H. M. & T. M. CHANCE.

METHOD AND APPARATUS FOR PUMPING LIQUIDS.

APPLICATION FILED JULY 24, 1913.

1,114,108. Patented Oct. 20, 1914.

FIG I

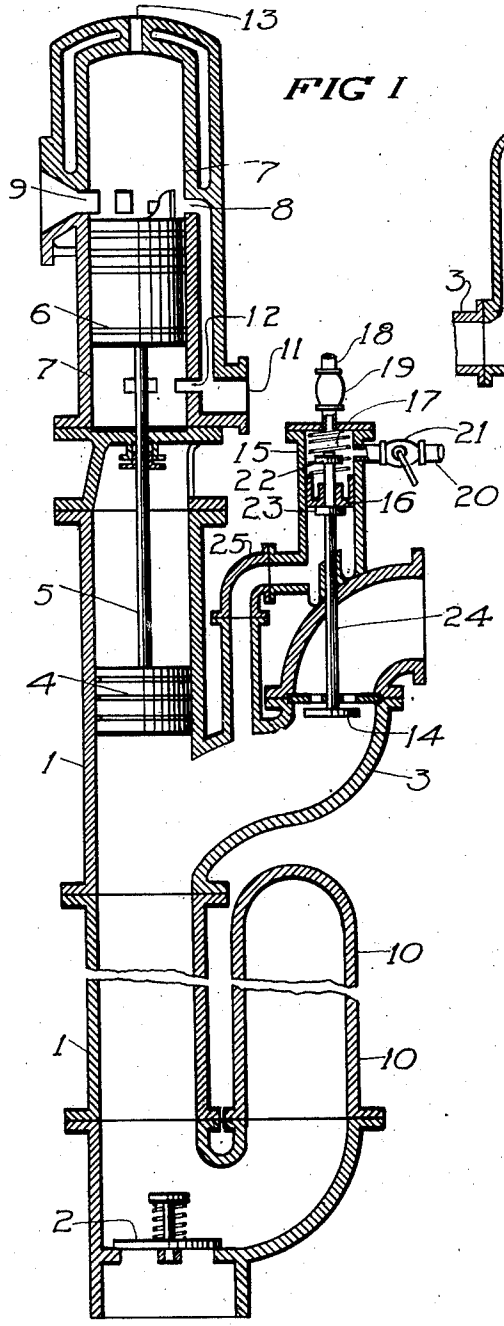
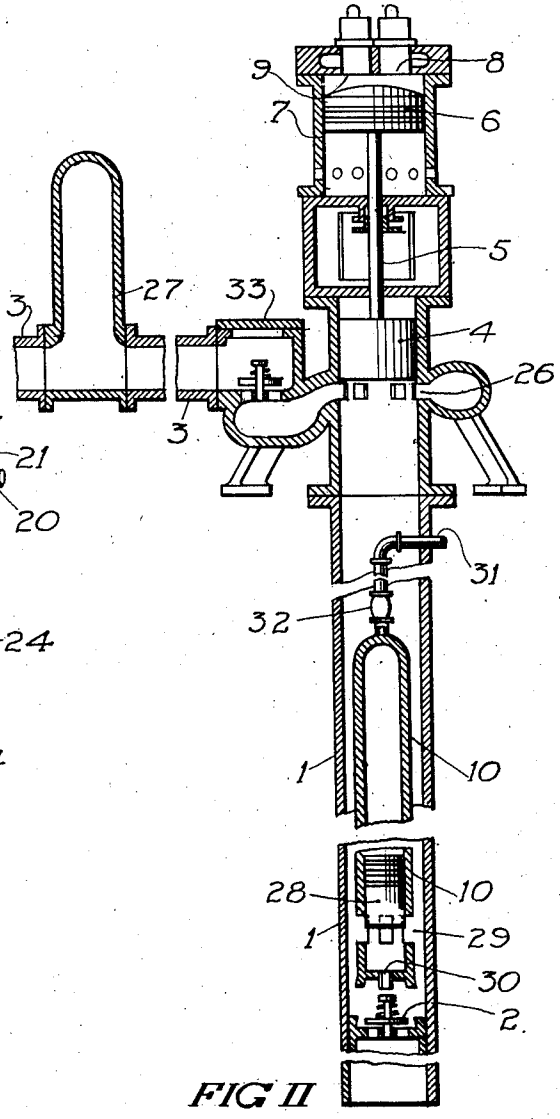


