

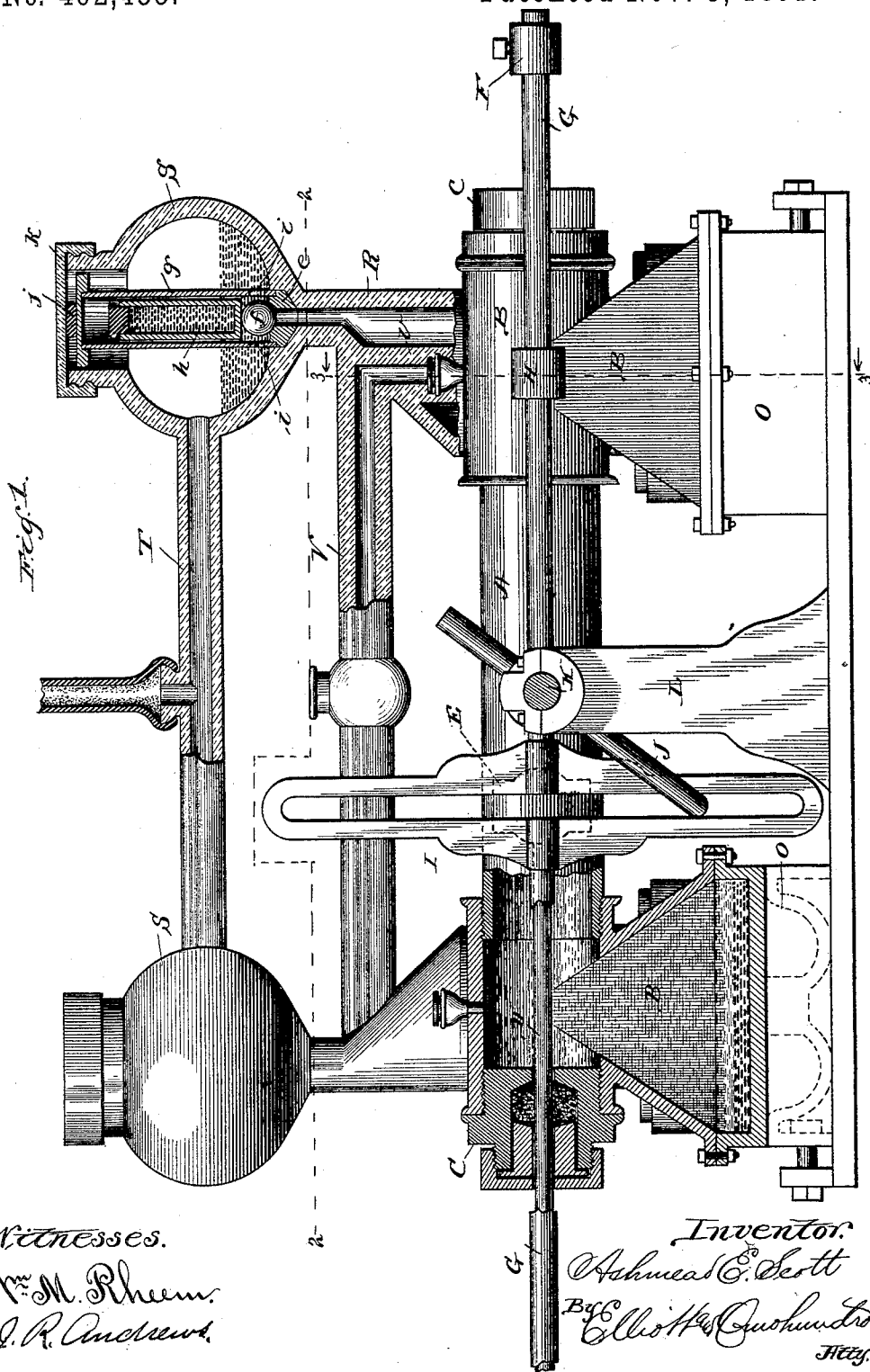
(No Model.)

