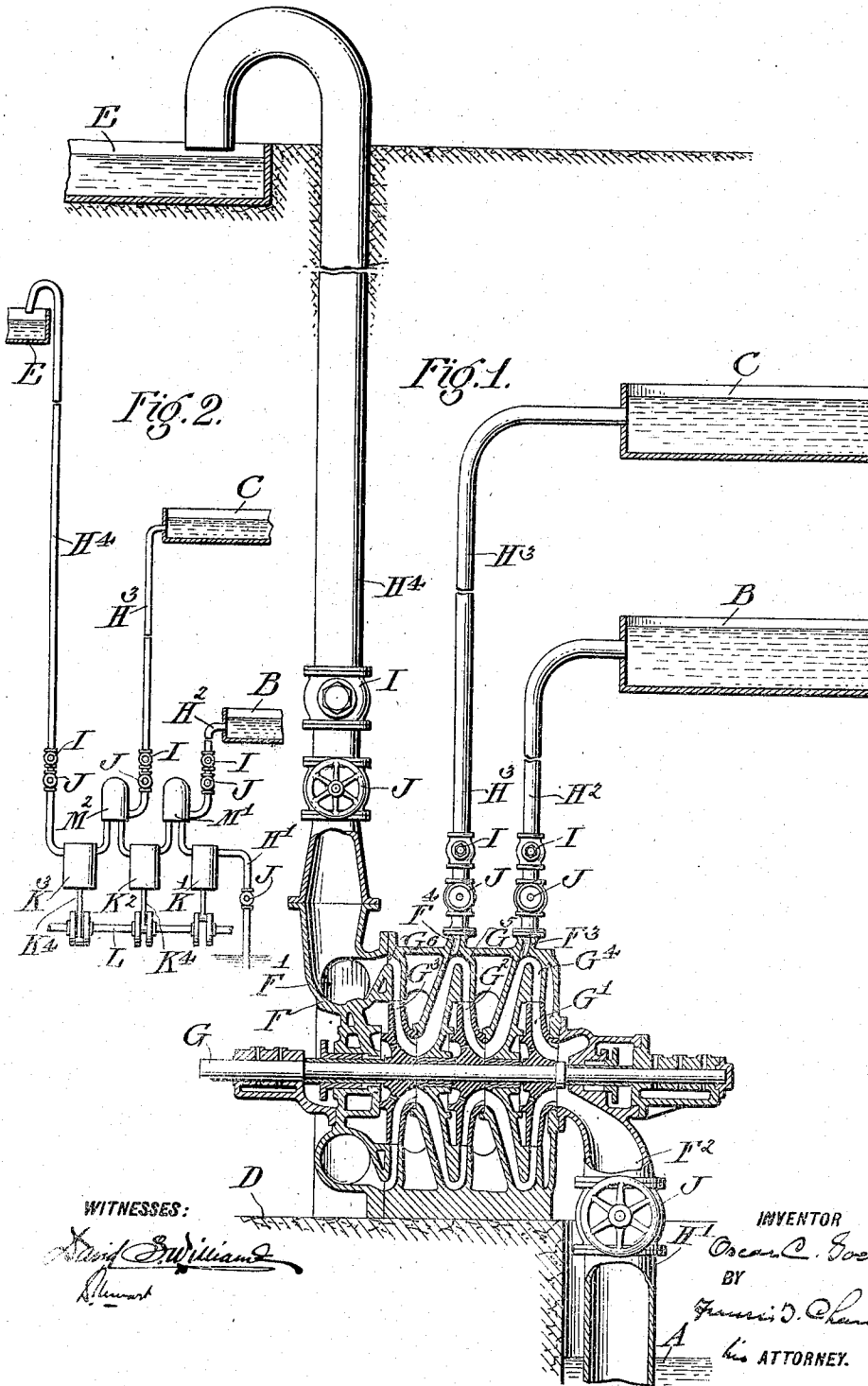


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METHOD OF AND APPARATUS FOR PUMPING FLUIDS.
APPLICATION FILED DEC. 7, 1907.