FIG II



Inventors

Witnesses

J. N. Zuinn

Edw. E. Schoukoff

Thomas M. Chance

Henry M. Chance

UNITED STATES PATENT OFFICE.

HENRY M. CHANCE AND THOMAS M. CHANCE, OF PHILADELPHIA, PENNSYLVANIA.

METHOD AND APPARATUS FOR PUMPING LIQUIDS.

1,114,108. Specification of Letters Patent. Patented Oct. 20, 1914.

Application filed July 24, 1913. Serial No. 780,997.

To all whom it may concern:

Be it known that we, HENRY M. CHANCE and THOMAS M. CHANCE, citizens of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Method and Apparatus for Pumping Liquids, of which the following is a specification.

The object of our invention is to provide an improved method for pumping liquids from mines and wells, or for use when it is desirable to apply the power used for pumping at a point located a considerable distance from, or height above the liquid to be pumped. At mines it is generally desirable to keep the application of power, and in fact to locate all machinery, so far as possible, at the surface, and in wells, especially in drilled wells it is usually necessary to place the prime mover used for pumping at the surface.

We accomplish the desired end by hydraulic transmission of the energy used for pumping, employing the liquid contained in the pump main for this purpose, and using this liquid to transmit energy from the prime mover to an accumulator located at or near the lower extremity of the pump main. The energy is transmitted to the accumulator by a downward motion of the liquid, produced by the prime mover and the reaction of the accumulator causes a reverse or upward movement of the liquid, which latter movement is utilized to discharge liquid from one end of the pump main and to take in new liquid to be pumped at the other or lower end of said main. Each outward or downward movement of the liquid in the pump main is produced by the application of energy at the upper or delivery end of the main, no liquid being discharged by this movement; each inward or upward movement of the liquid is produced by the reaction of the accumulator and liquid is discharged and new liquid to be pumped is taken in by this movement. In apparatus for carrying out this method of pumping, the power used for pumping is applied at or near the delivery end of the pump main.

Figure I is a vertical central cross section of an apparatus by which our method of pumping may be carried out, and illustrates the operation of an apparatus in which the energy is supplied by a two-stroke cycle by-pass scavenging internal combustion engine. Fig. II is a vertical central cross section of an apparatus suitable for use in operating our method of pumping when raising liquid from drilled wells, in which the accumulator is placed inside of the pump main. The drawing illustrates the operation of an apparatus in which the energy is supplied by a single-acting cylinder adapted to be operated by compressed air, steam or other elastic medium under pressure.

Like numbers being used to designate like parts in Figs. I and II, 1 is a pump main adapted to raise water from a lower to a higher level, 2 is an inlet valve to said main, 3 is a discharge outlet to said main, 4 is an actuator piston, 5 is a piston rod connecting said piston 4 with a power piston 6, 7 is a power cylinder provided with an inlet port 8 and exhaust port 9, 10 is an accumulator represented in both drawings as an air chamber, but which is intended to represent diagrammatically any organism capable of absorbing and giving out energy.