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A. E. SCOTT.
MERCURIAL AIR PUMP.

No. 462,455.

Patented Nov. 3, 1891.



(No Model.)

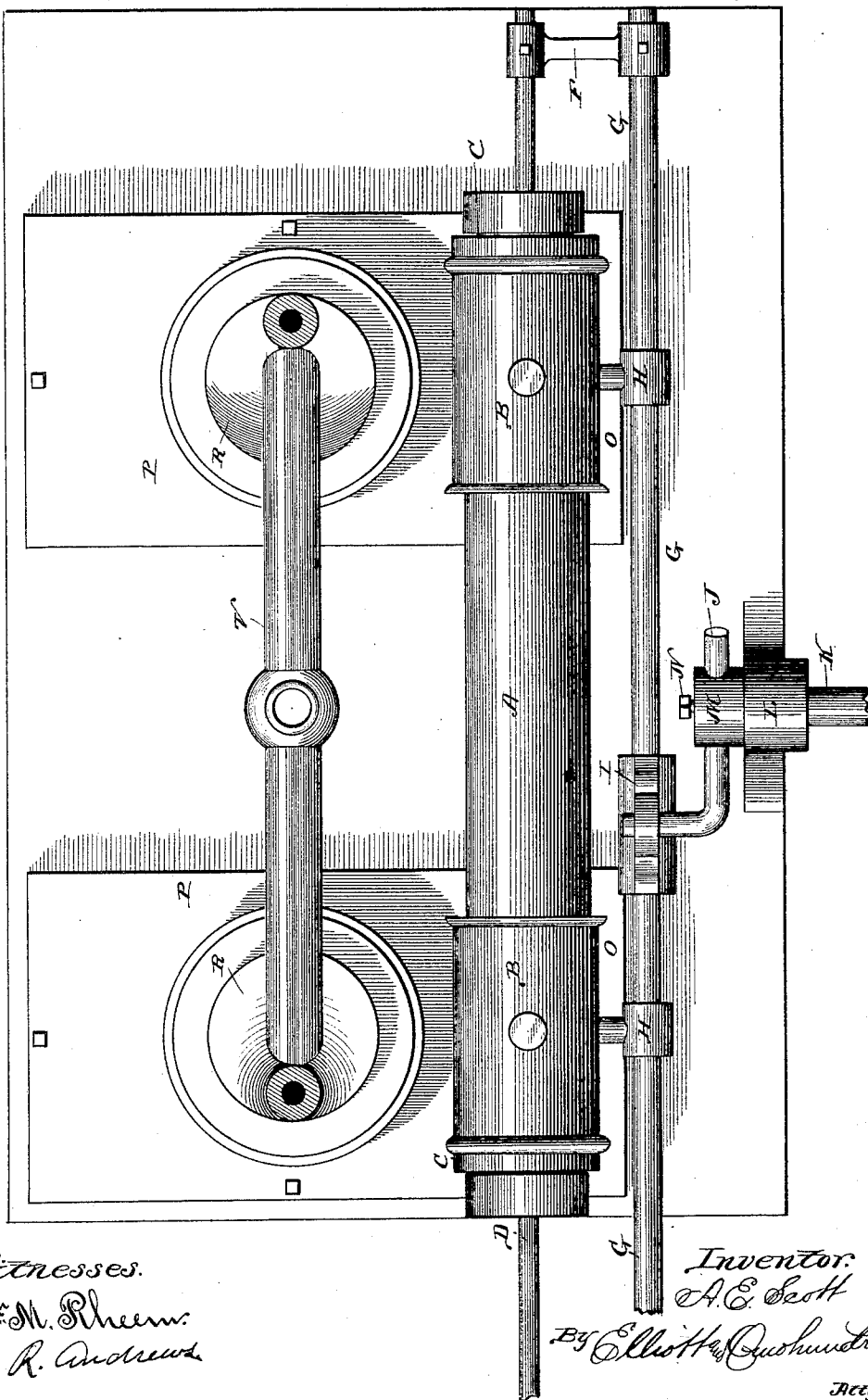
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Fig. 2.



