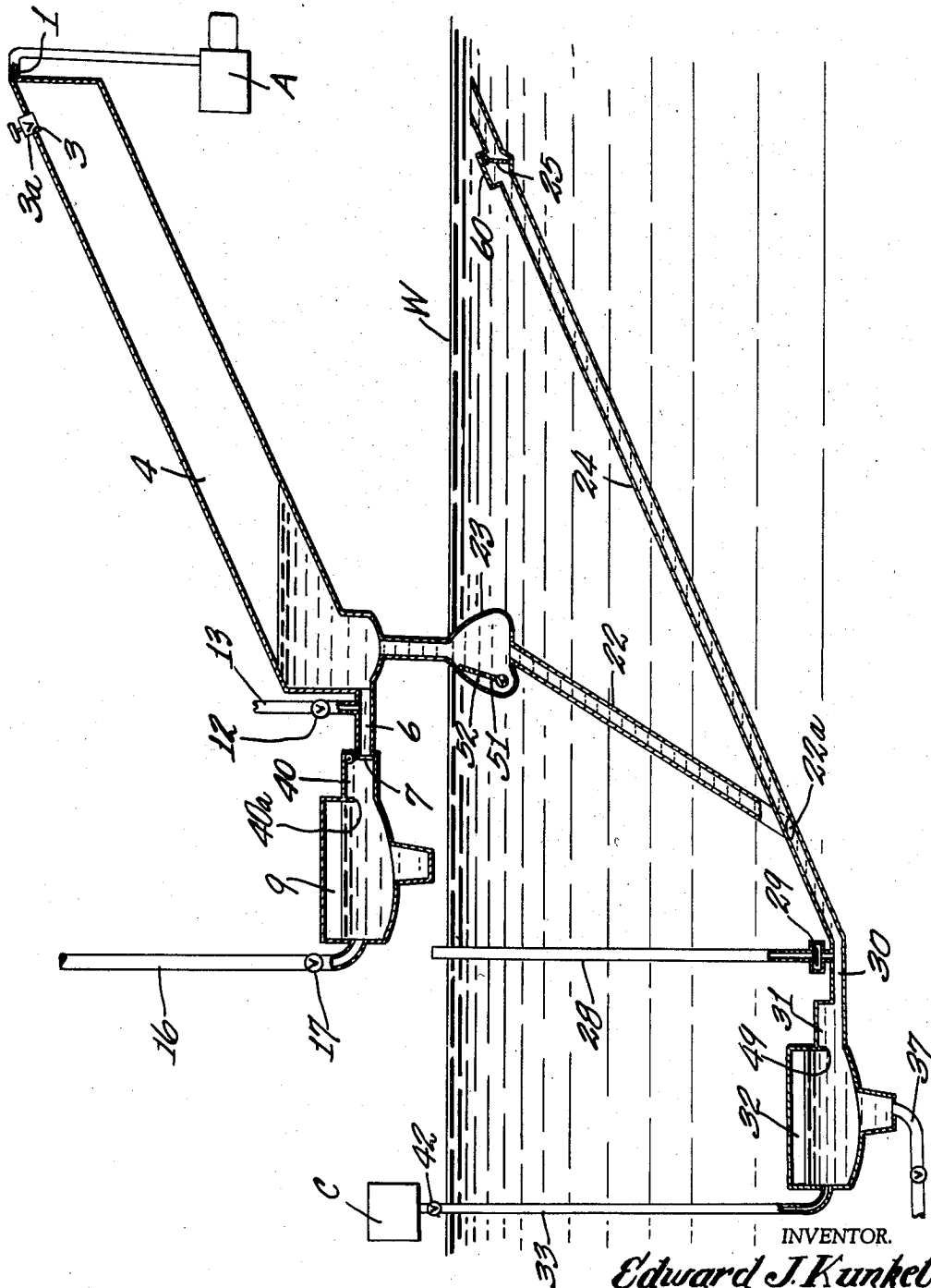
May 26, 1959

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2,887,956

HYDRAULIC RAM PUMP

Filed Jan. 3, 1955



1

2,887,956

## HYDRAULIC RAM PUMP

Edward J. Kunkel, Warren, Ohio

Application January 3, 1955, Serial No. 479,428

4 Claims. (Cl. 103-77)

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 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.

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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 3a, 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 40a 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 22a 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 3a 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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Aug. 25, 1959

J. WALEFFE

2,901,163

PRESSURE CONVERTER

Filed July 15, 1954

5 Sheets-Sheet 1

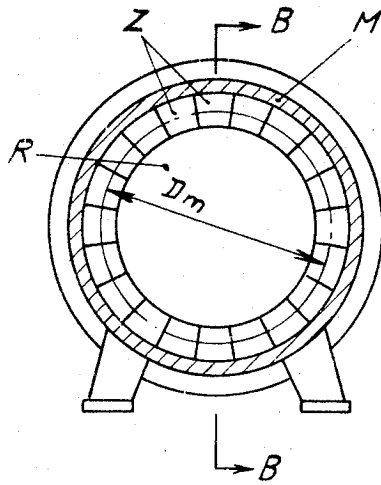


Fig. 1a

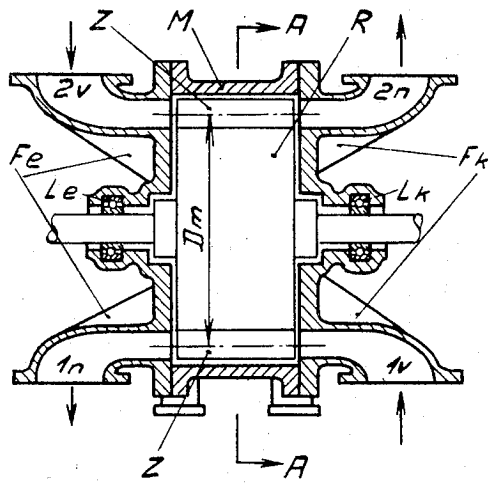


Fig. 1b

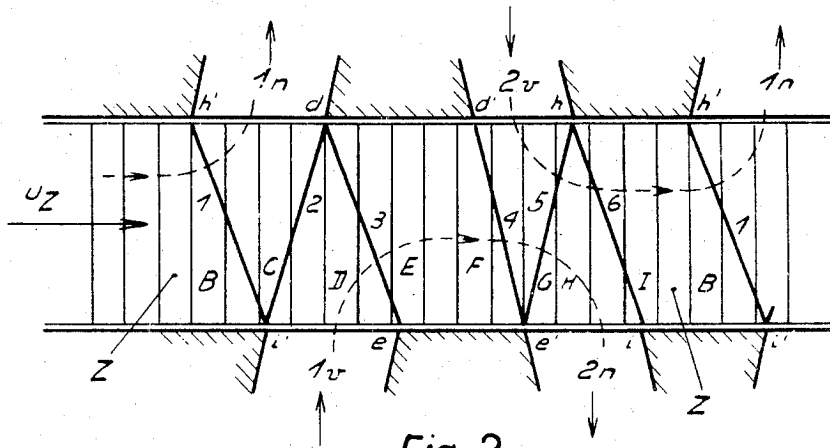


Fig. 2

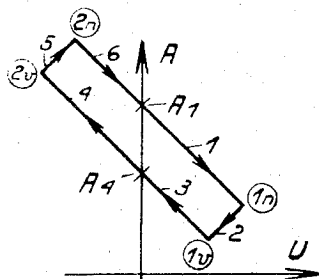
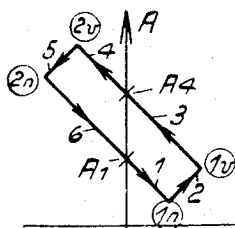


Fig. 2a



Inventor:  
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Fig. 2b by  
Pierce, Scheffler & Parker,  
Attorneys.

Aug. 25, 1959

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2,901,163

PRESSURE CONVERTER

Filed July 15, 1954

5 Sheets-Sheet 2

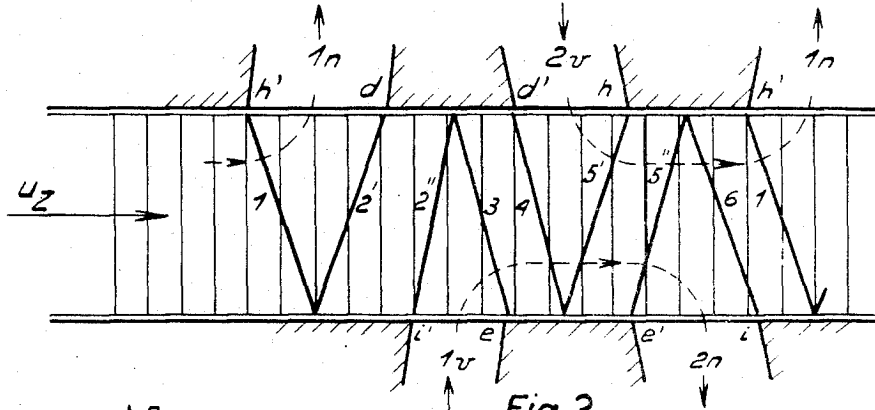


Fig. 3

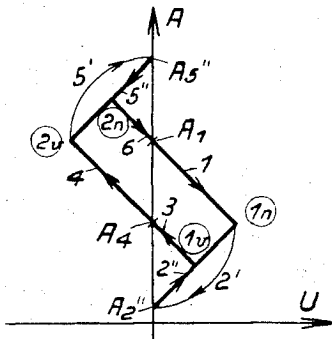


Fig. 3a

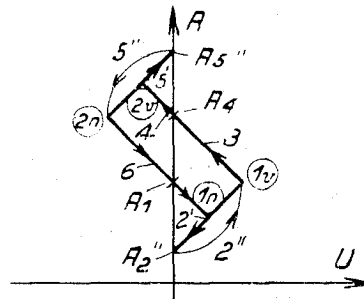


Fig. 3b

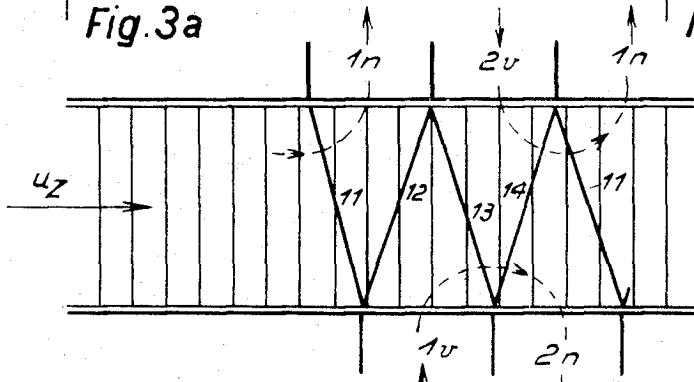


Fig. 4

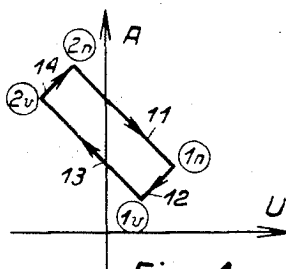


Fig. 4a

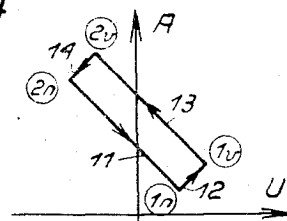


Fig. 4b



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J. WALEFFE

2,901,163

PRESSURE CONVERTER

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5 Sheets-Sheet 3

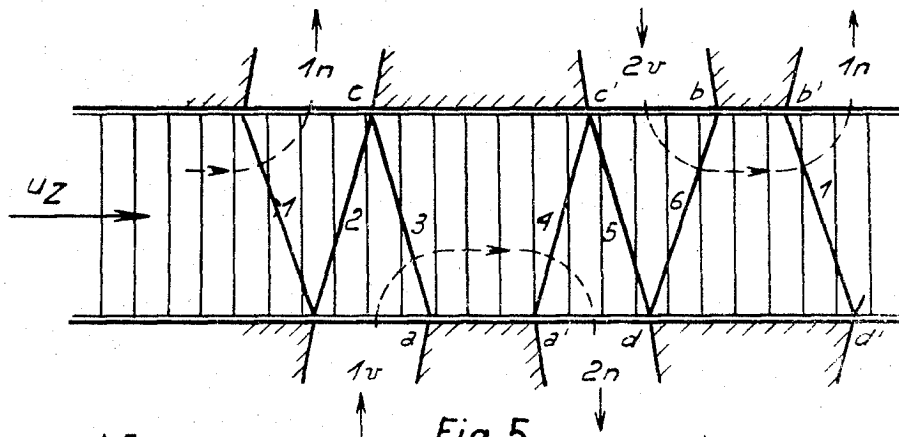


Fig. 5

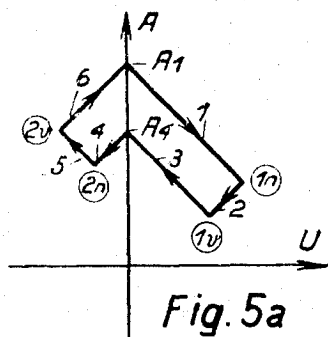


Fig. 5a

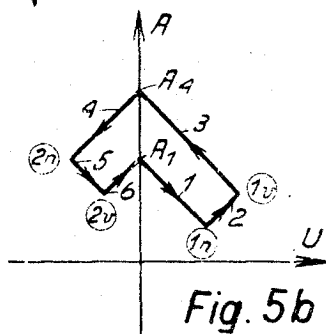


Fig. 5b

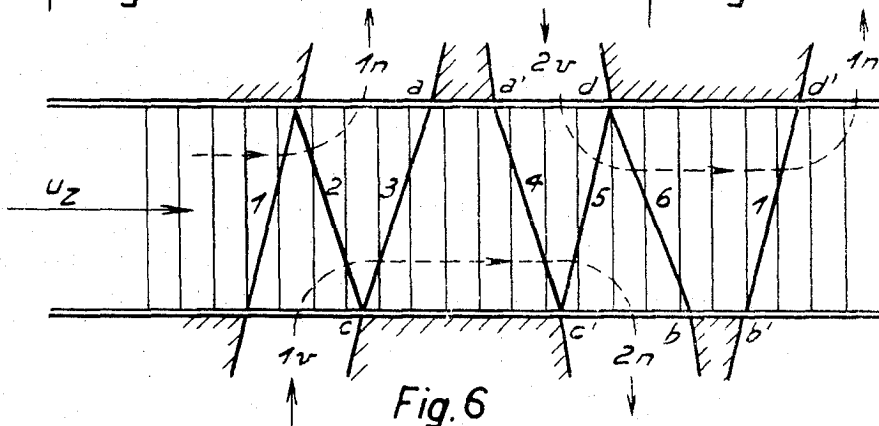


Fig. 6

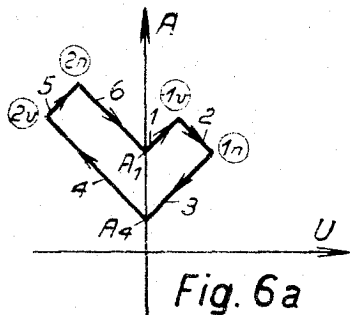


Fig. 6a

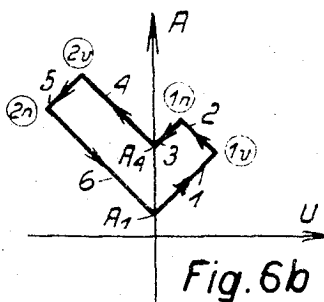


Fig. 6b

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J. WALEFFE

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PRESSURE CONVERTER

Filed July 15, 1954

5 Sheets-Sheet 4

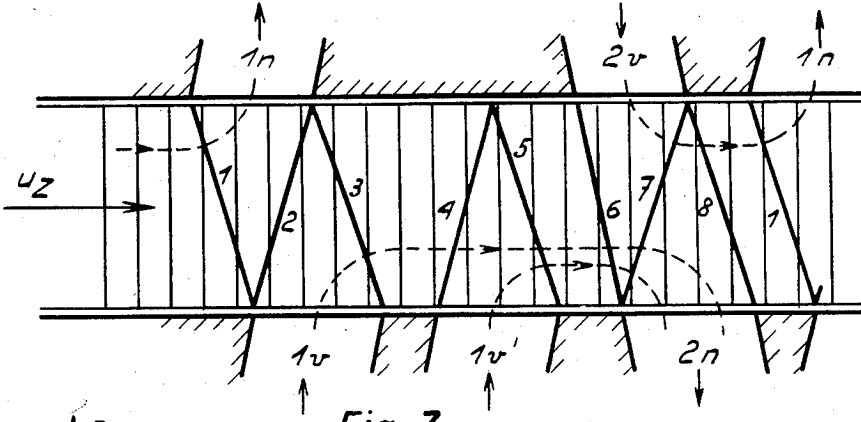


Fig. 7

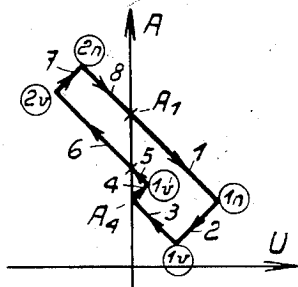


Fig. 7a

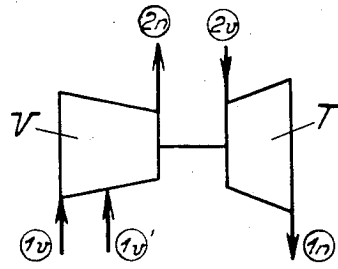


Fig. 7b

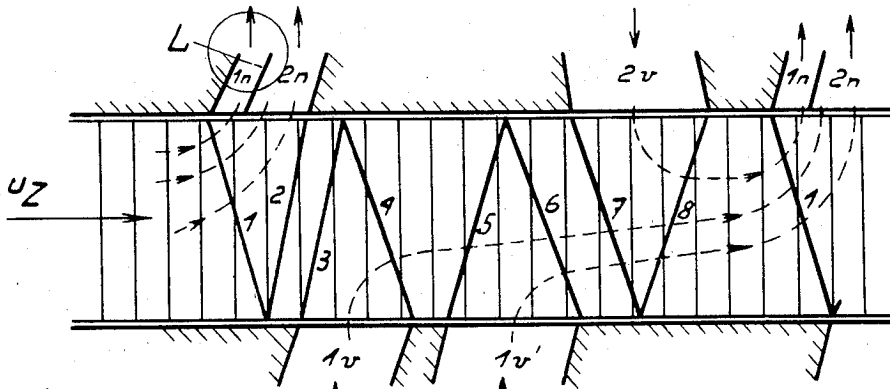


Fig. 8

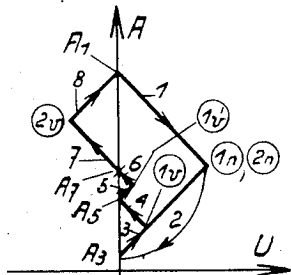


Fig. 8a

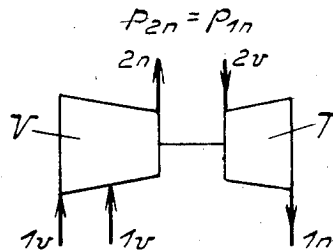


Fig. 8b

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J. WALEFFE

2,901,163

PRESSURE CONVERTER

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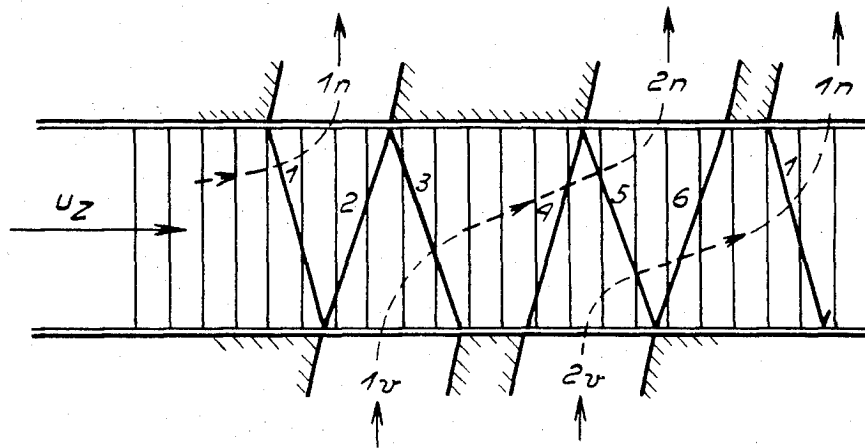


Fig. 9

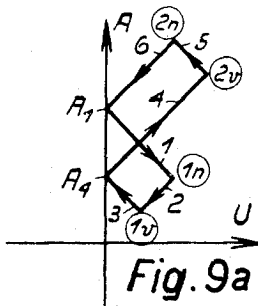


Fig. 9a

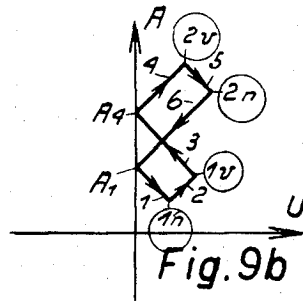


Fig. 9b

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2,901,163

**PRESSURE CONVERTER**

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Application July 15, 1954, Serial No. 443,686

Claims priority, application Switzerland July 29, 1953

7 Claims. (Cl. 230—69)

This invention relates to a pressure converter of the type including a cylindrical array of cells and control elements for regulating the flow of gaseous fluids into and out of the cells, the cells and regulating elements being supported for relative rotation.

A "pressure-exchanger" is a machine which takes in a compressible working-fluid at a low pressure level, compresses it with the aid of compression waves, and then delivers this fluid at a higher pressure level, while at the same time the machine expands a different working-fluid, or the same fluid in a modified condition and in different quantity, from a high to a low pressure level with the aid of expansion waves. The compression and expansion waves respectively are developed in oblong cells into which the working-fluid is introduced and discharged in sequence by control elements arranged adjacent to the ends of the cells. Either the cells are mobile being arranged for instance on a revolving shaft, and the control elements are stationary in a casing surrounding the shaft, or vice versa, the cells can be stationary and the control elements mobile. There is a time interval provided for both pressure stages during which one working fluid displaces the other from the cells. Consequently, the upper pressure values as well as the lower pressure values of the expanding working-fluid and of the working-fluid to be compressed are both equal within the respective cells, with the exception of insignificant differences caused by losses incurred during the flow of the working-fluids and by dynamic pressures.

The uniformity of the pressure values of both working-fluids, at the upper as well as the lower pressure cells or stages, limits the usefulness of the pressure-exchanger in many ways and prevents its practical use in many instances. Objects of the invention are to remove this disadvantage and provide a machine having an arrangement of cells in which not only each individual pressure within four intake and outlet pressure stages of two working-fluids can be entirely different, within practical limits, but in which more than two working-fluids can be compressed or expanded at still different—or equal—stages of pressure. Such a generally usable machine, to distinguish it from the known "pressure exchanger" with its limited usefulness will be termed a "pressure converter."

An object of the invention is therefore to provide a pressure converter for compression of at least one working-fluid from a lower pressure stage to a higher pressure stage by means of expansion of at least one working-fluid from a higher to a lower pressure stage; the machine being characterized by a plurality of cells with control elements at both ends to connect the cells successively with at least four chambers from which, or into which, the working-fluids flow, and where such connection between a cell in which previously introduced fluid is present at a certain pressure and a chamber at a different pressure stage will bring about the formation of a pressure wave which will traverse the cell and set its contents in motion to effect a transfer of working-fluid between the cell and the chamber; the control elements operating

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to re-seal the connection between the cells and the chambers not later than at the instant when the next-following and oppositely moving pressure wave arrives at that end of the cell at which the first wave had formed.

5 These and other objects and the advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1a is a transverse section, on line A—A of Fig. 1b, of a pressure converter embodying the invention and in which the cells are parallel to the axis of their supporting shaft;

Fig. 1b is an axial section, on line B—B of Fig. 1a, of the pressure converter;

Fig. 2 is a linear development of a section through the cells and control elements of one embodiment of the invention on a cylindrical surface passing through the centers of the cells;

Figs. 2a and 2b are vectorial diagrams illustrating pressure variations in a cell under different operating conditions;

Fig. 3 is a linear development of a cylindrical section through another embodiment of the invention;

Figs. 3a and 3b are vectorial diagrams illustrating pressure variations in a cell of the Fig. 3 apparatus;

Fig. 4 is a linear development of a cylindrical section through another embodiment of the invention;

Figs. 4a and 4b are vectorial diagrams illustrating pressure variations in a cell of the Fig. 4 apparatus;

Fig. 5 is a linear development of a cylindrical section through an embodiment of the invention;

Figs. 5a and 5b are associated vectorial diagrams;

Fig. 6 is a linear development of a cylindrical section through another embodiment;

Figs. 6a and 6b are associated vectorial diagrams;

Fig. 7 is a linear development of a cylindrical section through another embodiment;

Fig. 7a is a vectorial diagram showing pressure variations in a pressure converter as shown in Fig. 7;

Fig. 7b is a schematic view of a compressor-turbine assembly for comparison with the pressure converter of Fig. 7;

Fig. 8 is a linear development of a cylindrical section through a modified form of pressure converter;

Fig. 8a is a vectorial diagram showing pressure variations in a cell of the Fig. 8 apparatus;

Fig. 8b is a schematic view of a compressor turbine assembly for comparison with the pressure converter of Fig. 8;

Fig. 9 is a linear development of a cylindrical section through a further modification; and

Figs. 9a and 9b are vectorial diagrams showing pressure variations in a cell of the Fig. 9 apparatus.

As shown in Figs. 1a and 1b, the pressure converter comprises a rotor R having a cylindrical array of cells Z of a mean diameter  $D_m$  at its periphery, and apertured control members  $F_e$ ,  $F_k$  at the ends of the rotor and cooperating with cylindrical shell M to form a casing for the rotor. Pipe connections for the intake and discharge of the working-fluids are made to chambers in the side walls, the chambers being identified by reference characters  $1_v$ ,  $2_v$ ,  $1_n$  and  $2_n$  according to the system that numeral 1 indicates a lower pressure level and numeral 2 a higher pressure level, and letter v indicates a transfer of fluid from a chamber to the cells and letter n indicates a discharge of fluid from the cells into the chamber. The reference characters applied to the different chambers thus have the following significance:

$1_v$  is a chamber for the introduction of a working-fluid to be compressed;

$2_v$  is a chamber for the introduction of a working-fluid to be expanded;

1*n* is a chamber for the exhaust of expanded working-fluid; and

2*n* is a chamber for the exhaust of a compressed working-fluid.

In the illustrated practical embodiment of the invention, the shaft of rotor R is supported in bearings L*e* and L*k* mounted in the side walls F*e* and F*k* but it is to be understood that the cell assembly may be the stationary element of the pressure converter when the control elements are mounted for rotation. While the illustrated cells Z are each parallel to the axis of rotor R, they could be of helical form and the openings in the control elements may be so shaped that fluid enters and leaves the cells either parallel to or at an angle to the rotor axis.

In the Fig. 2 development, the walls of the cells Z appear as straight lines at right angles to their direction of movement from left to right, as indicated by the arrow U<sub>z</sub>, at constant velocity. The control elements have openings *h*'—*d*', *d*'—*h*', *i*'—*e*', *e*'—*i*' between corresponding solid portions *d*—*d*', *h*—*h*', *e*—*e*', *i*—*i*'. Each individual cell Z in turn moves past the control edges *h*', *i*', *e*', *d*', *e*', *h* and *i*, to complete a working cycle and it is advantageous to provide such number of cells on the rotor R that each revolution produces a plurality of working cycles. The establishment of a connection between a cell and a chamber will, because of the existing difference in pressure, always cause the formation of a pressure wave which traverses the cell and sets its contents in motion in the manner described in the following paragraph. It is obvious that the revolution of the shaft will cause the formation of identical waves in each particular cell and it will therefore suffice to follow the movements of only one of the cells on its way past the control openings in order to understand the method of operation of this arrangement.

Figure 2 shows one practical construction which develops a total of six waves during each working cycle. The contents of cell Z of Fig. 2 are practically at rest within the cell, and are at a certain pressure level when this cell is rotated into the position B at which its upper end is brought into communication with chamber 1*n* of the upper control element, this chamber containing fluid at a lower pressure level than that within cell Z. An expansion wave will therefore form at this end of the cell and traverse it; its course between the control elements being represented by the straight line 1. A part of the cell contents enters the chamber 1*n* and the cell Z arrives in position C at the instant when wave 1 arrives at the lower control element and simultaneously this lower end of cell Z is brought into communication with chamber 1*v*, where a lower pressure exists than in the cell after wave 1 has traversed it. The cell contents which move from the bottom toward the top, as viewed in Fig. 2, constitute a substance with a specific kinetic energy and hence "suck in," at this bottom end of the cell, the gaseous medium existing in chamber 1*v* in cases where the pressure in chamber 1*v* is lower than that at the adjacent end of the cell at position C. Therefore another expansion wave develops at this bottom end of the cell, the course of which is represented by the straight line 2. Furthermore, working-fluid from chamber 1*v* enters the cell. In position D at the instant when wave 2 reaches the upper control element this upper cell end is sealed by the control element face *d*—*d*'. Now a compression wave 3 develops at this point and in its wake the contents of the cell come practically to a standstill but at a higher pressure than before. When the cell reaches position E at the instant when wave 3 arrives at the lower end of the cell, this end is sealed by the lower control element face *e*—*e*', but no new wave originates here because in the wake of wave 3 the contents of the cell have practically come to a standstill, an effect caused by the sealing of the cell. The term: "at the instant" when one wave reaches one

end of a cell, can be defined as the short period of time which elapses while one cell moves past a control edge.

In position F the cell is brought into communication with chamber 2*v* in which the fluid pressure exceeds that in the cell Z after wave 3 has traversed it. At this point a compression wave 4 is formed and working-fluid enters the cell from chamber 2*v*. In position G at the instant when wave 4 reaches the lower end of the cell, the cell is connected with chamber 2*n* where a higher pressure exists than in the cell after wave 4 has traversed it. A compression wave 5 forms now at this point which discharges a part of the cell contents into chamber 2*n*. At position H, at the instant when wave 5 reaches the upper control element, the cell is sealed by the upper element face *h*—*h*', and an expansion wave 6 is formed, and in its wake the contents of the cell come practically to a standstill, and at a lower pressure than before. At position I this wave reaches the lower end of the cell at the instant it is sealed by the lower control element face *i*—*i*', but no new wave develops since, exactly as in position E, the cell contents are substantially stationary. The pressure of the cell contents is now again at the same level as at the beginning of the working cycle, and the cycle begins anew.

The above described arrangement of the control elements in relation to the cells has the effect that the control elements break the connection of each individual cell and the intake and outlet chambers not later than at the instant when a next-following wave (which has formed at the opposite end of the cell) arrives at that end of the cell where the first wave originated. This arrangement has the effect that one working-fluid, which enters the cells at a certain pressure, for example that of chamber 1*v*, and leaves the cells at a different pressure, for example that of chamber 2*n*, is being compressed, while at the same time another working-fluid which enters at the pressure of chamber 2*v* and leaves at the pressure level of chamber 1*n* is being expanded, and that all these pressure values may be different from each other. The working-fluids are transferred as shown by the dotted lines either from chamber 1*v* to chamber 2*n* or from chamber 2*v* to chamber 1*n* in the manner described above, namely by first entering part way into the cells, coming to a standstill in the cells, and at last leaving them again.

In order to achieve a closed working cycle, it is necessary that the waves 2 and 5 generate opposite pressure differences; therefore, if wave 2 is an expansion wave, as above described example, wave 5 must be a compression wave; and vice versa, if wave 2 is a compression wave, wave 5 must be an expansion wave.

The pressure difference between chamber 1*v* and chamber 1*n* depends not only on dynamic pressures and pressure losses in the cells and the intake and outlet chambers, but also on the amplitude of wave 2. Likewise, the pressure difference between chamber 2*v* and chamber 1*n* depends not only on dynamic pressures and pressure losses but upon the amplitude of wave 5.

