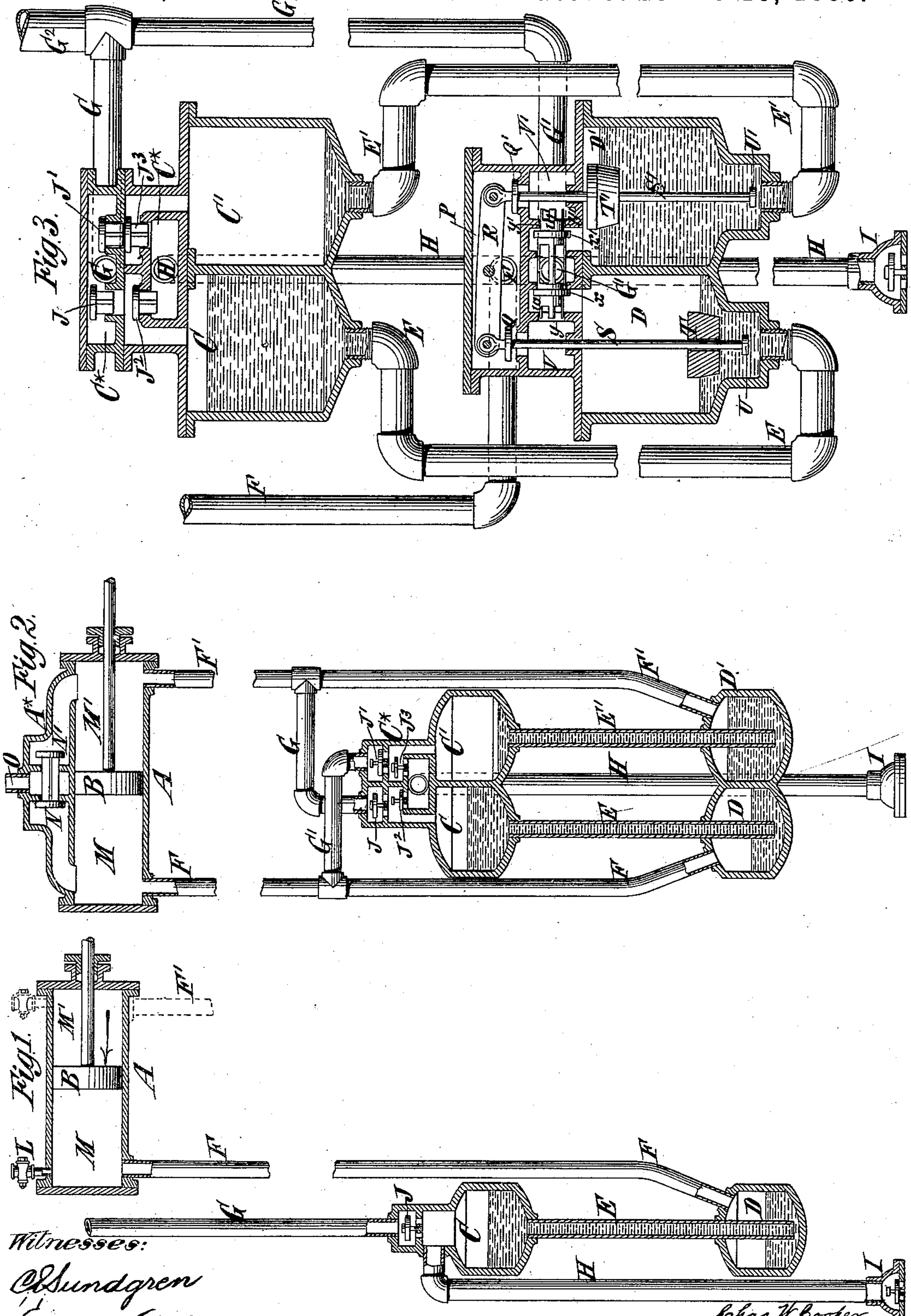
(No Model.)

C. W. COOPER.

APPARATUS FOR ELEVATING WATER.

No. 343,568. Patented June 15, 1886.