The operation of the prime mover illustrated by Fig. I will be readily understood without detailed description, 11 being an intake for air or combustible mixture which may be provided with any form of intake non-return valve, 12 being ports by means of which the lower portion of the cylinder 7 is used as an air or mixture pump and 13 being an aperture which may be equipped with any desired form of igniting device. The conduit 1 being filled with liquid and its lower end being immersed in liquid to be pumped, and the air chamber 10 containing air under a pressure equal to that produced by the liquid in conduit 1, the operation of the method and apparatus may be described as follows: It being assumed that the piston 6 is in a position near the top of cylinder 7, and that said cylinder contains a compressed combustible mixture which has been ignited, the downward stroke of pistons 6 and 4 communicate downward movement and velocity to liquid in the conduit 1, causing liquid to rise in the air chamber 10, increasing the pressure of air in that chamber. During this out or power stroke of the piston 4, the outlet valve 14 is held shut by pressure produced in this column of liquid. At the end of the power stroke of the piston 6, the exhaust ports 9 are uncovered, and the inlet ports 8 being uncovered permit scavenging of the waste gases, at the same time the piston 6 continues in movement until it over-

runs the ports 12 of the air pump and is brought to rest by cushioning on air entrapped in the lower portion of cylinder 7. If at the time that the piston is brought to rest, liquid in the conduit 1 is still moving downward, this downward movement will continue until arrested by the reaction of the air chamber 10, but during this period the continued travel of this body of liquid will cause a reduction of pressure or a partial vacuum in the region immediately below piston 4, and this reduction of pressure will permit valve 14 to open by gravity, or by gravity assisted by the pressure of air or liquid in the upper portion of cylinder 15 acting upon a piston 16, and if desired, by a spring 17. The pipe 18 and non-return valve 19 are for the admission of air or liquid under pressure into the upper portion of cylinder 15 and the outlet 20 and cock 21 are to control the escape of liquid from this portion of cylinder 15; cylinder 15 and these adjunctive devices, the movable piston 16 operating by contact with stops 22 and 23 attached to the valve rod 24, constituting a "cataract" control of the valve 14. The valve 14 having opened, liquid under pressure having entered cylinder 15, the valve 21 checking the outflow of liquid from this cylinder 15, the valve 14 is held open so long as the pressure in the upper part of conduit 1 is less than the pressure in cylinder 15. The column in conduit 1 having come to rest, the air chamber 10 reacting upon it causes a resurge of the liquid in conduit 1 causing liquid to flow out through the outlet 3 past the valve 14 and to be discharged, the velocity of the liquid in conduit 1 permitting the expansion of the air in the air chamber 10 to a pressure low enough to permit liquid to flow in through the inlet valve 2. During this period of discharge the pressure in the outlet 3 being transmitted through the connection 25 to the lower portion of the cylinder 15, causes the piston 16 to move upward, and raises and closes valve 14. Immediately upon valve 14 being closed, the liquid in the conduit 1 still having upward velocity, acts upon the piston 4, piston rod 5 and piston 6 forcing piston 6 back into its initial position, and compressing the new charge of combustible mixture contained in cylinder 7. The charge is then ignited and the operation repeated.

In the apparatus shown by Fig. II the sequence of operation will be understood from the preceding description, the piston 4 in this apparatus being made to perform the functions of the valve 14 of Fig. I by overrunning the outlet ports 26 of conduit 1. In the operation of this apparatus the pistons 4 and 6 are forced through their return stroke by the upward movement of liquid in the column 1 before the discharge of liquid occurs through ports 26 and outlet 3. The air chamber 27 is not essential to the operation of this apparatus, but is a useful adjunct when the liquid is discharged through discharge outlet 3 under pressure, that is, where it is desired to discharge liquid from the apparatus under pressure. It will be understood that the inlet 8 and exhaust 9 are provided with suitable valves and mechanism for operating same. In this Fig. II the accumulator 10 is shown as an air chamber and cylinder combined in the lower part of which there is a piston 28 which is limited in its downward movement by overrunning the ports 29 and cushioning on liquid contained in the lower portion of 10, the escape of which is throttled through a small opening 30. In operating apparatus of this type, the air in 10 may be maintained at a pressure equal to or greater than the static head, the downward movement of the piston being arrested, and the air being retained in the air chamber at this higher pressure during the suction period in which liquid is drawn in through the valve 2 and during which period the liquid in the conduit 1 has relatively high upward velocity. In this Fig. II showing this type of air chamber, the pipe 31 is provided as a means of supplying the air chamber 10 with air under pressure, the non-return valve 32 preventing the escape of air from the chamber 10 when the pressure in 10 is greater than the pressure under which air is being supplied through 31.

