H. MILNER.

PUMP FOR COMPARATIVELY INCOMPRESSIBLE LIQUIDS.

APPLICATION FILED JAN. 10, 1901.

972,558. Patented Oct. 11, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

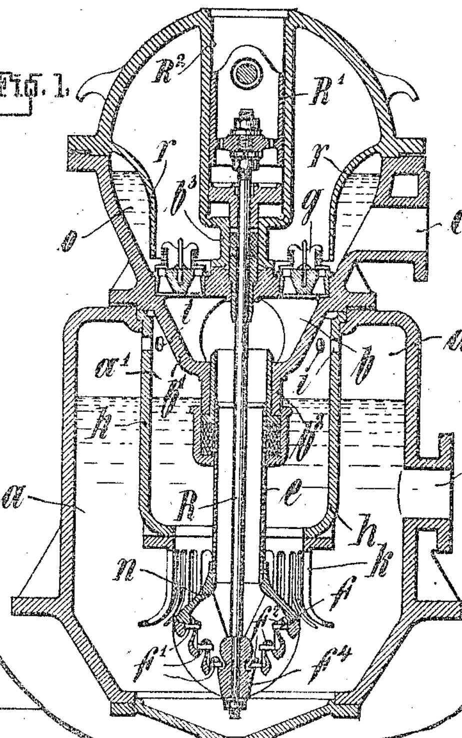


Fig. 2.

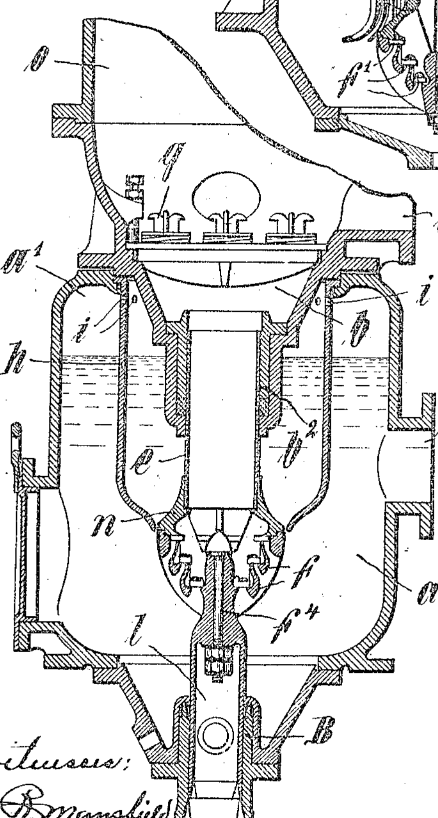
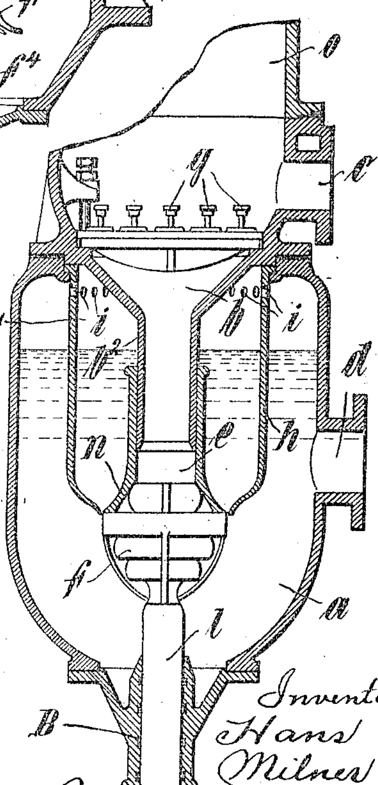


Fig. 3.



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2 SHEETS—SHEET 2.

Fig. 4.

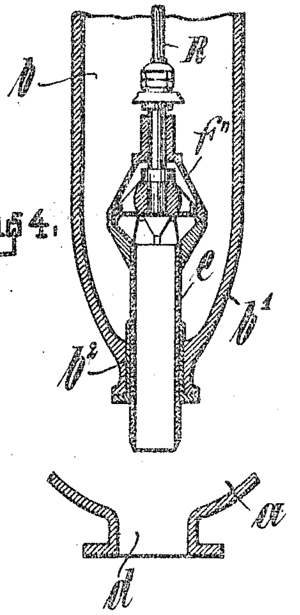


Fig. 5.