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Patented Sept. 7, 1909.



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METHOD OF AND APPARATUS FOR PUMPING FLUIDS.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, OSCAR C. GOERIZ, a subject of the Emperor of Germany, residing in the city and county of San Francisco, in the State of California, have invented a certain new and useful Improvement in Methods of and Apparatus for Pumping Fluids, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

The present invention consists of a method of and apparatus for pumping into common discharge outlet water or other fluid drawn from a plurality of sources which are so located or arranged that the fluid from some of the sources is supplied to the pumping apparatus under pressure different from that under which the fluid from other sources is delivered to it.

The object of the invention is, broadly speaking, to provide a method of and apparatus for so pumping the fluid that the pumping operation may be readily carried out with simple, compact, and compactly arranged apparatus and without a material loss in the potential energy which is contained in the fluid passing to the pump by reason of the pressure under which it is delivered to the pumping apparatus.

The invention is particularly adapted for use in pumping water from the various levels of a mine arranged one above another to a common discharge level located above the levels at which the water to be pumped collects.

In pumping from the various levels of a mine the pumping operation is carried out at a common pumping level located below all or all but the lower one of the various supply levels from which the water pumped is directly drawn, and the water from each supply level above the pumping level is allowed to flow down to the pumping level and is there added to the water from the supply levels below it after the pressure of the water from the latter levels has been raised to an equality with that due to the effective head of the water coming from said upper supply level, the pressure of the water from all the supply levels being finally raised to such a point that the water will flow from the pumping level to the discharge level.

The pumping apparatus employed comprises a multi-stage pump in which the

various pumping chambers may or may not be in a single mechanical structure in the various stages of which water drawn into the inlet side of each stage is suitably raised in pressure before being delivered at the outlet side, and the water from each level above the pumping level is admitted to the pump at the outlet side of that stage of the pump in which the water from the lower levels has been raised to a pressure corresponding to the effective head of the water flowing to the pump from said upper level. In the preferred form of apparatus for carrying out the invention a multi-stage centrifugal pump is employed, as such a pump permits of a ready control of the proportions of the water pumped from the different levels without materially interfering with the efficiency or operation of the pump. Instead of employing a centrifugal pump, however, there may well be employed in some cases a multi-stage pump of the kind in which there are a plurality of pumping chambers having progressively increasing discharge pressure, each chamber having its movable piston or plunger. In such a pump the various pistons or plungers are preferably connected to and are driven by a single shaft.

While, as before stated, the invention is particularly adapted for use in pumping water from the different levels of mines where the differences in the supply levels naturally result in different supply pressures at the pumping level, it may also be well used with advantage wherever it is desired to pump into a common outlet and against a common head or pressure water or other liquids supplied at different pressures, as, for instance, in fire fighting apparatus where high pressure and low pressure water mains are both available.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, reference may be had to the accompanying drawings and descriptive matter in which I have illustrated and described forms in which the invention may be embodied.

Of the drawings, Figure 1 is an elevation partly in section showing a centrifugal pump employed for pumping water from different levels of a mine, and Fig. 2 is a diagrammatic elevation of mine pumping apparatus

in which the pump employed is a multi-stage piston and cylinder pump.