It is preferable to make the circumferential lengths of the solid portions *d*—*d*', *e*—*e*', *h*—*h*' and *i*—*i*' of the control elements at least equal to the width of one cell in order to prevent any leakage between two adjoining intake and outlet chambers.

The manner of operation of the pressure-converter can be illustrated very clearly by a simplified time-pressure or U—A diagram as shown in Figures 2*a* and 2*b*, that is by a vector diagram with the non-dimensional magnitudes U and A, which are defined as follows: If *p* is the pressure of a working-fluid at any one time during the working cycle of the pressure-converter, *a* the pertinent sonic velocity, *u* the pertinent velocity of flow of this working-fluid in one or the other direction of cell-axis, *p*<sub>0</sub> any reference pressure and *a*<sub>0</sub> the reference sonic velocity at the pressure *p*<sub>0</sub>, then  $P=p/p_0$ ,  $A=a/a_0$  and  $U=u/a_0$ ;

these non-dimensional magnitudes which can be plotted on a U-A plane for each changing value of state of the working-fluids. If suitable scales are used, the compressions and expansions of the working-fluids will appear as straight lines at 45 degree angles, following one after the other corresponding to the sequences of the changes of state. In this case the A-axis can also be construed as P-axis.

The changes of state of one working-fluid in one of the cells Z then appear on the U-A diagram of Figure 2a as follows: Prior to the beginning of the working cycle the working-fluid contained in cell Z is at rest and at a certain pressure; this state of the working-fluid is represented by point  $A_1$  located on the A-axis. After the expansion wave 1 has traversed the cell, the working-fluid is in the state  $1n$ , corresponding to the pressure existing in chamber  $1n$ , that is, it has a pressure corresponding to the A(=P)-magnitude of the ordinate at the terminal of line 1, which represents the expansion wave and a certain velocity of flow corresponding to the magnitude and to the direction of the abscissa at the same point. The expansion wave 2, which follows the first wave, changes the working-fluid to the state  $1v$  and working-fluid enters the cell from the chamber  $1v$ . At the terminal point  $A_4$  of the compression wave 3, which coincides with the starting point of the next-following compression wave 4, the contents of the cell are again at rest. At the terminal point of wave 4 the state  $2v$  is reached and working-fluid enters the cell from chamber  $2v$ . The compression wave 5 which follows causes working-fluid in the state  $2n$  to flow into chamber  $2n$  and, finally, expansion wave 6 returns the cell contents to a state corresponding to point  $A_1$  on the A-axis and the working cycle begins anew.

It is now obvious that wave 2, which originates at the terminal point of wave 1, need not necessarily be an expansion wave as shown in Fig. 2a, but could also be a compression wave as shown in Fig. 2b, depending on the circumstance whether the pressure stage of the working-fluid corresponding to the state of  $1v$  is lower or higher than the pressure stage corresponding to the state of  $1n$ . In this case the pressure-converter will function as shown in the diagram of Figure 2b; the control edges of the control openings will be left in exactly the same position as in the case shown by Fig. 2a, but the pressures of the working-fluids are of a different magnitude in the two cases. A comparison of the two diagrams shows clearly that in the case represented by Fig. 2a the pressure jump of the working-fluid to be compressed from  $1v$  to  $2n$  is greater than the pressure drop of the working-fluid to be expanded between  $2v$  and  $1n$ , while in the case represented by Fig. 2b the pressure ratio is exactly reversed. Furthermore, in the case represented by Fig. 2a the pressure of the working-fluid at the stage  $1v$  is lower than the pressure of the working-fluid at stage  $1n$ , and the pressure of the working-fluid at stage  $2n$  is higher than the pressure of the working-fluid at the stage  $2v$ , while in the case of Fig. 2b this ratio is reversed also. The above given analysis shows that the pressure-converter can be used in relation with various pressure ratios; later on a description will be given of a pressure-converter which will produce other pressure differences.

Figure 3 and the associated U-A diagrams of Figs. 3a and 3b show another practical embodiment of the invention and its method of operation. In this apparatus the solid faces  $d-d'$ ,  $e-e'$ ,  $h-h'$ , and  $i-i'$  between openings of the control elements are increased in length, for instance for the purpose of ensuring the formation of desired waveform in case of different shaft speed of the machine. With this construction of the pressure-converter a total of eight pressure waves are developed in each working cycle. Wave 2 of the embodiment shown in Figure 2 is replaced by waves 2' and 2'' in Figure 2, and these waves, by use of the same symbols, are also shown in Figures 3a and 3b. Wave 2' is again an expansion

wave, while 2'' is a compression wave. In the same manner wave 5 of Fig. 2 is replaced by waves 5' and 5'', 5' being a compression-, and 5'' an expansion-wave. Before each of the waves 1, 2', 4 and 5'' begins to form, the contents of the cells are at rest; these points being represented in Figs. 3a and 3b by points  $A_1$ ,  $A_2''$ ,  $A_4$  and  $A_5''$ . All four of these waves are reflected at the opposite end of the cell while the cell is still sealed by the control elements. Without describing their derivation in detail, it is to be understood that the A-U charts associated with Fig. 3 and other views hereinafter described are constructed in the same manner as the Figs. 2a and 2b charts, and that the change in pressure condition is in each instance shown by a vector identified by the reference numeral of the pressure wave which produced it.

In Figure 4 it is shown how the closed portions of the control elements can be shortened in length to such degree as to approach the value of zero, for instance for the purpose of reducing the size of the machine. This embodiment utilizes four waves in the course of one working cycle. The control openings of the control elements are arranged in such manner that in the course of one working cycle each of the four waves reaches the opposite end of the cells at the instant when this end is being brought in connection with an intake or outlet chamber. Wave 11 as shown in Fig. 4a is an expansion wave and wave 13 is a compression wave. If, as shown in Fig. 4a, wave 12 is an expansion wave, wave 14 must be a compression wave, and if wave 12, as in the case shown in Fig. 4b, is a compression wave, wave 14 must be an expansion wave.

The pressure-converter shown in Fig. 5 and associated Figs. 5a and 5b differs from the pressure-converter shown in Fig. 2 in that respect, that here wave 4 is an expansion-, and wave 6 a compression-wave. The expansion wave 4 causes working-fluid to flow from the cell. Up to a certain amplitude of this wave the working-fluid discharged into chamber  $2n$  is at a higher pressure stage than at the time of its entry into the cell from chamber  $1v$ ; consequently, it has been compressed. The working-fluid that enters the cells at chamber  $2v$  and leaves them at  $1n$  has been expanded. A comparison with Fig. 2 will show that wave 4 of Fig. 5 originates at the lower or opposite end of the cell than that at which wave 5 of Fig. 2 originates. It is necessary, as in the case of Fig. 2, that waves 2 and 5 generate pressure waves opposed to each other. It is possible to increase the length of the relatively opposed solid faces  $a-a'$  and  $b-b'$  of the respective elements as shown in Fig. 3, or to reduce the length as shown in Fig. 4; however, the lengths of the solid faces are all interrelated to each other and to the course of pressure waves 3 and 4 with respect to the sealing face of the cell at the ends opposite those at which the waves originate. Contrary to the pressure-converter types shown in Figures 2 to 4, the pressure-converter shown in Figure 5 delivers the compressed working-fluid at  $2n$  before the working-fluid to be expanded enters the cells from chamber  $2v$ . This difference in the operating condition will be apparent from a comparison of the A-U vectors of Figs. 5a and 5b with the vectors of Figs. 2a and 2b respectively.

The pressure-converter shown in Figure 6 and associated Figures 6a and 6b first takes in working-fluid to be compressed from chamber  $1v$  before it expels the expanded working-fluid into chamber  $1n$ . Wave 1 is a compression- and wave 3 an expansion-wave; wave 1 causes the working-fluid to enter the cells. Up to a certain amplitude of this wave, the working-fluid entering the cells at  $1v$  is at a lower pressure stage than at the time when it leaves the cells at  $2n$ ; and it is compressed during its travel through the apparatus, while the working-fluid which enters the cells at  $2v$  and leaves them at  $1n$  is expanded.

A comparison of the U-A diagrams 2a, 2b, 5a, 5b and 6a, 6b pertaining to Figures 2, 5 and 6, respectively, makes it obvious that the pressure-converter is adaptable to a great variety of pressure ratios. Because of this advantage the pressure-converter has a much greater usefulness than the known "pressure-exchanger."

The pressure-converter has still other possible uses in that it can be utilized to compress one or more working-fluids while at the same time, in the same machine, one or more working-fluids are expanded. For this purpose any of the previously described constructions can be modified by the provision of additional chambers for fluid at other pressures. As shown in Fig. 7, for example, the chamber 1v for the introduction of a working-fluid is supplemented by a chamber 1v' for the same working-fluid at a higher pressure, and both components of this working-fluid are compressed and discharged into the chamber 2n. At the same time another working-fluid moves through the cells in expanding from the pressure level of chamber 2v to that of chamber 1n. In the case of a conventional assembly of a compressor V driven by a turbine T, as shown in Fig. 7b, the problem would be solved by providing the compressor with separate inlets 1v and 1v' for the working-fluid of different pressure levels.

In certain similar cases it is unnecessary to arrange additional pressure stages. If, for instance, it is desired to compress the two working-fluids from the pressures  $p_{1v}$  and  $p_{1v'}$  to the pressure  $p_{2n}$ , and if the latter is equal to the pressure  $p_{1n}$  at which the expanded working-fluid leaves the cells, it is possible to provide a single exit chamber in the pressure-converter, the construction then being as shown in Fig. 8 and the operation being as shown vectorially in Fig. 8a. The two working-fluids with identical terminal pressure level,  $p_{2n}=p_{1n}$ , will leave the cells at the same control opening which is subdivided only by the guide-wall L. Figure 8b indicates again how this problem would be solved in the case of an ordinary, turbine-driven, compressor assembly.

The described pressure converters are constructed in such manner that the working-fluid to be compressed both enters and leaves the cells at one end while the expanded working-fluid enters and leaves at the opposite ends of the cells. If it is desired that the working-fluids enter and leave at opposite ends of the cells, for example in order to simplify the arrangement of the flow line connections of a machine, it is possible to rearrange the flow openings of the control elements of a pressure-converter in the manner illustrated in Figure 9 and the pressure changes then take place according to the vectorial diagrams of Fig. 9a or 9b. In this case the control openings of the control elements are arranged in such manner, that in the course of one or several working cycles at least one of the working-fluids flows through the entire length of the cells in that it is fed into the pressure-converter at one cell-end and withdrawn at the other end. In the case of a pressure-converter constructed according to Figure 8, only the working-fluid to be expanded enters and leaves the cells at the same side of the machine.

I claim:

1. A pressure-converter comprising means establishing a plurality of cells in cylindrical array about an axis, wall means providing pressure chambers for gaseous fluids at the opposite ends of said plurality of cells and under different pressures, said wall means being apertured adjacent each end of said plurality of cells to control the transfer of fluids between the cells and the respective pressure chambers, and means supporting said cells and said apertured wall means for relative rotation to connect said cells in sequence to said pressure chambers to establish pressure waves moving along each cell

in sequence thereby to set its contents in motion, the dimensions of said cells and the peripheral lengths and locations of said wall apertures bearing such relation to each other that an end of each cell is opened at the beginning of a pressure wave originating at one end of the cell and is reclosed when the oppositely moving pressure wave arrives at such cell end from the opposite end of the cell.

2. A pressure-converter as recited in claim 1, wherein said pressure chambers include an inlet pressure chamber and an associated outlet pressure chamber at each end of said plurality of cells, and said wall apertures are relatively spaced to connect one end of a cell to said inlet pressure chamber during an interval when the other end of the cell is sealed, whereby a pressure wave traverses the cell and is reflected from said sealed other end, to seal said one end of the cell at substantially the instant that the reflected pressure wave arrives at said one end of the cell, thereby to reflect a pressure wave of opposite sense toward the other end of the cell, and then to open said one end of said cell to said wall associated outlet pressure chamber, the apertures being staggered in relation to each other to open an end of a cell to a pressure chamber at a time when its other end is sealed.

3. A pressure-converter as recited in claim 1, wherein said pressure chambers include an inlet pressure chamber at one end of the cells containing pressure fluid to be expanded and an inlet chamber at the opposite end of the cells containing pressure fluid to be compressed.

4. A pressure-converter as recited in claim 1, wherein said pressure chambers at one end of said cells include an inlet pressure chamber containing a first pressure fluid to be expanded and an outlet pressure chamber for said expanded pressure fluid, and wherein said pressure chambers at the opposite end of said cells include a pair of inlet pressure chambers each containing a second pressure fluid but at different pressure levels to be compressed and an outlet pressure chamber for said second compressed pressure fluid.

5. A pressure-converter as recited in claim 1, wherein said pressure chambers at one end of said cells include an inlet pressure chamber containing a first pressure fluid to be expanded, a first outlet pressure chamber for said expanded pressure fluid and a second outlet pressure chamber adjacent to said first outlet pressure chamber, and wherein said pressure chambers at the opposite end of said cells include a pair of inlet pressure chambers each containing a second pressure fluid but at different pressure levels to be compressed, said second pressure fluid being discharged after passage through said cells through said second outlet pressure chamber.

6. A pressure-converter as recited in claim 1, wherein said pressure chambers include a pair of inlet pressure chambers and an individual outlet pressure chamber for each inlet pressure chamber, each outlet pressure chamber being at the end of said cells opposite its inlet pressure chamber.

7. A pressure-converter as recited in claim 1 wherein said pressure chambers include an inlet pressure chamber and an associated outlet pressure chamber at each end of an opening into said cells and wherein said wall apertures at opposite ends of said cells are located such that each cell is transferred from a connection with a pressure chamber at one end to a connection with a pressure chamber at the other end at substantially the instant of arrival at such other cell end of a pressure wave originating at the opposite end of the cell.

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July 19, 1960

TERUICHI YAMAGUCHI ET AL

2,945,447

HYDRAULIC RAM

Filed Oct. 8, 1956

Fig. 2

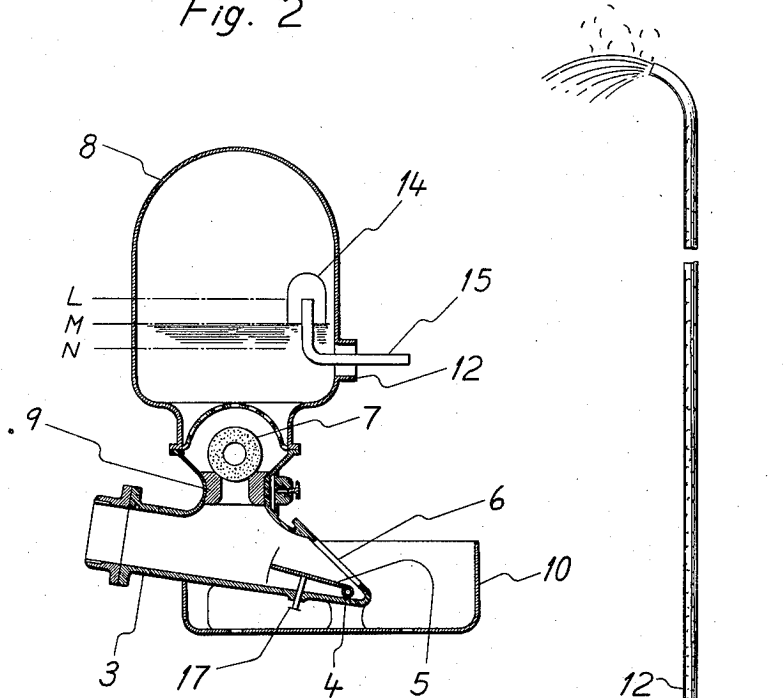
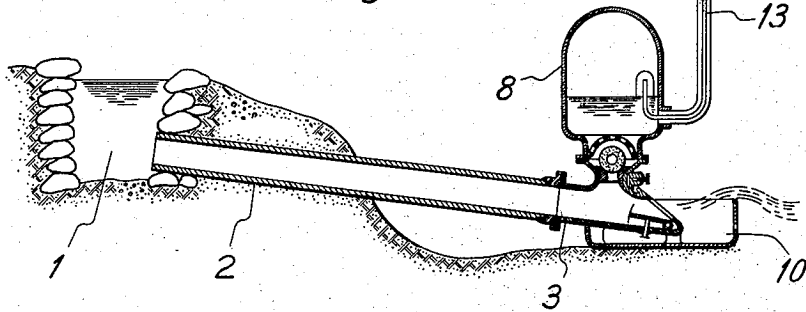


Fig. 1



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2,945,447

## HYDRAULIC RAM

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Claims priority, application Japan Aug. 2, 1956

1 Claim. (Cl. 103-77)

The present invention relates to a hydraulic ram, by which lower level water is pumped up to a higher level by raising and lowering optionally of the water level at a drain hole, regulating the quantity of suction air therefrom and the periodicity of a drain valve motion, and utilizing water hammer pressure in a valve chamber produced by intercepting water flow in a penstock.

The invention employs a novel arrangement of an inverted cup-shaped cover member which is fitted with adequate clearance at an end of a U-shaped air pipe inside of a buffer tank to which a lifting pipe is connected, so as to cover the air pipe concentrically, and an elastic spherical lifting valve, in which light gas such as hydrogen, etc. is enclosed, is disposed in the buffer tank.

Various objects of the present invention reside in its simple construction, freedom from troubles, low cost of manufacturing.

Another object of the invention is to maintain the water level in a buffer tank constant and to make the lifting quantity of water constant, under any conditions, as well as to prevent any dust located in the buffer tank from invading into the air pipe and blocking air holes thereon.

The present invention features in its construction an elastic spherical lifting valve, in which light gas such as hydrogen, etc. is enclosed, to make it nearly the same specific gravity as the water, as well as an inverted cup-shaped cover member which is fitted with adequate clearance at one end of the U-shaped air pipe that has air holes at its other end. The U-shaped air pipe has an end inside of a buffer tank to which a lifting pipe is connected, so as to cover the air pipe concentrically, setting the lower edge of the cover member to coincide with the water level in an equilibrium tank in the buffer state.

The ram thus equipped is especially useful where no electric main is available.

The principle of the present invention will be explained in details as under, with the aid of the accompanying drawing. In the drawing, Fig. 1 is an embodiment of the invention, showing a general layout of the hydraulic ram, and Fig. 2 is a sectional view of the ram.

The water flows into valve chamber 3 through penstock 2 from the head-waters 1 and dashes against the drain valve 5 which swings around hinge 4 and closes the drain hole 6, then, with its existing pressure, opens the spherical lifting valve 7 and flows into the buffer tank 8. As the valve 7 is so made that it encloses hydrogen within its spherical body and its specific gravity is nearly equal to and barely greater than water, at the moment when the pressure in the valve chamber 3 becomes slightly higher than the pressure in the buffer tank 8, the valve 7 will commence to open the inlet hole 9. After the pressure of flow-in water comes in equilibrium with the pressure in the tank 8, there begins some back flow of the water and when the pressure in

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the tank 8 becomes higher than that of the flow-in water, the lifting valve 7 will act with adequate back flow and close the hole 9, so that the pressure in the chamber 3 will rapidly become negative owing to the back flow inertia. Then the drain valve 5 will automatically open due to the negative pressure of the chamber 3 and its own weight. Thus the water in the drain pool 10 as well as the open air will be sucked simultaneously into the chamber 3. The drain valve 5 can be adjusted by the adjusting piece 17 controlling the periodicity of opening and closing the valve to obtain the highest efficiency of the ram. Outside of the drain hole 6, there is connected the drain pool 10.

The water in the buffer tank 8 will be lifted through a lifting pipe 12 by means of the flow-in water and the air. For the purpose of increasing the quantity of lifting water, a U-shaped air pipe 15 of small diameter is arranged in the lifting pipe 12. At the discharge end of the pipe 15, there are opened a number of small air holes 13, and at the other end inside the buffer tank, there is fitted an inverted cup-shaped cover member 14 with adequate clearance to cover the pipe 15. Thus, the air entering into the buffer tank 8 will be ejected from the air holes 13 as a number of bubbles, so that the lift of the ram may be increased. According to the experiment of the inventor, the ram action will become the more stable, the smaller the bubbles made.

The inverted cup-shaped cover member 14 is fitted at a suitable position for the purpose of preventing the dust that entered in the buffer tank 8, from invading into the air pipe 15, as well as for lifting smoothly the water that flows in impulsively. This arrangement will be explained in details as follows:

When the water level in the buffer tank situated at the lower edge of cover member 14, i.e. at position M, the air pressure and water pressure in the tank are in an equilibrium state, and the floating dusts are intercepted by the lower edge of the cover member 14 and cannot flow into the air pipe 15.

When the water of the chamber 3 and the air sucked in from the discharge hole 6 flow into the tank by overcoming its internal pressure, it acts to lift the water as well as to press down the water level. But, when the pressure in the tank is higher, i.e. the water level reaches position N, the air flows into the air pipe 15 and ejects small bubbles from the air holes 13 which act as to increase the lift, until the water level is raised and reaches the lower edge of the cover member 14. Under these conditions, there is no fear that the dusts would invade into the air pipe 15, because the water level is lower than the lower edge of the cover member 14.

When the water flowed into the buffer tank by overcoming its internal pressure, is far larger in quantity compared with the suction air, i.e. the water level reaches position L, the dusts are prevented by the air pipe cover member 14 from entering into the air pipe 15, because they are floating on the surface of water, and the lifting of water is continued by the compressed air until the water level reaches position M to become a stable condition.

As aforementioned, the present invention is so contrived that an elastic spherical valve of measurable motion is used to increase its forward stroke efficiency with adequate back flow as well as to increase the quantity of the suction air far more than that of the known valves, and that the lift of the ram can be increased. Further, due to the arrangement of the inverted cup-shaped cover member 14, the air hole will not be blocked by the dust, thus eliminating the irregularity of the lifting quantity which has been the defect of the known rams; thus the invention is recognized to be very useful for practical applications.

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Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

A water pump comprising a penstock for receiving water at a first level and for delivering water to a drain pool, said penstock having a valve chamber at an end thereof, a drain hole in said valve chamber, a drain valve pivotally mounted in said valve chamber for closing said drain hole, said drain valve being arranged so as to be opened by its own weight and to be closed by flowing water in said penstock, a buffer tank positioned above said valve chamber, said valve chamber having an inlet hole communicating said valve chamber with said buffer tank, an elastic spherical lifting valve disposed in said buffer tank for closing said hole, said lifting valve being filled with a light-weight gas to make the specific gravity

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of said lifting valve to be barely greater than water, a lifting pipe extending outwardly from said buffer tank and having a discharge level above said first level, said lifting pipe including an air pipe disposed therein and extending into said buffer tank, and a cup-shaped air pipe cover within said buffer tank and overlying said air pipe; said cover having a depending portion coinciding with the water level in said buffer tank when in an equilibrium state.

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- [54] RAM PUMPS
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- [73] Assignee: Katsuhiko Ohki, Briarcliff Manor, N.Y.
- [21] Appl. No.: 484,870
- [22] Filed: Apr. 14, 1983
- [51] Int. Cl.<sup>3</sup> ..... F04F 7/02; F16K 51/00
- [52] U.S. Cl. .... 417/226; 251/147
- [58] Field of Search ..... 417/226; 251/352, 121, 251/147

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[57] ABSTRACT

An improved ram pump of the type having a pump housing (7) an inlet (8) for intake of fluid, a reservoir (10) for supply of a dynamic fluid head to the pump, a release valve mechanism (11) for exhaust of fluid from the pump and a lift valve mechanism (12) for output of back pressure generated by the pump. The improvements comprise a partially spirally wound lead pipe (9) connecting the reservoir to the pump inlet, an adjustable release valve mechanism (11) having a valve cup (13) and annular adjustment ring (21) which cooperate to form variable outlet ports (23) that selectively restrict exhaust of fluid to vary the height of fluid above the valve (16) and a lift valve mechanism (12) biased at a pressure greater than approximately 10 gm/cm<sup>2</sup>.

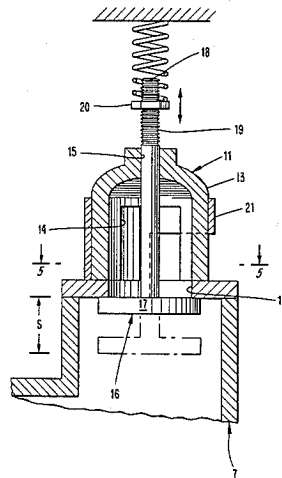
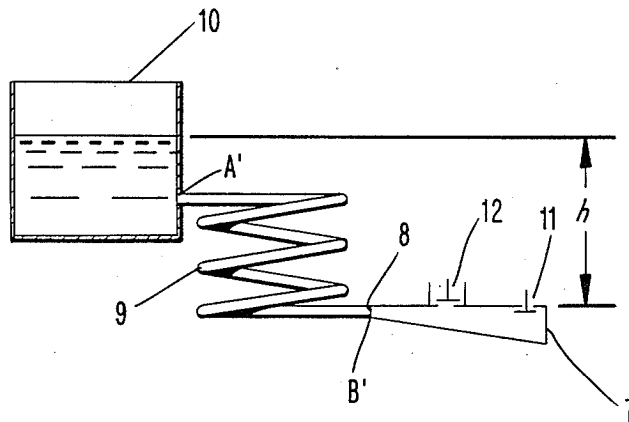
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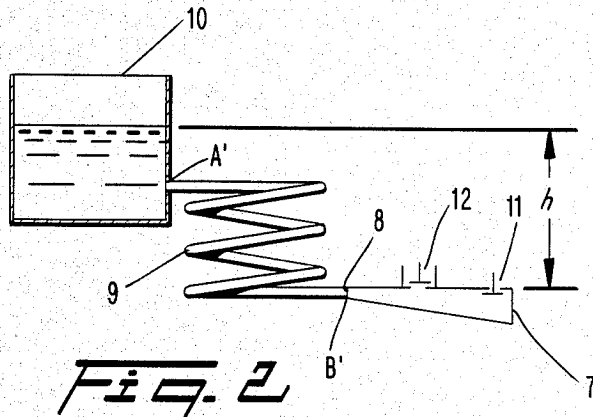
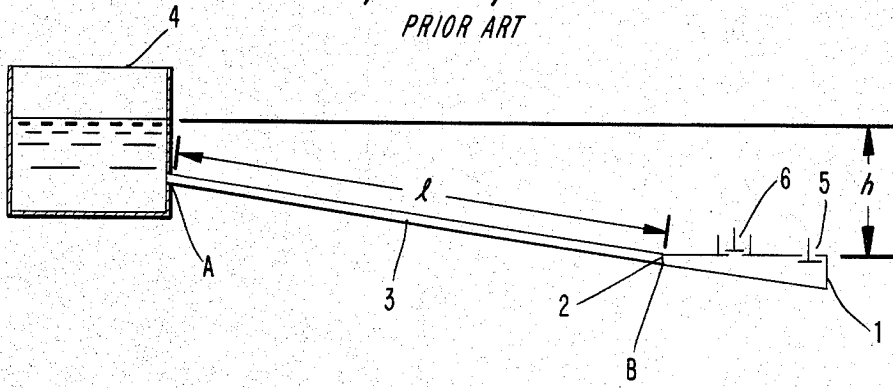
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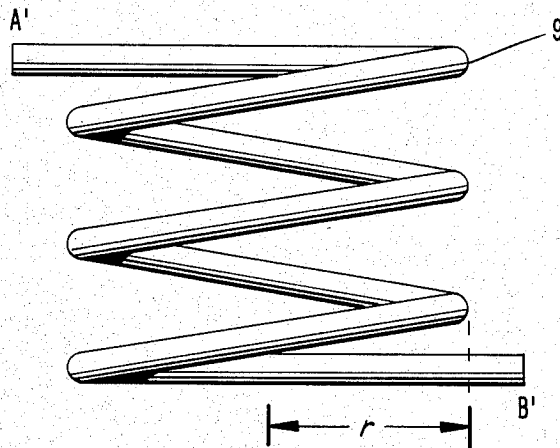
6 Claims, 6 Drawing Figures



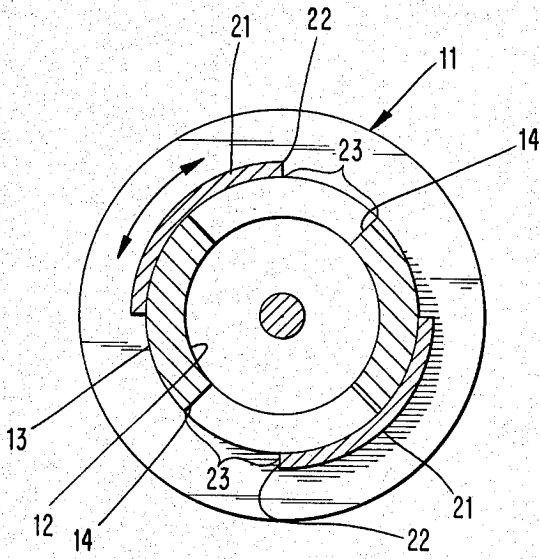
*Fig. 1*  
PRIOR ART



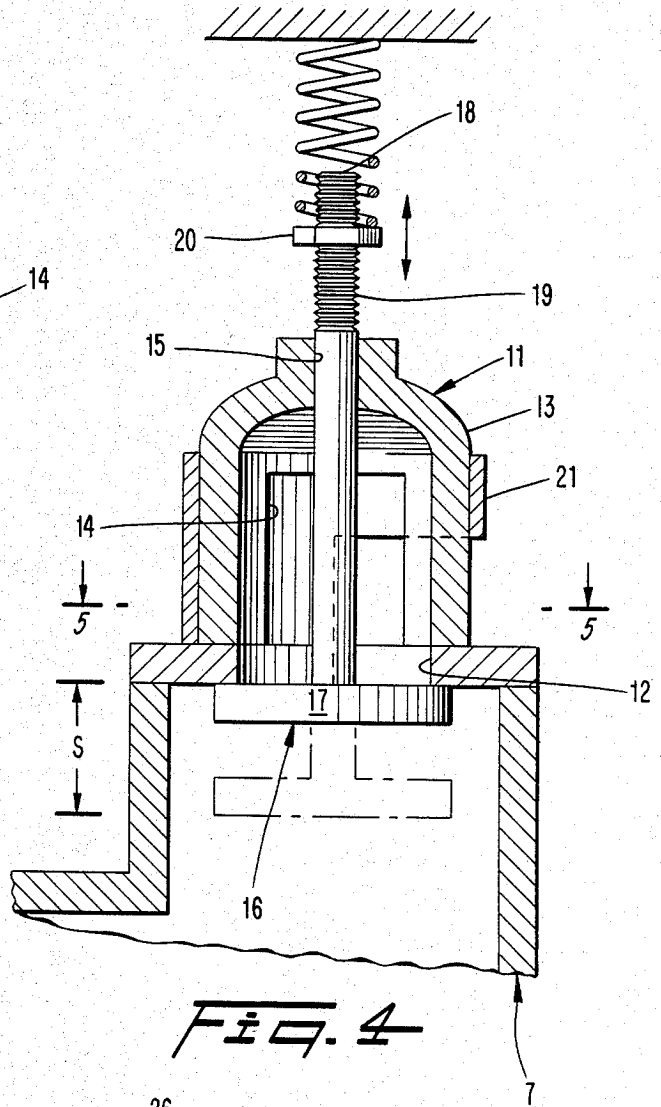
*Fig. 2*



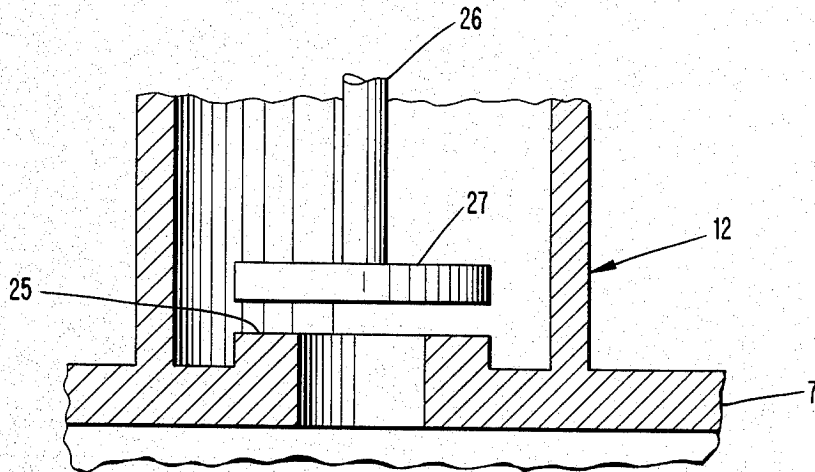
*Fig. 3*



*Fig. 5*



*Fig. 4*



*Fig. 6*

## RAM PUMPS

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The invention relates to improvements in fluid ram pumps.