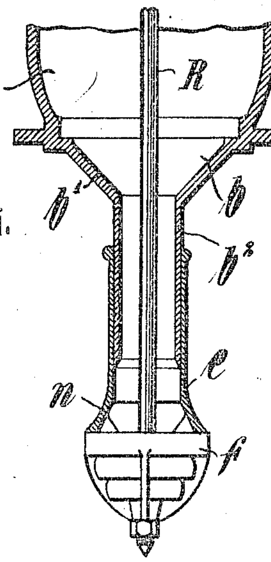


Fig. 6.

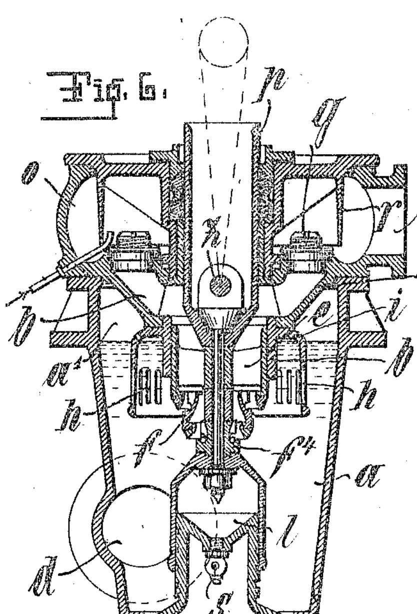
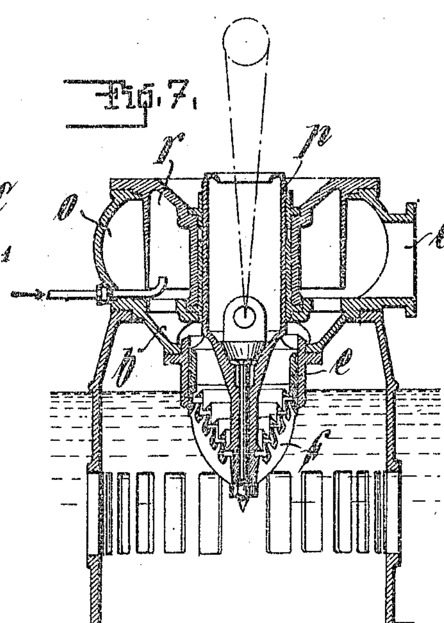


Fig. 7.



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UNITED STATES PATENT OFFICE.

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PUMP FOR COMPARATIVELY INCOMPRESSIBLE LIQUIDS.

972,558. Specification of Letters Patent. Patented Oct. 11, 1910.

Application filed January 10, 1901. Serial No. 42,802.

To all whom it may concern:

Be it known that I, HANS MILNER, a subject of the King of Hungary, residing at Budapest, in the Kingdom of Hungary, have invented certain new and useful Improvements in Pumps for Comparatively Incompressible Liquids, of which the following is a specification.

The present invention relates to the art of pumping liquids and consists in a novel construction of pump operating in a novel manner by taking out from a suction chamber the single liquid amounts which are to be given an accelerated movement successively or intermittently, liquid being supplied at the same time to the said suction chamber by the pressure of the atmosphere just as in ordinary pumps of the kind.

The objects in view are attained by rendering the pumping operations, properly speaking, that is, the drawing of the liquid from the suction chamber and the movement of it to the outlet, independent of the action of the low pressure in the suction chamber, which is contrary to the present practice. By so doing I avoid the formation of vacua in the liquid being pumped and consequently I insure great precision in the volumetric capacity and efficiency of the pump, under all circumstances, even when the piston speed is greatly increased. The invention furthermore increases the suction capacity of the pump so that a much greater height of suction can be realized, than heretofore; and the invention renders the heights of the liquid suction-columns independent of the speed of the reciprocating pump parts. Again, the injurious shocks caused by the liquid moving in the apparatus, as in old constructions, are avoided and eddies in the liquid current are greatly diminished, so that the mechanical efficiency of the pump, in respect to the power expended, is highly increased thereby.