Witnesses.

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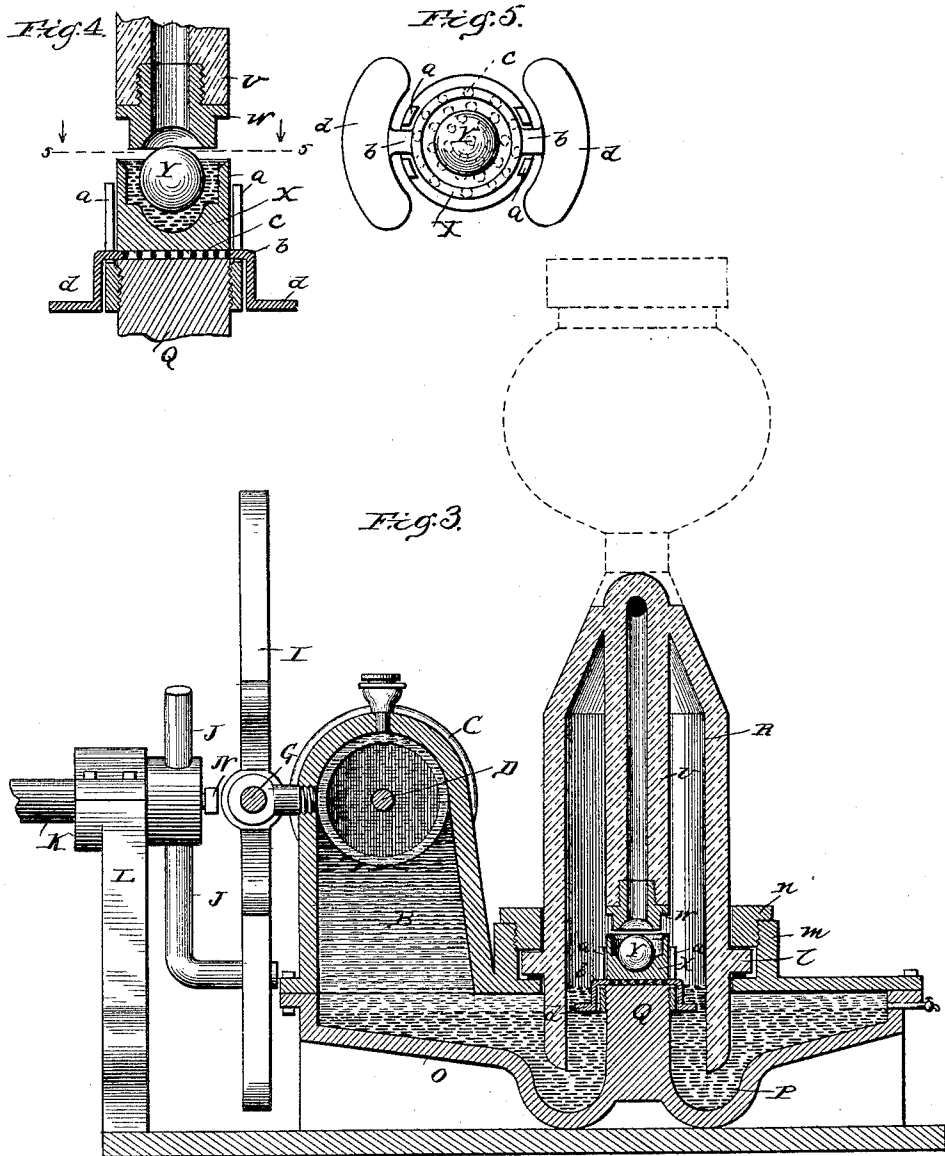
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UNITED STATES PATENT OFFICE.