Witnesses:

C. Sundgren

Henry McBride

Inventor: Chas. W. Cooper.
by his Attys
Brown & Hall

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

CHARLES W. COOPER, OF BROOKLYN, NEW YORK.

APPARATUS FOR ELEVATING WATER.

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To all whom it may concern:

Be it known that I, CHARLES W. COOPER, of the city of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Apparatus for Elevating Water, of which the following is a specification.

My invention relates to that class of apparatus for raising and forcing water in which water put under pressure, either naturally or artificially, is used as a transmitter of power for raising double the quantity of water, particularly from great depths or distances from the first source of power—as, for instance, from deep mines—and the invention is intended to obviate the use of tightly-fitting cylinders and pistons, or to permit of the arrangement of such cylinders and pistons, if used, at the top of the mine or other accessible point from which power is transmitted, and is also intended to obviate the difficulties and expense incident to the use of expensive and cumberous mechanical connections.

The invention consists in novel combinations of parts hereinafter described, and pointed out in the claims, including upper and lower mercury-vessels arranged one above another near the bottom of the mine or other locality from which water is to be raised, and connected by a mercury pipe or column, a suction-pipe leading to the upper vessel, a discharge-pipe leading from the upper vessel, and a pipe, through which water is supplied under pressure, leading to the lower vessel. Enough mercury is employed to about fill one vessel and the pipe connecting the vessels. When water is supplied under pressure to the lower vessel, the mercury therein will be forced into the upper vessel, and will displace through the discharge-pipe any water contained therein, and when the lower vessel is relieved of pressure the mercury will return thereinto by gravity, and the space created in the upper vessel by the fall of the mercury will fill with water through the suction-pipe.

In the accompanying drawings, Figure 1 is a vertical section of an apparatus embodying my invention in its simplest form, a single-acting cylinder and piston to create the working pressure being employed to give an intermittent discharge of water. Fig. 2 is a vertical section of an apparatus in which a double-acting cylinder and piston operate two reciprocating water-columns to obtain a continuous discharge; and Fig. 3 is a vertical section of an apparatus, which is operated by a water-column moving continuously into the machine to produce the constant discharge of double the volume of water at a height less than that of which the initial pressure is the equivalent.

Similar letters of reference designate corresponding parts in the several figures.

Referring first to Fig. 1, A is the cylinder of a single-acting forcing pump or ram, of which B is the reciprocating piston, and M the water-chamber. This ram may be located at any convenient place—at the top of a mine-shaft, for instance.

C and D are upper and lower chambers or vessels of about equal capacity, which may be located at the bottom of a mine, for instance. A pipe, E, communicates from the bottom of the chamber C to the bottom of the chamber D. A pipe, F, communicates from the chamber M of the cylinder A to the top of the chamber D. A suction-pipe, H, having a foot-valve, I, at the bottom, extends from the top of the chamber C into the water to be pumped. A pipe, G, extends from the top of the chamber C to the place of discharge, and a valve, J, affords outward communication from this chamber C into the pipe G. The cylinder A is provided with a cock, L, on top, as shown. The chambers C and D should be situated about from one-eleventh to one-twelfth as far apart vertically as the vertical distance from the level of water to be pumped upward to the actuating pump or ram A B. These chambers are connected by a mercury-column that reciprocates from one chamber to the other through the pipe E, the quantity of mercury being sufficient to nearly fill the pipe E and chamber C, but not enough to ever flow over into the suction-pipe H.

The operation is as follows: The chambers M, C, and D and pipes F and H are supposed to be full of water, (except the space occupied by mercury,) and the piston B to be reciprocating back and forth by means of any power suitably applied. A forward movement of the piston B in the direction of the arrow forces water down the pipe F into the chamber D, thereby causing the mercury therein to flow up the pipe E into the chamber C. The water upon the mercury in the chamber C is prevented by the foot-valve I from escaping down the suction-pipe H, and is thus necessarily forced through the valve J into the pipe G, and thence to the place of discharge. When the reverse motion of the piston B takes place, (to the right, as here shown,) the chamber M will be enlarged, and the mercury that has just previously been forced into the chamber C will fall into the chamber D, and thus force water from that chamber up the pipe F into the chamber M. At the same time the vacuum formed in the chamber C by the fall of the mercury will be supplied with water through the suction-pipe H, as in an ordinary piston-pump. Upon the next stroke of the piston B into the chamber M the first-described action will be repeated. The cock L is to supply the chamber M with water on the first start, or whenever it may be necessary. Of course another similar arrangement could be connected to the other chamber, M′, of the cylinder A by the pipe F′, (shown by dotted lines,) and the discharge pipe G could be used in common by both. This would make this apparatus, taken as a whole, a double-acting one, having two pipes for the forcing-water and one main pipe for the discharge.