## 2. Description of the Prior Art

In fluid mechanics, it is generally known that an abrupt stop in fluid flow through a pipe will rapidly generate a back pressure of magnitude many times that generated by the dynamic flow. Many people have experienced this phenomenon in their domestic water systems when they quickly shut off a water valve. This phenomenon is commonly known as "water hammer".

In the past, attempts have been made to harness the back pressure to perform useful work, such as vertically pumping high pressure fluid. These pumps are known as ram pumps.

Past designs of ram pumps have had a pump housing or body containing gas, such as air, and having an inlet connected by a lead or head pipe to a source of flowing fluid, such as a water reservoir located at some height above the pump. Water flows under the influence of gravity from the reservoir through the lead pipe, the pump inlet and in turn into the housing. The housing also has a release valve for water exhaust from the pump; rapid, abrupt closure of that valve creates a pressure increase in the pump housing which compresses air trapped in the housing. In theory, the housing pressure increase opens a lift valve, which allows the compressed air to expand and push water output through the lift valve and out of the pump. The output has a pressure greater than the hydrostatic pressure generated by the dynamic head flowing through the pump and can be used to perform useful mechanical work, such as pressurizing a municipal water system. Also in theory, repeated opening and closing of the release valve repetitively recreates back pressure waves which in turn activate the lift valve and perform useful work.

Ram pumps have had minimal acceptance in the past for three main groups of practical reasons—pump inefficiency, geometric restraints on lead pipe construction and inability to achieve theoretically attainable automatic pump operation. Inefficiency manifests itself in low pressure output through the lift valve. The lead pipes have had to be constructed with relatively long length and they could not be used under some geographic conditions.

Nonautomatic operation has been the result of the failure of past designs to coordinate opening and closing of the release and lift valves and failure to allow proper volumes of air into the pump housing. In theory, closure of the release valve would generate a pressure increase in the pump housing, which compresses air trapped therein. The lift valve would be constructed with biasing means to open at a predetermined pressure level so that the compressed air would expand and drive water out of the pump. Opening the lift valve would eventually decrease the pump housing pressure. Unfortunately, known ram pump designs have not supplied the proper volumes of air into the pump housing which are necessary to attain an output head under automatic operation. During automatic operation, some air is constantly dissolved into the water, decreasing air volume. When the air volume decreases below a critical level, automatic operation terminates. If an excessive volume

of air is supplied into the pump housing, the back pressure will only compress and lift air rather than lift water, which hampers pump efficiency.

If the release valve is constructed so that it automatically biases to the open position, the valve will open, allowing more water to flow through the pump body from the reservoir. At least in theory, carefully adjusting the release valve bias force will allow the valve to close once the hydrostatic pressure caused by flowing water through the pump is attained; the release valve then closes, setting up another pressure shock which repeats the lift valve opening process. Unfortunately, it has not been heretofore possible to construct a ram pump having efficient, fully automatic operation.

## SUMMARY OF THE INVENTION

An improved ram pump constructed in accordance with the teachings of the present invention provides for efficient automatic operation at higher output pressure levels than heretofore experienced.

One embodiment of the invention is an improved ram pump of the type having a pump housing, a lead pipe having an axial dimension, where the pipe is connected to the housing for inflow of fluid into the housing, a reservoir located above the pump housing connected to the lead pipe for supplying a source of a fluid head, a release valve mechanism and a lifting valve mechanism. The improvement comprises a portion of the lead pipe being spirally wound in the longitudinal dimension.

Another embodiment of the invention is an improved ram pump of the type having a pump housing, a lead pipe connected to the housing for inflow of fluid, a reservoir located above the pump housing connected to the lead pipe for supplying a source of a fluid head, a release valve mechanism, and a lifting valve mechanism. The improvement comprises a release valve mechanism having an outlet defined by the housing for exhaust of fluid from the pump; a release valve cup is attached to the housing and cooperates with the outlet, where the cup defines cup slots communicating with the outlet; an adjusting ring defines slots through the ring in the radial direction, the ring is adapted for communication with and slidable rotation about the release valve cup. The ring slots cooperate with the valve cup slots to form an outlet port, such that rotation of the ring varies the cross section of the outlet port. A valve having a stem portion is slidably mounted in the valve cup for reciprocating movement of the valve from an open position to a closed position, such that the valve blocks the outlet in the closed position and does not block the outlet in the open position.

In other embodiments of the invention, the valve has means for selectively adjusting the distance of valve reciprocation from the open position to the closed position.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic-elevational view of a prior art ram pump;

FIG. 2 is a schematic-elevational view of one embodiment of the present invention;

FIG. 3 is an elevational view of a lead pipe constructed in accordance with the teachings of the present invention;

FIG. 4 is an elevational-cross-sectional view of a release valve constructed in accordance with the teachings of the present invention;

FIG. 5 is a cross-sectional-plan view of a release valve constructed in accordance with the teachings of the inventions taken along 5—5 of FIG. 4; and

FIG. 6 is a cross-sectional view of a lift valve constructed in accordance with the teachings of the present invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

#### A. Prior Art

A known ram pump is schematically shown in FIG. 1. The pump has a pump housing 1 and an inlet 2 for intake of a moving fluid, such as water. The source of flowing water is a lead pipe 3 which is connected to a storage reservoir 4. The vertical distance between the reservoir 4 water level and the release valve 5 is represented by the distance  $h$ . Water exhausts from the pump body 1 through release valve 5, which is selectively closeable in order to stop waterflow. Closing release valve 5 stops the flow and in turn creates a back pressure wave or hammer. Useful work is performed by the pressure wave by diverting it through lift valve 6, which is set to open at a predetermined pressure. When the back pressure wave strikes lift valve 6, the valve opens, diverting the pressure wave to where it may perform useful work. This useful work may provide a municipal water system with a higher pressure head than the hydrostatic head created by the gravitationally induced flow through the distance  $h$ .

The known ram pump drawbacks have obviated widespread practical use at suitably high output pressure levels. First, the lead pipe 3 geometry necessary to create a desired output pressure head takes up a great deal of space (as will be explained below) and it is not suitable for hilly terrain. Second, automatic operation of the pumps has not been achieved at useful output pressure heads. The present invention solves these technical difficulties.

#### B. Lead Pipe

In order to achieve useful back pressure, it is generally thought that the length  $L$  of the lead pipe, such as shown in the Prior Art FIG. 1, must be greater than eight times that of the gravitational head  $h$ . It is further commonly thought that the lead pipe must extend in a straight line from the reservoir to the pump in order to maximize back pressure head for a given reservoir head and flow rate. Bends or restrictions in the lead pipe increase water flow friction through the pipe and thus decreases the back pressure head.

However, in practice it is difficult or nearly impossible to achieve the desired eight to one ratio. For example, if the reservoir head (also called the dynamic head or effective head) is 10 m, the lead pipe should be 80 m long, and be free of any bends. Long straight runs of piping may be impractical in urban areas, areas with steep terrain or hilly areas having great elevational fluctuations. The optimal geometric lead pipe configurations might not be possible without costly deep excavations.

Lead pipes constructed in accordance with the teachings of the present invention provide for more compact design flexibility for utilization in geographic terrain heretofore thought to be unsuitable for ram pumps. The present lead pipes also create higher back pressures and greater output pressure than the known lead pipe designs, when both operate under similar parameters.

Referring to FIG. 2, pump housing 7 has an inlet 8 connected to the improved lead pipe 9. Lead pipe 9

connects to reservoir 10. The pump housing 7 has a release valve mechanism 11 and a lift valve mechanism 12. As shown in FIGS. 2 and 3, lead pipes constructed in accordance with the teachings of the present invention are wound in a spiral or helical configuration. The helical winding design creates a higher back pressure than straight lead pipes operating under identical parameters. This difference is shown by way of the following experimental examples.

#### EXAMPLE 1

A straight lead pipe of 40 mm diameter and 8 m length was connected between a water reservoir and a ram pump. The effective head between the reservoir and pump was 1 m. A maximum output lift, or output head of 21 m was obtained.

#### EXAMPLE 2

A 40 mm diameter lead pipe having a length of 8 m was helically wound into a diameter of 75 cm (radius,  $R=37.5$  cm). Again, the effective head was 1 m. The maximum lift head that was obtained was 28 m.

#### EXAMPLE 3

A 40 mm diameter lead pipe having a length of 8 m was partially wound into a helix having a diameter of 40 cm. The end portions were in a straight unbent configuration and connected to the reservoir and ram pump. The reservoir head was 1 m. The maximum lift head that was obtained was 19 m.

#### EXAMPLE 4

A 50 mm diameter lead pipe having a length of 8 m was partially wound into a helix having a diameter of 40 cm. The unwound ends had both straight and bent portions to simulate elbows and turns. The reservoir head was 1 m. Maximum lift height that was obtained was 26 m.

The above examples are summarized in the following Table No. 1:

TABLE 1

EXAMPLE NO.	LEAD PIPE DIAMETER (mm)	HELICAL DIAMETER (cm)	MAXIMUM OUTPUT HEAD
1	40	—	21
2	40	75	28
3	40	40	19
4	50	40	26

The above examples show that a helically-wound lead pipe can be constructed which will create a higher lift head than the heretofore optimally-designed prior art straight lead pipes. The helix may be wound relatively tightly and still create maximum lift heads that approach that of the prior art designs (see example 3), while providing a geometric configuration that can fit into a more compact area. Lastly, an increase in the lead pipe diameter can compensate for bends or turns in the lead pipe, and still provide relatively high maximum lift heads.

As the experimental results show, a partially helically wound lead pipe may be designed to create higher lift head pressures than prior straight lead pipes, which may have application for much more demanding terrain.

#### C. Release Valve Mechanism

FIGS. 4 and 5 show a release valve mechanism constructed in accordance with the teachings of the present

invention. Referring to the figures, release valve mechanism 11 has a valve outlet 12 through the pump housing 7. The outlet 12 opens into a valve cup 13 which, as shown, has the form of a cylinder with a domed outer end. The valve cup 13 has slots 14 for passage of water therethrough once the water drains from valve outlet 12. The valve cup end opposite the outlet 12 has a bore 15 therethrough along the cup's (13) longitudinal axis. Valve 16 has a head 17 that cooperates with outlet 12 to seal the outlet when the valve is in a closed position.

second set of operating conditions, a 6 m reservoir head was combined with a 40 m lead pipe. The pump was adjusted to provide a 150 m water lift head. Under both sets of conditions, the adjustment ring 21 was used to vary the water level above the release valve to a pre-selected height. The quantity of water lifted was then measured under each water level release valve height adjustment setting. The results of these two operating conditions are summarized in the following Table No. 2:

TABLE 2

RESERVOIR (DYNAMIC) HEAD (m)	WATER LEVEL ABOVE RELEASE VALVE (mm)	WATER LIFT OUTPUT FLOW RATE (cc/min)	CHANGE IN WATER LIFTING OPERATIONS
2	5	0	no change
2	10	7,200	no change
2	15	10,600	no change
2	25	12,500	stopped lifting after 9 hours
6	10	0	no change
6	15	2,100	no change
6	30	2,800	no change
6	50	3,300	stopped lifting after 4 hours

Valve 16 also has a stem 18, which slidably inserts into the valve cup bore 15 and reciprocates from an open position to a closed position. In the open position, valve head 17 is spaced a distance  $s$  away from valve outlet 12. The distance  $s$  is also known as the stroke. In the closed position, valve head 17 presses against valve outlet 12 to seal pump housing 7. Stem 18 has a threaded upper portion 19 for receipt of a threaded nut 20. Changing the position of threaded nut 20 varies the stroke  $s$ .

The release valve mechanism 11 has an annular adjustment ring 21 adapted for placement over the outer circumference of the valve cup 13. Ring 21 has ring slots 22 that go through the ring around its perimeter. Ring slots 22 cooperate with valve cup slots 14 to form outlet ports 23. Rotation of ring 21 varies the cross-section of these ports 23, and thus the available cross-sectional area through which water exiting pump housing 7 may flow.

Decreasing the cross-sectional size of outlet port 23 decreases the exhaust flow rate through pump housing 7. If the inflow rate of water into pump housing 7 through inlet 8 remains constant, decreasing the size of outlet port 23 will raise the height of water in valve cup 13 above valve 16.

The water level above valve 16 affects the output pressure and quantity of water lifted through lift valve 12. When the size of outlet port 23 is increased, the water level decreases, leaving more room for air in the pump housing 7. Conversely, decreasing the outlet port 23 size decreases the volume of air in the pump housing 7. Thus, the present invention provides an accurate means for metering the volume of air contained within the pump housing 7, which may be optimized for maximum pump output. The effects of port 23 cross-sectional area on the quantity of water lifted is shown by the following example.

#### EXAMPLE 5

In the example, a 50 mm diameter adjustment ring 21 was used over valve cup 13. Adjustment ring 21 was tested for two sets of operating conditions. In the first set of conditions, a 2 m reservoir head was used in conjunction with 15 m lead pipe, and the pump was adjusted to provide a 20 m water output head. In the

As this example shows, the greater the height of water level above the release valve 16, the greater the pressurized water output flow rate through lift valve mechanism 12. However, the example also shows that automatic operation of the pump will cease if the water level above the release valve is too high because the housing contains too little metered air. Under the first set of operating conditions, a release valve water level of 25 mm stopped the pump after nine hours, and in the second set of operating conditions, automatic operation of the pump ceased after 4 hours when the water level was set at 50 mm.

Aside from drawbacks in use of prior designs of ram pumps due to geometric constraints on the lead pipe, another major problem discouraging their use has been inability to achieve consistent automatic pump operation.

In theoretical operation, the release valve would be abruptly closed, creating the back pressure or "water hammer". The back pressure would impinge upon and open the lift valve, allowing the back pressure surge to perform useful output work by pressurizing and lifting water. When the pressure surge dropped off, the lift valve would close and the release valve open, continuously repeating the process.

Past designs of ram pumps have not been known to achieve continuous automatic operation. While it was comparatively easy to shut the release valve by means of the pressure generated by flowing exhaust water, it has not been easy to open the valve when necessary. To ease release valve opening, it has been common to increase the opening force of the release valve against the water pressure in the pump body by increasing the valve's weight or by biasing it with a spring. Known designs have increased the valve's counteracting opening force to the point where it was equal to between approximately 40 and 60 percent of the hydrostatic pressure generated by the flowing water on the release valve. This high opening force has had a deleterious effect on known pump efficiency. The release valve becomes easier to open with a high opening force but it becomes harder and takes longer to close. A relatively slower closing time reduces lift capacity.



Release valve mechanisms constructed in accordance with the teachings of the present invention have dramatically departed from the past known attempts by using a counterforce opening weight of the valve on the water much less than that used in the past designs. In the present invention, the release valve mechanism only utilizes a counterforce pressure of less than approximately 15 percent of the hydrostatic pressure generated by the reservoir head on the valve. When combined with a lift valve constructed in accordance with the teachings of the invention, which will be described in subpart D below, fully automatic pump operation is achieved.

The significance of relatively light release valve counterforce pressures on the water contained within the pump body is illustrated by the following example.

EXAMPLE 6

Two test runs were performed with a ram pump having a circular outlet of 50 mm diameter and an appropriately sized corresponding release valve. In the first experimental run, a dynamic head h between the release valve and water reservoir was set at a height of 3 m and in the second run it was set at 8 m. In both runs, the water lift flow rate was set at 10,000 cc/min. The release valve's stroke s was then adjusted to provide optimum water lift pressure head for a given weight of the release valve. The release valve weight is defined as the hydrostatic pressure generated by the closed valve acting upon water inside the pump body divided by hydrostatic pressure generated by the dynamic (reservoir) head. Thus the weight is really a ratio of two hydrostatic pressures. The results are summarized in Table No. 3:

TABLE 3

DYNAMIC (RESERVOIR) HEAD (m)	WEIGHT OF RELEASE VALVE	STROKE (cm)	LIFT (OUTPUT) HEAD (m)
3	0.01	4.1	12
3	0.02	2.1	30
3	0.05	1.2	33
3	0.09	0.9	31
3	0.12	0.7	28
3	0.15	0.3	21
8	0.01	5.7	32
8	0.02	3.2	78
8	0.05	2.0	83
8	0.09	1.4	84
8	0.12	1.1	80
8	0.15	0.5	61

The experimental results clearly show that there is an optimal release valve weight and stroke range. If the release valve weight is too small, the valve will close too quickly and the water flowing through the pump body will not be able to generate a sufficiently rapid flow velocity to create a suitable water lift pressure head output.

In the above examples, the release valve head 17 had a cross-sectional surface area of 28 cm<sup>2</sup>. When the reservoir head was set at 3 m the actual weight of release valve necessary to create a valve weight ratio of 0.02 was 168 gms.

D. Lift Valve Mechanism

FIG. 6 shows a lift valve mechanism constructed in accordance with the teachings of the present invention. Lift valve mechanism 12 has a lift valve outlet 24 formed in the pump housing 7 for output of the back pressure wave. The valve outlet 24 has the valve outlet face 25. A lift valve 26 having valve head 27 cooperates

with the outlet face 25 to seal the pump housing by head and face contact pressure when the valve is in the closed position. Lift valve 26 reciprocates to an open position when struck by back pressure of above a threshold level.

In the past, it was thought that the lift valve should be constructed to have the minimal possible pressure against outlet face 25, in order to minimize the amount of back pressure.

A lift valve constructed in accordance with the teachings of the present invention, however, departs from past designs and teachings by making the lift valve 26 contact pressure on outlet face 25 relatively high. Some of the back pressure generated within the pump may be wasted by having to expend more back pressure energy to open the lift valve, but the present design allows a much higher initial back pressure generation in the pump.

While a greater percentage of back pressure energy may be wasted opening the lift valve than with the heretofore known lighter weight lift valve, the decrease in energy conservation is compensated by creation of a higher initial back pressure. Therefore, greater lift valve sealing pressure, when used in combination with a relatively light weight release valve as described above, generates higher back pressure within the pump housing and thus increases the pumping capacity. This improved lift valve performance is illustrated by means of the following example.

EXAMPLE 7

In ram pump having a 50 mm diameter inlet, two sets of test runs were performed with a reservoir head of 1 m and 3 m respectively. Contact pressure between lift valve 26 and outlet face 25 has increased and the height of the water lift head was measured. The contact pressure was measured with no water in the pump. The results are summarized in the following Table No. 4:

TABLE 4

DYNAMIC HEAD (m)	CONTACT PRESSURE BETWEEN VALVE AND OUTLET FACE (gm/cm <sup>2</sup> )	OUTLET HEAD
1	5	No automatic operation.
1	10	4.5
1	20	2.7
1	40	2.4
1	60	2.2
1	80	2.1
3	5	No automatic operation.
3	10	12.0
3	20	6.8
3	40	6.3
3	60	6.0
3	80	5.8

As the results show, if the contact pressure between the valve and outlet face is too small, the pump does not work automatically. When the contact pressure is less than approximately 10 gm/cm<sup>2</sup> the back pressure that is created is not sufficient to lift water. If the contact pressure is increased to greater than approximately 10 grams per square centimeter, the ram pump functions automatically. Through the experiments, it was found that if the pressure is increased to more than 20 grams per square centimeter, the pump starts to work automatically, but only after the water lift head becomes higher

than the reservoir head. Accordingly, the pump must be manually cycled until sufficient back pressure is obtained to initiate automatic operation.

If the contact surface area between the lift valve outlet face 25 and valve head 27 is 98 cm<sup>2</sup>, the total weight of the valve must be greater than 980 grams in order to operate the pump automatically and greater than 1960 grams for automatic operation when the water is lifted up a little higher than the dynamic head. Of course, the contact pressure may be obtained by use of a spring, or other biasing means.

E. Summary

Improvements in the lead pipe, release valve mechanism, and lift valve mechanism constructed in accordance with the teachings of the present invention allow for efficient automatic utilization of ram pumps for generation of useful output work pressures. The above examples, tables and figures were for illustrative purposes only and should not be construed to limit the scope of the claims in any way.

I claim:

1. A ram pump powered by a fluid head created by a reservoir located above said pump comprising:

- (a) a pump housing;
- (b) a lead pipe connected to the reservoir and said pump housing for inflow of fluid from the reservoir into said pump housing;
- (c) a release valve mechanism having:
  - (1) a release valve outlet defined by said housing for exhaust of fluid from said pump;
  - (2) a release valve cup attached to said housing and cooperating with said outlet, said cup having cup slots in communication with said outlet;
  - (3) an adjusting ring having ring slots through said ring in a radial direction, said ring adapted for communication with and slidable rotation about said release valve cup, said ring slots cooperating with said valve cup slots to form an outlet port having a cross section, such that rotation of said ring varies said cross section;
  - (4) a release valve reciprocating valve having a stem portion slidably mounted in said valve cup for movement from an open position, to a closed position, such that said release valve reciprocating valve blocks said outlet in said closed position;

(5) means for biasing said release valve reciprocating valve in said open position, such that a bias force generated thereby when said release valve reciprocating valve is in said closed position is between approximately 2% and 12% of a hydrostatic pressure generated by said reservoir fluid head on said closed release valve reciprocating valve; and

(d) a lifting mechanism having:

- (1) a lifting valve outlet defined by said housing;
- (2) a lifting valve outlet face on said lifting valve outlet;
- (3) a reciprocating lifting valve having a valve head, said valve head cooperating with said lifting valve outlet face to contact said lifting valve outlet face and seal said lifting valve outlet when the said reciprocating lifting valve reciprocates to a closed position; and
- (4) means for biasing said reciprocating lifting valve to said closed position, a bias force generated thereby establishing a contact pressure between said head and lifting valve outlet face greater than approximately 10 g/cm<sup>2</sup> without fluid in said pump.

2. The improvement according to claim 1 wherein said release valve reciprocating valve biasing means comprises gravitational force exerted on said release valve reciprocating valve.

3. The improvement according to claim 1 wherein said release valve reciprocating valve biasing means comprises a spring.

4. The improvement according to claim 1 wherein said release valve reciprocating valve has means for selectively adjusting a distance of valve reciprocation from said open position to said closed position.

5. The improvement according to claim 4 wherein said means for selective adjustment of release valve reciprocation includes threads on said release valve reciprocating valve stem and a threaded nut adapted for engagement with said valve stem threads such that threading said nut along said valve stem varies said reciprocation distance.

6. The improvement according to claim 5 wherein said reciprocation distance is adjustable between approximately 5 mm and 40 mm.

\* \* \* \* \*

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- [54] **HYDRAULIC RAM-TYPE WATER PUMP**  
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 [73] **Assignees:** Larry A. Cox; Louis B. Garcia, both  
 of Carmichael, Calif.  
 [21] **Appl. No.:** 261,360  
 [22] **Filed:** Oct. 24, 1988  
 [51] **Int. Cl.<sup>4</sup>** ..... F04F 7/02  
 [52] **U.S. Cl.** ..... 417/226  
 [58] **Field of Search** ..... 417/225, 226, 227

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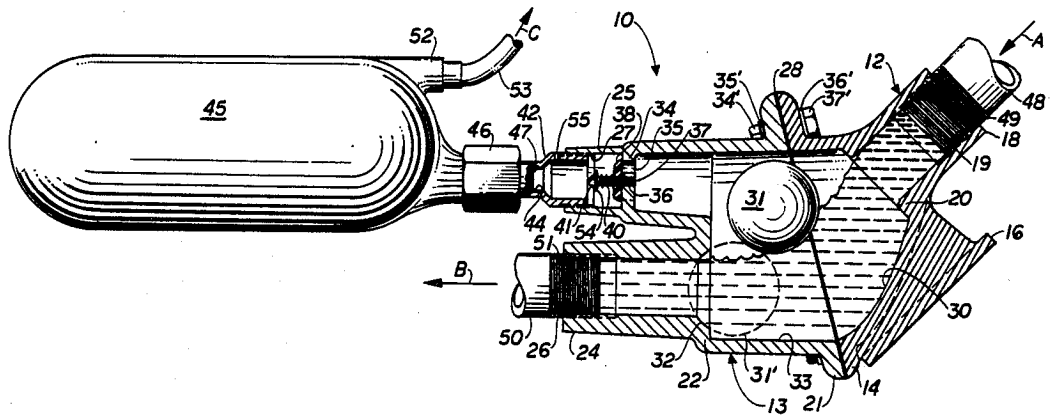
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*Primary Examiner*—Leonard E. Smith  
*Assistant Examiner*—Eugene L. Szczecina, Jr.  
*Attorney, Agent, or Firm*—Mark C. Jacobs

[57] **ABSTRACT**

A motorless water pump for utilizing the rate of flow of falling water to pump the same to a higher location. The pump utilizes a phenomenon known as "water hammer" to use the force of the running water to close a valve and pump the water to a higher location. The pump is economical, portable and contains relatively few moving internal parts.