ASHMEAD E. SCOTT, OF BLUE ISLAND, ILLINOIS.

MERCURIAL AIR-PUMP.

SPECIFICATION forming part of Letters Patent No. 462,455, dated November 3, 1891.

Application filed December 4, 1889. Serial No. 332,593. (No model.)

To all whom it may concern:

Be it known that I, ASHMEAD E. SCOTT, a citizen of the United States, and a resident of Blue Island, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Mercurial Air-Pumps, of which the following is a specification.

This invention relates to improvements in mercurial air-pumps in which heretofore the mercurial and mechanical portions of the pump have consisted of separate apparatus connected with each other through pipe or hose, the mechanical part being used either for the purpose of relieving the pressure upon the discharge-pipes upon the mercurial part of the pump or for the purpose of compressing air or a gas and transmitting the power of such compression through the medium of the gas to the mercury, so as to force the mercury up into the vacuum chamber or bulb, or for both purposes.

There are numerous objections to the manner of operating a mercurial pump by transmitting the power of a piston through a gas or other compressible medium to the mercury, the principal one being that the pump must work against a constant pressure, or the stroke of the piston be increased or diminished to meet any variations of pressure in the discharge-pipe.

Another objection is that the piston must fit tightly within its cylinder, else air or the gas will leak around the piston during both strokes thereof, and the necessarily snug fit of the piston in the cylinder will necessarily and materially increase the friction therebetween, and consequently the power required to operate the pump. As a result of the leaking of the air around the piston the amount of mercury displaced at each stroke will vary materially and thus reduce the capacity of the pump.

The prime object of this invention is to dispense with the employment of air, gas, or any other yielding or compressible medium between the piston and mercury, and to substitute instead thereof a connection which will respond instantly and fully to every movement of the piston.

Another object is to dispense with any auxiliary pump or apparatus requiring long connecting passages, more or less contracted, be-

tween the mechanical and mercurial portions of the pump and to unite the entire pump in a single apparatus of compact form.

A further object is to have the pump of such a character that the active elements thereof will be self-adapted to the varying conditions of pressure, temperature, and work, and finally to provide certain details of construction in the carrying out of my invention or as illustrated in the accompanying drawings, in which—

Figure 1 represents a side elevation of a mercurial air pump embodying my invention, with parts broken away to more clearly disclose the internal structure thereof; Fig. 2, a horizontal section on the line 2 2 of Fig. 1; Fig. 3, a transverse vertical section on the line 3 3 of Fig. 1, looking in the direction indicated by the arrows; Fig. 4, an enlarged detail view of the float-valve in the vacuum-chamber of the pump, and Fig. 5 a horizontal section thereof.

Similar letters of reference indicate the same parts in the several figures of the drawings.

Referring by letter to the accompanying drawings, A indicates a horizontal cylinder connected at each end with hollow T-shaped castings B, provided with removable heads C, of any suitable construction, through a stuffing-box in which work piston-rods D, secured at their inner ends to a single piston E, fitting and working within the cylinder A and connected at their outer ends by means of cross-heads or connecting-bars F, with the driving-bars G, working through and guided in suitable bearings H, projecting from the sides of the T's. This driving-bar is operated so as to impart a reciprocating action to the piston by means of a vertically-slotted cross-piece I, into which projects the bent end of a crank-arm J, adjustably secured in any suitable manner to a rotating shaft K, journaled in a suitable bracket L, cast upon or otherwise rigidly secured to the base of the machine. In practice the driving-bar is preferably formed in two parts secured at their inner ends to the slotted cross-piece, which latter is located between the guides H for said bars, and in effect constitutes a portion of the bar. The adjustability of the crank-arm J may be secured in any well-known and convenient