It will be understood that in this method of pumping, any desired type of prime mover may be used for furnishing the power for operation, and any type of piston or means of applying pressure to the upper portion of the conduit 1 may be used to replace the piston 4; for instance, the piston 4 may be replaced by a diaphragm, and this diaphragm may be operated by hand or other power. It will also be understood that the conduit 1 while represented in these drawings as vertical, may be placed at any desired inclination or inclinations, and is not necessarily straight or of uniform cross section. It will also be understood that while both of the drawings illustrate prime movers of a vertical type, other types of prime movers are equally applicable in operating the method.

It will be further understood that while the drawings illustrate the application of pressure to the upper portion of the column of liquid in the conduit 1, by means of a piston 4, that other means of applying power impulses or pressure, and of discontinuing the application of such impulses or pressure may be used, and that a piston is not essential to the operation of this method of pumping, because an elastic medium under pressure, such as air, steam, or an ignited com-

bustible mixture, may be made to act directly upon the liquid in the upper portion of the conduit 1, or that liquid under pressure may similarly be used as a source of power for producing the power impulses necessary for operation, without the intervention of a piston or pistons.

It will be understood that liquid may be discharged, if desired, from apparatus of the type shown by Fig. II, during the early part of the power stroke and before the piston 4 has overrun and closed the ports 26. When the quantity pumped per stroke is a relatively small volume, the whole discharge may be made during this period, but the pumping or elevating of the liquid is effected during the upward oscillation of the column of liquid, and the ejection of liquid during the early part of the power stroke is merely one of the many ways in which the method may be used. The discharge valve 33 is useful when liquid is to be discharged under pressure and when ejection from the pump main is effected during the early part of the power stroke.

The foregoing description of our invention will enable those familiar with the pumping of liquids to apply our method in many different ways and to use many different kinds of apparatus other than those shown by the drawing, for it is apparent that any of the parts may be duplicated, that two or more pump mains may be used in place of one, that two or more accumulators may be used in place of one, that the inlet may be any form of opening or openings controlled by any device or devices to close the opening or openings, that the discharge outlet may be single or multiple and controlled by any suitable device, that the pump main may be vertical or inclined at any desired inclination or inclinations, that any desired type of prime mover may be used to furnish the energy required for operation of the method, that the movement of the liquid on the return or pumping stroke may, if desired, be utilized to move the actuating device back to its initial position, that the movement of the actuating device on its return stroke may, if desired, be used to react on the prime medium to compress it, or to do other useful work, and that many other applications of the method are possible and that many adjunctive devices may be added to the apparatus shown, without departing from the spirit of our invention.

We believe our invention to differ radically from all methods heretofore known or used and do not desire to limit ourselves to the described or illustrated applications of the method and apparatus, but claim the invention in its broadest sense without limitation as to the particular devices or means whereby it may be operated and without limitation as to the uses to which it may be put, or as to the conditions under which it may be used.

Having described our invention we claim:

1. A pump for pumping liquids comprising in combination a conduit adapted to contain liquid to be pumped and adapted to be used as a pump main through which liquid may be raised, one end of said conduit being relatively higher than the other end, the upper portion of said conduit being provided with a discharge outlet and the lower portion being provided with a valved inlet, an accumulator in operative relation to the lower portion of said conduit and means near the upper portion of said conduit for applying pressure and energy to liquid contained in said conduit and for transmitting said pressure and said energy to said accumulator.