**7 Claims, 4 Drawing Sheets**



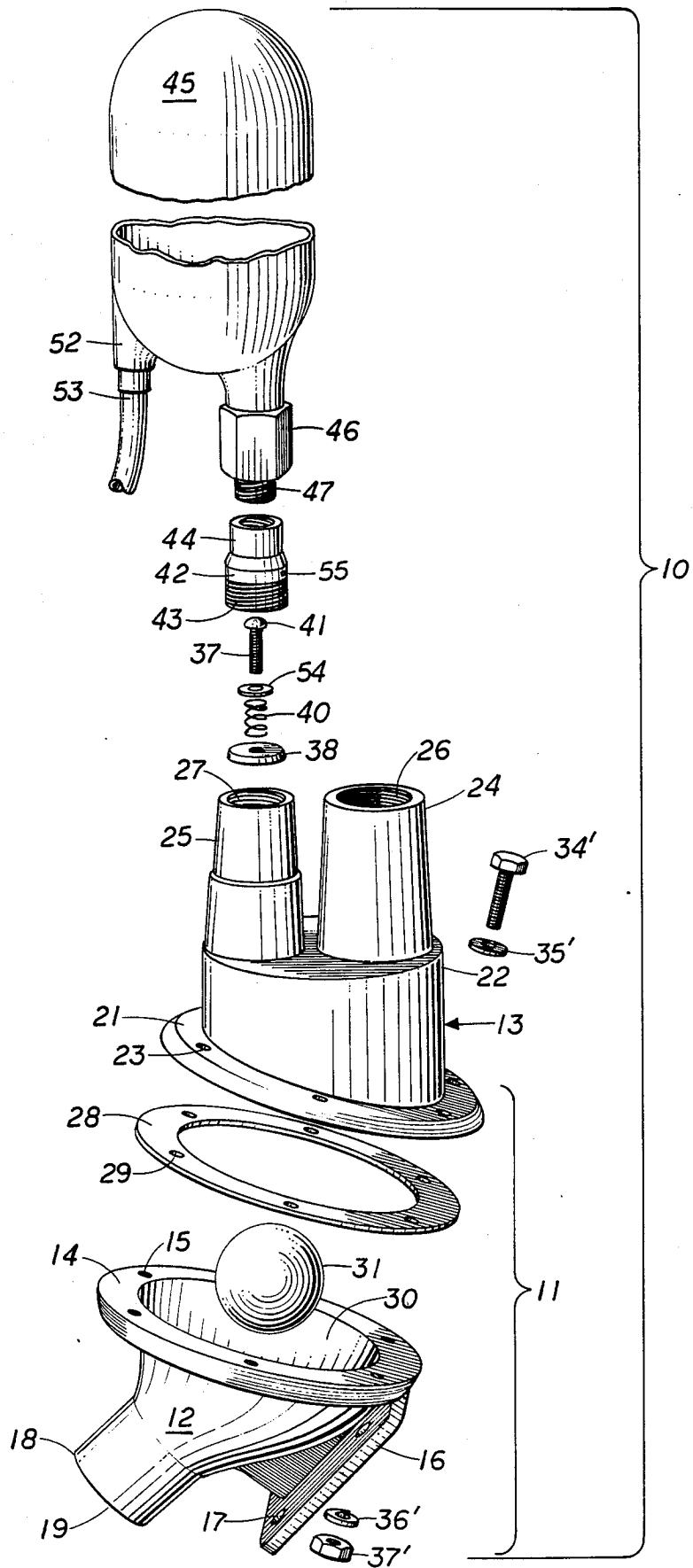


FIG. 1

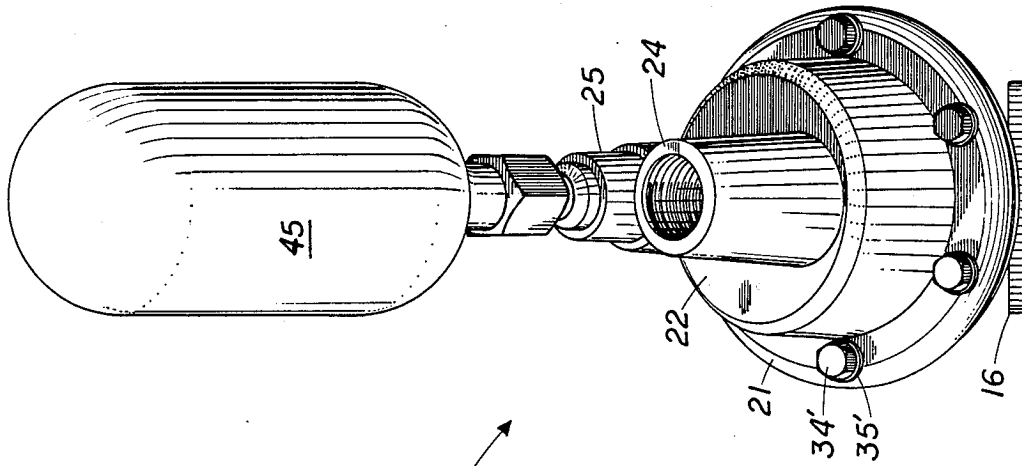


FIG. 3

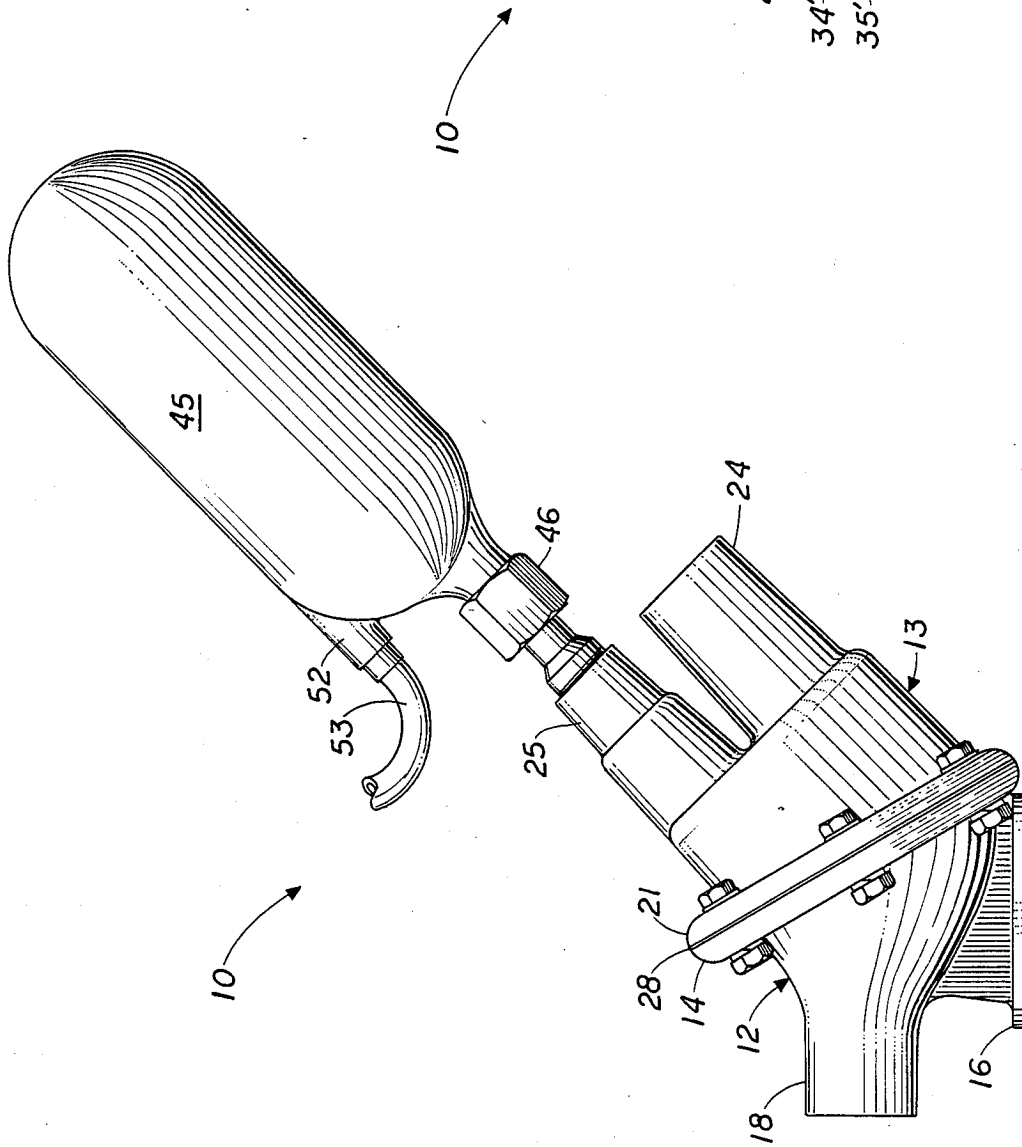


FIG. 2

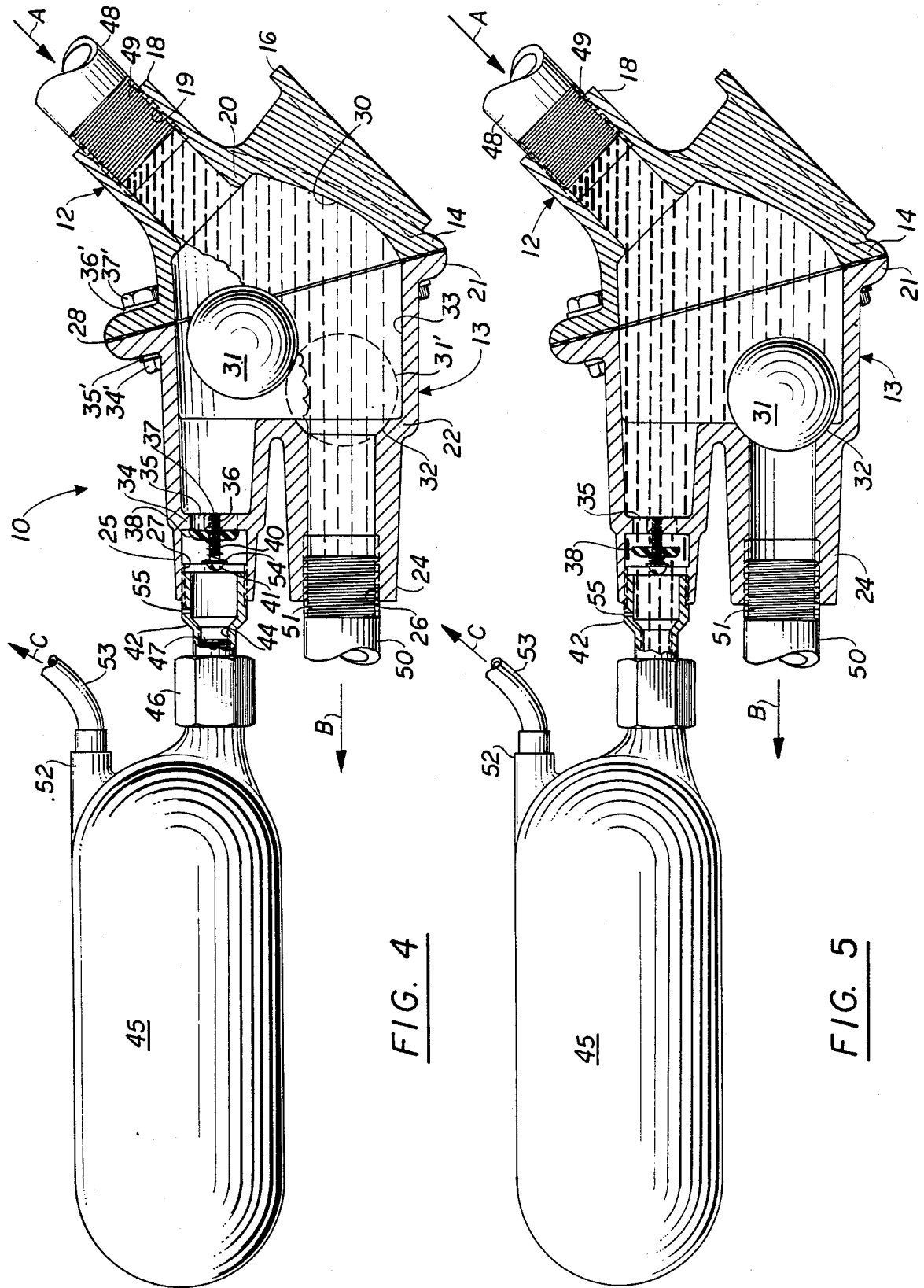


FIG. 4

FIG. 5

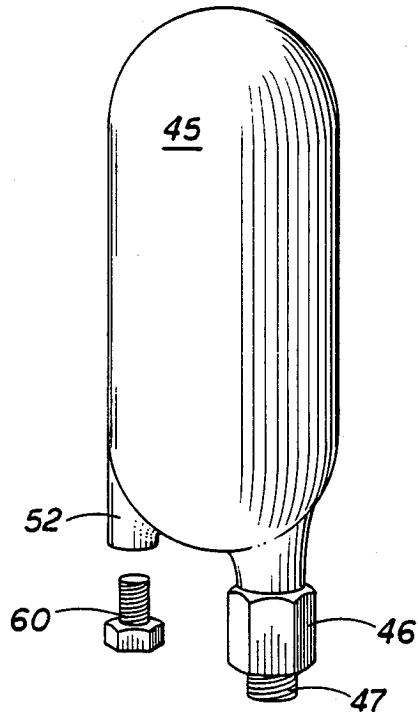


FIG. 6

## HYDRAULIC RAM-TYPE WATER PUMP

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The invention relates to water pumps; and, more particularly, to a motorless water pump using the force of running water to pump the same to a higher location.

#### 2. Description of the Prior Art

Motorless water pumps are known for using the force of flowing water to pump the same to a higher location. One such pump is manufactured by the Skookum Co., Inc., Portland, Oreg., under the name "Skookum-Columbia Hydraulic Ram". This pump uses a waste valve to close off water flow through a pipe outlet to a higher location. The incoming water overcomes the tension on the spring of the waste valve closing the pipe outlet and creating a water hammer effect. This instantaneous pressure of great thrust forces a spring biased valve, normally closing off an air dome, to open admitting water and air to the dome. This relieves pressure on the waste valve which again opens automatically closing the discharge valve and repeating the process. The Skookum pump uses a large number of parts in the valving areas and such parts may clog or become otherwise inoperative or inefficient in use. There is a need for a pump utilizing the water hammer effect using fewer parts and that is more efficient and economical than prior art pumps.

### SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved motorless water pump.

It is a further object of this invention to provide a motorless water pump utilizing water flow and fall thereof to pump water to a higher location.

It is still further an object of this invention to provide such a pump which is economical and uses few internal moving parts.

These and other objects are preferably accomplished by providing a motorless water pump having a floating light-weight ball which seals a valve seat leading into a water outlet, a water inlet leading into the housing having the ball therein and a second water outlet that is spring valve controlled leading to an air dome whereby incoming water moves the ball to close off the first outlet creating a water hammer effect opening up the valve at the second outlet and thereby pumping water out of the first water outlet to a higher location.

### BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded view of a pump in accordance with the teachings of the invention;

FIGS. 2 is a side view of an assembled view of the pump of FIG. 1;

FIG. 3 is an outlet end view of an assembled view of the pump of FIG. 1;

FIG. 4 is a sectional view of the pump of FIGS. 1 to 3; and

FIG. 5 is a view similar to FIG. 4 showing another position of the ball valve.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 of the drawing, a pump 10 is shown having a main housing 11 comprised of a pair of mating flanged sections 12, 13. Flanged section 12 has an apertured flange plate 14, generally circular, with a

plurality of spaced apertures 15 and an integral mounting plate 16. Plate 16 may also have one or more apertures 17 and, as seen in FIG. 2, is at an angle with respect to the plane of plate 14. A water inlet or drive pipe 18 having a threaded inlet 19 (FIGS. 3 and 4) is provided integral with flange plate 14 and may have a boss 20 (see particularly FIG. 3) surrounding pipe 18 also an integral part of plates 14, 16 and pipe 18. As seen in FIG. 2, preferably the central longitudinal axis of pipe 18 is parallel to the plane of flange plate 16. Also, as seen in FIG. 1 the inlet 19 of pipe 18 opens into the interior of flanged section 12.

Flanged section 13 is also comprised of a generally circular flange plate 21 and an integral boss 22. Plate 21 has a plurality of spaced apertures 23 which are aligned with apertures 15 in flanged section 12 when sections 12 and 13 are assembled. A pair of spaced outlets 24 and 25 are provided on section 13 integral with boss 22 having threaded throughbores 26, 27, respectively, fluidly communicating with the interior of section 13. As seen in FIG. 1, outlet 24 is longer than outlet 25. As seen in FIG. 4, a seat 32 is also provided on the interior wall 33 of flanged section 13 communicating with the throughbore 26 of outlet 24. Seat 32 also conforms to the configuration of ball 31. A plurality of bolts 34', spring washers 35', plain washer 36' and nuts 37' (only one set shown in FIG. 1 for convenience of illustration) are provided for insertion into aligned apertures 23, 29 and 15 for securing flanged sections 12, 13 and gasket 28, the assembled pump 10 being shown in FIGS. 2 to 4. Note small hole 55 in section 13, see infra.

A generally circular gasket 28 of any suitable material is provided between flange plates 21 and 14. A plurality of spaced apertures 29 are provided in gasket 28 aligned with aperture 23 and 15 so that, when assembled, gasket 28 is sandwiched between plates 21 and 14 thus preventing leakage. Thus, gasket 29 may be any suitable gasket material, such as rubber, cork, etc.

As seen in FIG. 1, the interior 30 of flanged section 12 surrounding inlet 19 is stepped and provides a seat for a preferably lightweight hollow ball 31, which may be of plastic or any other suitable material, and of a size to seat against seat 32 thereby blocking outlet 24 and closing off the same.

Looking at FIG. 4, the outlet to throughbore 27 is partially closed off by a partition wall 34 having a semi-annular opening 35 therethrough and a threaded aperture 36 receiving therein a threaded screw 37. A resilient bell-shaped valve member 38 is provided in outlet 25 covering semi-annular opening 35 and retained thereto by screw 37 passing therethrough. A spring 40 surrounds the shaft of screw 37 between the head of the screw 41, (which head is preferably slotted for adjustment), and valve member 38. A washer 54 is provided (see FIG. 1) between screw head 41 and spring 40. It is to be understood that pressure of water acting on the underside of valve member 38 moves valve member 38 against the bias of spring 40 to the position shown in FIG. 5 uncovering the opening 35 as will be discussed further hereinbelow.

Outlet 25 is closed off by a valve housing 42 mated at its lower threaded end 43 to threaded throughbore 27 terminating at top in a reduced internally threaded neck 44. Neck 44 is adapted to be threaded to a water delivery pipe for delivering water from pump 10 to a higher location. Also, housing 42 can be removed for access to screw 37 for adjusting spring pressure of the same.



Drive pipe inlet 19 is threaded for connection to a drive pipe for supplying water to pump 10 from a higher location.

An air dome 45 is provided having an elongated generally cylindrical configuration (FIGS. 1 and 2) with an integral nut portion 46 and a hollow threaded end 47 for mating with neck 44. Optionally, a drain plug, such as a threaded screw screwed into the neck portion 52 of dome 45 may be provided for draining the water therefrom if element 53 is not employed for its intended purpose.

Pump 10 is assembled as shown in FIGS. 4 and 5 and as heretofore discussed, by coupling of dome 45 to neck 44, nut portion 46 being used to tighten the same. Drive pipe 48 (FIGS. 4 and 5), having a threaded end 49, coupled to a source of running water (arrow A), is threaded to water inlet 18. Outlet pipe 50, having threaded end 51, is coupled to throughbore outlet 26.

The water (arrow A) delivered through pipe 48 enters pump 10 from the source thereof through a head or fall into inlet 18 and must have a predetermined minimum flow rate.

Thus, any stream of water providing a minimum rate of flow may be used to power pump 10. The greater the gallons of water flowing per minute through the drive mechanism (exiting the pump in direction of arrow 3), the larger capacity pump that can be used and the higher the water exiting outlet 53 (arrow C) can be pumped. Obviously, the size and capacity of pump 10 is chosen depending on the amount of water available, its flow rate, and the amount of water desired to be pumped to a reservoir or other higher location.

In any event, the water arrow A enters pump 10 through drive pipe 18. The speed of the incoming water passes by ball 31 (FIG. 4), which is buoyant and floating, striking the lower half thereof forcing ball 31 to cover the seat 32 surrounding the opening into outlet 24 as seen by ball 31' in dashed lines in FIG. 4. This causes an abrupt stop to the flow of the water resulting in a phenomenon known as the "water hammer" effect in the art.

This "water hammer" effect is an instantaneous pressure of great thrust which forces the discharge valve 38 to open (FIG. 5) admitting water through housing 42 to dome 45, squirting into the hollow interior of reservoir 45. This lifts water through the small outlet pipe 53 see arrow C as high as 30 times greater than the head or fall of water from the source thereof through pipe 48 into drive pipe 18. The opening of valve 38 simultaneously allows water to be pumped entering dome 45 for storage and use and relieves pressure on ball 31. This allows ball 31 to return to the floating position shown in solid lines in FIG. 4, at the upper portion of the interior of pump the water now flows through the drive outlet (arrow B), then repeating the foregoing process in a continuous action. The air pressure in dome 45 absorbs the spurting action of the water injection and smooths out the flow of water through pipe 53.

The pump 10 is completely independent of electricity, gasoline or other external power source and uses the force of flowing water to pump gallons of water efficiently and continuously with little cost. The invention herein can be used for irrigation, watering livestock, camping, municipal water supply, mills, etc; where ever-running water exists and a fall of such water can be utilized. No wells need be dug or driven and no pump motors that can fail are used.

As discussed, pump 10 must be located below the water source and a minimum vertical fall of water (such as 2 feet) through drive pipe 18, is needed. Suitable valves (not shown) may be used on pipes 48 and 50 to control the water flow when operation is not desired. Any suitable materials, such as metals, plastics, fiberglass, rubber where applicable, may be used. Obviously a plurality of pumps such as pump 10 may be used and the air dome can be of any desired size and internal capacity.

The pump herein is portable and lightweight, as for example, 10 to 15 pounds for a 2" diameter pump, and is merely placed on the ground and held in position in any suitable manner. Drive pipe 48 can be of any suitable diameter; reduction connections can be used. The air dome 45 acts as a pressure tank to force the output water through pipe 53 to a higher level. Typically dome 45 measures 2" x 8". Although I have disclosed a specific embodiment of the invention, variations thereof may occur to an artisan and the invention is to be limited only by the scope of the appended claims.

#### OPERATION

As noted earlier, this pump includes a small hole 55 in section 13. Its use will now be discussed. When the ball is in the down or pump position 31', the hole shoots a small stream of water into the air under the effect of water hammer, and when the ball moves back to the floating or charging position 31, a bubble of air is drawn into the pump. The bubble of air keeps the dome full of air down to the outlet line.

When water enters the dome under such instantaneous pressure from the water hammer effect it emulsifies the air admitted through hole 55 with the water and pumps it out of the dome creating a partial vacuum that pulls in outside air through hole 55 to neutralize that vacuum.

I claim:

1. A motorless water pump adapted to utilize the water hammer effect to transfer running water to a higher location comprising:
  - a main pump housing;
  - a fluid inlet opening into one end of the interior of said housing;
  - a pair of generally parallel spaced fluid outlets communicating with the interior of said housing at a location higher from said fluid inlet
  - a said interior being stepped and providing a seat for a ball;
  - a valve seat leading into the first of said outlets;
  - a spring biased valve closing off the second, i.e the other of said outlets;
  - an air dome connected to the said other of said outlets, said air dome having an internal reservoir in fluid communication with the interior of said housing and having an outlet; and
  - a lightweight floating ball disposed in the interior of said pump having a configuration conforming to said valve seat whereby, running water entering said inlet flows out of said one of said outlets, said ball is moved into engagement with and conforms to said valve seat causing an abrupt stop to the flow of incoming water thereby creating a water hammer effect resulting in an instantaneous pressure of water thrust forcing said spring biased valve to open to pump water out the second of said outlets and into the interior of said dome.

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2. In the pump of claim 1 wherein said pump housing is comprised of two mating parts, with a resilient gasket disposed at the junction of said parts.

3. In the pump of claim 1 wherein said valve is a resilient member normally closing off said restricted opening, said valve including a screw threaded into a threaded opening adjacent said restricted opening having a slotted enlarged head thereon, said resilient member slidably mounted on said screw between said head and said restricted opening, and a spring encircling said screw disposed between said head and said resilient member for normally biasing said resilient member into a position closing off said restricted opening.

4. In the pump of claim 1 wherein the other of said outlets includes a terminal threaded end, a valve housing having a first diameter portion threadably engaging

said threaded end and a second threaded diameter portion of an inner diameter less than the inner diameter of said first diameter portion located higher than said first diameter portion.

5. In the pump of claim 1 wherein said ball is a hollow rubber ball.

6. In the pump of claim 1 wherein said pump housing has an integral base plate having a planar surface lying in a generally horizontal plane, the longitudinal axis through the center of said inlet being at an angle corresponding with the plane of said planar surface.

7. In the pump of claim 1 wherein said air dome has a removable plug coupled to a neck portion fluidly communicating with the interior of said air dome for draining water therefrom.

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# United States Patent [19]

[11] Patent Number: **5,271,721**

Richards

[45] Date of Patent: **Dec. 21, 1993**

- [54] **HYDRAULIC RAM PUMPS**
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- [73] Assignee: **Peppermint Springs Pty Ltd, Nariel via Cudgewa, Australia**
- [21] Appl. No.: **582,876**
- [22] PCT Filed: **Apr. 14, 1989**
- [86] PCT No.: **PCT/AU89/00163**
- § 371 Date: **Dec. 11, 1990**
- § 102(e) Date: **Dec. 11, 1990**
- [87] PCT Pub. No.: **WO89/09882**
- PCT Pub. Date: **Oct. 19, 1989**

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*Primary Examiner*—Richard A. Bertsch  
*Assistant Examiner*—Peter Korynyk  
*Attorney, Agent, or Firm*—Dvorak and Traub

### [30] Foreign Application Priority Data

Apr. 14, 1988 [AU] Australia ..... PI7751

- [51] Int. Cl.<sup>5</sup> ..... **F04F 7/02**
- [52] U.S. Cl. .... **417/226**
- [58] Field of Search ..... **417/226**

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### [57] ABSTRACT

Hydraulic ram pump apparatus is provided, of the type including a body member (7) having a water flow passage therethrough, a waste gate (1) disposed in the passage, a delivery outlet (23) and a one-way delivery valve (10, 11) disposed in the outlet. The improvement therein lies in the waste gate (1) being pivotally mounted to the body member (7) and configured such that, in its fully open position (1a), the waste gate (1) does not significantly restrict the flow of water through said passage, in the interest of efficiency at low drive heads. The waste gate (1) is spring biased towards its open position to provide opening assistance to the waste gate (1) at low drive heads. The spring bias is such that it is at its greatest when the waste gate (1) is fully closed and is substantially zero when the waste gate is fully open.

2 Claims, 2 Drawing Sheets

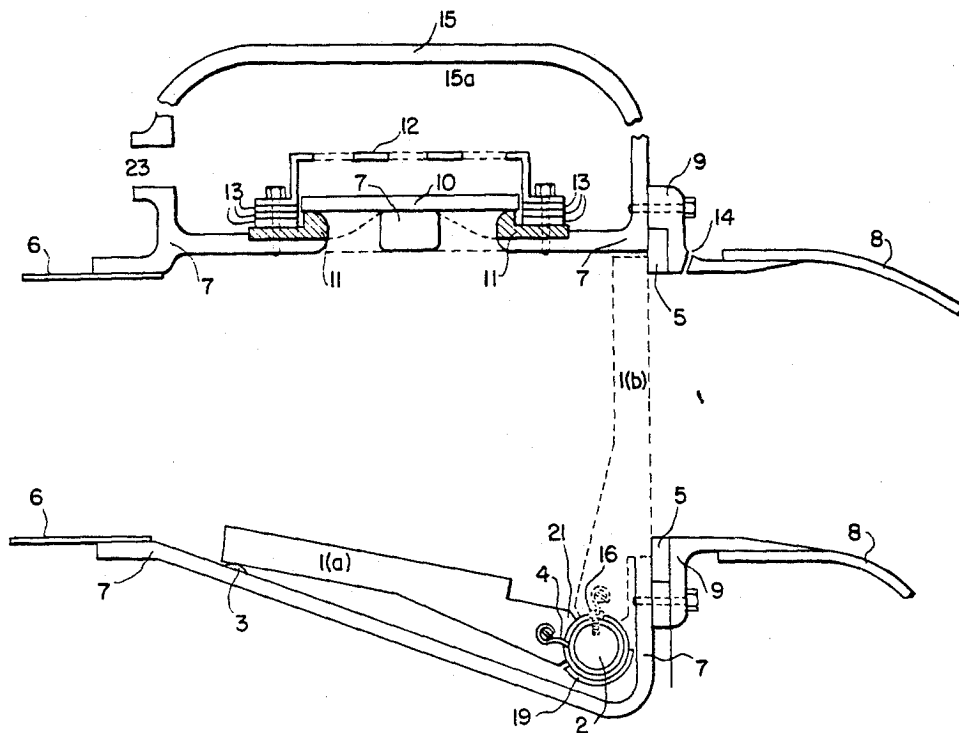


FIG. 1

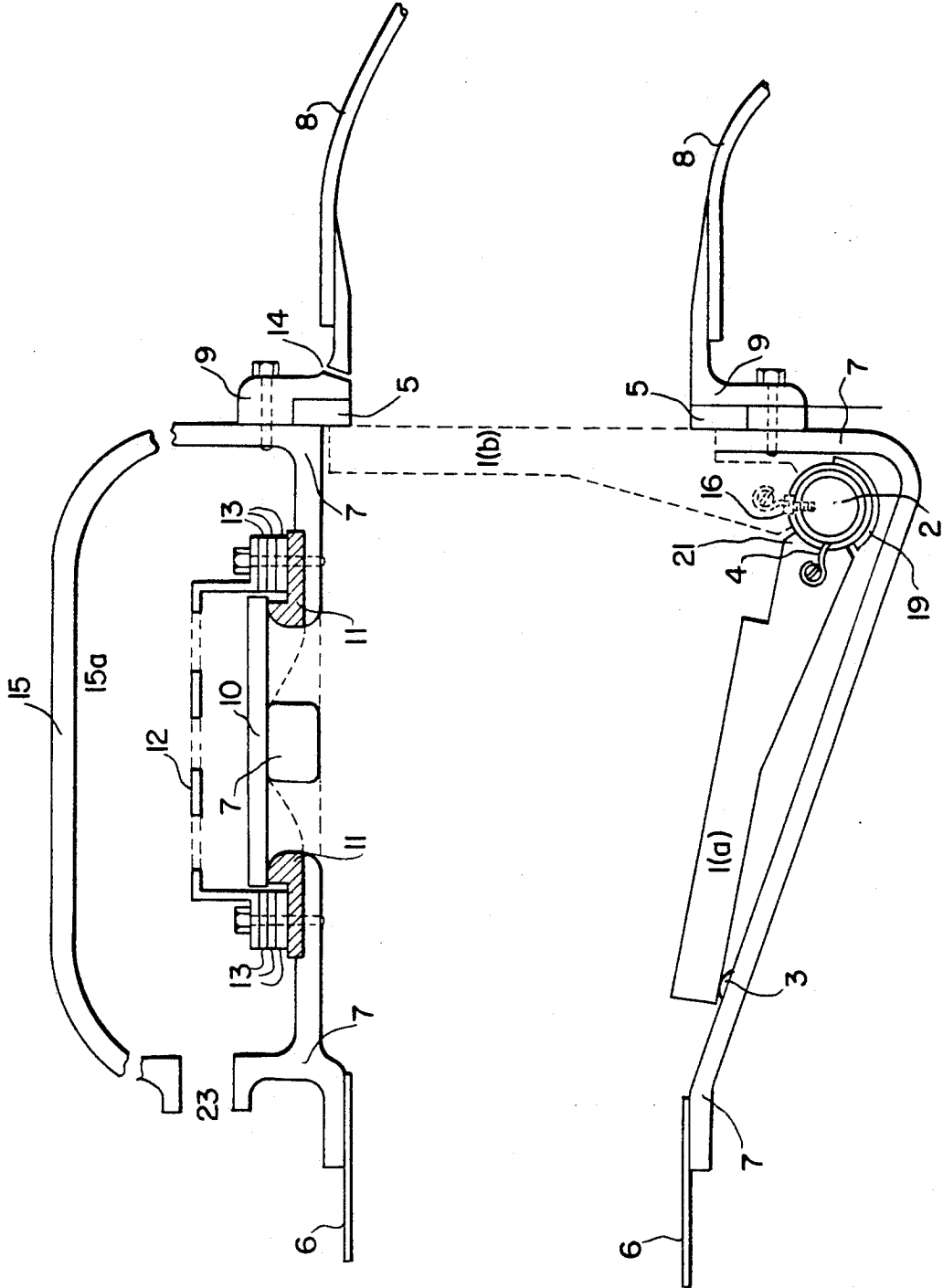
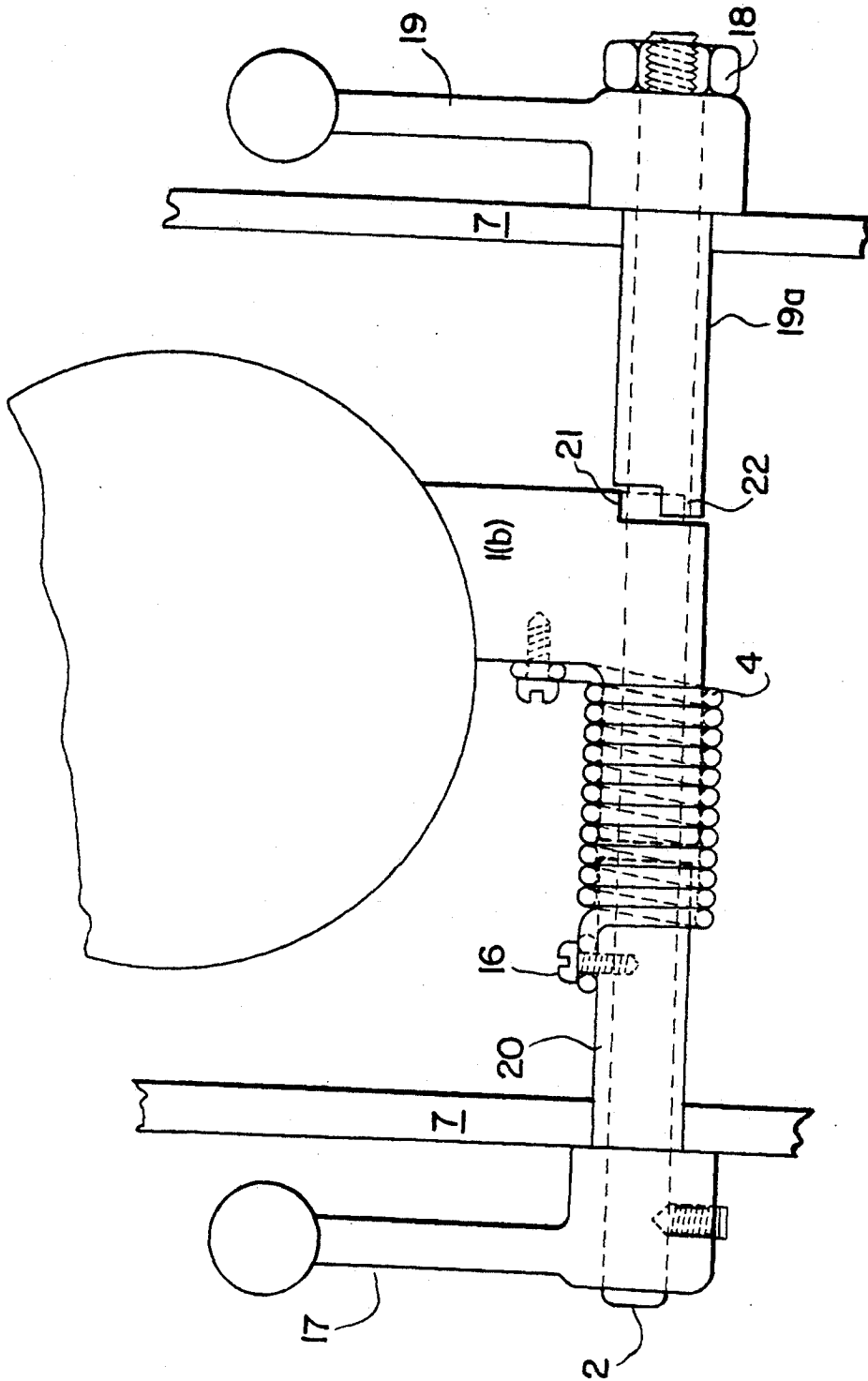


FIG. 2



## HYDRAULIC RAM PUMPS

## FIELD OF THE INVENTION

This invention relates to hydraulic apparatus.

This invention has particular but not exclusive application to hydraulic ram pumps, and for illustrative purposes reference will be made to such application. However, it is to be understood that this invention could be used in other applications, such as control apparatus using the hydraulic ram principle.

