M. A. MOULIN.

LIQUID PISTON VACUUM PUMP.

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1,000,286. **Patented Aug. 8, 1911.**

Fig.1.

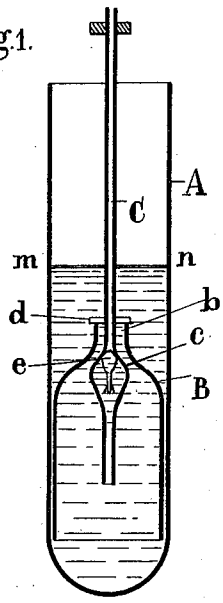


Fig.2.

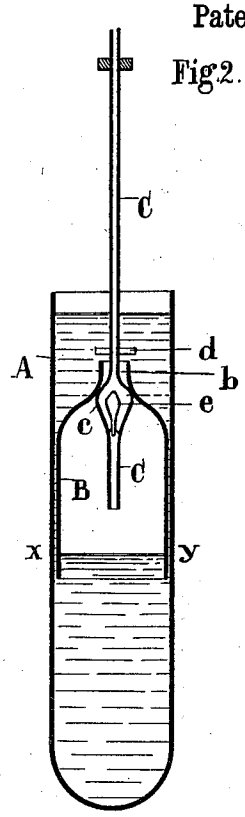
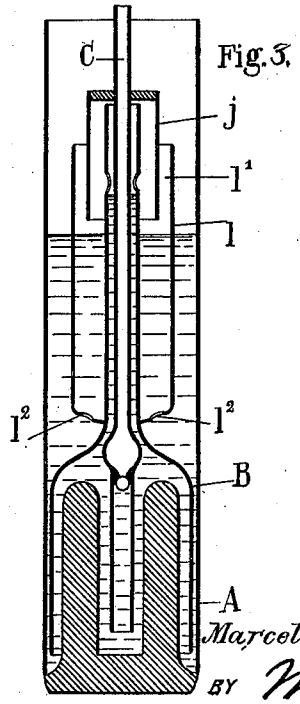


Fig.3.



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LIQUID-PISTON VACUUM-PUMP.

1,000,286. Specification of Letters Patent. **Patented Aug. 8, 1911.**

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To all whom it may concern:

Be it known that I, MARCEL ANDRÉ MOULIN, a citizen of the Republic of France, and resident of 303 Rue du Faubourg St. Antoine, Paris, France, have invented new and useful Improvements in Liquid-Piston Vacuum-Pumps, of which the following is a specification.

This invention has reference to a vacuum pump with a liquid piston and is characterized by the employment of a frictionless and loosely fitting piston whose tightness to gas is insured by a liquid without appreciable vapor pressure, which need not be lubricating, which by reason of its viscosity leaks through slowly in comparison to the speed of working of the system; the liquid which has escaped being afterward utilized to drive out the gas filling the space where it is not wanted. With such an arrangement a very complete vacuum may be rapidly attained with simple apparatus, employing only a small quantity of liquid, which is an important point when mercury is used.

Referring to the annexed drawings: Figure 1 is a sectional elevation of an apparatus ready to work in which the loosely fitting piston consists of a bell movably arranged on the tube stem of a piston in such a manner as to form a return valve. Fig. 2 is a sectional elevation corresponding to the finish of the sucking stroke. Fig. 3 is a sectional elevation of a variation of the preceding apparatus provided with a separator to separate the liquid from the gas and prevent the liquid from jumping out of the cylinder.

The apparatus shown in Figs. 1 and 2 comprises a cylindrical tube A containing the liquid which has no appreciable vapor pressure (mercury, oil, etc.) in which can move with convenient play a kind of bell B forming a nonhermetic piston. At the upper part this bell is provided with an opening *b* in which the tube C engages, which tube is connected with the vessel to be exhausted. The upper part *b* of the bell B can come into contact with a swelling *c* of the inside tube C or with a convenient shoulder portion; the bell is limited in its movement along this tube by a stop *d*. Inside, the tube C is provided with a valve *e* opening downward—(a floating valve (Figs. 1 and 2), a controlled valve, or a simple ball which can float on the liquid (Fig. 3))—which valve is retained by some arrangement (not shown) in the tube C.

The system consisting of the tube C and the bell B of the one part and the liquid of the other part is movable one part relatively to the other. This will result either from displacing the tube C which carries with it the bell, or from displacing the liquid by some process as for example giving to the cylinder A an alternative vertical movement by some mechanical means. In what follows it will be assumed that the cylinder A is moved, while the tube C is fixed.

The system works as follows:—When the cylinder A is at the top of its stroke (Fig. 1) the liquid arrives at the level *m—n*. When the cylinder is lowered the bell B comes into contact with the swelling *c* of the tube C and the liquid inside continuing its descent leaves a vacuum above it in the bell B (Fig. 2). At the same time part of the liquid escapes through between the bell B and the cylinder A, but the dimensions of the apparatus are so proportioned that in spite of the escape the level arrives at *x—y* below the lower end of the tube C at the end of the stroke. The gas contained in the receptacle to be exhausted goes out by the tube C during the down stroke if the pressure is sufficient or at the end of the stroke when the tube C is opened and the valve *e* is lowered if the pressure is very slight. During the following up stroke of the cylinder A the liquid rises again and compresses the gas in the bell B until the said bell rises and comes into contact with the stop *d*. The gas is then completely driven through the opening *b* by the liquid which had escaped between the cylinder and the bell during the down stroke. In the tube C the liquid is stopped by the valve *e*. Thanks to its shape this arrangement, which is easily taken to pieces, allows a rapid working without eddying the liquid, at the same time allowing the creation of as complete a vacuum as with the usual mercury pumps. One can of course create an approximate vacuum above the liquid (level *m—n*, Fig. 1) contained in the cylinder A either by the use of an auxiliary pump of the same type, or by the use of another simpler pump, or by any other means. In this case it is sufficient to close the upper part; this arrangement enables gas to be collected.