It is well known, that in the suction chamber of all pumps as at present constructed, there must remain or be left a certain degree of tension, *i. e.* a certain low pressure, otherwise the liquid would not be raised, that is to say, moved or thrown from the suction chamber into the pump when the piston recedes; in other words, the liquid already sucked into the suction chamber, would not react or follow the action of the pump. As soon as in consequence of the increase of the piston speed the expenditure of work necessary to drive the liquid in a given interval of time becomes greater than can be intrusted to the working capacity of the said condition of tension or low pressure in the suction chamber, the liquid separates from the piston and vacua leading to serious accidents occur within the liquid. As is well known, this may happen very easily and frequently when the piston is working with great speed and the contents of the suction chamber are very rarefied, that is to say, when the suction-heights to be overcome are unduly great. In order, therefore, in the new method of pumping, not to make any demand upon the condition of tension in the suction chamber, which condition of tension, in general, is wholly insufficient, I insert a reciprocating hollow pump-part into the liquid-contents in condition of rest in the suction chamber, and I inclose in this manner a quantity of liquid (without moving or displacing it) corresponding to a full stroke portion in the interior of the pump, thus utilizing to the best advantage the inertia (permanence) of the stationary mass of the medium to be pumped. This quantity or charge of liquid has not yet been subjected to any pumping movement and that means a new accomplishment. The liquid is taken out by a scooping plunger independently of the degree of the low pressure in the suction chamber in agreement with the height of the water column to be overcome. When the plunger in the next moment returns the free volume of the suction-chamber increases in correspondence with the withdrawal of the plunger and contrary to pumps of the kind heretofore known, the liquid behind the plunger is not sucked out of the suction-chamber, but becomes deposited, stratum by stratum, in place of the withdrawing plunger. In such a pumping method there are no liquid portions, determined as to time and volume, which, as heretofore, would be forced from the suction chamber to quickly follow the piston owing to the strength of the residuary tension in the suction chamber and therefore the tension in the suction chamber can be kept lower, so that a greater height of the suction water-column can be surmounted by this method of pumping.

In the suction chamber the new scooping-plunger does not positively work to gage or measure the liquid, but the liquid flows into said chamber in an even or equalized current not influenced by the reciprocation of the plunger owing to the low pressure in the suction chamber. The latter is not identical with the suction chambers of the ordinary kind, but it is a special sucking chamber in which notwithstanding the reciprocations of the particular plunger therein the sucking tension is always maintained alike. The conical or tapered valve carrier immerges and reciprocates therein agitating the liquid the less so the longer the axis of the said body is in proportion to the diameter of its base. The conical or tapered shape of the valve-carrier of the plunger freely reciprocating within the liquid contained in the suction chamber of a pump is the main feature of the present invention. During the out-stroke the liquid does not run or flow into the vacant space produced by the withdrawing piston at the same rate as the piston, but its speed is diminished to a component at a certain proportion owing to the tapered shape of the plunger. The expenditure of mechanical power required for the condition of tension in the suction chamber to produce said movement of the liquid being equivalent to the acquired kinetic energy $\left(\frac{m v^2}{2}\right)$ accordingly is reduced in proportion to the squares of the speed amounts of the running-in speed. I can, however, still further diminish the expenditure of power by distributing the same, so to say, over both strokes, inasmuch as I replace one part of the volume to be filled on the return stroke of the transporting pump element by the succession of a rigid element or "filler," connected with the reciprocating parts, so that, for instance, merely the half of the liquid mass has to be brought to the rushing-in speed, that is to say, the speed the liquid assumes in running into the vacuum or vacant space produced by the withdrawing piston. In such manner, the expenditure of work which has to be done on the part of, and at the cost of the condition of low pressure or tension (expanding force) in the suction chamber on pumping, is reduced to a minimum and, thus, as already explained, the maximum heights of suction water-columns can be attained, that is to say, the capacity for suction of the pump is greatly increased in my method. It is, however, obvious, that since the pumping operations can go on without the aid of the tension in the suction chamber, this tension also does not require to be increased when the high speed of the strokes is still further increased.

These improvements relate to the sucking operations in the pumping action. As regards the pressing operations, the, for the most part, fine jets of liquid, issuing from the orifices of the delivery-valves, meet with considerable obstruction in penetrating the liquid above, so that by friction and whirl-currents, great loss of energy takes place. For the purpose of improving this condition and of economizing the consumption of work, I cause very thin layers of liquid to be above the delivery-valves. This I effect by lowering to the extent desired, the level of the liquid above the valves, by means of diving-bells or diving chambers for gas or air, having wide mouths below. The currents of liquid streaming out of the delivery valves now meet with no considerable resistance, so that the mechanical efficiency of the pump is in this manner also essentially improved. The direction of the stroke of the plunger does not essentially affect the feature and basis set forth above as regards the construction of pumps in accordance with the present invention. Accordingly such pumps may be employed without difficulty with a piston stroke of any direction.