The pumping of stream, lake or reservoir water for agricultural or domestic purposes has been practiced since before recorded history. Any number of expressions of man's ingenuity have been applied to getting water from a source to a point of use. However, since there is a net energy cost in elevating water against gravity and since the potential energy of the raised water is never recovered, all means of raising the water require energy to be input. In the developed nations, the ready availability of convenient power such as electricity and internally combustible fuels has fostered a pumping technology substantially dependent on such power sources. This technology is of course completely inappropriate for use in third world or developing countries, not only from the point of view of energy supplies but also from the point of view of keeping maintenance up to the hardware.

In areas or applications where power-dependant equipment is impossible or undesirable to use, other means of supplying energy to the task of pumping must be sought. Traditionally, the art of water pumping began with the archimedean screw. This requires manual or other power for rotation and may be powered by the wind via a windmill or by water via a waterwheel or screw. The disadvantage of the archimedean screw is a severe limitation of the obtainable head, at least while retaining the apparatus' general simplicity of construction. Other simple hardware powered by wind or water includes piston pumps.

Wind powered apparatus in general have the disadvantage of being dependent upon the blowing of the wind at adequate energy flux to do useful work. Water powered apparatus are more reliable in this context but are often relatively complex and prone to mechanical failure and fouling. Waterwheels, screws and turbines are also very inefficient and at low heads need to be of very large size to make use of the available power in the water flow.

One relatively recent means of pumping utilizing the energy of a flowing stream of other water head is the use of hydraulic ram pumps. In general terms these pumps utilize the energy of water flowing through an inlet tube to close a gate across the tube. The closing of the gate creates a pressure pulse upstream of the gate, which pressure pulse exceeds the local water pressure. The tube is provided with an outlet upstream of the gate and fitted with a one-way delivery valve, such that the overpressure pulse pumps a quantity of water through the delivery valve. The delivery valve is generally air cushioned with the air supply to the air cushion being provided by a snifter valve adapted to draw air into the tube upstream of the waste gate and thence into the delivery valve. As the overpressure pulse decays the valve closes and the gate opens to allow the bulk of the water to return to the stream or outfall as waste. The cycle is then repeated at a frequency dictated by the

velocity of the water flow and the configuration of the gate.

Conventional hydraulic ram pumps generally do not function at heads of less than 900 mm of water. The factors limiting low drive head performance in conventional hydraulic ram pumps include the following:

(a) A conventional waste gate generates considerable head loss, particularly when adjusted for low drive head conditions. This head loss increases the drive head necessary to produce satisfactory fluid velocities in the drive pipe.

(b) The bodies of conventional hydraulic ram pumps create considerable head loss due to a rapid change in flow direction.

(c) Conventional hydraulic ram pumps require a relatively large drive pipe "length to diameter ratio" (called L/D from here on) to operate reliably because their waste gates will not open properly with the reduced negative pressures created in hydraulic ram pumps using small L/D's at low fluid velocities. However, small drive pipe L/D's are essential in low drive head conditions to minimise head loss in the drive pipe.

(d) When operating at low drive heads, conventional hydraulic ram pumps tend to stop when impurities are caught in the waste gate or the delivery valve because the negative pressures, already low due to low fluid velocities in the pump, are reduced even further by a waste gate sealing badly. There is then insufficient negative pressure to reopen the waste gate.

(e) To obtain useful quantities of delivered fluid when operating at very low drive heads, a large volume of fluid must pass through the hydraulic ram pump. The cycle time of the hydraulic ram pump is also reduced dramatically at very low drive heads and these two factors mean a large diameter drive pipe is necessary to produce a large delivery flow per pulse. This large flow per pulse necessitates a large cross section delivery valve to reduce friction loss, but at large delivery heads the volume displaced by the moving delivery valve is comparable to the volume being pumped per pulse and the pumping efficiency becomes quite small.

(f) When operating with low drive heads, hydraulic ram pumps must be installed very close to the down stream fluid level to maximise the drive head available to the pump. This makes the air injecting valve very prone to inundation when there are small changes in the stream height. The air injecting valve is also prone to blockage due to its small cross section and the large positive pumping pressures which may force debris into the valve.

The above disadvantages are generally caused by the traditional design of the waste gate and mechanism, the delivery valve design and the perceived necessity of using a air injecting valve on the upstream side of the waste gate.

## SUMMARY OF THE INVENTION

The present invention aims to alleviate the above disadvantages and to provide hydraulic ram pumping apparatus which will be reliable and efficient in use. It is a further object of the present invention to provide a hydraulic ram pump which is particularly suited for applications using head pressures at which conventional hydraulic ram pumps do not operate efficiently. Other objects and advantages of this invention will hereinafter become apparent.

With the foregoing and other objects in view, this invention in one aspect resides broadly in hydraulic ram pump apparatus of the type including:

a body member having a water flow passage there-through;

a waste gate disposed in said passage;  
a delivery outlet; and

a one-way delivery valve disposed in said outlet, wherein said waste gate is configured such that, in its fully open position, the waste gate does not significantly restrict the flow of water through said passage.

Preferably, the body member comprises a substantially cylindrical housing incorporating the waste gate and the delivery outlet and valve in a single assembly. Preferably, the inlet end of the passage is connected to an inlet pipe which delivers the water to the assembly. The purpose of the inlet pipe is to set the L/D ratio discussed above, with the optimum L/D ratio being selected as the best compromise between minimum head loss (small L/D ratio) and increased waste gate opening negative pressure pulse (large L/D ratio).

The body member is preferably provided with a generally circular waste gate mounted to the body member such that the waste gate, in its fully open position, does not significantly restrict the flow of water through the passage. This is preferably achieved by providing a recess in the housing in to which the waste gate can sit in its fully open position. In the interest of efficiency at low drive heads, the waste gate is preferably pivotally mounted to the body member at this recess such that the waste gate does not significantly impede the flow of the water when the gate is in its fully open position. The recess is preferably in the form of a ramped recess having its deepest point at the downstream, pivoted end of the fully open waste gate. The waste gate is also preferably of a thickness such that the upstream edge of the waste gate is available to form a working surface for the flowing water to start to pick up the waste gate from the recess. When the waste gate is picked up from the recess, the water flow then drives the waste gate towards the closed position in a manner analogous to a conventional hydraulic ram pump.

The body member is also preferably provided with a seat to provide an impact area for the waste gate as it closes, as well as to seal the waste gate in its closed position. Again, it is preferable that the seat does not protrude significantly into the water flow path defined by the passage through the body.

The waste gate is preferably spring biased towards its open position to provide opening assistance to the waste gate at low drive heads. Preferably, the spring bias is such that it is at its greatest when the waste gate is fully closed and is substantially zero when the waste gate is fully open. The large spring bias of the waste gate towards the open position allows the waste gate to open with the very small opening negative pressures associated with small drive heads, whilst the zero spring bias applying at the fully open position permits the same small drive head to pick the waste gate out of the recess and to close the same against its seat with sufficient force to provide a positive pumping pulse.

Accordingly, in a further aspect this invention resides broadly in hydraulic ram pump apparatus of the type including:

a body member having a water flow passage there-through;

a waste gate disposed in said passage;  
a delivery outlet; and

a one-way delivery valve disposed in said outlet, wherein said waste gate is biased towards its fully open position, the said bias being at its greatest when the waste gate is fully closed and substantially zero when the waste gate is fully open.

The bias is preferably provided by a spring acting between the body member and the waste gate with it being particularly preferred to use a helical spring about the pivot axis of the waste gate to prevent unnecessary interference with the flow of water through the apparatus.

The delivery outlet is preferably disposed between the body member and a delivery pipe conveying the pumped water to a point of use or storage. Preferably, the outlet is of the type having a cushioning air chamber above the outlet delivery valve to provide a compressible space, allowing water to pass into the outlet irrespective of the water condition further along the delivery pipe. The delivery valve is preferably of the type known as a disc valve and seat, wherein a disc shaped member is disposed on a circular seat and retained on the seat by gravity and back pressure, with or without spring assistance. The maximum displacement of the valve disc from its seat is preferably adjustable in order to optimize the pumping efficiency through the valve.

In a further aspect, this invention resides in hydraulic ram pump apparatus of the type including:

a body member having a water flow passage there-through;

a waste gate disposed in said passage;  
a delivery outlet; and

a one-way delivery valve disposed in said outlet, wherein said one-way delivery valve is adjustable in its extent of opening to optimize pumping efficiency of the hydraulic ram pump.

Preferably, the delivery valve is of the disc type described above and the adjustment is provided by adjustably limiting the lift of the valve disc off its seat during a pumping cycle. At large drive heads the valve can be adjusted to decrease the displacement of the valve disc such that the volume displaced by the moving disc is less than the volume being pumped per pulse to improve the pumping efficiency.

The delivery outlet and valve, being preferably of the air cushioned type, must be supplied with air to replace that which inevitably passes out along a delivery pipe attached to the outlet. In the past, an air injecting valve has been provided to provide air to the body member in the region of the delivery valve, that is, upstream of the waste gate. However, these air injecting valves suffer from the disadvantage described above at (f) in that exposure to the high positive pumping pressures may force debris into the valve and effect a blockage.

Accordingly, in another aspect, this invention resides broadly in a hydraulic ram pump apparatus of the type including:

a body member having a water flow passage there-through;

a waste gate disposed in said passage;  
a delivery outlet positioned upstream of said waste gate;

a one-way delivery valve disposed in said outlet; and  
an air injecting valve supplying cushioning air to said one-way delivery valve, wherein said air injecting valve is located downstream of said waste gate such that air is drawn through said air injecting valve and into the body member upstream of said waste gate during the opening phase of said waste gate.

Preferably, the air injecting valve consists of a small orifice which passes from outside the pump body to the point in the waste fluid flow downstream from the waste gate seat.

Since the pressure downstream of the waste gate is always lower than the peak pressure upstream of the waste gate, the air injecting valve is never subjected to the pumping pressures which was the primary cause of blockage in the prior art apparatus. The air injecting valve is preferably of a size to maintain an adequate air supply to the delivery valve for cushioning purposes without providing so much that the apparatus gas locks. The size of the air injecting valve is determined by experiment in individual apparatus, if desired the air injecting valve may be adjustable.

The downstream waste outlet of the apparatus preferably takes the form of a descending waste pipe which extends down to below the water level downstream of the apparatus. Such an arrangement provides for the creation of a siphon effect assisting acceleration of the waste gate to its fully closed position and accordingly increasing the pump pulse peak pressure. A second advantage of this configuration is that the siphon connection with the downstream water level prevents uncontrolled entry of air into the apparatus and thus prevents vapour locking of the apparatus.

#### BRIEF DESCRIPTION OF THE DRAWINGS

In order that this invention may be more easily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention, wherein:

FIG. 1 is a side view in vertical section of apparatus in accordance with the present invention, and

FIG. 2 is a front view in vertical section of the apparatus of FIG. 1.

#### DETAILED DESCRIPTION OF THE INVENTION

In the FIGURES, a hydraulic ram pump assembly is provided having a waste gate 1 illustrated in its fully open position 1a and illustrated in its fully closed position 1b. The waste gate 1 is pivotally mounted on a shaft 2 located transverse to and out of the direct line of the water flow. The waste gate 1 is biased towards its fully open position by spring 4 coaxial with the shaft 2. The waste gate 1 is adapted to seal in its fully closed position against annular seal ring 5. The water is supplied to the apparatus via feed pipe 6 attached to the inlet side of housing 7. The waste gate 1 in its fully open position rests in recess 7a in the lower portion of the housing 7, which recess also accommodates the shaft 2 and the spring 4. The waste side of the housing 7 is terminated by an annular seal housing 9 adapted to retain the seal 5 as well as to mount waste outlet pipe 8. The seal housing 9, seal 5 and waste pipe 8 are of a diameter similar to that of the inlet pipe 6 such that the flow of water is not significantly impeded. The waste pipe 8 is curved down to the downstream water level to provide a siphon to assist the water hammer action of the apparatus to open and close the waste gate 1.

The upper portion of the housing 7 upstream of the waste gate 1 is provided with a delivery outlet comprising apertures in the housing 7. The apertures are closed by a delivery valve comprised of a valve disc 10 adapted to seal against seal 11. The displacement of the valve disc 10 on the pump stroke is limited by stop 12 which is adjustable via selectable spacers 13. The deliv-

ery valve is housed in housing extension 15 formed integrally with the housing 7. The housing extension 15 defines an air space 15a which provides elastic cushioning of the pump. The valve housing 15 is provided with a delivery port 23 to which a delivery pipe can be attached. The cushioning air for the valve is supplied by air injecting valve 14 located downstream of the waste gate 1. The air injecting valve 14 consists of a small orifice which passes from outside the pump body to the point in the waste fluid flow downstream from the waste gate seat.

The shaft 2 is mounted to the housing 7 via shaft sleeve 20. The shaft sleeve 20 also provides a mounting point for the spring 4 at 16. The effective spring tension is controlled by rotation of the shaft 2 and sleeve 20 assembly relative to the waste gate 1 extension to the shaft 2. This relative rotation is effected by rotation of control lever 17 attached to the shaft 2. Start and stop control of the assembly is provided by start/stop lever 19 acting on sleeve 19a which is provided with gate opening lug 22. A gate closing lug 21 is provided on the waste gate 1. The position of the lever 19 is retained as desired by lock nut 18.

The open waste gate 1(a) is nearly in balance in the position shown with the combined forces of gate 1(a) buoyancy and spring 4 torsion nearly balancing the gravitational force acting on the gate 1(a). In this position the open gate 1(a) rests lightly against gate stop 3 and creates very little head loss. As the fluid velocity passing the leading edge of gate 1(a) from drive pipe 6 reaches a point where the pressure and viscous forces acting on the gate 1(a) overcome all other forces acting on the gate 1(a), the gate 1(a) begins to close. (the sum of spring 4 torsion, buoyancy and gravitational forces acting on the gate is defined as the gate opening force and hereinafter called  $F_o$ ).

The gate 1(a) rotates clockwise about gate pivot shaft 2 and as the gate 1(a,b) projects further into the fluid flow the increasing pressure and viscous forces more than cope with the increasing  $F_o$  and the gate 1(a,b) quickly accelerates up to the velocity of the water.

When the waste gate 1(a,b) reaches the closed position, the gate opening force  $F_o$  has increased significantly because the spring 4 which was acting to close the gate 1(b) when the gate 1(a) was open, is now acting with the negative pressure pulse to open the gate 1(b), and the gravitational and buoyancy forces acting to open the gate 1(b) have dropped to almost zero.

This large value of gate opening force  $F_o$  when the gate 1(b) is closed enables the gate 1(b) to swing open with only very small negative pressures associated with operating the pump at small L/D's and/or sealing problems due to debris caught between the gate 1(b) and the waste gate seat 5.

Waste tube 8 carries the fluid which has passed through the pump waste outlet 9 in a large radius to the downstream fluid level. The waste tube 8 is either immersed under the down stream fluid or has its open end tilted back. This traps fluid in the waste tube 8 and prevents gas entering the pump body 7.

The waste tube 8 also acts as a siphon and applies most of the pressure difference between the upstream and downstream fluid level across the drive pipe 6. Consequently, the hydraulic ram pump may be mounted as high as the upstream fluid level and away from potential flooding.

The delivery valve disc 10 deals against the valve seat 11 and is constrained in its movement by valve stop 12.



The volume of fluid displaced by valve disc 10 when it opens is determined by the distance between the top of the valve disc 10 and the bottom of the valve stop 12. This distance may be adjusted by changing the thickness of the spacers 13 to optimise the delivery efficiency of the hydraulic ram pump at different delivery heads.

Air injecting valve 14 injects gas into the downstream side of the waste gate seat 5 because there is always negative pressure inside the pump waste outlet 9.

This negative pressure is normally small due to the siphon effect of the waste tube 8 and momentarily large due to the negative water hammer effect when the waste gate 1(b) closes.

When the waste gate 1(a,b) opens after a pumping cycle, the reverse flow of water through the pump waste outlet 9 carries some of the injected gas into the roof of the pump body 7 where it is subsequently carried into the air chamber 15 during the following pumping cycle.

One end of spring 4 is rigidly connected to control lever 17 by spring clamp 16 which clamps spring 4 to the pivot shaft 2 through shaft sleeve 20. The position of control lever 17 and consequently, spring clamp 16 determines the maximum value of  $F_o$ . The force  $F_o$  acting on the gate 1(a,b) may be adjusted by moving control lever 17 to suit specific pumping conditions. When control lever 17 is correctly adjusted, lock nut 18 may be tightened to prevent control lever 17 from moving.

Because all moving parts of the low drive head hydraulic ram pump are not directly accessible, it is necessary to provide a means of opening and closing the gate 1(a,b) from outside the pump body 7.

This is necessary to manually pump air out of the pump body 7 if the hydraulic ram pump has been stopped for any length of time.

When lock nut 18 is loose, rotation of start/stop lever 19 past the point where it contacts gate opening lug 21 causes the gate 1(a,b) to open. If start/stop lever 19 is

rotated in the opposite direction past the point where it contacts gate closing lug 22, the gate 1(a,b) may be forced to close.

It will of course be realised that while the above has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as defined in the claims appendant hereto.

I claim:

1. A hydraulic ram pump apparatus comprising:

a body member having a water flow passage there-through;

a waste gate pivotally mounted in said passage and being movable between an open position wherein water may flow past said waste gate and a closed position wherein said waste gate substantially closes said flow passage;

a delivery outlet having a non-return valve therein and located upstream of said waste gate, said delivery outlet having an air chamber having air compressed by the passage of water delivered to said air chamber through said non-return valve, said air being supplied through an air injection valve located downstream of said waste gate and into said body member upstream of said waste gate during the opening of said waste gate; and

a waste water outlet downstream of said waste gate; and gate biased away from the closed position, the bias being greatest when the waste gate is closed and the bias being substantially non-existent when said waste gate is open.

2. The hydraulic ram pump of claim 1 wherein said air injection valve comprises an orifice communicating with the fluid flow to atmosphere, said orifice providing a valve action due to the relative velocities of air and water.

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# United States Patent [19]

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Richards

[45] Date of Patent: **May 10, 1994**

- [54] **HYDRAULIC RAM PUMPS**
- [75] Inventor: **Ian J. Richards, Victoria, Australia**
- [73] Assignee: **Peppermint Springs Pty Ltd., Victoria, Australia**
- [21] Appl. No.: **805,390**
- [22] Filed: **Apr. 26, 1993**

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### Related U.S. Application Data

[63] Continuation of Ser. No. 582,876, Dec. 11, 1990.

### [30] Foreign Application Priority Data

Apr. 14, 1988 [AU] Australia ..... PI7751

- [51] Int. Cl.<sup>5</sup> ..... **F04F 7/02**
- [52] U.S. Cl. .... **417/226**
- [58] Field of Search ..... 417/226

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### [57] ABSTRACT

Hydraulic ram pump apparatus is provided, of the type including a body member (7) having a water flow passage therethrough, a waste gate (1) disposed in the passage, a delivery outlet (23) and a one-way delivery valve (10, 11) disposed in the outlet. The improvement therein lies in the waste gate (1) being pivotally mounted to the body member (7) and configured such that, in its fully open position (1a), the waste gate (1) does not significantly restrict the flow of water through said passage, in the interest of efficiency at low drive heads. The waste gate (1) is spring biased towards its open position to provide opening assistance to the waste gate (1) at low drive heads. The spring bias is such that it is at its greatest when the waste gate (1) is fully closed and is substantially zero when the waste gate is fully open.

**11 Claims, 2 Drawing Sheets**

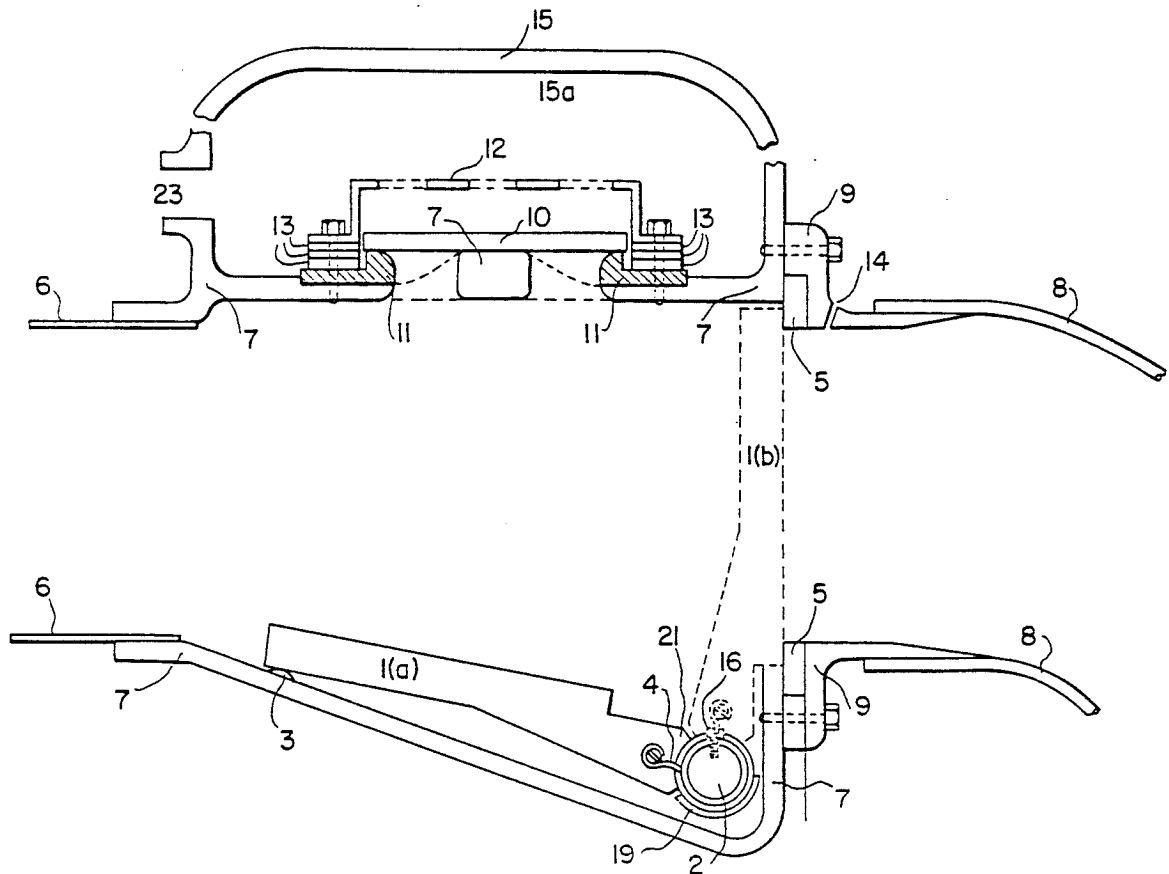
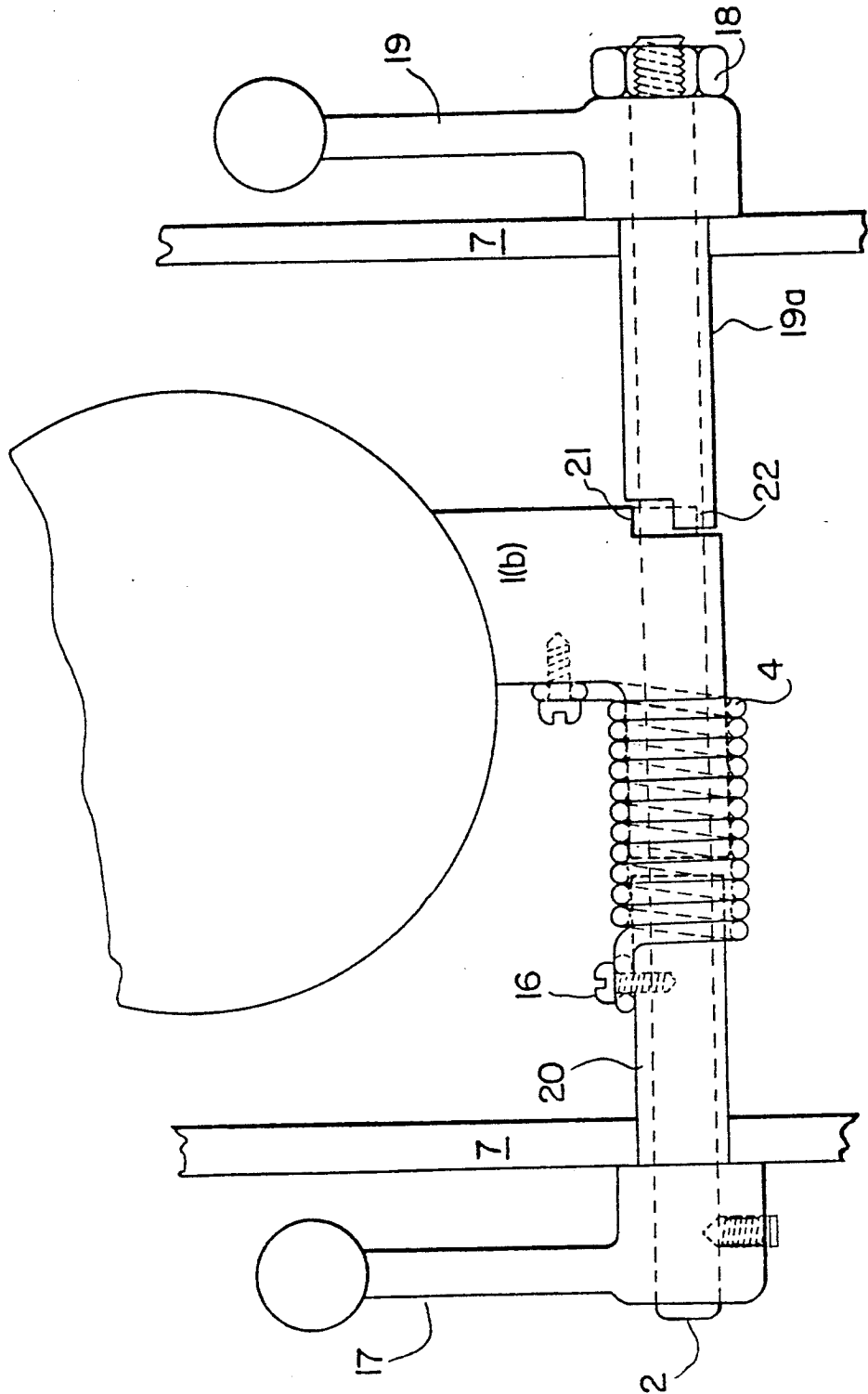




FIG. 2



## HYDRAULIC RAM PUMPS

This is a continuation of copending application U.S. Ser. No. 07/582,876 filed on Oct. 12, 1990, now issued. 5

### FIELD OF THE INVENTION

This invention relates to hydraulic apparatus.

This invention has particular but not exclusive application to hydraulic ram pumps, and for illustrative purposes reference will be made to such application. However, it is to be understood that this invention could be used in other applications, such as control apparatus using the hydraulic ram principle. 10

The pumping of stream, lake or reservoir water for agricultural or domestic purposes has been practiced since before recorded history. Any number of expressions of man's ingenuity have been applied to getting water from a source to a point of use. However, since there is a net energy cost in elevating water against gravity and since the potential energy of the raised water is never recovered, all means of raising the water require energy to be input. In the developed nations, the ready availability of convenient power such as electricity and internally combustible fuels has fostered a pumping technology substantially dependent on such power sources. This technology is of course completely inappropriate for use in third world or developing countries, not only from the point of view of energy supplies but also from the point of view of keeping maintenance up to the hardware. 15 20 25 30

In areas or applications where power-dependant equipment is impossible or undesirable to use, other means of supplying energy to the task of pumping must be sought. Traditionally, the art of water pumping began with the archimedean screw. This requires manual or other power for rotation and may be powered by the wind via a windmill or by water via a waterwheel or screw. The disadvantage of the archimedean screw is a severe limitation of the obtainable head, at least while retaining the apparatus' general simplicity of construction. Other simple hardware powered by wind or water includes piston pumps. 35 40 45

Wind powered apparatus in general have the disadvantage of being dependent upon the blowing of the wind at adequate energy flux to do useful work. Water powered apparatus are more reliable in this context but are often relatively complex and prone to mechanical failure and fouling. Waterwheels, screws and turbines are also very inefficient and at low heads need to be of very large size to make use of the available power in the water flow. 45 50

One relatively recent means of pumping utilizing the energy of a flowing stream of other water head is the use of hydraulic ram pumps. In general terms these pumps utilize the energy of water flowing through an inlet tube to close a gate across the tube. The closing of the gate creates a pressure pulse upstream of the gate, which pressure pulse exceeds the local water pressure. The tube is provided with an outlet upstream of the gate and fitted with a one-way delivery valve, such that the overpressure pulse pumps a quantity of water through the delivery valve. The delivery valve is generally air cushioned with the air supply to the air cushion being provided by a snifter valve adapted to draw air into the tube upstream of the waste gate and thence into the delivery valve. As the overpressure pulse decays the valve closes and the gate opens to allow the bulk of the 55 60 65

water to return to the stream or outfall as waste. The cycle is then repeated at a frequency dictated by the velocity of the water flow and the configuration of the gate.

Conventional hydraulic ram pumps generally do not function at heads of less than 900 mm of water. The factors limiting low drive head performance in conventional hydraulic ram pumps include the following:

(a) A conventional waste gate generates considerable head loss, particularly when adjusted for low drive head conditions. This head loss increases the drive head necessary to produce satisfactory fluid velocities in the drive pipe.

(b) The bodies of conventional hydraulic ram pumps create considerable head loss due to a rapid change in flow direction.

(c) Conventional hydraulic ram pumps require a relatively large drive pipe "length to diameter ratio" (called L/D from here on) to operate reliably because their waste gates will not open properly with the reduced negative pressures created in hydraulic ram pumps using small L/D's at low fluid velocities. However, small drive pipe L/D's are essential in low drive head conditions to minimise head loss in the drive pipe.

(d) When operating at low drive heads, conventional hydraulic ram pumps tend to stop when impurities are caught in the waste gate or the delivery valve because the negative pressures, already low due to low fluid velocities in the pump, are reduced even further by a waste gate sealing badly. There is then insufficient negative pressure to reopen the waste gate.

(e) To obtain useful quantities of delivered fluid when operating at very low drive heads, a large volume of fluid must pass through the hydraulic ram pump. The cycle time of the hydraulic ram pump is also reduced dramatically at very low drive heads and these two factors mean a large diameter drive pipe is necessary to produce a large delivery flow per pulse. This large flow per pulse necessitates a large cross section delivery valve to reduce friction loss, but at large delivery heads the volume displaced by the moving delivery valve is comparable to the volume being pumped per pulse and the pumping efficiency becomes quite small.

(f) When operating with low drive heads, hydraulic ram pumps must be installed very close to the down stream fluid level to maximise the drive head available to the pump. This makes the snifter valve very prone to inundation when there are small changes in the stream height. The snifter valve is also prone to blockage due to its small cross section and the large positive pumping pressures which may force debris into the valve.

The above disadvantages are generally caused by the traditional design of the waste gate and mechanism, the delivery valve design and the perceived necessity of using a snifter valve on the upstream side of the waste gate.

### SUMMARY OF THE INVENTION

The present invention aims to alleviate the above disadvantages and to provide hydraulic ram pumping apparatus which will be reliable and efficient in use. It is a further object of the present invention to provide a hydraulic ram pump which is particularly suited for applications using head pressures at which conventional hydraulic ram pumps do not operate efficiently. Other objects and advantages of this invention will hereinafter become apparent.

With the foregoing and other objects in view, this invention in one aspect resides broadly in hydraulic ram pump apparatus of the type including:

- a body member having a water flow passage there-through;
- a waste gate disposed in said passage;
- a delivery outlet; and
- a one-way delivery valve disposed in said outlet, wherein said waste gate is configured such that, in its fully open position, the waste gate does not significantly restrict the flow of water through said passage.