The various parts of this pump can nat-

urally be constructed of any suitable material (glass, metal, ebonite, etc.). The valve *e* may be controlled by the movement of the cylinder A to insure its lowering when the pressure of the gas is slight. This valve and the upper part of the bell need not close hermetically; they can be provided, either the valve or its seat, with india rubber.

The tube C can be provided above the valve *e* with a guard valve to prevent the ascent of the liquid when the pump is stopped, if the valve *e* closes badly.

To obviate the conveying along of air by the liquid which is driven from the bell and which falls back into the cylinder A and to prevent the shooting of liquid out of the cylinder, some kind of separator may be added to the arrangement, such as is shown in Fig. 3 which comprises a bell *j* fixed to the tube C and a reversed bell *b* supported by the bell B which forms a trap with the bell *j*.

The gas escapes by the annular part l^1 and the mercury runs back by the openings l^2.

In the figures the bottom of the cylinder A has been shown of such a form as to necessitate the use of the least possible quantity of liquid.

It must be remarked that in these arrangements the part of the tube C within the bell B may be longer than the latter without in the least modifying the action of the pump.

The bell B can have its upper part of any shape, the interior of the bell being tapered to insure all the gas being driven out. The bell B may be provided on its outside with circular grooves the effects of the eddies thus produced adding to the effects of the viscosity of the liquid. The speed of the escape of the liquid may thus be diminished and a greater play may be permitted. Lastly with some materials a very small play may be used without fear of seizing. If the escape of the liquid is not then sufficient to completely drive out the gas, channels may be added to increase the escape.

It is of course understood that the arrangements above described have only been shown as examples and the invention can be varied in constructional details; these arrangements are intended to rapidly create a good vacuum in a receptacle, but they could be applied to fluids other than gases by suitably modifying the construction.

Claims.

1. A liquid piston vacuum pump, the tightness of which is assured by a liquid without appreciable vapor pressure running with less speed than the working speed of the system, the said pump comprising a cylinder containing the liquid, a bell forming a piston, a hollow stem connected to the apparatus to be exhausted, and traversing the bell with play, and a shoulder on said stem serving as a seat to the upper part of the bell.

2. A liquid piston vacuum pump, the tightness of which is assured by a liquid without appreciable vapor pressure running with less speed than the working speed of the system, the said pump comprising a cylinder containing the liquid, a bell forming a piston, a hollow stem connected with the apparatus to be exhausted, and extending above the said bell, a tube prolonging the bell and concentric with the hollow stem, and a bell into which the said tube runs for the purpose of preventing the projection of the liquid and the dragging of the gas.

3. A liquid piston vacuum pump, comprising a cylinder containing liquid without appreciable vapor pressure, a bell forming a piston and fitting loosely in said cylinder, and having a contracted open upper end, the said bell during the stroke of the pump in one direction displacing a part of said liquid, forming a vacuum in the interior of the bell, and a hollow stem connected with the apparatus to be exhausted, the said stem loosely traversing the bell, and provided within the bell with an enlarged portion forming a seat for the upper part of the bell, the hollow stem being provided with a downwardly opening valve.

4. A liquid piston vacuum pump, comprising a cylinder containing liquid without appreciable vapor pressure, a bell forming a piston and fitting loosely in said cylinder, the liquid displaced by the bell on the suction stroke of the pump escaping slowly between the wall of the cylinder and the bell, a hollow stem traversing the bell and extending above the same for connection with the apparatus to be exhausted, a bell fixed to the hollow stem, and a reversed bell supported by the bell forming the piston, and forming a trap with the bell fixed to the hollow stem.

5. A vacuum pump, comprising a cylinder containing liquid and open at the top, a bell forming a piston adapted to displace a part of the liquid in said cylinder during the suction stroke of the pump to form a vacuum space, the said bell fitting loosely in said cylinder to permit the gradual return of the displaced liquid, a hollow stem for connection with the apparatus to be exhausted and traversing the bell and through which the air or gas passes to the said vacuum space, the liquid during the return stroke of the pump compressing the gas and forcing it through the upper part of the bell, and a trap through which the gas escapes.

6. A liquid piston vacuum pump comprising a cylinder containing liquid without appreciable vapor pressure, a bell forming a piston and fitting loosely in said cylinder,

the upper part of said liquid in the cylinder being separated from the lower part by said bell during the stroke of the pump in one direction forming a vacuum in said bell, the liquid displaced escaping slowly between the wall of the cylinder and the bell, a hollow stem extending through the bell for connection with the apparatus to be exhausted, the lower end of said hollow stem at the end of the said stroke of the pump being above the level of the lower part of the said liquid in the cylinder, and the air or gas passing through said hollow stem to the interior of the bell, a downwardly opening valve in said hollow stem for preventing the return of the gas through said stem, a tube prolonging the said bell and concentric with the said hollow stem, a bell fixed to the said hollow stem and into which the upper end of said tube extends, and a reversed bell supported by the bell forming the piston and having openings in its lower end for the escape of the liquid from the reversed bell to the cylinder, the said reversed bell surrounding and being spaced from the bell fixed to the hollow stem, the said liquid during the stroke of the pump in the other direction compressing the gas in said bell piston, the gas passing through the tube prolonging the bell piston into the bell fixed to the hollow stem, and escaping therefrom through the annular space between the said bell and the reversed bell.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses.

MARCEL ANDRÉ MOULIN.

Witnesses:

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LEON PEILLET.