In the drawings, and referring first to Fig. 1, A, B, and C represent the bodies of water forming the sources of supply of the water pumped, these bodies collecting in the various run ways or levels of the mine. D represents the pumping level which is located below the upper levels B and C and above the level A. E represents the discharge level or upper surface of the body of water into which the water pumped from the levels A, B, and C is discharged. In the pumping level is located a centrifugal pump F, which may be operated by an electric or other motor. The rotating portion of the pump comprises a shaft G having secured to it three impellers or rotating sets of blades G', G², and G³. The impellers G', G², and G³ discharge into the stationary outlet passages G⁴, G⁵, and G⁶ formed in the casing or stationary part of the pump F. The pump is provided with a low pressure inlet connection F² leading to the impeller G', and with intermediate inlet passages F³ and F⁴ which communicate with the passages G⁴ and G⁵ respectively, and therefore lead in effect to the inlet sides of impellers G² and G³. The passage G⁶ leads to the outlet passage F⁵ of the pump. To the inlet passages F², F³, and F⁴ are connected conduits H', H², and H³, respectively, leading from the water levels A, B, and C, respectively. A conduit H⁴ leads from the outlet passage of the pump to the discharge level E. Preferably, in each of the conduits H² and H³ is located a non-return or check valve I arranged to prevent an upward flow of water through the conduits H² and H³. Preferably, also, each of the pipes H² and H³ has in it a throttle valve J. The conduit H⁴ is also provided ordinarily with a non-return valve I to prevent downward flow of water from the conduit, and with a manually controlled throttle valve J. A throttle valve may also be located with advantage under some circumstances in the supply conduit H'.

In operation, the water passing to the inlet sides of the impellers G', G², and G³ is discharged into the passages G⁴, G⁵, and G⁶ respectively under a pressure which exceeds that at which it is received by an amount corresponding to the potential energy put into the water by the impellers. The pump impellers should, of course, be of a proper size and form and should be run at the proper speed for efficient operation under the conditions of use. Satisfactory operation of pumping apparatus of the type disclosed in Fig. 1 can be had, however, under widely varying conditions on account of the inherent self regulating qualities of the apparatus. The pressure of the water entering the pump from conduit H² through the inlet F³, for in-

stance, must be equal to the pressure of the water at the adjacent portion of the pump passage G⁴. The pressure of the water entering the pump through port F² is that due to what I may call the effective head of the water in the conduit H². This effective head is equal to the static head less the loss in head due to the friction. This loss of head due to friction is not constant, but depends upon the rate of flow through the conduit H², increasing to a maximum when the outlet F³ is unrestricted, and decreasing to zero when the outlet F³ is closed. In a centrifugal pump the pressure of the water delivered by an impeller running at a constant speed is not constant, but decreases as the volume of water delivered by the impeller increases, though not in direct ratio. As a result of this characteristic regulation, water will pass, for instance, to the impeller G² from the inlet port F³ and from the impeller G' so long, on the one hand, as the maximum pressure imparted to the water by the impeller G' does not exactly equal or exceed the static head due to the difference between levels B and D, and, on the other hand, so long as the pressure of the water delivered by the impeller G' does not fall below the pressure corresponding to the static head less the maximum friction loss of head in the conduit H². The ratio of the volume of water passing to impeller G² from the impeller G' can be varied by varying the discharge of the impeller G' or by varying the effective head of water passing into the pump through port F². The latter method of variation can be readily had through the operation of the throttle valve J in the conduit H², as the effect of opening and closing this valve is within quite wide limits exactly the same as decreasing or increasing respectively the frictional resistance of the conduit to the flow of water through it. It will thus be seen that by adjusting the various throttle valves J the relative amounts of water pumped from the different sources can be varied without otherwise altering the operation of the pumping apparatus. Under special conditions, as where it is desirable to draw relatively large amounts of water continuously from the levels B and C, it may be desirable to make the impellers G', G² and G³ of progressively increasing capacities. Where, however, as is frequently the case, the supply from the upper levels is intermittent the impellers may well be made all of the same size, as when so made the pump will operate with reasonable efficiency even though a large proportion of the water pumped is drawn through the ports F³ and F⁴. At times some or all but one of the valves J in pipes H', H² or H³ may be closed, altogether.

The apparatus shown in Fig. 1 is capable of operation in ways differing from that de-

scribed above. For instance, in a fire protection, at one of the levels, say C, a reservoir may be located to be filled from level A, the valves J in conduits H⁴ and H² being then closed. In case of fire, by closing conduit H' and opening conduit H⁴ the water could be pumped from level C to level E or delivered from the pump with a pressure corresponding to the head of level E with much less horsepower of course than would be required to then pump the same water directly from level A.