In Fig. 2 is shown a double-acting apparatus on the same general principle as described in Fig. 1, but where each of the pipes F F′ are used to convey the feeding-water and the discharge-water alternately. While one volume is forced down one of the pipes F F′ by the piston B, two volumes are forced up the other of those pipes, and then vice versa. The cylinder A, with its chambers M M′, piston B, the chambers C C′ D D′, connecting-pipes E E′, with mercury-columns, operate in the same manner as the similar parts in Fig. 1. The chambers C C′ are surmounted by a valve-chest, C*, with which the suction-pipe H communicates, and in which are suction-valves J^2 J^3 and discharge-valves J J′. The outlet-valve J, from the chamber C, permits outward communication from that chamber through the discharge-pipe G to the pipe F′, and a similar outlet-valve, J′, permits similar communication from the chamber C′ through the pipe G′ to the pipe F. The cylinder A is surmounted by a valve-chest, A*, from which leads the final discharge-pipe O. Communication between the two water-chambers M M′ and the pipe O is controlled by two valves, N N′, connected so that when one is closed the other is always open.

The operation is as follows: In the drawings the piston B is shown moving to the left, and as it began to move the current, starting toward the discharge O, immediately caused the valve N to close upon its seat. Therefore the water in the chamber M is necessarily forced down the pipe F upon the mercury in the chamber D, and the pressure upon this mercury forces it upward into the chamber C, thus displacing an equal quantity of water in that chamber, which is thus forced through the valve J, pipes G and F′ into the chamber M′. During the same stroke the mercury in the chamber C′ falls into D′, and thus forces an equal volume of water up the pipe F′, and at the same time the chamber C′ receives water from the suction-pipe H, as before described. Thus for each volume of water that descends by the pipe F two volumes ascend by the pipe F′, and while one of these volumes fills the chamber M′ the other leaves by the valve N′, and represents the net effect of one stroke of the machine. Upon reversing the stroke the corresponding effects will be produced in each of the corresponding opposite chambers.

In Fig. 1 the duty of the falling mercury-column being to draw water into the chamber C, and also to force it into the vacuum formed when the piston B is enlarging the chamber M in the cylinder A, the height of the mercury column should be proportioned to that duty.

In Fig. 2 the duty of the mercury-columns is to draw water into the machine and force it through the cylinder A, up the pipe O, to the final discharge, ordinarily against atmospheric pressure, and the heights of the mercury-columns should be calculated accordingly. In both cases due allowance should be made for the head necessary to overcome the friction of liquids flowing through the pipes. The less excess there is in the height of mercury-columns over that necessary the more economical in power will be the apparatus.