manner, a simple form being illustrated in the drawings, in which the shaft K terminates in an enlarged head M, through a transverse slot in which the arm works, and may be secured in any adjusted position by means of a set-screw N, working through the head and bearing thereon. The bent end of the crank-arm works freely in the slot in the cross-piece, and may, if desired, be provided with an anti-friction roller (not necessary to be shown) to reduce the friction between said members, it being understood that the axis of rotation of the crank-arm is in the same horizontal plane with the center of the drive-bar and that the end of the crank-arm moves vertically in the slot in the cross-piece, so as to convert the rotary motion of the crank into a reciprocating motion of the drive-bar. The adjustment of the length of the crank-arm enables a corresponding adjustment of the stroke of the piston, which of course corresponds in its movements exactly with the drive-bar; but it will be understood that the movements or stroke of the piston is always confined to the cylinder A, which opens at its end into the T's. These T's are preferably cylindrical in the upper or cross portion thereof, but rectangular in cross-sections in the vertical or lower portion thereof, flaring toward the lower end, where they are preferably provided with flanges adapted and arranged to rest upon corresponding flanges formed upon cisterns O, resting upon and adjustably secured to the base of the machine, and by which the T's are supported, the vertical stem or portion of the T opening directly into the cistern, thus placing the interior of the cylinder in communication with the interior of the cistern through the passages formed by the T. These cisterns are more clearly illustrated in Fig. 2, are rectangular in plan, and provided with bottoms sloping downward from all sides toward circular wells P, located in the center of the cisterns, the walls of which preferably curve outwardly to join the slope of the bottom and upwardly at the center of the well, so as to form a pillar Q, for the purpose hereinafter described. The flange upon the T is enlarged sufficiently at one side thereof to form a cover or lid for the entire cistern, the T being located at one end thereof, while the cover or lid is provided with a central opening immediately above the well sufficiently large to permit the passage of the lower end of a vertical pipe R down into the well below the plane of junction between the walls of the well and the sloping bottom of the cistern.

As the construction and operation of the two sides of the pump are identical, the description, for convenience and clearness, will now be confined to one side only.

The upper end of the pipe R, which we will designate as the "vacuum-chamber," terminates in a bulb S, with one side of which connects a discharge-pipe T for conducting off or discharging the air from the bulb as rapidly as forced therein by the pump. The

pipe R is also provided with a central internal pipe U, formed integrally therewith or hermetically sealed therein, and more clearly illustrated in Figs. 1 and 3, the lower end of which terminates just above the upper end of the pillar Q, while with the opposite end thereof is connected a pipe V, leading to the vessel from which the air is to be exhausted. The lower end of the pipe U is provided with a removable valve-seat W, while immediately below this seat-band and above the upper end of the pillar Q is a floating valve-cup X, in which is confined a ball-valve Y, adapted and arranged to fit upon the valve-seat on the end of the pipe U when the cup X is elevated. This cup is guided in its movements by a suitable frame *a*, preferably cylindrical, to correspond with the shape of the cup, and secured to the end of the pillar. Below the cup and resting upon the end of the pillar is interposed a perforated disk-like plate *b*, upon which the cup is directly supported, said disk having depending arms *c*, to which are secured horizontal wings *d* to increase the buoyancy of the plate and cup when acted upon by the mercury, as will hereinafter be described. The bulb S is partially filled with mercury below the opening to the pipe T, and the passage connecting the bulb with the vacuum-chamber R is also provided with a removable valve-seat *e* for a ball-valve *f*, guided and working within a vertical tube *g*, extending centrally through the bulb and holding the valve-seat *e* in position. This ball is preferably composed of glass as the most suitable for constant contact with mercury, but of course has not sufficient specific gravity to remain upon its seat against the buoyancy of the mercury in the bulb, and to obviate this difficulty a weighted vessel *h* is employed, preferably consisting of a short tube filled with mercury, working in the tube *g* and resting upon the ball-valve *f* and having sufficient gravity to overcome the buoyancy of the mercury in the bulb and seat the valve with a certain quantity of mercury in the bulb, so that the valve will at all times be seated under substantially the same conditions—that is to say, that whenever the mercury in the bulb is reduced to approximately a certain predetermined amount the valve will be seated and prevent the exit of any more mercury from the bulb, thus bearing a mercury seal for the valve *f*. The tube or casing *g* is perforated, as shown at *i*, near the lower end thereof, to permit the egress of the mercury from the bulb, and may be held in place at the top of the bulb by springs or cushions *j*, or in any other well-known and convenient manner, and removed from or placed in the bulb through the opening in the upper end thereof, closed by the removable cap *k*. The vacuum chamber or pipe R may be secured in position in any suitable manner, so as to render the joint air-tight, one form of connection being shown in the drawings, in which the pipe is provided with an

