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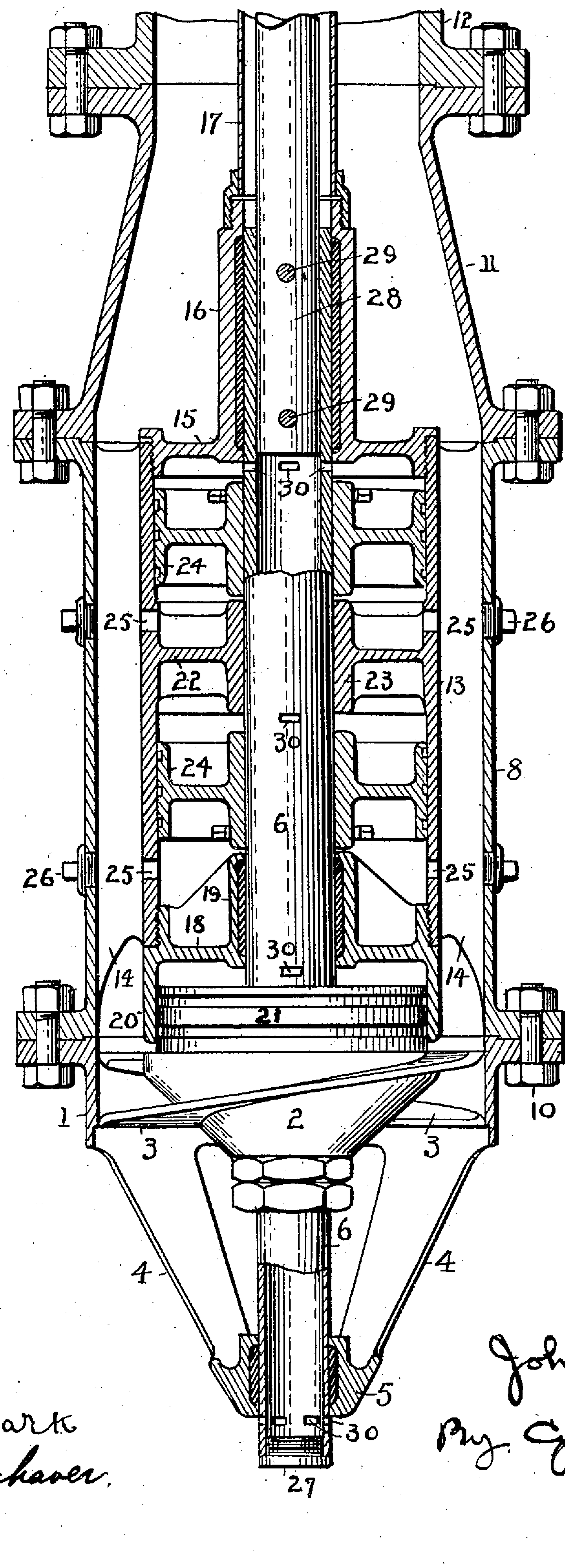
J. W. ALVORD.

HIGH SPEED ROTARY PUMP.

APPLICATION FILED DEC. 24, 1902.

NO MODEL.



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No. 735,691. Patented August 11, 1903.

UNITED STATES PATENT OFFICE.

JOHN WATSON ALVORD, OF CHICAGO, ILLINOIS.

HIGH-SPEED ROTARY PUMP.

SPECIFICATION forming part of Letters Patent No. 735,691, dated August 11, 1903.

Application filed December 24, 1902. Serial No. 136,465. (No model.)

To all whom it may concern:

Be it known that I, JOHN WATSON ALVORD, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in High-Speed Rotary Pumps; and I do 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, reference being had to the accompanying drawing, and to the figures of reference marked thereon, which forms a part of this specification.

This invention relates to centrifugal pumps, and especially to those that are run at high speeds and lift water from deep wells, by which I mean wells a hundred feet or more in depth. In such wells the pump is located far below the surface of the ground and rotates in a horizontal plane, the shaft extending to the surface, where it is connected to a suitable motor. The weight of this upright shaft and the other rotating parts, together with the superimposed water column, is very great, and it is a serious problem to guide and support the shaft. In another application recently filed I have set forth means for maintaining such a shaft in proper alinement. The present invention has to do with the supporting of the superimposed water column, the shaft, and other rotating parts.

