(No Model.) 2 Sheets—Sheet 1.

A. FALKENAU.

DUPLEX PUMP.

No. 419,147. Patented Jan. 7, 1890.

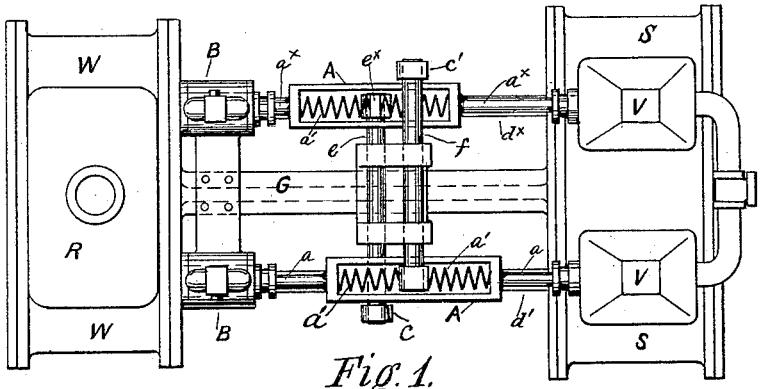

Fig. 1.

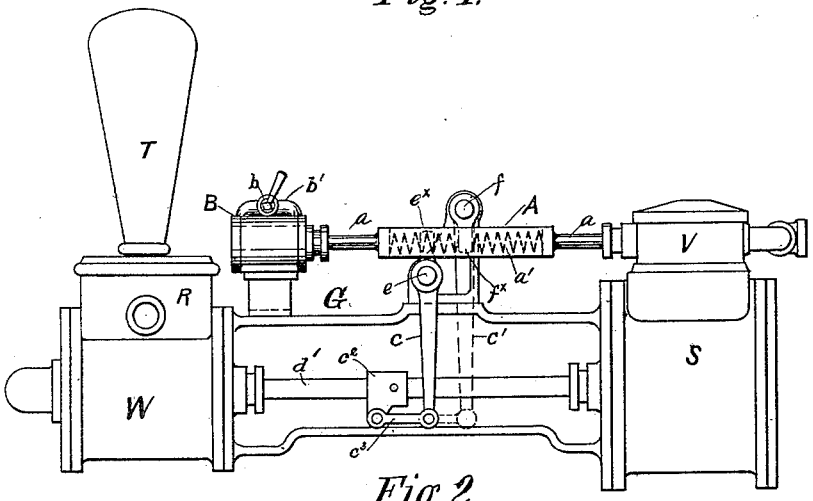

Fig. 2.

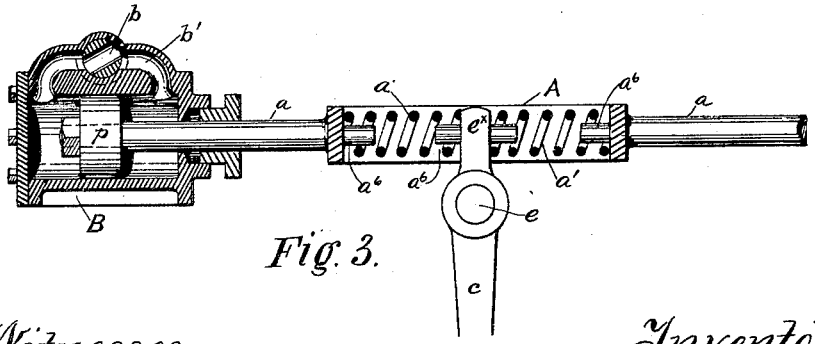

Fig. 3.

Witnesses.
J. Norman Dixon.
Louis Altmaier.

Inventor
Arthur Falkenau,
By his attorneys
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(No Model.) 2 Sheets—Sheet 2.

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DUPLEX PUMP.

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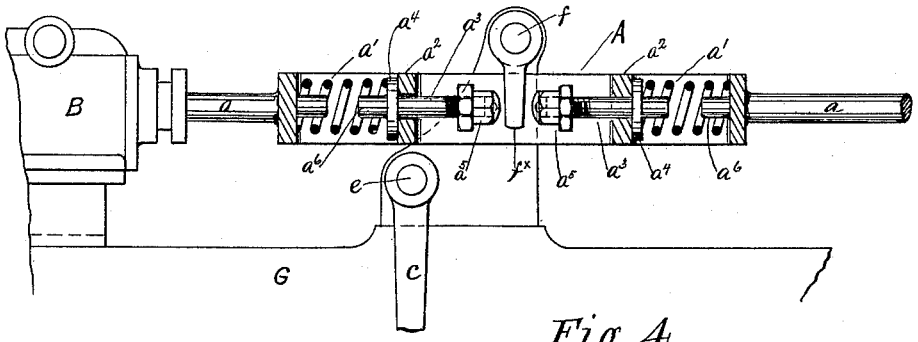

Fig. 4.