In the drawings, Figure 1 is a vertical section through one form of construction of a pump embodying my invention. Fig. 2 is a similar section through the lower part of a similar, but slightly modified, form of construction having a filler. Fig. 3 is a section similar to Fig. 2, being also slightly modified. Fig. 4 is a vertical section through a valved hollow plunger and through a part of its surrounding casing. Fig. 5 is a section similar to Fig. 4, slightly modified. Fig. 6 is a vertical section through another form of construction of my improved pump, and Fig. 7 is a similar section showing another form of construction.

Referring to Fig. 1, *a* designates the suction chamber of the pump, having an inlet *d* connected to the liquid supply, said inlet being below the top of the chamber, which leaves a dead-air space *a'* therein in which rarefied air is confined above the surface of the liquid.

At the top of, and preferably depending into, the chamber *a* is a conical casting *b'* which forms what I term the lifting chamber *b*, which communicates with the suction chamber through a valved plunger *e f* hereinafter described, and which communicates with a force chamber *o* overhead, through openings closed by valves *g*, so arranged as to permit egress of fluid from chamber *b* into chamber *o*, but to prevent inflow from chamber *o* into chamber *b*. The force chamber *o* has an outlet *c* with which any desired carry off pipe not shown may be connected.

As shown the machine part of the lifting chamber *b'* has an axial cylindrical extension b^2, which is telescoped by a cylinder *e*, attached at its lower end to a hollow valve-containing plunger *f*, said plunger having, a preferably steep-roof like compact part or member n and connected therewith is the new inverted-step-valve acting to draw or take the liquid from the chamber a in a manner free of any sucking action.

As shown in the drawings a series of concentric contact rings of the seats f' with projections or catchers f^2, arranged in the shape of an inverted pyramid is provided to support and carry the valves. The latter not shown for clearness sake, are of ordinary construction and adapted to open inwardly so as to admit liquid into the interior of the plunger e f at the down stroke. Preferably the part n of the plunger is enlarged beyond the capacity of the latter so as to allow of the provision of so many inlet valves in the plunger that the liquid without being moved or displaced can easily enter and fill the plunger and cylinder as they descend. In the bottom of the plunger is a central piece f^4 which is rigidly connected to the lower end of a piston rod R, which extends upwardly through the cylinder e and lifting chamber b, and through a stuffing box b^3 in the top of chamber b, and is connected to a reciprocating cross-head R′ guided in a sleeve R^2 depending into chamber o, said cross-head R′ being connected to and reciprocating by any suitable engine, not shown.

In practice, the plunger f and its valves are always kept below the water level in chamber a, so that no air will be sucked into chamber b, nor drawn from chamber a', and the opening and closing of the valves will be instantaneously effected by the water with the least possible resistance. For each reciprocation of the multi-valve-plunger f an amount of water will be raised equal to the length of stroke of the plunger multiplied by the cross sectional area of the telescoping part e.

To further prevent ebullition of liquid in chamber a, in the apparatus shown in Fig. 1, I provide a cylindrical curtain h, surrounding the cylinder e and depending from the top of chamber a to and below the water level in chamber a, said curtain serving to divide the upper part of the body of water in chamber a into two concentric bodies. The lower part of curtain h may be extended, as at k, said extension being formed with vertical slots or apertures so as not to impede the passage of water to the plunger, while preventing violent eddying or splashing thereof. Apertures i in the top of the curtain h permit free passage of air from one side thereof to the other, so that the water will not pulsate in the curtain or chamber to any annoying extent.

In the pressure air chamber or vessel o a diving bell r is so arranged as to cause the level of the liquid therein to be a little above the delivery valves g, when the bell is filled with compressed air in the usual manner.

Fig. 2 shows a construction of pump when the plunger e f is to be driven from below, instead of from above, similar letters indicate like parts having similar functions. It will be noted that in this instance the slotted extension k on the lower end of the curtain h is omitted. l is a filling out plunger or "filler" serving to partially occupy the stroke volume *i. e.* the space in the liquid left free by or after the withdrawing plunger e, f, whereby the motion or flow within the liquid in the suction chamber is correspondingly decreased, due to its being distributed at any desired ratio among the two strokes. Said filler l is connected to part f^4 of the plunger, and passes through a stuffing box B in the lower end of chamber a, and may be directly connected to the engine for reciprocating the plunger.

The construction shown in Fig. 3 is quite similar to that shown in Fig. 2, having the filler l, and the parts n e made integral and inclosing the extension b^2.

In the modification indicated in Fig. 4 the plunger-valve is arranged to work within the chamber b on the outlet end of cylinder e, so that the latter freely works to take out the liquid from the chamber a.

The modification, shown in Fig. 5 is similar to that in Fig. 3, with the plunger operated from above, instead of from below.