It has been proposed to balance the weight of such shafts and superimposed water column by the pressure of the water column in the uptake or delivery pipe.

My invention consists in certain novel constructions and arrangements of parts whereby this result can be effectively accomplished and automatically regulated. The shaft is journaled in bearings which permit it to have a certain amount of lengthwise play. Secured to the shaft is one or more pistons, which fits or fit in a cylindrical portion or portions of the stationary pump-casing and each forms one end of a chamber. The under side of the piston is exposed to the pressure of the water column in the uptake, while its upper side is subjected to the pressure in the chamber. There is an outlet from the chamber to the suction side of the pump, and this outlet is controlled by the lengthwise play of the shaft, closing gradually as the shaft rises and opening when it falls. As there is a constant small leakage past the piston into the chamber, the pressure in said chamber tends to gradually increase, thus lessening the effective upward pressure on the under side of the piston. The shaft therefore moves slowly downward until it causes the outlet to open and relieve the pressure in the chamber, whereupon the fall of the shaft is checked. Thus by a series of constant adjustments and readjustments of the relative pressures on the two sides of the piston the differential pressure tending to lift the shaft is kept approximately constant, so that the shaft remains floating on the water column in substantially a constant position irrespective of the fluctuations in the actual pressure of the water column.

This invention is applicable to pumps having a great variety of impellers and can be carried out in many different ways. The accompanying drawing illustrates one mode of applying it to a rotary pump having a plain screw-impeller, the view being a longitudinal section of the pump.

The casing of the pump is made in sections, the lower section 1 being cylindrical to snugly inclose the impeller, which has a conical body 2 and helical blades 3, by means of which the water is given an upward motion when the impeller is rotated. The section 1 has depending arms 4, supporting the lower bearing 5 for the impeller-shaft 6. This section also has a flange 7, on which is mounted the preferably cylindrical body-section 8 by means of the flanges 9 and bolts 10. The upper section 11 is preferably conical and is fastened to the top of the body-section 8 and also to the lower end of the uptake or delivery pipe 12, preferably by the flanges and bolts shown. The body-section has a concentric inner shell 13, preferably united with the outer shell by radial webs 14, cast integral with both shells. The inner shell is provided at each end with a head, the upper one 15 carrying a bearing 16 for the impeller-shaft and also supporting the lower end of the shaft-casing 17. The lower head 18 has a bearing 19 for the impeller-shaft and also a cylindrical flange 20, inclosing a piston 21, on said shaft just above the body of the impeller and slightly less in diameter than said body. Midway of the inner shell is a diaphragm 22, in which is a bearing 23 for the shaft 6. This diaphragm divides the shell into two chambers, in each of which is a piston 24, secured to the shaft 6 and fitting the inside of the shell. Below each piston one or more holes 25 are made in the shell, preferably by drilling through both shells, the holes in the outer shell being afterward closed by screw-plugs 26. It is evident that more than two chambers and pistons may be used, if desired.

The impeller-shaft 6 is tubular, its lower end being closed by a screw-plug 27, while its upper end is closed by the inwardly-projecting lower end of the pump-shaft 28, which fits in the shaft 6 and is secured thereto by transverse pins 29. The pump-shaft is preferably solid to give a maximum torsional strength. Ports 30 are cut at suitable points in the impeller-shaft just below the lower bearing 5 and the bearings 16, 19, and 23.