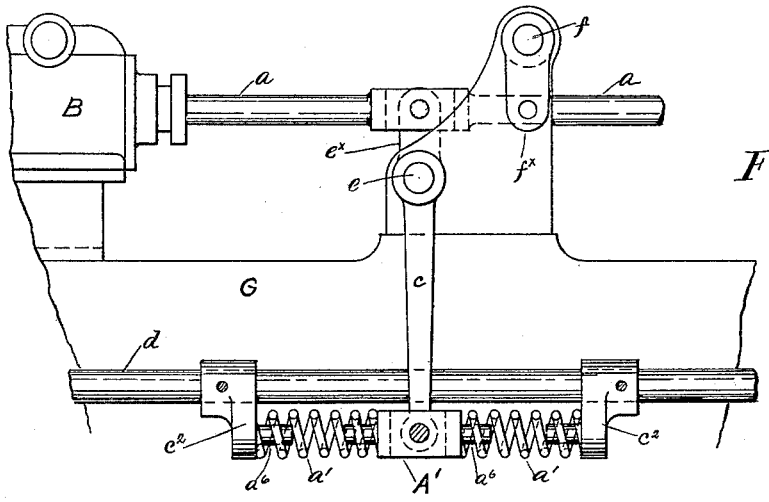

Fig. 5.

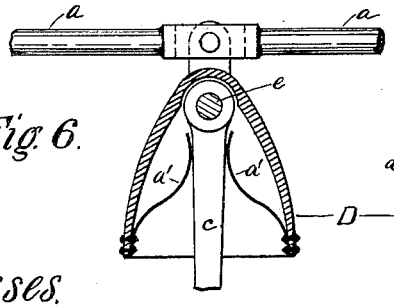

Fig. 6.

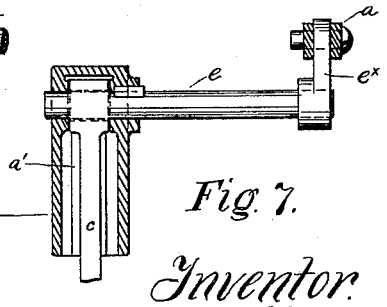

Fig. 7.

Witnesses.
F. Norman Dixon.
Lewis Altmaier.

Inventor.
Arthur Falkenau
By his attorneys,
Strawbridge & Taylor

UNITED STATES PATENT OFFICE.

ARTHUR FALKENAU, OF PHILADELPHIA, PENNSYLVANIA.

DUPLEX PUMP.

SPECIFICATION forming part of Letters Patent No. 419,147, dated January 7, 1890.

Application filed June 19, 1889. Serial No. 314,868. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR FALKENAU, a citizen of the United States, residing in the city and county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Duplex Pumps, of which the following is a specification.

My improvements are applicable in general to all forms of duplex pumps whether used for the pumping of liquids or as vacuum or air pumps.

In the accompanying drawings I have represented my improvements as applied to and embodied in the well known Worthington high pressure steam pump, which happens, moreover, to be a type of pump in connection with which my improvements are especially applicable.

Duplex pumps as ordinarily constructed consist of two steam pumps placed side by side and so combined as to act reciprocally upon the steam valves of each other, the one piston acting to give steam to the other, after which it finishes its own stroke, and then waits for its valve to be acted upon before it can renew its motion.

In the Worthington engine the motion of the valves, which are ordinary slide valves working each upon a flat face over ports or openings, is produced by vibrating levers which swing through the whole length of the stroke of the piston rod, and it is this valve motion that is the distinguishing characteristic of the pump and to the perfecting of the acting of which my improvements are herein shown as applied.