In the diagrammatic embodiment of my invention shown in Fig. 2, the multi-stage pump comprises three pumping chambers K', K² and K³, each having a piston, the connecting rods K⁴ of which are coupled to and driven by the common shaft L. In this form, the outlets of the low pressure and intermediate chambers K' and K² are connected to air regulating pressure chambers or reservoirs M', M², and the inlet sides of the chambers K² and K³ are connected to the reservoirs M' and M² respectively. In this form of my invention where the pumping pistons all make the same number of strokes of equal length it is essential that the chambers K', K² and K³, should be of progressively increasing capacities, that is, the pistons should be of progressively increasing diameters, since a pump of this kind does not have the capacity for automatic regulation of output characterizing a centrifugal pump. Instead of varying the diameters of the pistons, the length of stroke or speed of stroke of the different pistons may be adjusted to give the desired result. In consequence of this difference in the regulating characteristics of the two pumps, the centrifugal pump should be used in preference to the other where the conditions make it desirable to vary from time to time the relative volumes of fluid pumped which are drawn from the sources of different pressures.

The advantages of employing a single apparatus for pumping a fluid from supply sources of different pressures which characterize the present invention are obvious. For one thing it reduces the cost of the apparatus employed, as one large pump and its operating motor cost less of course than a plurality of smaller pumps and motors. Moreover, the attendance is reduced with the single apparatus from what it would be with the plurality of smaller devices.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The method of pumping fluid drawn from fluid sources of different pressures which consists in adding the fluid from each high pressure source without material loss of pressure to the fluid from the lower pressure source or sources after bringing the lat-

ter up to a pressure equal to the pressure at which the fluid from the high pressure source is added.

2. The method of pumping liquid supplied from sources of different pressures which consists in adding the liquid from each supply source of relatively high pressure without material loss of pressure to the liquid drawn from the source or sources of lower pressure after bringing up the pressure of the latter liquid to an equality with the pressure at which the liquid from said relatively high pressure source is added, and then further increasing the pressure of all the liquid received up to that point to the effective pressure at which the liquid from the source, if any, of next higher pressure is added or to the discharge pressure.

3. The method of pumping liquid drawn from sources of supply located at different levels to a discharge level located above all the supply levels, which consists in bringing all the liquids pumped to a pumping level located below some of the supply levels and in adding at the pumping level the liquid drawn from each supply level located above the pumping level to the liquid brought from all the lower supply levels after bringing the pressure of the latter liquid up to an equality with the effective pressure at which the liquid from said upper level is added, and in finally raising the pressure of all the liquid sufficiently to cause it to flow from the pumping level to the discharge level.

4. The method of pumping an inelastic fluid to a common discharge level from a number of different supply levels, which consists in bringing all the liquid pumped to a pumping level located below some of the supply levels; bringing up the pressure of the fluid pumped to a pressure great enough to flow from the pumping level to the discharge level in such successive stages that for each supply level located above the pumping level there is a pressure stage equal to the effective head of the fluid brought from that supply level, and adding the fluid brought from each upper supply level to the fluid from the lower levels at the corresponding pressure stage.

5. The combination of a multi-stage pump and connections for supplying liquid to the pump at the outlet side of a low pressure stage of the pump at a pressure equal to the pressure of the liquid delivered from said stage into the following or succeeding stage.

6. In a pumping system for pumping liquid from the different levels of a mine to a common discharge level located above the supply levels, the combination of a multi-stage pump at a pumping level located below some of the supply levels, and conduits connecting each of the upper supply levels in progressive order to the outlet sides of various corresponding stages of the pump.

7. In a pumping system for pumping liquid from the different levels of a mine to a common discharge level located above the supply levels, a multi-stage centrifugal pump at a pumping level located below some of the supply levels, conduits connecting each of the upper supply levels in progressive order to the outlet sides of the various pump stages, and means for throttling the flow of liquid through said conduits to vary the amounts of water drawn from the different sources. 10

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Witnesses:

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