The operation of the pump is as follows: The impeller is rotated at high speed and forces the water up through the annular space between the outer and inner shells of the body-section 8 of the casing. The water passes freely through the holes 25, and the pressure due to the weight of the rising water column in the uptake-pipe is thus transmitted to the under side of the pistons 24. By properly proportioning the area and number of said pistons to the total weight of the rotating parts and the superimposed water column said weight can be balanced by the lift on the pistons. Hence no step-bearing is required for the shaft. There is a little leakage of water past the pistons into the chambers above them, and this water in time fills the chambers. In order to prevent it from acquiring a pressure equal to that on the under side of the pistons, and thus neutralizing the lifting effect of the water column, the ports 30 are so arranged with reference to the stationary shaft-bearings that when the pressure in the chambers reaches a predetermined limit the consequent drop of the shaft will bring said ports below said bearings, thus permitting the water in the chambers to enter the tubular shaft and escape through the lower ports into the well on the suction side of the impeller. By closing the lower end of the shaft and providing the lower set of ports I form an intermediate chamber between the casing and the well, and thus prevent too sudden changes of pressure in the chambers; but as soon as sufficient water has escaped to permit the resultant increased pressure on the under side of the piston to lift the pistons and shaft the ports will be closed and the equilibrium reëstablished. The shaft, pistons, and impeller thus have a constant slight motion up and down as these adjustments of pressure occur. It will be noticed that they are independent of the actual pressure in pounds per square inch, since the balancing effect is due to the differential pressure on the under side of the piston and not to the actual pressure of the water column. It will also be noticed that by means of the piston 21 and its chamber and escape-ports the area of the impeller subjected to a downward pressure is no greater than that of its blades and that this is partially balanced by the upward pressure of the water column on so much of the conical body of the impeller as lies above the blades.

I am aware that it has been proposed to provide the shaft of a rotary pump with a balancing-piston and to utilize the water leaking past said piston to lubricate the adjacent shaft-bearing; but my invention aims to utilize the leakage to set up a differential pressure on the under side of the piston, so as to automatically balance the rotating parts irrespective of the height of the water column—a result not possible in the aforesaid proposed construction.

I claim—

1. In a rotary pump, the combination with an upright axially-movable shaft, of a balancing-piston secured thereto and having its under side exposed to the pressure of the water column, a stationary casing containing a chamber above said piston, and means controlled by the axial movement of the shaft for permitting the escape of water from said chamber to the suction side of the pump, and thus regulating the pressure in said chamber.

2. In a rotary pump, the combination with an upright axially-movable shaft, of a stationary casing containing a chamber concentric with said shaft and having means to admit the pressure of the water column in the uptake, a piston secured to said shaft and fitting the walls of said chamber, and escape-ports above said piston controlled by the axial movement of said shaft.

3. In a rotary pump, the combination with an upright axially-movable tubular shaft, of a stationary casing containing a chamber concentric with said shaft and having holes in its walls, a piston secured to said shaft and fitting the walls of said chamber above said holes, and escape-ports in said shaft above said pistons.

4. In a rotary pump, the combination with an upright axially-movable tubular shaft, of a stationary casing comprising two concentric shells, the inner one being closed at the top and bottom and having holes in its walls, one or more pistons in said inner shell above said holes and secured to said shaft, and escape-ports in said shaft above said pistons, controlled by the axial movement of said shaft.

5. In a rotary pump, the combination with an upright axially-movable tubular shaft, of a stationary casing comprising two concentric shells, the inner one having a diaphragm and provided with holes in its walls above and below said diaphragm, heads closing the top and bottom of said inner shell, shaft-bearings in said heads and diaphragm, pistons

secured to said shaft above said holes, and escape-ports in said shaft adjacent to the lower ends of said bearings.

6. In a rotary pump, the combination with an axially-movable tubular shaft having its lower end closed and provided with ports, of a bearing adjacent to and above said ports, a balancing-piston secured to said shaft and having its under side exposed to the pressure of the water column, a stationary casing containing a chamber for said piston, and means for putting said chamber in communication with the interior of said shaft when the resultant pressure on the under side of the piston falls below a predetermined limit.

7. In a rotary pump, the combination with a stationary casing comprising two concentric shells, of a shaft concentric with said shells, an impeller on the shaft having a conical body carrying a piston fitting a chamber at the lower end of the inner shell, means for permitting the escape of leakage-water from said chamber to the suction side of the pump, and a balancing-piston in the inner shell exposed underneath to the pressure of the water column and above to the pressure in a chamber in said shell.

8. In a rotary pump, the combination with a stationary pump-casing, of an impeller, its shaft, a balancing-piston secured on the shaft, a casing surrounding said piston and communicating below the piston with the uptake, and means for automatically regulating the pressure on the top of the piston, whereby the differential pressure on its under side will remain substantially constant.

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

JOHN WATSON ALVORD.

Witnesses:

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