2. A pump for pumping liquids, comprising in combination a pipe, one end of which is relatively higher than the other end, a discharge outlet near the upper end of said pipe, a valved inlet near the lower end of said pipe, an accumulator near the lower end of said pipe and means for applying power impulses near the upper end of said pipe to liquid contained in said pipe.

3. A pump for pumping liquids comprising in combination a vertical pipe, a valved inlet and an accumulator near the lower end of said pipe, a discharge outlet near the upper end of said pipe and means in operative relation to the upper part of said pipe for applying pressure and energy to liquid contained in said pipe.

4. A pump main adapted to convey liquid from a lower to a higher elevation provided with an inlet for liquid near its lower end and a discharge outlet near its higher end, a prime mover operatively arranged to transmit energy to the higher end of said main and an accumulator in operative relation to the lower end of said main.

5. A method of pumping liquid which consists in imparting downward movement and velocity to a confined body of liquid, in causing said velocity to store energy in an accumulator, in causing the resistance of said accumulator to bring said body of liquid to rest, in causing said accumulator to react upon and to impart upward movement and velocity to said body of liquid, in causing said upward movement to discharge liquid from the upper portion of said body of liquid and to permit new liquid to flow into the lower portion of said body of liquid.

6. A method of pumping liquid which consists in imparting downward movement and velocity to a confined body of liquid by means of the energy of a prime medium having high initial pressure and expansive force, in causing said velocity to store energy in an accumulator, in causing the resistance

of said accumulator to bring said body of liquid to rest, in causing said accumulator to react upon and to impart upward movement and velocity to said body of liquid, in causing said upward movement to discharge liquid from the upper portion of said body of liquid and to permit new liquid to flow into the lower portion of said body of liquid.

7. A method of pumping liquid which consists in imparting downward movement and velocity to a confined body of liquid by means of the energy of a prime medium having high initial pressure and expansive force, in causing said velocity to store energy in an accumulator, in causing the resistance of said accumulator to bring said body of liquid to rest, in causing said accumulator to react upon and to impart upward movement and velocity to said body of liquid, in causing said upward movement to discharge liquid from the upper portion of said body of liquid, to permit new liquid to flow into the lower portion of said body of liquid and to compress a fresh charge of said prime medium.

8. A method of pumping liquids which consists in causing liquid contained in a pipe provided near its lower end with a non-return valve and which lower end is in operative relation to a resilient cushion to oscillate, in causing the downward oscillation to store energy in said cushion, in causing the upward oscillation to permit liquid to be discharged from the upper portion of said pipe and to flow into the lower portion of said pipe.

9. A method of pumping liquids which consists in transmitting energy and pressure by means of a confined body of liquid from a region of discharge to an accumulator located near a region of intake, in permitting the energy thus stored in said accumulator to act upon said body of liquid and to produce movement in said body of liquid toward the region of discharge, in permitting liquid to discharge at said region of discharge and in permitting liquid to flow into the apparatus at the intake.

10. A method of pumping liquid by means of an oscillating body of liquid contained in a conduit provided with a discharge outlet near its upper extremity and a valved intake near its lower extremity which lower extremity is in operative relation to an accumulator, which consists in applying a power impulse to that portion of said body of liquid near the region of discharge, thus transmitting motion and pressure to said accumulator, in discontinuing the application of said power impulse, in permitting the body of liquid to come to rest, in causing the energy stored in said accumulator to react upon and communicate motion to said body of liquid in a direction opposite to that produced by said power impulse, in permitting liquid to flow out through said discharge outlet and new liquid to flow in through said valved inlet, and in repeating the above described operation, whereby oscillations are produced in said body of liquid and whereby the oscillation in an upward direction is utilized to pump liquid.

In testimony whereof we have hereunto signed our names, at Philadelphia, Pennsylvania, this 21st day of July 1913.

HENRY M. CHANCE.
THOMAS M. CHANCE.

Witnesses:
E. R. BARNARD,
CHAS. BUSH.