annular flange *l*, adapted and arranged to rest upon the lid or cover of the cistern around the central opening therein, fitting within an annular flange *m*, projecting upwardly from the top of the lid, and screw-threaded on the inner surface thereof for reception of a screw-threaded plug or washer *n*, filling the space between the flange *m* and the exterior walls of the vacuum-chamber. This joint may be packed in the usual manner to prevent the exit of either air or a fluid. The cistern is nearly filled with mercury, which of course rises to a greater height in the vacuum-chamber, into which it freely passes from the cistern through the well in the bottom thereof, because of the superior pressure upon the surface of the mercury contained in the cistern outside of the vacuum-chamber, while the remainder of the cistern, the interior of the *T*, and the piston-cylinder is filled with oil or a like non-compressible fluid, it being understood that the oil is poured into the cistern and other parts while the piston is at the extreme of its instroke, so that immediately the outward stroke is begun the oil will be forced to move down into the cistern and that the oil can at no time rise into the vacuum-chamber, because of the seal provided by the dipping of the lower end of the pipe forming the vacuum-chamber into the mercury-well below the lowest line to which the mercury can be forced. Assuming now that the piston is at the extreme of its instroke with relation to the right-hand pump, which has been shown and described in detail, the first result of the outstroke of the piston will be the forcing of the oil down into the cistern, and consequently the forcing of the mercury out of the well and cistern up into the vacuum-chamber. As the mercury continues to rise in the vacuum-chamber, the cup carrying the ball-valve *Y* will be elevated by the action of the mercury upon the wings *d* of the perforated disk *b* until the valve is seated, closing the end of the pipe *U*, after which the mercury will continue to rise in the vacuum-chamber, forcing the air contained therein upwardly toward the mercury bulb *S* until the atmosphere is sufficiently compressed to unseat the bulb-valve *f* and force its way into the bulb through the mercury therein, to be in turn discharged therefrom. It is intended that at the completion of the outstroke of the piston the mercury from the cistern will rise in the vacuum-chamber until it unites with the mercury in the bulb, a part, in fact, entering the bulb, so as to insure the expulsion of every particle of air from the vacuum-chamber. On the reverse or instroke of the piston the oil and the mercury start back with the piston, following, of course, as fast as the piston moves, the mercury falling back into the vacuum-chamber, which will be sealed as to the mercury-bulb as soon as the mercury which has been forced into the bulb from the vacuum-chamber passes out again, for it will be understood that the float-valve *f* of the bulb has sufficient

gravity to be seated always in approximately the same quantity or density of mercury; but, as before described, whenever that quantity is added to and assisted by the pressure of the pump it will readily rise or float in the bulb. As the piston continues its instroke the mercury will continue to fall in the vacuum-chamber, producing a perfect vacuum in the upper part thereof until the mercury falls below the end of the internal pipe *U* in the vacuum-chamber, when, as soon as the ball-valve *Y* is relieved of the upward pressure of the mercury, it will be unseated by the inrush of air from the vessel being exhausted through the pipe *U* to fill the vacuum in the chamber, this inflow of air continuing until the piston has completed its instroke and the parts are in the position shown in Fig. 3. Of course as a perfect vacuum is approached in the vessel being exhausted the gravity of the valve *Y* will be mainly depended upon to unseat it. When the outstroke again commences, the end of the pipe *U* will again be sealed and the operation before described will be repeated at each complete stroke of the piston, every instroke drawing the air from the vessel being exhausted into the vacuum-chamber and every outstroke discharging it from the vacuum-chamber until finally a practically perfect vacuum is produced in the vessel being exhausted.