In Fig. 3 the chambers C C′ D D′, connecting-pipes E E′, and mercury reciprocating through these pipes, the outlet-valves J J′, inlet-valves J^2 J^3 of chambers C C′, and common suction-pipe H, all perform the same functions, respectively, as the similar parts in Fig. 2. The forcing-pipe F in this figure leads into an induction-chamber, P, which is common to the two chambers D D′, and which contains two induction valves, Q Q′, that are so connected by a lever, R, that the closing of one insures the opening of the other. From the ends of this lever are suspended rods S S′, which extend into the chambers D D′, as shown, and to these rods the induction-valves Q Q′ are attached. Sliding on the rods S S′ are round iron floats T T′, supported by the mercury, and which are of such a size as to fit at the proper times into the lower parts of the chambers D D′, respectively, in the manner of a piston in a cylinder, although the fit need not be a tight one. Nuts or collars U U′ limit the downward movements of the floats upon these rods. Chambers V V′ are intermediate between the induction-chamber P and the chambers D D′, and in the partition between the chambers V V′ and D D′ are holes *y y′*, which form short cylinders, in which slide small pistons *w w′*, and these pistons are capable of moving entirely out of their cylinders or holes, so that the holes may at proper times form open communication between the chambers V V′ and D D′. Eduction-valves *x x′*, opening inwardly as to the chambers D D′, open communication at proper times from these chambers D D′ to the common discharge-pipe G′. The pistons *w w′* and valves *x x′* may either form one piece or may be in several separate pieces pressing against one another, so that they will all move simultaneously. A discharge-pipe, G, from the chamber C C′ connects with G′, and a pipe, G^2, is a continuation common to both.

The operation is as follows: Water put under high pressure by any means is constantly flowing into the chamber P, and, as shown in the drawings, is now entering through the valve Q and chamber V and piston hole or cylinder *y* into the chamber D, and from there forcing the mercury into the chamber C, and the water out of that chamber into the discharge-pipe G, as before described. High-pressure water is upon the valve *x*, and holds it to its seat, and thus the valve *x′* is held open, so that the mercury-column from C′ to D′ is free to force the water in D′ out through the discharge-pipe G′, to join the water from the pipe G, and form a common current through G^2. The flow of mercury from D into C will continue until the float T is arrested by the collar U, and by that time it will have fallen to the part of the cylinder D in which it fits as a piston. The pressure will then be upon the float T, and consequently through the rod S upon the left-hand end of the lever R. This end will then be pulled downward, bringing the valve Q to its seat and lifting the valve Q′ from its seat against the pressure that was holding it down. The valve Q will then in turn be held to its seat by the high pressure upon it. The valve Q′ being thus held open, the chambers P and V′ will be in communication, and the high pressure from the pipe F will act upon the piston *w′* and cause it to force the valve *x′* against its seat, while the piston itself will be forced out of its cylinder *y′*. Communication will thus be established from the pipe F into the chamber D′, when the reverse stroke of that just described will take place. Thus, for each volume of water that enters the apparatus by the pipe F, two volumes will be discharged by the pipe G^2, one of them being supplied by the pipe G, and the other by the pipe G′. To get the full effect of these volumes, the mercury-columns should be high enough relatively to the discharging-water columns, and the passage should be free enough, to insure that the action produced by the falling of the mercury-column shall be quite as fast or slightly faster than the action produced by the high-pressure column of water. If the mercury-column does its work first, the column of mercury will come to a balance with the discharge-water column, and the action upon that side will simply rest until the stroke reverses.

The object of reducing the size of the chambers D D′ at the bottom is merely to reduce the size of the iron floats. The chambers could be made of one diameter and the floats T to fit them as pistons for the whole length; or if the iron floats T T′ should be made heavy enough so that when they are arrested by the collars U U′ and the mercury leaves them their mere weight should be sufficient to overbalance the pressure holding down the valves Q Q′, then there need be no fit at all between the floats and the walls of the cylinders D D′.

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

1. In a water-elevating apparatus, the combination, with two mercury-vessels arranged one above another and a pipe leading from the bottom of the upper vessel downward to the bottom of the lower vessel, of suction and discharge pipes leading from the upper part of the upper vessel and a pipe leading to the lower vessel, and through which water may be supplied under pressure to force the mercury therein into the upper vessel, substantially as herein described.

2. In a water-elevating apparatus, the combination, with pairs of upper and lower mercury-vessels and pipes leading from the bottom of the upper vessels to the bottom of the lower vessels, of suction and discharge valves communicating with the upper part of the upper vessels and suction and discharge pipes leading to and from the upper vessels, a forcing water-column and induction-valves controlling communication between said column and the upper part of the lower vessels, and eduction-valves controlling communication between the upper part of the lower vessels and a common discharge-pipe, substantially as herein described.

CHAS. W. COOPER.

Witnesses:
C. HALL,
FREDK. HAYNES.