In pumps of the duplex type as heretofore constructed, when air happens to be taken in with the water in the suction, more especially in the use of the pumps as vacuum or air pumps, the resistance at the beginning of each stroke is so small that the piston first acted upon, under the pressure of its steam shoots forward, and therefore almost instantly throws the valve of the second engine, the piston of which in its turn shoots forward and throws the valve of the first engine before the latter has completed its stroke; with the ultimate and constant result of shortening the stroke of both pistons to one half or three fourths of the intended throw, to the material diminution of the capacity of the pump and to the absolute destruction of its usefulness as a vacuum pump. Heretofore effort has been made to remedy this defect by increasing the slack motion between the nuts or tappets which drive the valves, with the result, however, that the port opening has been reduced.

It is the object of my invention to overcome the foregoing defect, and this object I accomplish by the interposition between the actuating piston rod and its driven valve of an elastic, flexible or compressible medium, or connection, adapted first to receive and store up the energy of the motion of the piston rod, and then to give it out to the valve rod under the control of a resisting and regulating medium such, for instance, as the confined flow of a liquid.

A Worthington high pressure steam pump of the ordinary construction, but embodying my improvements in one or more equivalent forms of embodiment and application, is represented in the accompanying drawings and hereinafter described, the particular subject matter claimed as novel being hereinafter definitely specified.

In the accompanying drawings, Figure 1 is a top plan view, and Fig. 2 a side elevation of a duplex pump embodying my improvements. Fig. 3 is a central, vertical, longitudinal, sectional detail of the spring housing and springs upon the valve rod, and of the liquid cylinder. Fig. 4 is a view similar to Fig. 3, of a modification in which the spring housing contains not only springs, but also a slack motion device. Fig. 5 is a fragmentary, side elevational detail, representing the application of an elastic medium between the lever and the piston rod. Fig. 6 is a side elevational view partly sectional, of a modification of the spring housing and springs shown in Figs. 1 to 4, and Fig. 7 a cross-sectional view of the same.

Similar letters of reference indicate corresponding parts.

In the accompanying drawings, S S are the steam cylinders and V V the steam valve chests of said cylinders.

W W are the water cylinders, R is the force chamber, and T the air chamber.

d' $d^{\times}$ are the piston rods, and a $a^{\times}$ the valve rods.

f is the upper rock shaft, e the lower rock shaft, c the short lever of the lower rock shaft, and c' the long lever of the upper rock shaft.

c^2 is the cross head of the short lever, and c^3 the cross head link of said cross head c^2, which devices are, of course, duplicated with respect to the long lever c'.

$e^\times$ is the rocker toe of the lower rock shaft, and $f^\times$ the rocker toe of the upper rock shaft.

All of the foregoing devices, together with the connecting frame G, are standard elements of a duplex pump of the Worthington type, or essential equivalents of such elements, and in themselves form no part of my invention.

In the Worthington engine, the cross heads are, as shown, respectively mounted upon the piston rods, and by means of links are connected with the levers, so that the motion of the piston rods occasions the throw of the levers with which they are respectively connected and also the oscillation of the rock shafts of said levers. The rocker toes of the said rock shafts are, moreover, in the said engine directly connected with the valve rods by rigid links; the result of which construction is that every movement of the piston rods is directly transmitted to the valve rods.

In the practice of my invention, I, as already stated, interpose between each actuating piston rod and its driven valve, an elastic, flexible, or compressible medium or connection, and in connection therewith employ a regulating device such as a fluid cylinder or dash pot. Perhaps the simplest application of these devices is that represented in Figs. 1, 2, and 3, of the drawings, in which the elastic medium for temporarily storing the energy derived from the piston rod and utilized for the driving of the valve rod, consists of spiral springs a', conveniently maintained in a yoke or spring housing A, connected with or formed as a part of the valve rod with which springs, and, it should be remarked, that a single continuous spring might be employed,—the rocker toe of a given lever engages. As is apparent the throw of the lever under the movement of its piston rod will occasion a corresponding throw of the rocker toe of its rock shaft, and a consequent compression, in one or the other directions, within its housing of one or the other of the springs represented in said Figs. 1, 2, and 3,—a compression serving to temporarily store the energy of the spring, and only give it off under the gradual expansion of said spring under the control of a regulating device such, for instance, as the oil or other liquid in a liquid cylinder or dash pot B, the piston p of which is connected with a prolongation of the valve rod a beyond the spring housing, and the flow of the liquid in which is through a double mouthed passage-way or port b' in communication with both ends of the cylinder and adapted to be controlled or regulated by a cock b.