Preferably, the body member comprises a substantially cylindrical housing incorporating the waste gate and the delivery outlet and valve in a single assembly. Preferably, the inlet end of the passage is connected to an inlet pipe which delivers the water to the assembly. The purpose of the inlet pipe is to set the L/D ratio discussed above, with the optimum L/D ratio being selected as the best compromise between minimum head loss (small L/D ratio) and increased waste gate opening negative pressure pulse (large L/D ratio).

The body member is preferably provided with a generally circular waste gate mounted to the body member such that the waste gate, in its fully open position, does not significantly restrict the flow of water through the passage. This is preferably achieved by providing a recess in the housing in to which the waste gate can sit in its fully open position. In the interest of efficiency at low drive heads, the waste gate is preferably pivotally mounted to the body member at this recess such that the waste gate does not significantly impede the flow of the water when the gate is in its fully open position. The recess is preferably in the form of a ramped recess having its deepest point at the downstream, pivoted end of the fully open waste gate. The waste gate is also preferably of a thickness such that the upstream edge of the waste gate is available to form a working surface for the flowing water to start to pick up the waste gate from the recess. When the waste gate is picked up from the recess, the water flow then drives the waste gate towards the closed position in a manner analogous to a conventional hydraulic ram pump.

The body member is also preferably provided with a seat to provide an impact area for the waste gate as it closes, as well as to seal the waste gate in its closed position. Again, it is preferable that the seat does not protrude significantly into the water flow path defined by the passage through the body.

The waste gate is preferably spring biased towards its open position to provide opening assistance to the waste gate at low drive heads. Preferably, the spring bias is such that it is at its greatest when the waste gate is fully closed and is substantially zero when the waste gate is fully open. The large spring bias of the waste gate towards the open position allows the waste gate to open with the very small opening negative pressures associated with small drive heads, whilst the zero spring bias applying at the fully open position permits the same small drive head to pick the waste gate out of the recess and to close the same against its seat with sufficient force to provide a positive pumping pulse.

Accordingly, in a further aspect this invention resides broadly in hydraulic ram pump apparatus of the type including:

- a body member having a water flow passage there-through;
- a waste gate disposed in said passage;

- a delivery outlet; and
- a one-way delivery valve disposed in said outlet, wherein said waste gate is biased towards its fully open position, the said bias being at its greatest when the waste gate is fully closed and substantially zero when the waste gate is fully open.

The bias is preferably provided by a spring acting between the body member and the waste gate with it being particularly preferred to use a helical spring about the pivot axis of the waste gate to prevent unnecessary interference with the flow of water through the apparatus.

The delivery outlet is preferably disposed between the body member and a delivery pipe conveying the pumped water to a point of use or storage. Preferably, the outlet is of the type having a cushioning air chamber above the outlet delivery valve to provide a compressible space, allowing water to pass into the outlet irrespective of the water condition further along the delivery pipe. The delivery valve is preferably of the type known as a disc valve and seat, wherein a disc shaped member is disposed on a circular seat and retained on the seat by gravity and back pressure, with or without spring assistance. The maximum displacement of the valve disc from its seat is preferably adjustable in order to optimize the pumping efficiency through the valve.

In a further aspect, this invention resides in hydraulic ram pump apparatus of the type including:

- a body member having a water flow passage there-through;
- a waste gate disposed in said passage;
- a delivery outlet; and
- a one-way delivery valve disposed in said outlet, wherein said one-way delivery valve is adjustable in its extent of opening to optimize pumping efficiency of the hydraulic ram pump.

Preferably, the delivery valve is of the disc type described above and the adjustment is provided by adjustably limiting the lift of the valve disc off its seat during a pumping cycle. At large drive heads the valve can be adjusted to decrease the displacement of the valve disc such that the volume displaced by the moving disc is less than the volume being pumped per pulse to improve the pumping efficiency.

The delivery outlet and valve, being preferably of the air cushioned type, must be supplied with air to replace that which inevitably passes out along a delivery pipe attached to the outlet. In the past, a snifter valve has been provided to provide air to the body member in the region of the delivery valve, that is, upstream of the waste gate. However, these snifter valves suffer from the disadvantage described above at (f) in that exposure to the high positive pumping pressures may force debris into the valve and effect a blockage.

Accordingly, in another aspect, this invention resides broadly in a hydraulic ram pump apparatus of the type including:

- a body member having a water flow passage there-through;
- a waste gate disposed in said passage;
- a delivery outlet positioned upstream of said waste gate;
- a one-way delivery valve disposed in said outlet; and
- a snifter valve supplying cushioning air to said one-way delivery valve, wherein said snifter valve is located downstream of said waste gate such that air is drawn through said snifter valve and into the body member

upstream of said waste gate during the opening phase of said waste gate.

Preferably, the snifter valve consists of a small orifice which passes from outside the pump body to the point in the waste fluid flow downstream from the waste gate seat.

Since the pressure downstream of the waste gate is always lower than the peak pressure upstream of the waste gate, the snifter valve is never subjected to the pumping pressures which was the primary cause of blockage in the prior art apparatus. The snifter valve is preferably of a size to maintain an adequate air supply to the delivery valve for cushioning purposes without providing so much that the apparatus gas locks. The size of the snifter valve is determined by experiment in individual apparatus, if desired the snifter valve may be adjustable.

The downstream waste outlet of the apparatus preferably takes the form of a descending waste pipe which extends down to below the water level downstream of the apparatus. Such an arrangement provides for the creation of a siphon effect assisting acceleration of the waste gate to its fully closed position and accordingly increasing the pump pulse peak pressure. A second advantage of this configuration is that the siphon connection with the downstream water level prevents uncontrolled entry of air into the apparatus and thus prevents vapour locking of the apparatus.

In order that this invention may be more easily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention wherein:

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1. is a side view in vertical section of apparatus in accordance with the present invention, and

FIG. 2. is a front view in vertical section of the apparatus in FIG. 1.

#### DETAILED DESCRIPTION OF THE INVENTION

In the figures, a hydraulic ram pump assembly is provided having a waste gate 1 illustrated in its fully open position 1a and illustrated in its fully closed position 1b. The waste gate 1 is pivotally mounted on a shaft 2 located transverse to and out of the direct line of the water flow. The waste gate 1 is biased towards its fully open position by spring 4 coaxial with the shaft 2. The waste gate 1 is adapted to seal in its fully open position against annular seal ring 5. The water is supplied to the apparatus via feed pipe 6 attached to the inlet side of housing 7. The waste gate 1 in its fully open position rests in recess 7a in the lower portion of the housing 7, which recess also accommodates the shaft 2 and the spring 4. The waste side of the housing 7 is terminated by an annular seal housing 9 adapted to retain the seal 5 as well as to mount waste outlet pipe 8. The seal housing 9, seal 5 and waste pipe 8 are of a diameter similar to that of the inlet pipe 6 such that the flow of water is not significantly impeded. The waste pipe 8 is curved down to the downstream water level to provide a siphon to assist the water hammer action of the apparatus to open and close the waste gate 1.

The upper portion of the housing 7 upstream of the waste gate 1 is provided with a delivery outlet comprising apertures in the housing 7. The apertures are closed by a delivery valve comprised of a valve disc 10 adapted to seal against seal 11. The displacement of the

valve disc 10 on the pump stroke is limited by stop 12 which is adjustable via selectable spacers 13. The delivery valve is housed in housing extension 15 formed integrally with the housing 7. The housing extension 15 defines an air space 15a which provides elastic cushioning of the pump. The valve housing is provided with a delivery port 23 to which a delivery pipe can be attached. The cushioning air for the valve is supplied by snifter valve 14 located downstream of the waste gate 1. The snifter valve 14 consists of a small orifice which passes from outside the pump body to the point in the waste fluid flow downstream from the waste gate seat.

The shaft 2 is mounted to the housing 7 via shaft sleeve 20. The shaft sleeve 20 also provides a mounting point for the spring 4 at 16. The effective spring tension is controlled by rotation of the shaft 2 and sleeve 20 assembly relative to the waste gate 1 extension to the shaft 2. This relative rotation is effected by rotation of control lever 17 attached to the shaft 2. Start and stop control of the assembly is provided by start/stop lever 19 acting on sleeve 19a which is provided with gate opening lug 22. A gate closing lug 21 is provided on the waste gate 1. The position of the lever 19 is retained as desired by lock nut 18.

The open waste gate 1(a) is nearly in balance in the position shown with the combined forces of gate 1(a) buoyancy and spring 4 torsion nearly balancing the gravitational force acting on the gate 1(a). In this position the open gate 1(a) rests lightly against gate stop 3 and creates very little head loss. As the fluid velocity passing the leading edge of gate 1(a) from drive pipe 6 reaches a point where the pressure and viscous forces acting on the gate 1(a) overcome all other forces acting on the gate 1(a), the gate 1(a) begins to close. (the sum of spring 4 torsion, buoyancy and gravitational forces acting on the gate is defined as the gate opening force and hereinafter called  $F_o$ ).

The gate 1(a) rotates clockwise about gate pivot shaft 2 and as the gate 1(a,b) projects further into the fluid flow the increasing pressure and viscous forces more than cope with the increasing  $F_o$  and the gate 1(a,b) quickly accelerates up to the velocity of the water.

When the waste gate 1(a,b) reaches the closed position, (gate 1(b)) the gate opening force  $F_o$  has increased significantly because the spring 4 which was acting to close the gate 1(b) and the gravitational and buoyancy forces acting to open the gate 1(b) have dropped to almost zero.

This large value of gate opening force  $F_o$  when the gate 1(b) is closed enables the gate 1(b) to swing open with only very small negative pressures associated with operating the pump at small  $L/D$ 's and/or sealing problems due to debris caught between the gate 1(b) and the waste gate seat 5.

Waste tube 8 carries the fluid which has passed through the pump waste outlet 9 in a large radius to the downstream fluid level. The waste tube 8 is either immersed under the downstream fluid or has its open end tilted back. This traps fluid in the waste tube 8 and prevents gas entering the pump body 7.

The waste tube 8 also acts as a siphon and applies most of the pressure difference between the upstream and downstream fluid level across the drive pipe 6. Consequently, the hydraulic ram pump may be mounted as high as the upstream fluid level and away from potential flooding.

The delivery valve disc 10 deals against the valve seat 11 and is constrained in its movement by valve stop 12.

The volume of fluid displaced by valve disc 10 when it opens is determined by the distance between the top of the valve disc 10 and the bottom of the valve stop 12. This distance may be adjusted by changing the thickness of the spacers 13 to optimise the delivery efficiency of the hydraulic ram pump at different delivery heads.

Snifter valve 14 injects gas into the downstream side of the waste gate seat 5 because there is always negative pressure inside the pump waste outlet 9.

This negative pressure is normally small due to the siphon effect of the waste tube 8 and momentarily large due to the negative water hammer effect when the waste gate 1(b) closes.

When the waste gate 1(a,b) opens after a pumping cycle, the reverse flow of water through the pump waste outlet 9 carries some of the injected gas into the roof of the pump body 7 where it is subsequently carried into the air chamber 15 during the following pumping cycle.

One end of spring 4 is rigidly connected to control lever 17 by spring clamp 16 which clamps spring 4 to the pivot shaft 2 through shaft sleeve 20. The position of control lever 17 and consequently, spring clamp 16 determines the maximum value of  $F_0$ . The force  $F_0$  acting on the gate 1(a,b) may be adjusted by moving control lever 17 to suit specific pumping conditions. When control lever 17 is correctly adjusted, lock nut 18 may be tightened to prevent control lever 17 from moving.

Because all moving parts of the low drive head hydraulic ram pump are not directly accessible, it is necessary to provide a means of opening and closing the gate 1(a,b) from outside the pump body 7.

This is necessary to manually pump air out of the pump body 7 if the hydraulic ram pump has been stopped for any length of time.

When lock nut 18 is loose, rotation of start/stop lever 19 past the point where it contacts gate opening lug 21 causes the gate 1(a,b) to open. If start/stop lever 19 is rotated in the opposite direction past the point where it contacts gate closing lug 22, the gate 1(a,b) may be forced to close.

It will of course be realised that while the above has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as defined in the claims appendant hereto.

I claim:

1. A hydraulic ram pump apparatus comprising:
  - a body member having a water flow passage there-through; a waste gate pivotally mounted in said flow passage and being movable between an open position wherein said waste gate resides in a recess disposed in said body member and water may flow past said waste gate and a closed position wherein said waste gate substantially closes said flow passage, said waste gate being biased away from said closed position such that said bias is greatest when said waste gate is closed and said bias is substantially non-existent when said waste gate is open;
  - a waste water outlet downstream of said waste gate; and
  - a delivery outlet having an adjustable non-return valve therein and located upstream of said waste

gate, said non-return valve is adjustable to optimize the pumping efficiency through the valve.

2. A hydraulic ram pump according to claim 1, wherein said waste gate is biased away from said recess to assist in the initiation of closure of said waste gate.

3. A hydraulic ram pump according to claim 1, wherein the bias is provided by a spring acting between the body member and the waste gate.

4. A hydraulic ram pump according to claim 3, wherein said spring is a helical spring mounted about the pivot axis of the waste gate.

5. A hydraulic ram pump according to claim 1, wherein the delivery outlet includes an air chamber, air in said air chamber being compressed by the passage of water delivered to said chamber via said non-return valve.

6. A hydraulic ram pump according to claim 5 wherein said air is supplied through an air injection valve located downstream of said waste gate and into said body member upstream of said waste gate during the opening of said waste gate.

7. A hydraulic ram pump according to claim 6, wherein said air injection valve comprises a simple orifice communicating the fluid flow to atmosphere, the dimensions of the orifice being selected to provide a valve action due to the relative viscosities of air and water.

8. A hydraulic ram pump according to claim 1 wherein said waste outlet comprises a pipe extending down to below the water level downstream of the pump.

9. A hydraulic ram pump according to claim 1, wherein the pivot axis of said waste gate is provided by a shaft affixed thereto and passing through said body member, said shaft being rotatable from without said body member for manual operation of said waste gate.

10. A hydraulic ram pump apparatus comprising:
 

- a body member having a water flow passage there-through;

- a waste gate pivotally mounted in said flow passage and being movable between an open position wherein said waste gate resides in a recess disposed in said body member and water may flow past said waste gate, and a closed position wherein said waste gate substantially closes said flow passage;

- a delivery outlet having an adjustable non-return valve therein and located upstream of said waste gate, said non-return valve is adjustable to optimize the pumping efficiency through the valve; and

- a waste water outlet downstream of said waste gate, said waste gate being biased away from said closed position by a spring acting between said body member and said waste gate, said spring providing an opening bias which is greatest when said waste gate is closed, and said opening bias is substantially non-existent when said waste gate is open, said spring further providing a closing bias when said waste gate is fully open to assist in the initiation of closure of said waste gate.

11. A hydraulic ram pump according to claim 10 wherein the upstream edge of said waste gate in its open position is of a dimension to form a working surface against which the flow may act to pick up the waste gate from the recess in combination with said closing bias.

\* \* \* \* \*



UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 5,310,322  
DATED : May 10, 1994  
INVENTOR(S) : Ian J. Richards

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

On the title page item [21] should read --053,903--.

On the title page item [63] should read --Continuation of Serial No. 582,876  
Dec. 11, 1990 filed as PCT/AU89/00163, April 14, 1989--.

Signed and Sealed this  
Ninth Day of April, 1996



Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks



US006142746A

# United States Patent [19] Lundgren

[11] **Patent Number:** **6,142,746**  
[45] **Date of Patent:** **Nov. 7, 2000**

[54] **PULSATING VALVE FOR HYDRAULIC RAMS HAVING A LIQUID VESSEL ATTACHED THERETO**

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[86] PCT No.: **PCT/SE97/01768**

§ 371 Date: **Jun. 15, 1999**

§ 102(e) Date: **Jun. 15, 1999**

[87] PCT Pub. No.: **WO98/17920**

PCT Pub. Date: **Apr. 30, 1998**

[30] **Foreign Application Priority Data**

Oct. 23, 1996 [SE] Sweden ..... 9603900

[51] **Int. Cl.<sup>7</sup>** ..... **F04F 7/02**

[52] **U.S. Cl.** ..... **417/226**

[58] **Field of Search** ..... 417/226, 225, 417/104, 92

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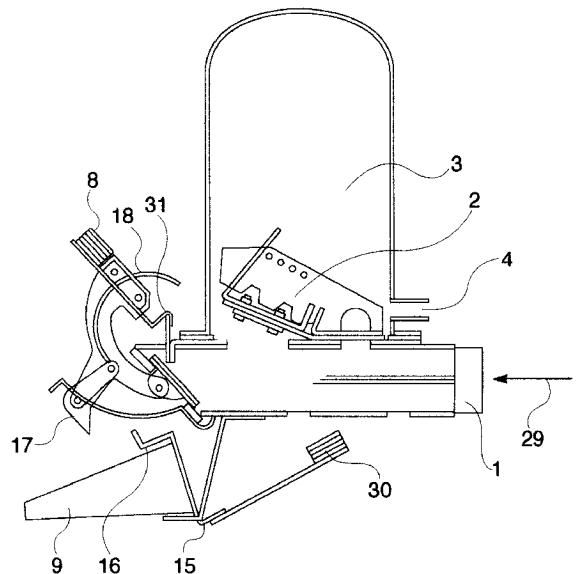
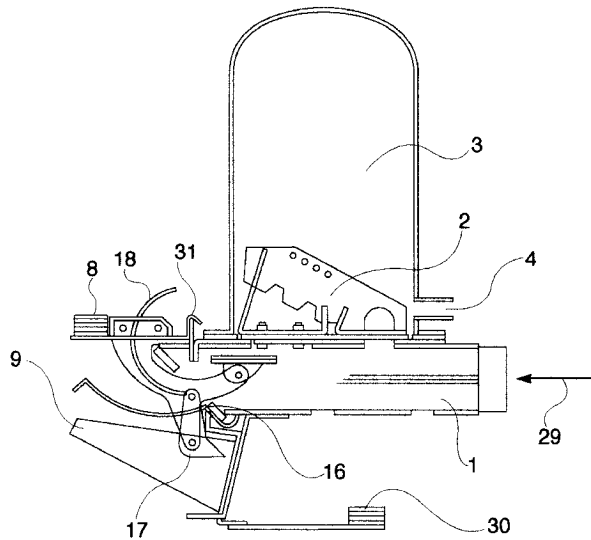
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*Assistant Examiner*—Robert Z. Evora  
*Attorney, Agent, or Firm*—Robert P. Bell

[57] **ABSTRACT**

A pump device is disclosed, comprising a supply tube 1, for a liquid with a relatively low head, an accumulator 3 connected to supply tube 1 via a one-way valve 2, an outlet tube 4 from the accumulator for liquid with a relatively high head, and an outlet valve, provided at the supply tube 1 after the accumulator, which outlet valve opens and shuts an outlet 5 at the supply tube 1. The pump device is primarily characterized in that the outlet valve comprises a damper 6 movable between a position, in which the opening 5 is left open, and a position, in which the opening 5 is closed.

**11 Claims, 6 Drawing Sheets**



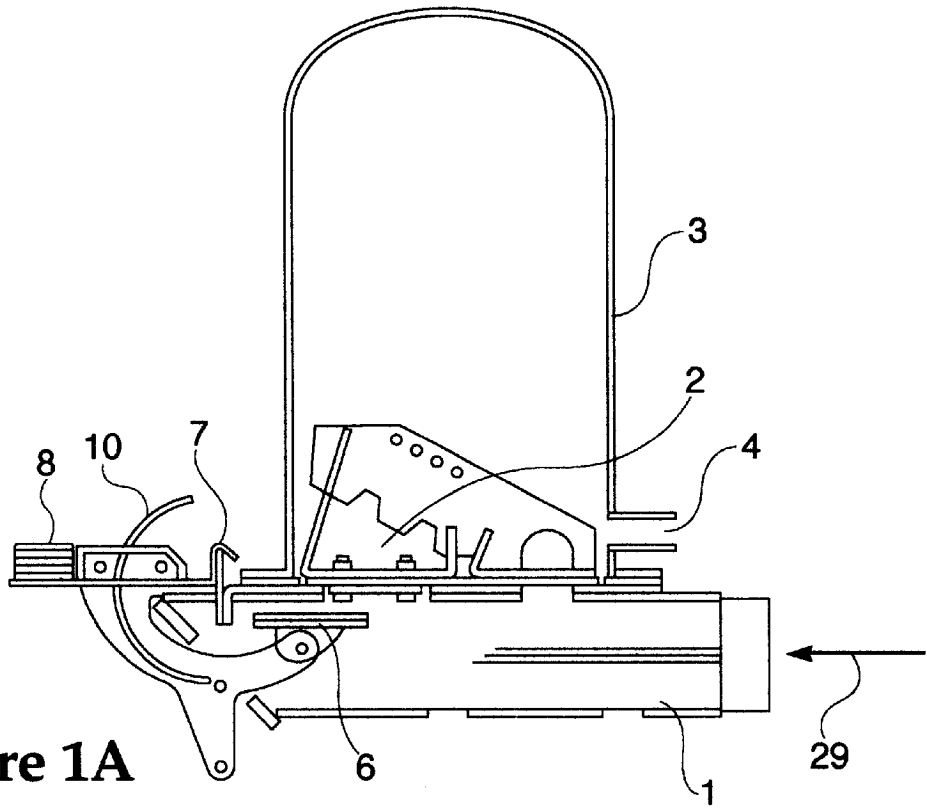


Figure 1A

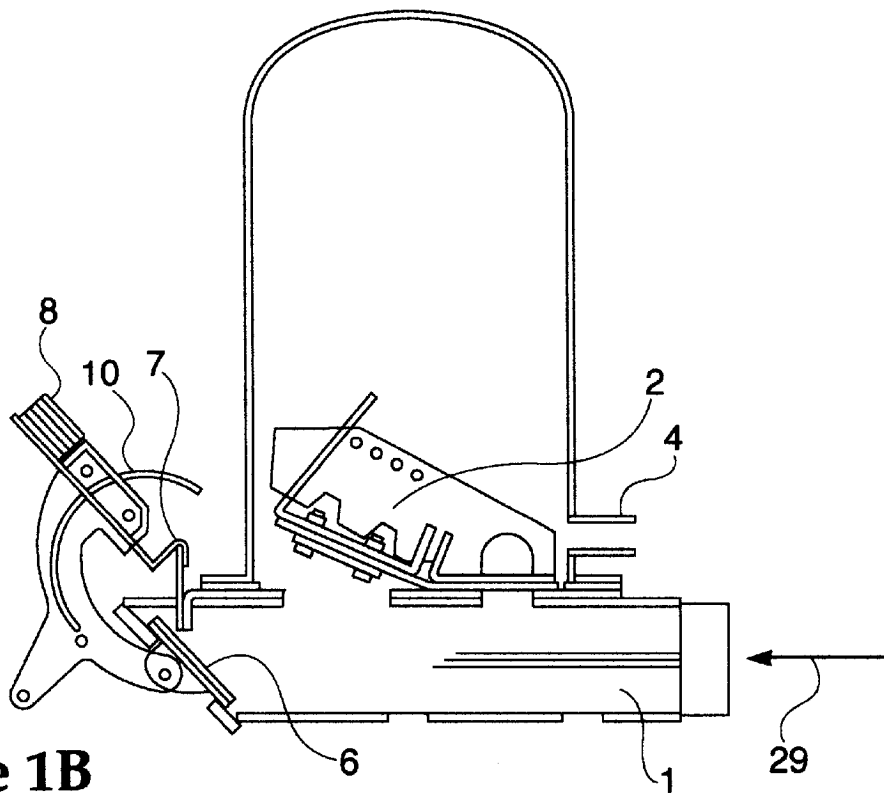


Figure 1B

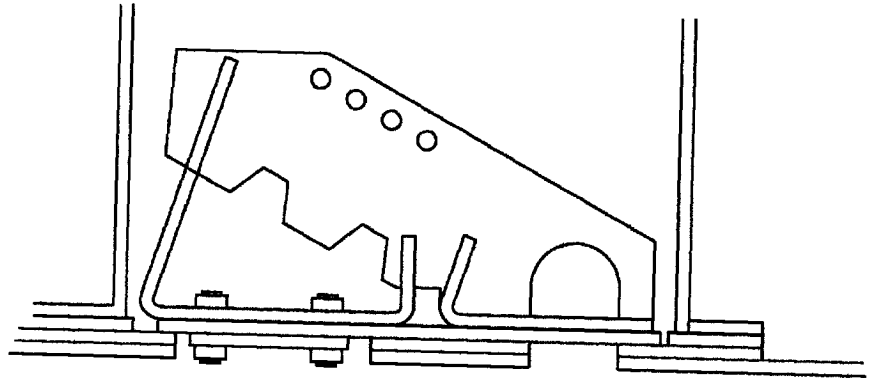


Figure 2A

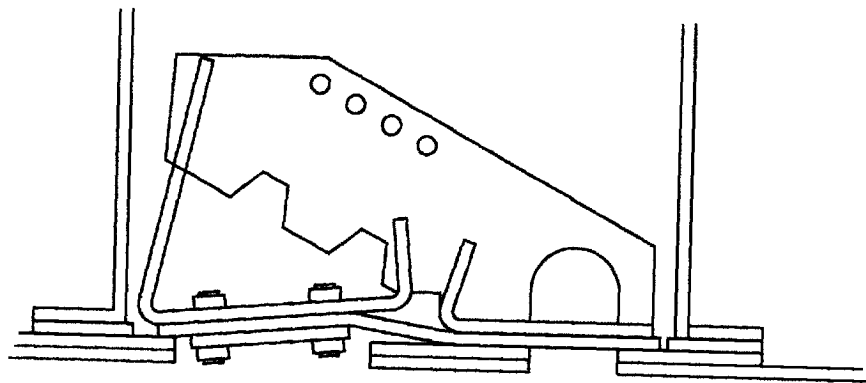


Figure 2B

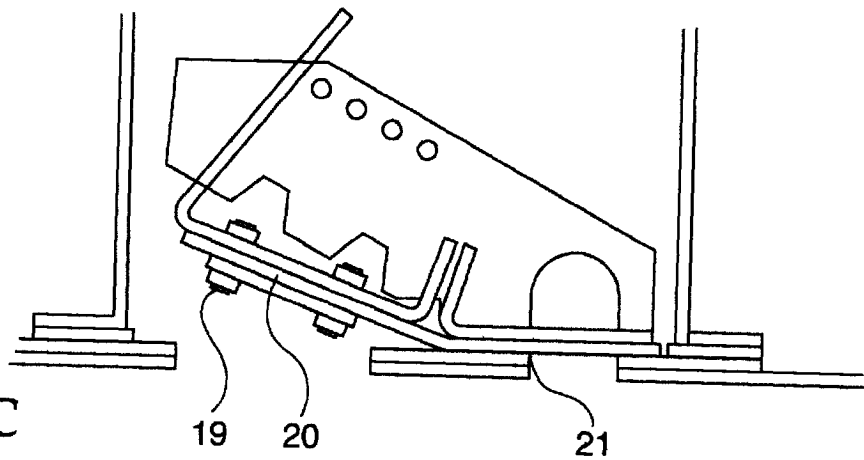


Figure 2C

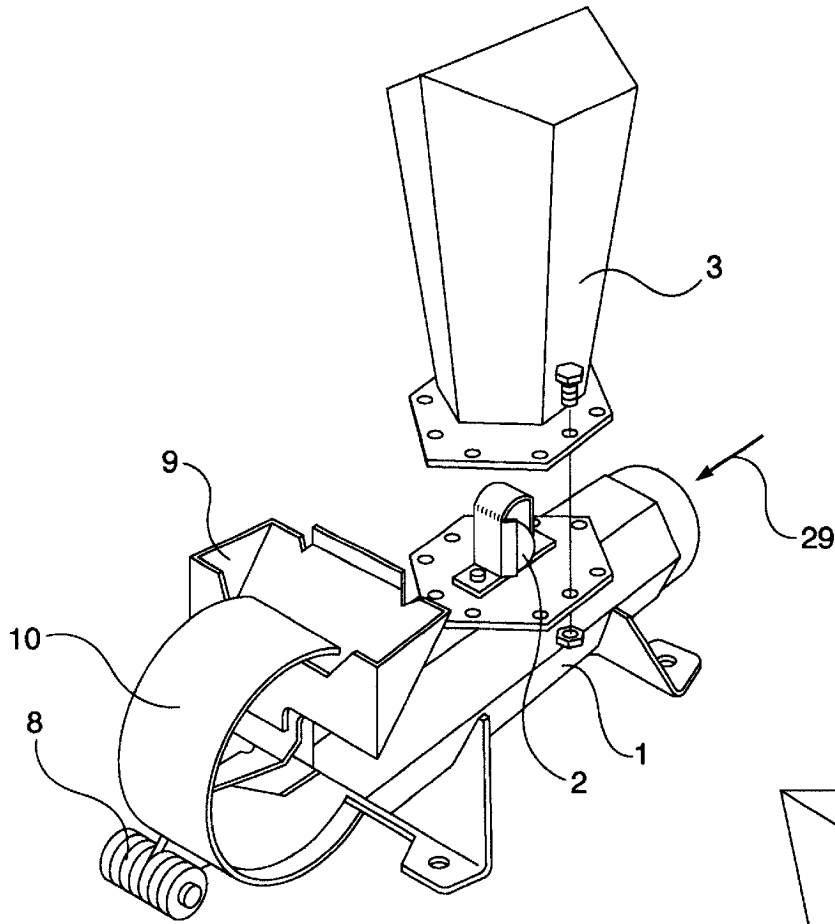


Figure 3

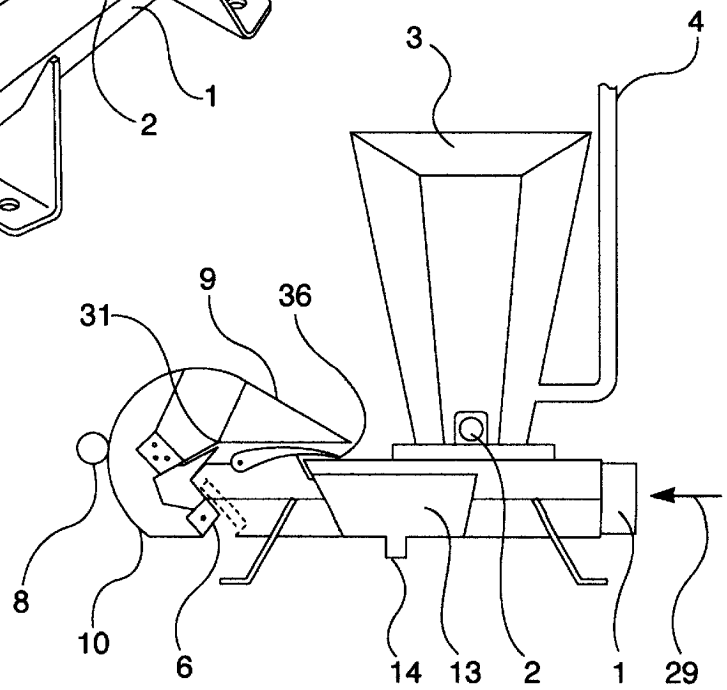
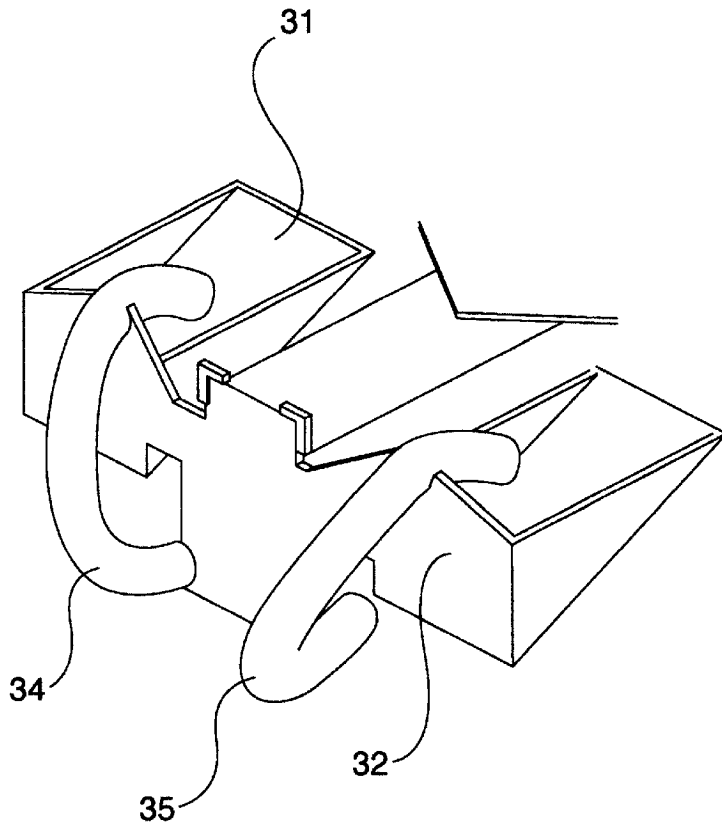
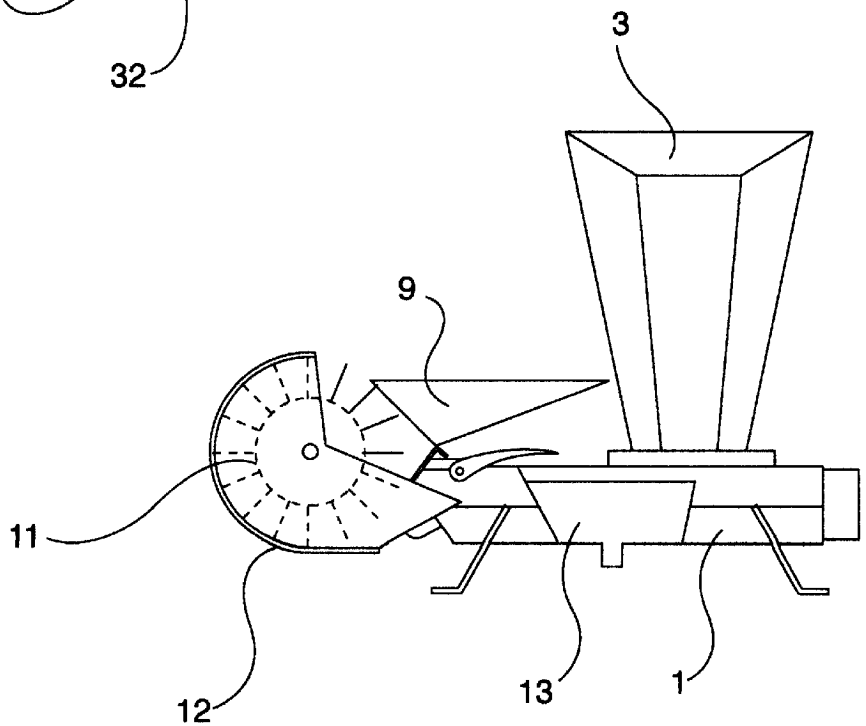