Fig. 7 is a vertical section of a modification of the pump with a counter-piston p, which affords, in coöperation with the plunger e f, a large piston-area for mounting the valves, the difference only between the two piston areas (of e and p), acting to lift the liquid and only the pressure on the said areal difference exerting a strain on or influencing the driving rods of the machine. By such means the speed of the liquid in passing through the valved piston can be regulated according to desire and is rendered independent of the purposely chosen speed of the piston.

Fig. 6 is a vertical section of a pump with a counter-piston p, as in Fig. 7, in combination with a filler l of the kind shown in Figs. 2 and 3.

In Figs. 6 and 7 there is also shown how I suspend a diving bell r in the air-vessel o, just as in Fig. 1, with the effect of decreasing the loss of energy within the liquid due to friction and eddy currents.

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

1. In a pump the combination of a suction chamber adapted to be only partially filled with the liquid raised by suction, a lifting chamber adjacent to but unconnected with said suction-chamber, and a valved reciprocating pumping element therein having its valved end working freely below the level

of the liquid to be pumped so as to take out liquid without exerting any sucking action thereon.

2. In a pump the combination of a suction chamber, adapted to be only partially filled with the liquids raised by suction; a lifting-chamber adjacent to, but unconnected with said suction chamber; discharge valves on the discharge of this lifting-chamber, a reciprocating pumping element, operating between and within said chambers; a pyramidical or basket-like valve-carrier or support, attached directly to, and reciprocating with said pumping element, the travel of said valve-carrier taking place below the surface of the liquid contents of the aforementioned suction chamber; and valves inside said valve-carrier or support to admit fluid into the interior of the plunger, substantially as and for the purpose set forth.

3. In a pump the combination of a suction-chamber, adapted to be only partially filled with the liquids raised by suction; a lifting-chamber, adjacent to, but unconnected with said suction chamber; discharge-valves on the discharge of this lifting-chamber; a reciprocating pumping plunger operating between, and within said chambers; valves, attached to and reciprocating with said pumping plunger, the travel of which takes place below the surface of the liquid contents of the aforementioned suction chamber, a "filling out" plunger of a diameter different from that of the pumping plunger and working in said suction chamber and attached directly to, and reciprocating with said pumping plunger, substantially as and for the purpose set forth.

4. In a pump the combination of a suction chamber, adapted to be only partially filled with the liquid raised by suction; a lifting-chamber, adjacent to, but unconnected with said suction-chamber; a reciprocating pumping element working between, and within said chambers; valves attached to, and reciprocating with said pumping element; discharge-valves on the discharge of this lifting-chamber, an air-chamber, above said valves, and a diving bell for air or gas of suitable form and dimensions suspended in said air-chamber, substantially as and for the purpose described.

5. In a pump the combination of a suction-chamber adapted to be only partially filled with the liquids raised by suction, a lifting-chamber adjacent to but unconnected with said suction-chamber, discharge valves on the discharge end of the lifting-chamber, a reciprocating pumping element operating between, and within said chambers, a valve carrying head of conical shape rigidly connected to and reciprocating with said pumping element, and a displacer-piston projecting outward and working in said suction-chamber and attached directly to and reciprocating with said pumping element, substantially as and for the purpose set forth.

6. In a pump the combination of a suction chamber, adapted to be only partially filled with the liquids raised by suction; a lifting-chamber, adjacent to, but unconnected with said suction chamber; discharge-valves on the discharge of this lifting-chamber; a reciprocating pumping element operating between and within said chambers; valves attached to and reciprocating with said pumping element, the travel of which takes place below the surface of the liquid contents of the aforementioned suction-chamber, a partition mantle in said suction-chamber surrounding said pumping element, and adapted to restrict the eddying movements of the liquid, substantially as and for the purpose set forth.

7. In a pump the combination of a suction chamber, adapted to be only partially filled with the liquids raised by suction; a lifting-chamber adjacent to, but unconnected with said suction-chamber; discharge valves on the discharge of this lifting-chamber, a reciprocating pumping element operating between, and within said chambers, valves attached to, and reciprocating with said pumping element, the travel of which takes place below the surface of the liquid contents of the aforementioned suction chamber, and the area of whose bases is increased with respect to the working piston's surface and a steep roof-like, compact part between the enlarged valve-carrier and pumping element; substantially as and for the purpose set forth.

In testimony whereof I have hereunto set my hand in the presence of two witnesses.

HANS MILNER.

Witnesses:

JOSEPH WIEKMANN,

MOLNAROVY.