As will be readily understood the application of the piston under the control of the liquid in the liquid cylinder, to the valve rod, will, in connection with the spiral springs, serve to graduate and deprive of abruptness the movement of said valve rod in either direction under the abrupt impulse of the rocker toe operating in connection with said valve rod,—the springs tending to drive the valve rod in one or the other direction, but their power only actually driving the rod as fast as the flow of the liquid in the cylinder will permit, and the cock upon the port of said cylinder being capable of such adjustment as to control to a nicety the time at which the valve shall reach the end of its stroke, with the result that each piston is permitted to complete its stroke before, as heretofore, being prematurely reversed by the shooting forward of the other piston.

As represented in Fig. 1, two sets of liquid cylinders and spring housings are employed, one in connection with each valve rod.

It is, of course, to be understood that the dash pot or cylinder represented is simply a type of a resisting and regulating medium adapted for operation in connection with the elastic medium, and like it applied to the valve rod; and that a friction device in the nature of a sliding grip, or a weight device, will be the mechanical equivalents of the dash pot.

In Fig. 4 I have represented a modification of the application of the springs, in which an adjustable slack motion such as that at present employed, is retained, and in which, therefore, the springs do not store up any energy at all until a portion of the stroke of the piston has been completed. In this construction the springhousing is provided with intermediate bearings a^2, through which pass supplemental sections a^3 of the valve rod, each of which sections has longitudinal movement through its bearing, is provided externally of said bearing with a fixed collar a^4, and internally with an adjustable nut a^5 which can be set to regulate the uncontrolled throw of the rocker toe. In this construction the springs a' are introduced between the extremities of the housing and the collars on the supplemental sections of the valve rod.

In Fig. 5 I have shown yet another modification in which the elastic medium is interposed between the cross head on the piston rod and the lower extremity of the lever operating in connection with such piston rod. In this construction the cross heads e^2 are in duplicate, and the lower extremity of the lever is pivoted to a spring boss A' against the respective outer extremities of which the inner extremities of the springs a' bear, while the outer extremities of said springs bear against the cross heads.

In each one of the applications already de-

scribed, the spiral springs are conveniently, although not necessarily, retained in place by studs a^6, respectively applied to the spring housing and the rocker toe, as shown in Figs. 1, 2, and 3; to the spring housing and to the supplemental sections of the valve rod, as shown in Fig. 4; and to the cross heads and spring boss, as shown in Fig. 5.

In Fig. 7 I have represented still another application of the elastic medium, in which the lever is not keyed to but free to swing with respect to its rock shaft as an axis; and in which there is fixedly connected with the rock shaft a depending bell-shaped spring housing, which I have designated by the letter D, and which contains flat springs a' which bear against and respectively receive the thrust of the lever under the movement of its piston rod. Of course in this connection a liquid cylinder, or its equivalent, is also employed.

Having thus described my invention, I claim:—

1. The combination, in a duplex pump, of a piston rod, a valve rod, an elastic medium intermediate between said rods for receiving and temporarily storing the energy of the piston rod which drives the valve rod, and a regulating medium such, for instance, as a liquid cylinder the piston of which is connected with the valve rod, and which contains a liquid or fluid by the flow of which the movement of the valve rod is regulated, substantially as set forth.

2. The combination, in a duplex pump, of a piston rod and a valve rod, a piston-operated lever, a rock shaft which the throw of said lever oscillates, a rocker toe upon said rock shaft, springs housed in connection with said valve rod and engaging said rocker toe, and a liquid cylinder the piston of which is a part of or connected with said valve rod, substantially as set forth.

3. The combination, in a duplex pump, of a piston rod, a piston-operated lever, a rock shaft which the throw of said lever oscillates, a rocker toe upon said rock shaft, a valve rod provided with a spring housing, springs within said housing and engaged with said rocker toe, and a dash-pot the piston of which is connected with the valve rod, substantially as set forth.

4. The combination, in a duplex pump, of a piston rod, a piston-operated lever, a rocker shaft which the throw of said lever oscillates, a rocker toe upon said rock shaft, a valve rod, a spring housing formed with intermediate bearings and provided with supplemental sections of valve rod, springs operating upon said sections, and a dash-pot the piston of which is connected with the valve rod, substantially as set forth.

In testimony that I claim the foregoing as my invention I have hereunto signed my name this 28th day of May, A. D. 1889.

ARTHUR FALKENAU.

In presence of—
J. BONSALL TAYLOR,
WM. C. STRAWBRIDGE.