Figure 4



**Figure 5**



**Figure 6**

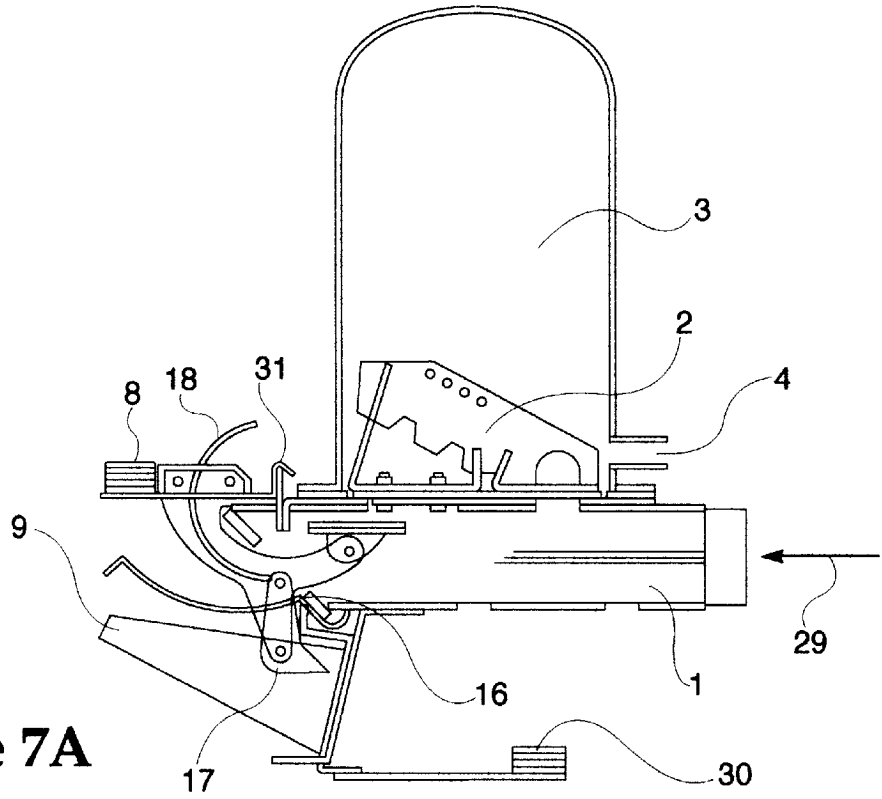


Figure 7A

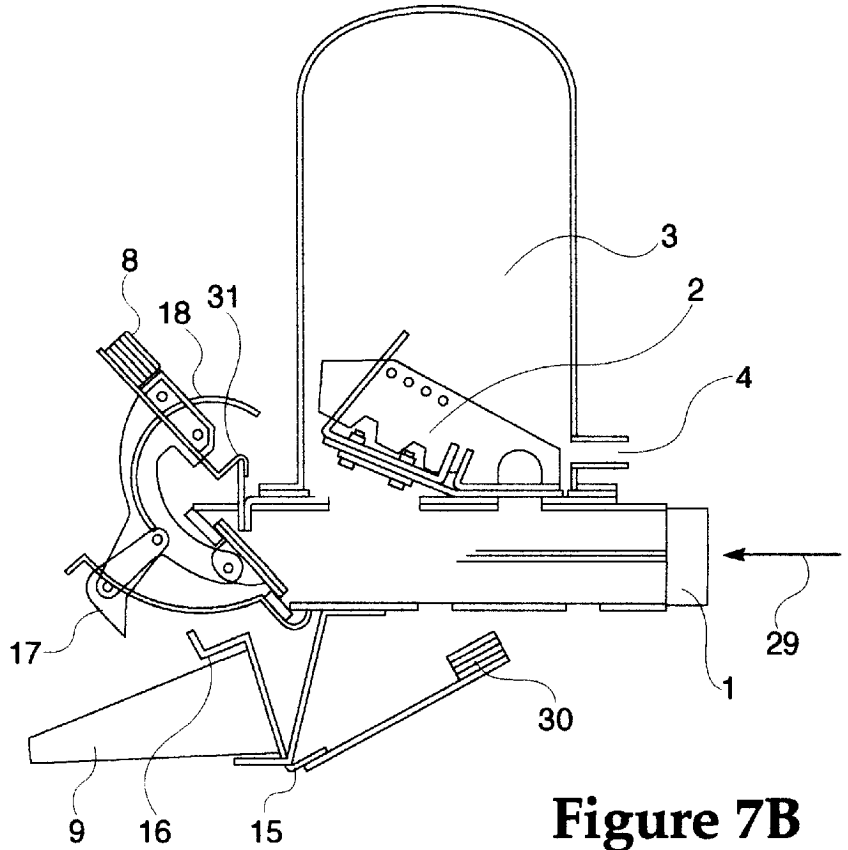


Figure 7B

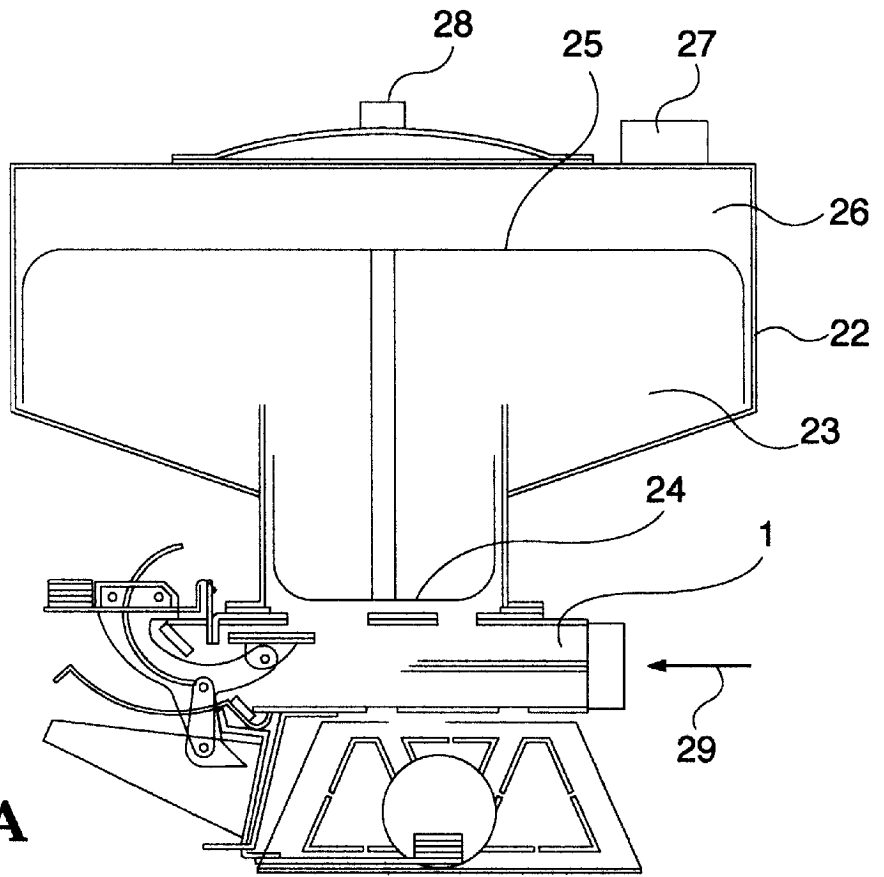


Figure 8A

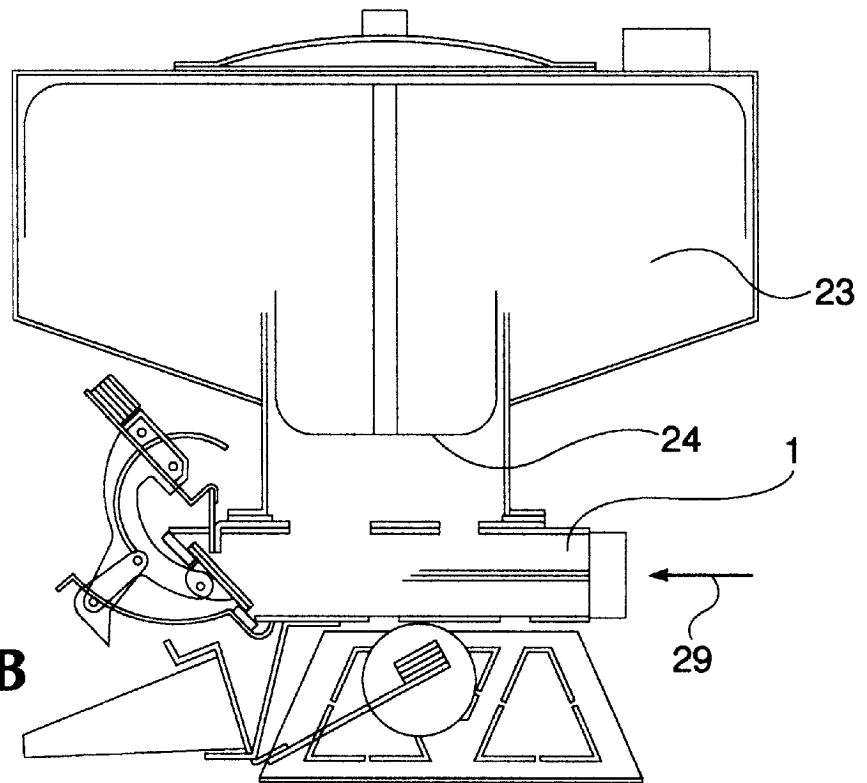


Figure 8B



**PULSATING VALVE FOR HYDRAULIC  
RAMS HAVING A LIQUID VESSEL  
ATTACHED THERETO**

**CROSS-REFERENCE TO RELATED  
APPLICATIONS**

This application is a 371 of PCT/SE97/01768 filed on Oct. 23, 1997.

**FIELD OF THE INVENTION**

The present invention relates to an improved hydraulic ram pump device.

**BACKGROUND OF THE INVENTION**

Hydraulic ram pump devices are known in the art. Such pump devices typically comprise a supply tube for receiving a liquid with a relatively low head, an accumulator connected to the supply tube via a one-way valve, an outlet tube from the accumulator for producing liquid with a relatively high head. An outlet valve, provided at an outlet of the supply tube, after the accumulator, outlet opens and shuts the outlet at the supply tube. Such hydraulic ram pumps have long been known in the art.

In such a Prior Art design, the outlet valve may be provided with a float, which is closed at a certain liquid flow, and opened again when the liquid flow has ceased. Such a pump operates well as long as the liquid fed, usually water, is free from impurities. Even small impurities may, however, disturb the operation of such an outlet valve, whereby the pump device of this type ceases to operate.

Thus there remains in the art a demand for hydraulic ram pump devices which are not disturbed by a reasonable amount of impurities in the actual liquid, and this have a reliable function and are simple in design and thus cheap in manufacture.

**SUMMARY OF THE INVENTION**

According to the present invention, such a hydraulic ram pump device is characterized in that the outlet valve comprises a damper movable between a first position, in which the opening is left open, and a second position, in which the opening is closed. The pump device according to the invention may be designed in various ways within the spirit and scope of the present invention. In one embodiment, the damper may be arranged to rotate around a first axis and is provided with an adjustable first weight which provides a torque acting in the direction towards the first open position of the outlet valve, and thus influences the time interval between opening and closing of the outlet valve.

In a second embodiment, which is particularly advantageous if the supply tube feeds liquid with a relatively low head, a vessel is provided, cooperating and coupled to the outlet valve. The vessel is movable between a first position and a second position. When the vessel is in the first position, the outlet valve is held open. The vessel collects flowing liquid from the outlet until the weight of the collected liquid brings the vessel to the second position in which the outlet valve is held closed.

Liquid then flows out of the vessel, and the reduction in weight allows the vessel to return to its first position. The vessel may be provided with a second variable weight, which provides a torque in the direction towards the first position of the vessel, and thus influences the time interval between the open and closed positions of the outlet valve.

The cooperation and coupling of the outlet valve with the vessel can be carried out in different ways. For example, the

damper may be fixed to the vessel. In this case, a bow bar may be fixed to the vessel, provided to guide liquid, flowing from the outlet, to the vessel.

In another embodiment, where the damper is fixed to the vessel, a paddle wheel may be provided in such a way, rotatably mounted to a frame, such that liquid flowing from the outlet causes the paddle wheel to rotate and thereby transport the liquid into the vessel.

In order to achieve safe operation, it is possible, in one advantageous embodiment of the pump device of the present invention, to provide a vessel with a relatively small outlet opening to be filled with overflowing liquid and arranged to act, in an emptied condition, upon the outlet valve in the direction towards its open position. It is not necessary to fix the damper to the vessel in such an embodiment.

In yet another embodiment, the damper may be provided to pivot around a second axis between open and closed positions, and the vessel may be provided with a first element, such that when the vessel moves from the first position to the second position it acts upon a second element at the damper in order to close the outlet valve. Suitably, a guide rail may be provided to guide liquid to the second axis, in order to prevent the formation of ice at low temperatures.

The one-way valve may be designed in various ways. In one advantageous design the one-way valve may comprise an opening in the bottom of the accumulator, cooperating with a plate which at the lower side is provided with an elastic, sealing membrane. The plate may be guided such that it may be lifted at one end, opening a relatively large passage.

Even if the pump device according to the invention is primarily intended for use in pumping water with a relatively low head to a higher level, it may also be used in yet another embodiment, for compressing gas, particularly air. In this embodiment, the accumulator may be provided with a piston, arranged to glide in the accumulator. The piston may be designed with a relatively smaller surface, turned towards the liquid, coming from the supply tube, and a relatively larger surface, turned towards a chamber, to which is fed gas, preferably air, of a relatively low pressure via a first valve. The gas may be compressed by movement of the piston, caused by the pump device, and the compressed gas may then flow through a valve to a user.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The invention will be described in more detail, reference being made to the enclosed schematic Figures of which:

FIG. 1A illustrates one embodiment of the pump device according to the invention, in a cross-section side view, illustrating the outlet valve in an open position.

FIG. 1B illustrates the embodiment of the pump device according FIG. 1A, also in cross-section side view, illustrating the outlet valve in a closed position.

FIG. 2A is a cross-section side view of a one-way valve in a closed position.

FIG. 2B is a cross-section side view of a one-way valve in a partly open position.

FIG. 2C is a cross-section side view of a one-way valve in an open position.

FIG. 3 is a perspective view, illustrating an alternative embodiment of the pump device, with the outlet valve in an open position.

FIG. 4 is a side view of the pump device of FIG. 3 with the outlet valve closed.

FIG. 5 is a perspective view illustrating a detail of another embodiment of the pump device.

FIG. 6 is a side view illustrating one further view of the pump device.

FIG. 7A is a side view of the preferred embodiment of the pump device in a first position.

FIG. 7B is a side view of the preferred embodiment of FIG. 7A in a second position.

FIG. 8A is a side view illustrating one special embodiment provided for the compression of gas in a first position.

FIG. 8B is a side view illustrating one special embodiment provided for the compression of gas in a second position.

#### DETAILED DESCRIPTION OF THE INVENTION

In FIGS. 1A and 1B a supply tube 1 for a liquid with a relatively low head, is fed according to arrow 29. Above supply tube 1 an accumulator 3 is provided, with a one-way valve 2 in the bottom and an outlet tube 4 for liquid with a relatively high head.

After accumulator 3 is provided an outlet valve at supply tube 1. The outlet valve comprises damper 6, movable between one position, in which an opening 5 at the supply tube is left open (FIG. 1A), and another position, in which opening 5 is closed (FIG. 1B). Damper 6 is arranged rotatable around a first axis 7, as is provided with a variable first weight 8, which provides a torque in the direction towards the open position of the outlet valve.

In operation, liquid, usually water, flows through supply tube 1 and out through opening 5, until opening 5 is closed by damper 6. When damper 6 closes, a pressure surge occurs opening one-way valve 2, such that pressure in accumulator 3 increases.

The one-way valve may comprise, in this embodiment as illustrated in FIGS. 2A-2C, of an opening 19 in the bottom of accumulator 3. A plate 19 cooperates with opening 19. At the lower side of the plate is provided an elastic sealing membrane. The plate being so guided such that it may be lifted at one end, opening a relatively limited passage, and that it may be lifted at the other end, opening a relatively larger passage. Variable weight 8 contributes to setting the interval between opening and closing of the outlet valve.

In another embodiment illustrated in FIGS. 3 and 4, a vessel 9 is attached to damper 6 via a bow bar 10. Damper 6 with vessel 9 are swingable around an axis 31 between a first position, where the outlet valve is kept open while vessel 9 collects liquid flowing from the outlet until the collected liquid brings the vessel to take its second position when damper 6 is closed. A variable weight 8 may be attached to damper 6/vessel 9 and provides a torque acting in the direction towards the open position of the outlet valve, whereby the time interval between the opening and closing of the outlet valve can be controlled.

In FIG. 4, a device is illustrated for performing the function. Here, a vessel 13 is provided, hanging on an axis. Vessel 13 is provided with a relatively limited outlet opening 14 at the bottom side. Vessel 13 is filled intermittently by liquid flowing from vessel 9. Vessel 13 presses down on a spring 36 at the bottom of vessel 9 in its second position. When the liquid in vessel 13 has flown out, vessel 13 will be emptied though its outlet opening 14, whereby the spring 36 is released from its pressing weight, and is thereby brought to lift the vessel 9 in the direction of its first position, if the outlet valve for some reason should not turn back to its open position. Vessel 13 can also be filled directly from the outlet of supply tube 1.

FIG. 5 illustrates an embodiment where two vessels 32, 33 are attached to damper 6. Two bow formed tubes 34, and 35, which are attached to vessels 32, 33, may also be free from these and instead be attached to supply tube 1.

The embodiment in FIG. 6 illustrates a paddle wheel 11 so arranged, rotatable in a housing 12, such that liquid, flowing from the outlet brings the paddle wheel 11 to rotate and thus feed the liquid to vessel 9.

FIGS. 7A and 7B illustrate the preferred embodiment of the present invention, where damper 6 is provided rotatable around a horizontal axis 31 between its open and closed positions. Vessel 9 is rotatable around a relatively low axis and is provided with a first element 16 in the form of an arm, which is provided to act upon a second element 17 in the form of a second arm connected to damper 6 in such a way when vessel 9 moves from its first position (i.e., when liquid is filled in), to the second position, where liquid is emptied, the damper will be closed.

As the pump device may be used at temperatures below the freezing point for water, it is suitable to provide a guide rail 18, intended to guide some liquid to the axis 31 in order to prevent the formation of ice, which could prevent movement around axis 31.

Also within the scope of this embodiment, it may be suitable to provide variable weights for controlling the time interval between the opening and closing of the outlet valve. The damper may be provided with a variable weight 8, which provides the damper a torque directed towards an open position. Vessel 9 may be provided with a variable weight 30, which provides a torque in the direction towards the first position of the vessel and thus the open position of the damper.

In the embodiment illustrated in FIGS. 8A and 8B, the accumulator 22 may be provided with a piston 23, arranged to glide in accumulator 22. Piston 23 is designed with a relatively smaller surface 24, turned towards the liquid coming from supply tube 1 through opening 19, which in this embodiment lacks a one-way valve. Piston 23 exposes a relatively larger surface 25 towards a chamber 26, to which is fed gas, preferably air, of a relatively low pressure via first valve 27. The gas may be compressed by the upward movement of piston 23, caused by the liquid, pressed in through opening 19. The compressed gas flows through a valve 28. Piston 23 returns by its own weight if by a spring (not shown).

While the preferred embodiment and various alternative embodiments of the invention have been disclosed and described in detail herein, it may be apparent to those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope thereof.

What is claimed is:

1. A pump device comprising:

- a supply tube for a liquid with a relatively low head;
  - an accumulator connected to the supply tube via a non-return valve;
  - an outlet tube from the accumulator for liquid with a relatively high head; and
  - an outlet valve, provided at the supply tube after the accumulator, said outlet valve opens and shuts an outlet at the supply tube,
- wherein the outlet valve comprises a damper movable between an open position in which the outlet opening is left open, and a closed position in which the outlet opening is closed,

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wherein the damper is arranged rotatable around a first axis and is provided with a variable first weight, which provides a torque acting in the direction towards the open position of the outlet valve and thus influences a time interval between the opening and the closing of the outlet valve,

wherein said pump device further comprises a vessel provided, cooperating with the outlet valve, said vessel being movable between a first position and a second position, whereas the outlet valve in the first position is kept open when the vessel continuously collects flowing liquid from the outlet, until the collected liquid brings the vessel to take the second position in which the outlet valve is kept closed until the liquid flows out from the vessel, whereby the vessel will return to its first position, and

wherein the damper is rotatable around a second axis between the open and closed positions, and the vessel is provided with a first closure element which, when the vessel moves from said first position to the second position, acts upon a second element at the damper in order to close the outlet valve.

2. A pump device according to claim 1, wherein the non-return valve comprises an opening in the bottom of the accumulator, cooperating with a plate which at the lower side is provided with an elastic sealing membrane, the plate being so guided such that it may be lifted at one end, opening a relatively limited passage, and that it may be lifted at the other end, opening a relatively larger passage.

3. A pump device according to claim 1, wherein the first vessel is provided with a second variable weight providing a torque in a direction towards the first position of the first vessel, and thus influences the time interval between the open and closed position of the outlet valve.

4. A pump device according to claim 3, wherein the damper is fixed to the first vessel with a firm connection.

5. A pump device according to claim 4, further comprising:  
a bow bar fixed to the first vessel provided to guide liquid flowing from the outlet to the first vessel.

6. A pump device comprising:  
a supply tube for a liquid with a relatively low head;  
an accumulator connected to the supply tube via a non-return valve;  
an outlet tube from the accumulator for liquid with a relatively high head; and  
an outlet valve, provided at the supply tube after the accumulator, said outlet valve opens and shuts an outlet at the supply tube,

wherein the outlet valve comprises a damper movable between an open position in which the outlet opening is left open, and a closed position in which the outlet opening is closed,

wherein the damper is arranged rotatable around a first axis and is provided with a variable first weight, which provides a torque acting in the direction towards the open position of the outlet valve and thus influences a time interval between the opening and the closing of the outlet valve,

wherein said pump device further comprises a first vessel provided, cooperating with the outlet valve, said first vessel being movable between a first position and a second position, whereas the outlet valve in the first position is kept open when the first vessel collects flowing liquid from the outlet, until the collected liquid

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brings the first vessel to take the second position in which the outlet valve is kept closed until the liquid flows out from the first vessel, whereby the first vessel will return to its first position, and

wherein the first vessel is provided with a second variable weight providing a torque in a direction towards the first position of the first vessel, and thus influences the time interval between the open and closed position of the outlet valve.

7. A pump device according to claim 6, wherein the damper is fixed to the first vessel with a firm connection.

8. A pump device according to claim 7, further comprising:  
a bow bar fixed to the first vessel provided to guide liquid flowing from the outlet to the first vessel.

9. A pump device according to claim 7, further comprising:  
a paddle wheel provided rotatable in a housing such that liquid flowing from said outlet causes the paddle wheel to rotate and thereby transport the liquid to the first vessel.

10. A pump device according to claim 9, further comprising:  
a second vessel with a relatively small outlet opening provided to be filled with overflowing liquid and is arranged to act in an emptied condition, upon the outlet valve in a direction towards the open position.

11. A pump device comprising:  
a supply tube for a liquid with a relatively low head;  
an accumulator connected to the supply tube via a non-return valve;  
an outlet tube from the accumulator for liquid with a relatively high head; and  
an outlet valve, provided at the supply tube after the accumulator, said outlet valve opens and shuts an outlet at the supply tube,  
wherein the outlet valve comprises a damper movable between an open position in which the outlet opening is left open, and a closed position in which the outlet opening is closed,

wherein the damper is arranged rotatable around a first axis and is provided with a variable first weight, which provides a torque acting in the direction towards the open position of the outlet valve and thus influences a time interval between the opening and the closing of the outlet valve,

wherein said pump device further comprises a first vessel provided, cooperating with the outlet valve, said first vessel being movable between a first position and a second position, whereas the outlet valve in the first position is kept open when the first vessel collects flowing liquid from the outlet, until the collected liquid brings the first vessel to take the second position in which the outlet valve is kept closed until the liquid flows out from the first vessel, whereby the first vessel will return to its first position,

wherein the damper is rotatable around a second axis between the open and closed positions, and the first vessel is provided with a first closure element which, when the first vessel moves from said first position to the second position, acts upon a second element at the damper in order to close the outlet valve, and

wherein said pump device further comprises a guide rail provided to guide liquid to said second axis.



US006234764B1

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**Obermoser**

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(45) **Date of Patent:** **May 22, 2001**

(54) **HYDRAULIC RAM PUMP**

FOREIGN PATENT DOCUMENTS

(76) Inventor: **Karl Obermoser**, Vogtstr. 15, D-86653 Honheim (DE)

307348 \* 10/1916 (DE) .  
1952034 A1 \* 12/1995 (DE) .

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

\* cited by examiner

(21) Appl. No.: **09/142,312**

*Primary Examiner*—Henry C. Yuen  
*Assistant Examiner*—Mahmoud Gimie  
(74) *Attorney, Agent, or Firm*—Hedman & Costigan

(22) PCT Filed: **Apr. 16, 1997**

(57) **ABSTRACT**

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§ 102(e) Date: **Sep. 3, 1998**

(87) PCT Pub. No.: **WO97/40277**

PCT Pub. Date: **Oct. 30, 1997**

(30) **Foreign Application Priority Data**

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Dec. 4, 1996 (EP) ..... 96119475

(51) **Int. Cl.<sup>7</sup>** ..... **F04F 7/02**

(52) **U.S. Cl.** ..... **417/226; 417/65**

(58) **Field of Search** ..... **417/226, 92, 65**

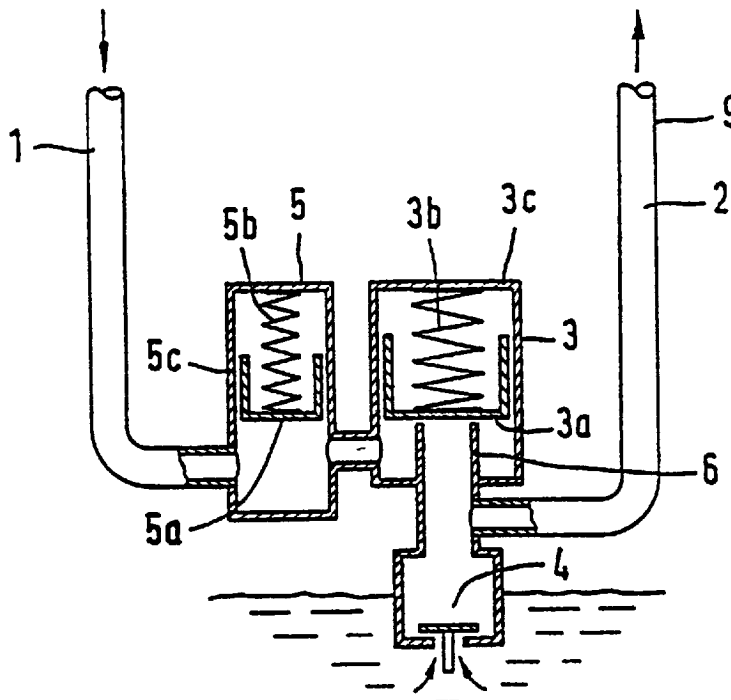
The invention relates to a hydraulic ram pump, comprising: a propulsion water line fed with propulsion water, a delivery line which can be connected to delivery water via a bottom valve, a ram pump valve which is connected to the propulsion water line and delivery line, the propulsion water flowing into the delivery line when the ram pump valve is open and, after the closing of the ram pump valve, the water column flowing further in the delivery line sucking in delivery water via the bottom valve, the ram pump valve being held by spring force in its closed position separating the propulsion water line from the delivery line, and a pressure reservoir being provided, which is connected to the propulsion water line upstream of the ram pump valve in the direction of flow, the valve member being of annular design, axially movable and tightly connected to the delivery line, the effective cross section of this connection being larger than the cross section of the valve seat, and the valve seat of the ram pump valve and the valve seat of the bottom valve being mechanically coupled in order to transmit kinetic energy.

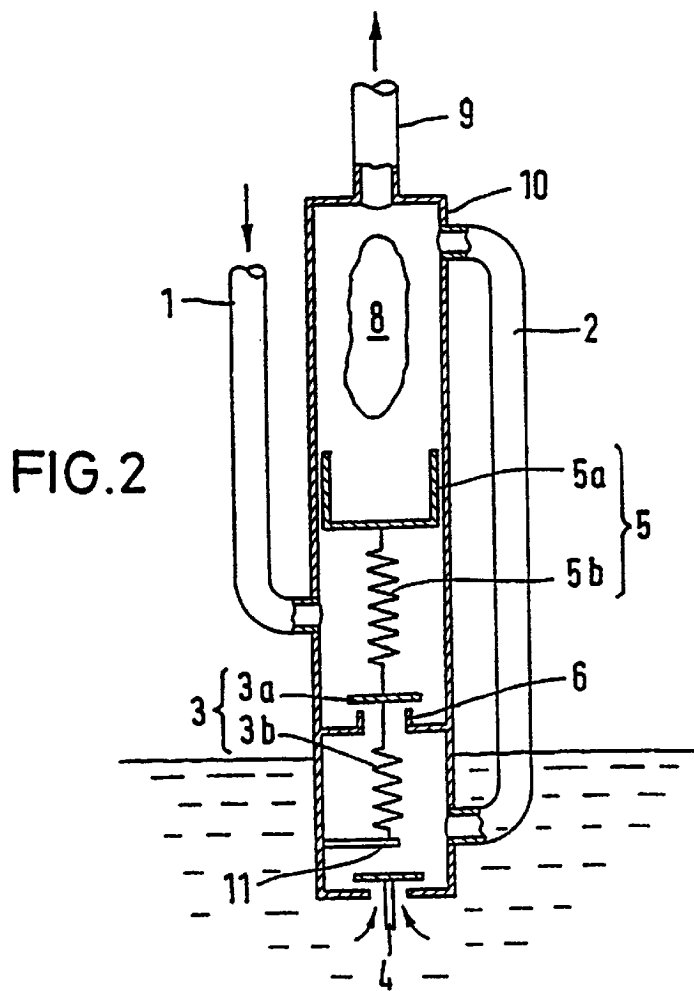
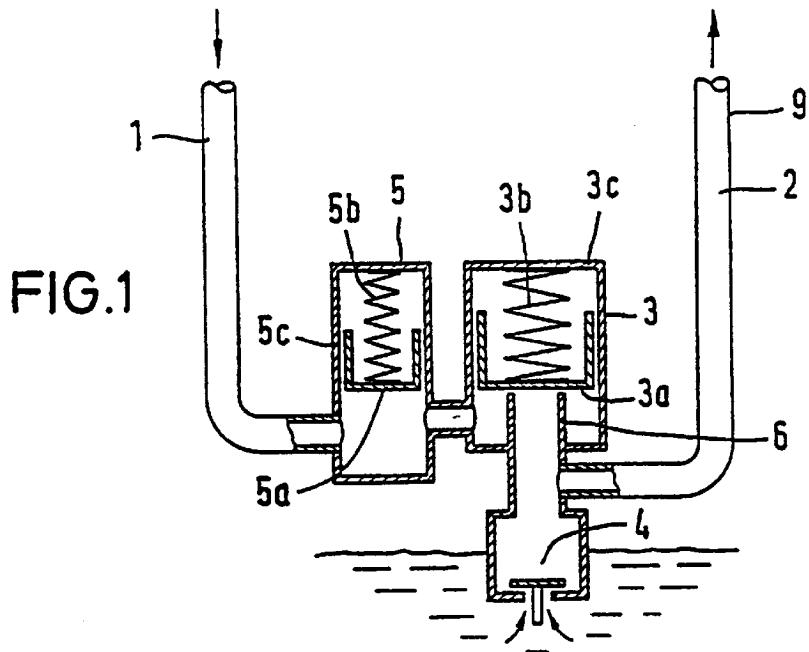
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**8 Claims, 2 Drawing Sheets**







## HYDRAULIC RAM PUMP

## BACKGROUND OF THE INVENTION

The invention relates to a hydraulic ram pump for converting low amounts of water at high pressure into large amounts of water at low pressure. Such ram pumps are also designated suction rams. Rams denote ram pumps which can be used in reverse for the conversion of large amounts of water at low pressure into low amounts of water at high pressure. The ram pump according to the invention can do both, that is to say it can optionally be used to increase pressure or to increase volume flow.

Suction rams have been known at least since 1905 ("Trägheitsmaschinen als Möglichkeit der hydraulisch-mechanischen Energieumformung" [Inertial machines as an option for hydraulic-mechanical energy conversion], presentation by Ivan Cyphelly, Fegawerk/Switzerland, held at the IHP of RWTH Aachen, Prof. Backé, Jun 21, 1991). They employ a ram valve which, as in the case of the hydraulic rams having a propulsion water pipe and a natural drop, is abruptly closed by the hydrodynamic pressure drop which is produced by the water flowing through the valve.

In the case of known suction rams (for example German Patent No. 804,288, 1949, or in the case of the suction ram still built today by the company Fegawerk S. A., Le Locie/Switzerland), when the ram valve closes the kinetic energy of the flowing water in the propulsion water line is dissipated, because the propulsion water is stopped. In order to keep this loss as small as possible, the suction ram from Fegawerk has as the propulsion water line a hose having an extremely large cross section, by which means high velocities of the propulsion water are additionally avoided.

The above-mentioned known suction rams require a specific constant propulsion water volume flow for satisfactory functioning, since when the propulsion water volume flow falls below that needed, the ram pump valve no longer closes and the efficiency falls to zero.

The ram valve is exposed to a particularly high loading as a result of the abrupt stopping of the propulsion water column, this loading being still considerably higher in known suction rams than in conventional hydraulic rams in which, as the result of the stopping of the propulsion water column, the pressure which is backed up at the valve is only that which must be achieved in order to deliver into an air receiver. This high loading on the ram pump valve has an unfavorable effect on the lifetime of the known suction ram.

These disadvantages are overcome by the ram pump described in the German Patent Application DE 19520343, which is not a prior publication (EPC Art. 54(3)), according to which the ram pump valve is not formed as a nonreturn valve, as in the previously mentioned prior art, which is held open by spring force and closed by the propulsion water flow, but as a valve which is held closed by spring force and opened by the propulsion water pressure.

## SUMMARY OF THE INVENTION

Furthermore, according to the invention, provision is made to actuate the ram pump valve cyclically in the manner of an oscillatory circuit in cooperation with a pressure reservoir element which is likewise acted on by the propulsion water. Because of its construction, this suction ram can operate both to increase pressure and also to increase volume flow.

Since in the case of this ram pump the propulsion water pressure is taken up, before the opening of the ram pump

valve, by the pressure-adjustable element of a pressure reservoir element, it is ensured that the propulsion water is not stopped abruptly when the ram pump is operating but rather can be fed to the latter continuously, by which means the ram pump valve is distinctly relieved of load in comparison with the prior art, which is to the benefit of the lifetime of the ram pump as a whole.

By means of the construction of the ram pump valve of this ram pump as a closing valve, and its driving by the propulsion water in conjunction with a pressure reservoir element, it is furthermore achieved that the ram pump valve still opens even at the smallest propulsion water volume flow, since the opening pressure for the ram pump valve is built up by the pressure reservoir element even given a minimal propulsion water flow. This therefore also achieves a distinct increase in the efficiency of the ram pump in comparison to the suction ram treated above.

Further details of this ram pump are explained in more detail below using FIGS. 1 and 2 of the drawing, according to which:

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a schematic representation of a first embodiment, and

FIG. 2 shows a second embodiment of the ram pump described in DE 19520343, which is not a prior publication.

FIG. 3 shows a longitudinal sectional view through a preferred embodiment of the ram pump.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

The hydraulic ram pump shown in FIGS. 1 and 2 in general comprises in a conventional way a propulsion water line 1, a delivery water line 2, a ram pump valve 3 and a bottom valve 4 for sucking up delivery water. Located at the end of the delivery water line 2 is the ram outlet 9. The ram pump valve 3 comprises a piston 3a and a restoring or closing spring 3b which biases the piston 3a against a valve seat 6. The ram pump valve 3 is held closed by a spring.

Furthermore, provision is made that the propulsion water line 1 is connected not only as in the prior art to the pressure side of the ram pump valve 3 but additionally to a spring reservoir 5.

The pressure reservoir element 5 is formed as a spring reservoir in the embodiments of the ram pump shown in FIGS. 1 and 2.

According to the embodiment shown in FIG. 1, the spring reservoir 5 has its own casing 5c, which communicates with the propulsion water line 1 upstream of the ram pump valve 3. Located in the casing 5c is a piston 5a which is biased by a spring 5b and which forms the pressure-adjustable element of the pressure reservoir element.

The piston 3a, the restoring spring 3b and the valve seat of the ram pump valve 3 are likewise accommodated in their own casing 3c, separate from the casing 5c, in the case of the embodiment of the ram pump shown in FIG. 1, with the result that the ram pump valve 3 and the spring reservoir 5 are effectively connected to each other only via the propulsion water.

In FIG. 2, the elements of the spring reservoir 5 and of the ram pump valve 3 are accommodated in a common casing 10 and coupled mechanically to one another: the piston 5a of the spring reservoir 5 is arranged at the upper end of the coupled piston-spring system, and the pressure reservoir spring 5b connects the piston 5a to the piston 3a, located

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beneath the latter, of the ram pump valve **3**, whose restoring spring **3b** runs in the upward direction and is fixed at a stationary abutment **11** in the casing **10**. The lower end of the casing dips into the delivery water and is closed by the bottom valve **4**.

The propulsion water line opens into the casing **10** at the level of the reservoir spring **5b**, while the delivery water line branches off from the casing at the level of the lower end of the closing spring **3b**.

The closing spring **3b** and the pressure reservoir spring **5b** are tension springs in the case of this embodiment of the suction ram of FIG. 2.

The ram pump shown in FIGS. 1 and 2 operates as follows:

The propulsion water flows through the propulsion water line **1** and stresses the pressure reservoir spring **5b** via the propulsion water pressure acting on the piston **5a** (pressure reservoir phase), until the pressure on the area of the ram pump valve piston **3a**, less the area of the valve seat **6**, overcomes the force of the restoring or ram pump valve closing spring **3b**. The ram pump valve **3** then opens abruptly, since as the opening begins the propulsion water pressure acts on the area of the entire ram pump valve piston **3a**. The reservoir spring **5b** is now relieved (relief phase), in that it accelerates the mass of water in the delivery line **2** via a reciprocating movement of the piston **5a**, as a result of which the pressure in this line falls until the force of the closing spring **3b** overcomes the pressure on the entire area of the ram pump valve piston **3a** and the ram pump valve closes. In the renewed pressure reservoir phase which now follows, the water flowing further in the delivery line **2** sucks water out of the bottom valve **4** until the water flow comes to a standstill because of the counter pressure as a result of the delivery head. Further relief and pressure reservoir phases then proceed cyclically.

The ram pump shown in FIG. 2 runs cyclically through pressure reservoir and relief phases, like the ram pump shown in FIG. 1. In contrast to the ram pump shown in FIG. 1, in the case of the ram pump of FIG. 2 the pressure reservoir piston **5a**, because of its spring coupling to the ram pump valve piston **3a**, partially takes over the changeover function of the latter. This means that the propulsion water stresses the pressure reservoir spring **5b** via the propulsion water pressure acting on the piston **5a** (pressure reservoir phase) until the pressure on its area, less the area of the valve seat **6**, overcomes the force of the restoring or ram pump valve closing spring **3b**. The ram pump valve **3** then opens abruptly, since as the opening begins the propulsion water pressure acts on the area of the entire pressure reservoir piston **5a**. The pressure reservoir spring **5b** is now relieved (relief phase), in that it accelerates the mass of water in the delivery line **2** via a reciprocating movement of the piston **5a**, as a result of which the pressure in this line falls until the force of the closing spring **3b** overcomes the pressure on the entire area of the pressure reservoir piston **3a** and the ram pump valve closes. In the renewed pressure reservoir phase which now follows, the water flowing further in the delivery line **2** sucks water out of the bottom valve **4** until the water flow comes to a standstill because of the counter pressure as a result of the delivery head. Further relief and pressure reservoir phases then proceed cyclically.

In FIG. 2, there is additionally arranged in a free space of the casing **10** above the piston **3b** an air-filled hose **8**, which buffers the pulsating movements of the ram pump valve piston **3b** and of the water in the delivery line **2**, by which means a relatively quiet mass flow is ensured at the ram

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pump outlet **9**. Other known means for buffering can in principle also be used.

The object of the present invention is to provide a hydraulic ram pump which, given a compact construction, ensures a high efficiency and a long lifetime, and can be operated both to increase pressure and to increase volume flow.

Accordingly, the hydraulic ram pump according to the invention is in principle constructed as shown in FIGS. 1 and 2 and explained above. A special feature of the ram pump according to the invention consists in a mechanical coupling of the valve seat of the ram pump valve to the valve seat of the bottom valve in such a way that the kinetic energy which arises when closing one valve is transmitted to the other valve for the purpose of opening its valve member. In addition to the advantages already treated above of a ram pump of this type, this achieves more favorable operation in terms of energy. A further advantage is that the detrimental section between the two valves, which represents a problem in the prior art, since the kinetic energy of the water in this connecting section cannot be utilized and, when the ram pump closes, can lead to cavitation in the latter, can be kept optimally short. Finally, a compact construction of the ram pump is ensured by the fact that the ram pump valve and the bottom valve are arranged directly adjacent to each other and axially.

The compact construction benefits from a design of the pressure reservoir in the shape of a bellows which carries the valve member of the ram pump valve at one end. Likewise beneficial to the compact construction is the arrangement of the restoring spring for the valve member of the ram pump valve inside the pressure reservoir bellows. Finally, according to the invention the compact construction benefits from the formation of the restoring spring for the bottom valve in the shape of a bellows which is arranged in the pump in such a way that the delivery water passes through it.

The invention is explained in more detail below by way of example using FIG. 3. of the drawing; this shows a longitudinal sectional view through a preferred embodiment of the ram pump according to the invention. Parts which are functionally identical to those in FIGS. 1 and 2 are designated in FIG. 3 by the same reference numbers.

The ram pump shown in FIG. 3 has a generally tubular casing **20** having a cylindrical jacket **21** which is closed at one end, the lower end in FIG. 3, by a bottom **22** and which is closed at its other end, the upper end in FIG. 3, by a lid **23**. The interior of the tubular casing **20** is subdivided axially by a partition **24** into a larger-volume subchamber **25** and a smaller-volume subchamber **26**.

The bottom **22** of the casing **20** is designed in two parts in the embodiment shown and comprises a ring **27** whose outer circumference corresponds to the outer circumference of the jacket **21**, and whose acentric inner circumference has an internal thread into which a closure stopper **28** with an external thread is screwed. In order to seal off the parts **27** and **28** in relation to each other, there is designed at the outer circumference of the closure stopper **28** an annular groove in which there is seated an O ring **29** which is supported on the inner circumference of the ring **27**.

A propulsion water line, not shown, is connected to an inlet pipe **30** which passes through a hole in the lid **23** and a corresponding hole in the partition **24**. The inlet pipe **30** is tightly connected at least to the partition **24**. Inserted tightly into a further hole in the partition **24** is a tubular valve seat carrier **31** which has an annular part **4a** projecting into the smaller subchamber **26**, said annular part **4a** forming with its



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outside pointing toward the lid **23** a valve seat **4b** of the bottom valve **4**, which in addition has a restoring spring **4c** which is formed as a bellows, to one end of which the valve member **4b** is firmly connected and the other end of which is firmly connected to a pipe connection **32** which passes through a hole in the lid **23**, is firmly connected to the latter and is connected to a delivery line, not shown. Formed at the other end of the valve seat carrier **31** is a valve seat **6** in the shape of a conical surface which tapers in the direction of the valve seat **4a** of the bottom valve **4** and, for the purpose of cooperation, cooperates with a spherical surface, complementary thereto, formed on the valve member **3a** of the ram pump valve **3**, which is likewise formed in the shape of a circular disk which is firmly connected to one end, the upper end in FIG. 3, of a bellows **5** which, as explained below, forms the pressure reservoir of the ram pump and is firmly connected with the other end to the inner surface of the closure stopper **28** in the bottom of the casing **20**. Supported on the inside of the annular ram pump valve member **3** is a restoring spring **3b**, whose other end is supported at the upper end of a supporting pipe **33** which is inserted with its other end in a hole in the closure stopper **28** and is firmly connected to the latter. At the lower end, the supporting pipe **33** is penetrated radially by holes **34** which, on the one hand, open into the interior of the pipe **33** and, on the other hand, open into the inner space enclosed by the bellows **5**.

The valve body **3a** of the ram pump valve **3** has a central hole which is penetrated by a cylindrical body **35** which, with its end pointing toward the bottom valve **4**, projects into the inner space enclosed by the valve seat carrier **31** and is broadened at the other end in the manner of a flange, this flange-like end part serving for fastening the valve body **3** to the bellows **5**. On that side of the flange pointing toward the bellows **5** there is formed a retaining body for the restoring spring **3b**, this spring engaging around said retaining body. This body, as well as the flange end of the cylindrical body **35** and the latter itself, are completely penetrated by a capillary bore which finds its extension in a capillary tube **36** which extends as far as into the bottom region of the retaining pipe **33**.

The jacket of the casing **20** is preferably pierced at a plurality of locations in the region of the smaller subchamber **26**, and metal screens **37** and **38** are seated in these piercings.

As is shown schematically in FIG. 3 by a wavy line at the upper end of the ram pump, the latter is immersed below the surface of a water reservoir.

The mode of operation of the ram pump according to the invention, which is constructed as explained above using FIG. 3, is explained below.

Propulsion water is pumped by an external pump (not shown), via the connecting nozzle **30**, into the lower subchamber or pressure chamber **1** of the ram pump. Since the valve member **3** is held by the restoring spring **3b** in the closed position against the valve seat **6** of the ram pump valve **3**, the pressure in the pressure chamber outside the bellows **5** rises, and this rising pressure leads to an elastic deformation of the bellows **5**, which preferably consists of metal. This means that the folds of the bellows **5** fulfill the function of a spring reservoir for the hydraulic suction ram.

The liquid pressure building up in the subchamber **25** effects an increasing force on the end face of the bellows **5** carrying the ram pump valve member **3a**, and this pressure finally overcomes the closing force of the restoring spring **3b**. As a result, the ram pump valve **3** opens, or its valve member **3a** comes free of its valve seat, and the liquid

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pressure which is present in the pressure chamber **25** now acts on the entire end face of the bellows **5** and, respectively, the outer face of the valve member **3a**, as a result of which the ram pump valve **3** opens still further, and as a result of which the pressure in the subspace **25** falls slightly. In addition, with the ram pump valve **3** open, the pressure in the subchamber **25** acts on the inner space of the bellows **4c**, which forms the restoring spring for the bottom valve **4**, which is still closed at this time, and the delivery water which is present in this inner space, and accelerates the latter, as a result of which the pressure falls further until it falls below that value at which the restoring spring **3b** presses the valve body **3** once more against its valve seat and thereby closes the ram pump valve, the pressure in the subchamber **25** being built up once more.

The kinetic energy which is transmitted to the associated valve seat **6** by the closure of the ram pump valve **3** is transmitted via the valve seat carrier **31** to the valve seat **4a** of the bottom valve **4**, and opens this valve as a result of this elastic shock. At the same time, the kinetic energy entrained in the delivery water is used up, in that the delivery water sucks water from the surroundings against the weight of the delivery water through the bottom valve **4**, which is now open, the valve body **4b** being lifted off the valve seat **4a**. At the same time, the bottom valve **4** is held open by a slight negative pressure in the bellows **4c**. As soon as the energy contained in the delivery water has been used up, the bottom valve **4** is closed once more by the spring force resident in the bellows **4c**.

The kinetic energy of this closing process is transmitted by an elastic shock via the valve seat carrier **31** to the valve seat **6** of the ram pump valve **3** and by the latter to the valve member **3a** of the ram pump valve **3**, as a result of which the latter is opened. At the same time, the delivery water which has just remained stationary swings back slightly because of the elasticity of the bellows **4c** and produces a small setting shock which promotes the opening of the ram pump valve.

Because of the valve seats, which according to the invention are mechanically coupled or formed in one piece, for the bottom valve **4** and the ram pump valve **3**, the closing energy of the respective valve is advantageously employed to open the respective other valve. This advantage cannot be achieved in the case of ram pumps of conventional construction, since the valve seats of the two valves under discussion (the bottom valve is a nonreturn valve) are designed to be separate from one another, so that kinetic energy cannot be transmitted from one valve to the other. The kinetic energy which is released during the closure is rather dissipated by means of damping, for example in the sealing rubber of the valve. Damping of this type is conventionally also necessary in order to prevent the so-called bouncing of the respective valve member on the valve seat. In the case of valves which are designed according to the invention, connected to each other via the valve seat or formed as a material unit, this bouncing does not occur, since the kinetic energy is introduced by the closing valve into the other valve, in order to trigger or to promote its opening.

Conventionally, the flow round a valve member is axial, and the flow runs apart radially between the valve member and the valve seat following the inflow. By contrast with this, the flow in the valves which are designed according to the invention with a common valve seat runs radially inwardly together between the valve members and the associated seats and then axially away from the respective valve. It is only this that provides the capability of a common valve seat. A further advantage of the coupling of the valve

seats of the two valves, according to the invention, consists in the fact that the section between the two valves can be kept negligibly short.

By means of a simple measure, the ram pump according to the invention and explained above can also be operated as a normal ram. For this purpose it is merely necessary to provide an additional spring which has the effect that the bottom valve **4** is open in the rest position. The mode of operation of this modified ram pump is as follows:

Initially, the delivery water is accelerated because of its natural fall, and it emerges into the open through the opened bottom valve **4** via the tube connection **32** until a hydrodynamic negative pressure between the valve member **4b** and the valve seat **4a** and a backpressure in the bellows **4c** effect the closure of the bottom valve **4**. As a result, the ram pump valve **3** opens, and the kinetic energy of the delivery water charges the spring reservoir (bellows **5**), as a result of which the ram pump valve **3** closes once more and the process, as explained above, begins again from the beginning. However, if the spring reservoir (bellows **5**) is already charged (that is to say no water under pressure is consumed), the bottom valve **4** does not close when the delivery water has come to a standstill but only after the excess energy from the spring reservoir has accelerated the delivery water in the converse manner or backward. Following the closure of the ram pump valve **3**, the delivery water then initially sucks water in through the bottom valve **4**, until the flow direction reverses. This means that, if no water under pressure is needed, the consumption of delivery water also returns to a minimum.

The purpose of the capillary tube **36** or the capillary opening in the valve member (FIG. **3**) is that the pressure in the interior of the bellows **5** becomes equal to the average pressure in the bellows **4c** and in the delivery line. This achieves the situation where the pressure difference between propulsion water and delivery water, at which the ram pump valve opens, is independent of the delivery head. And as a result the load on the external propulsion water pump is always the same, irrespective of whether the ram pump is employed to deliver large quantities of surface water or small quantities of water from a great depth.

What is claimed is:

1. A hydraulic ram pump, comprising:

a propulsion water line (**1**), a delivery line (**2**) which receives delivery water via a bottom valve (**4**), a ram pump valve (**3**) which is connected to the propulsion water line (**1**) and delivery line (**2**), the propulsion water flowing into the delivery line when the ram pump valve (**3**) is open and, after closing of the ram pump valve, the water column flowing further in the delivery line sucking in delivery water via the bottom valve (**4**), the ram pump valve (**3**) being arranged coaxially with the bottom valve (**4**) with mutually adjacent valve seats and held by spring force in its closed position separat-

ing the propulsion water line from the delivery line, and a pressure reservoir (**5**) being provided, which is connected to the propulsion water line upstream of the ram pump valve (**3**) in the direction of flow wherein the pressure reservoir (**5**) has a bellows which is supported at one end in a subchamber (**25**) of a two-part casing and is acted on externally by the propulsion water, which is conducted into this subchamber (**25**) of a two-part casing and is acted on externally by the propulsion water, which is conducted into this subchamber (**25**) via the propulsion water line (**30**), and which carries at the other end the valve member (**3a**) of the ram pump valve (**3**), the valve seat (**6**) of which is seated in a partition (**24**) subdividing the casing (**20**) and is connected to the valve seat (**4a**) of the bottom valve (**4**), and which is arranged in the other subchamber, which communicates with the delivery water.

2. The hydraulic ram pump as claimed in claim **1**, wherein the ram pump valve (**3**) and the bottom valve (**4**) are essentially arranged coaxially, with mutually adjacent valve seats.

3. The hydraulic ram pump as claimed in claim **1**, wherein the two valve seats (**4a**, **6**) are formed at the opposite ends of a valve seat carrier (**24**).

4. The hydraulic ram ovum as claimed in claim **1**, wherein the bellows (**5**) serves as an elastic, variable-volume component of the pressure reservoir, without changing its axial extent in order to store pressure.

5. The hydraulic ram pump as claimed in claim **1**, wherein a restoring spring (**3b**) for the ram pump valve (**3**) is arranged in the interior of the pressure reservoir bellows (**5**), runs coaxially with the latter and is supported with one end on the inside of the valve (**6**) of the ram pump valve (**3**) and with its other end on the casing (**2**).

6. The hydraulic ram pump as claimed in claim **1**, wherein the valve member (**3a**) of the ram pump valve (**3**) is penetrated by a capillary bore which connects the interior of the pressure reservoir bellows (**5**) to the space between the valve member (**4a**) of the bottom valve (**4**) and the valve member (**6**) of the ram pump (**3**).

7. The hydraulic ram pump as claimed in claim **5**, wherein a capillary tube (**36**), which extends as far as into the bottom region of the pressure reservoir bellows (**5**), is connected to the capillary bore.

8. The hydraulic ram pump as claimed in claim **1**, wherein the bottom valve (**4**) has a bellows (**4c**) which at its one end carries the valve member (**4a**) of the bottom valve (**4**), and at its other end is supported on the casing (**20**) in such a way that this valve member (**4b**) is forced against its valve seat (**4a**) in the closed position.

\* \* \* \* \*



US00D338891S

# United States Patent [19]

[11] Patent Number: Des. 338,891

Folk

[45] Date of Patent: \*\* Aug. 31, 1993

[54] WATER POWERED RAM PUMP

D. 101,992	11/1036	Larson	.....	D15/7
D. 110,935	8/1938	Voorhees et al.	.....	D15/7
D. 311,372	10/1990	Angel	.....	D15/7
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[76] Inventor: James E. Folk, 2770 White Ct., N.E., Conyers, Ga. 30207

Primary Examiner—A. Hugo Word  
Assistant Examiner—R. Seifert

[\*\*] Term: 14 Years

### [57] CLAIM

[21] Appl. No.: 461,437

The ornamental design for a water pump, as shown.

[22] Filed: Jan. 5, 1990

### DESCRIPTION

[52] U.S. Cl. .... D15/7

[58] Field of Search ..... D15/7, 9; 123/41.31; 60/398; 290/43, 54; 417/334

FIG. 1 is a left side perspective view of a water pump showing my new design;

FIG. 2 is a right side perspective view;

FIG. 3 is a top plan view;

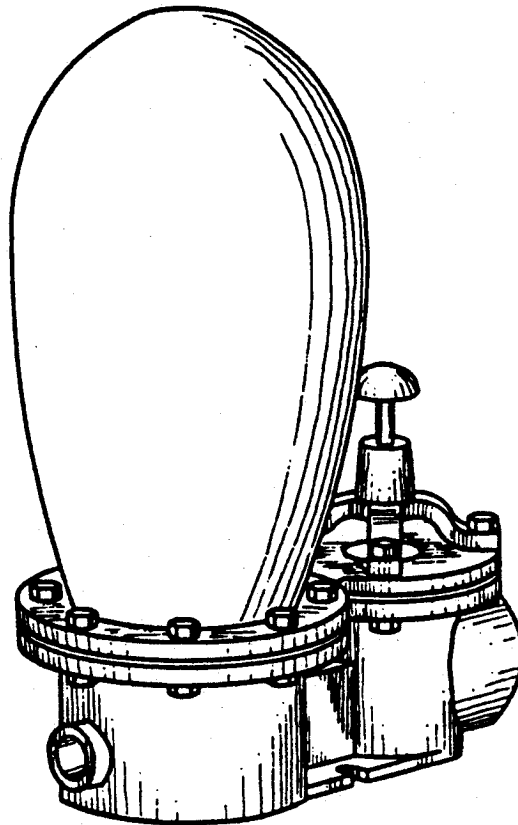
FIG. 4 is a bottom plan view; and,

FIG. 5 is an enlarged detail of the waste valve assembly.

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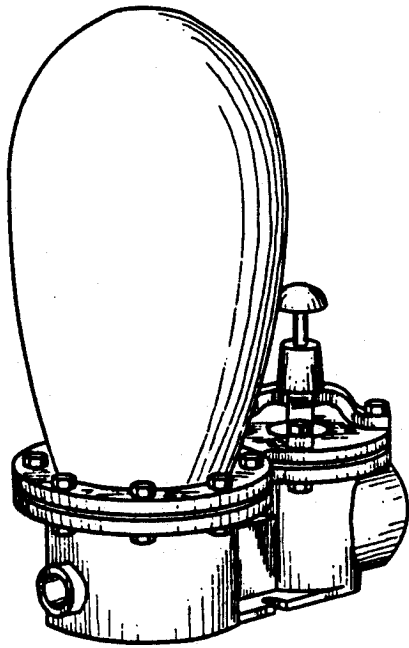


fig. 1

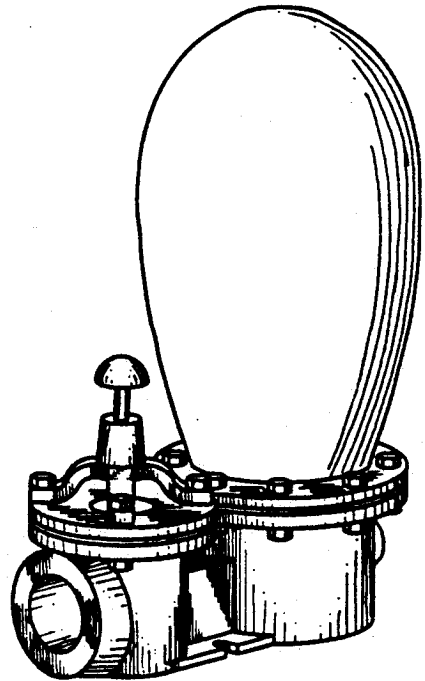


fig. 2

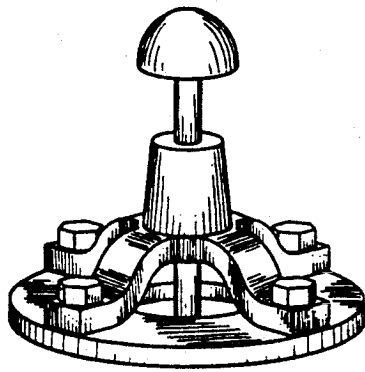


fig. 5

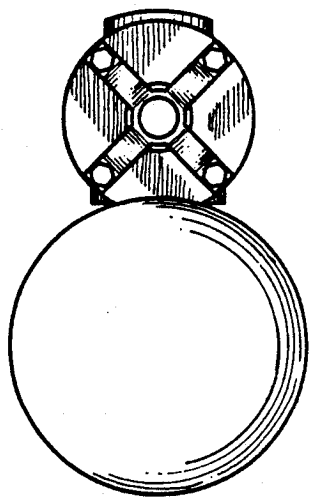


fig. 3

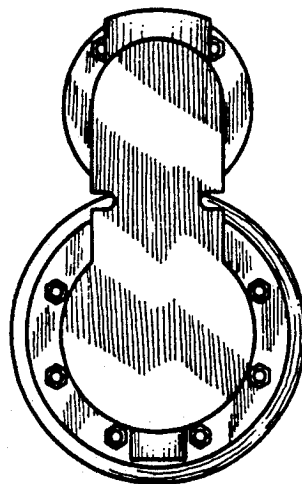


fig. 4