The employment of the perforated disk *b* under the float-cup of the ball-valve *Y*, while not absolutely essential, is very advantageous, in that by means of the wings thereof the valve is rendered far more sensitive and obedient to the action of the mercury when rising in the vacuum-chamber, causing the valve to be seated more promptly than if the buoyancy alone of the mercury were depended upon. Nor is the employment of the float-cup *X* an absolute necessity, for the ball alone might be employed and accomplish the same result; but the use of the cup is preferred, because it provides a mercurial seal for the pipe *U* before the main body of mercury from the well reaches the valve-seat, thus guarding against any back flow of air into the pipe from the vacuum-chamber during the early part of the stroke. As will be seen, the ball-valve is of less diameter than the cup, and consequently there will always be retained within the cup a small quantity of mercury, which will operate as a double seal for the end of the internal pipe, the mercury in the cup reaching and sealing the valve-seat before the mercury in the vacuum-chamber reaches the valve-seat. The employment of the winged disk or its equivalent possesses the further advantages of permitting the valve to be located higher in the vacuum-chamber than if the ball alone were employed, which result is of especial advantage, in that when approaching a higher vacuum and the pump is working rapidly the valve will be unseated some time before the instroke is completed, and will remain unseated during

a sufficient part of each instroke to permit the passage of the rarefied air from the vessel being exhausted into the vacuum-chamber, but will be seated almost instantly upon the commencement of the instroke, by reason of the action of the upwardly-moving column of mercury upon the wings of the disk.

By reference to Fig. 3 it will be observed that the surface of the mercury in the vacuum chamber or pipe R is considerably higher than the surface of the mercury in the cistern. If there were a vacuum above the mercury in the vacuum-chamber and the pressure were entirely removed from the oil in the cylinder A the mercury in the vacuum-chamber would fall still lower, until an equilibrium was established between the weight of the column of mercury in the vacuum-chamber and the column of mercury and oil in the cistern and cylinder; but the piston-stroke is adjusted to reverse before this point is reached, leaving always a balance of weight in favor of the column of mercury in the vacuum-chamber, as a result of which the piston is assisted on its instroke in producing the vacuum by the superior gravity of the column of mercury in the vacuum-chamber. This additional weight in the column of mercury in the vacuum-chamber, together with the fact that the area of the oil-passage in the T is greater than the area of the cylinder and that the area of the space between the bottom of the vacuum-chamber and the bottom of the well is greater than the area of the vacuum-chamber, permits of a rapid action of the pump working up to full capacity at all times, even when a perfect vacuum is reached.

While the material of which the pump is composed does not form a part of this invention, it may be suggested that those parts which do not come in contact with any gas or corrosive vapor handled by the pump may best be made of metal, and those parts with which the mercury comes in contact must be made of some material which does not amalgamate with mercury. For general purposes a brass cylinder, iron cisterns and lids, glass vacuum-chamber, and mercury or discharge bulb with glass valves and valve-seats, and hard-rubber casings and mechanism will be found efficient and durable. The valve-seats should be hermetically sealed in place by some substance not effected by corrosive vapors or gases, which may best be done by dipping them in melted paraffine wax and forced into position while warm. Connections between vacuum-chamber and vessel being exhausted should be treated in the same manner. The cisterns should, preferably, have a capacity twice that of the vacuum-chamber, so that there will be sufficient room for a quantity of oil between the mercury and lid when the mercury is at the highest point in the cistern. One purpose in making the cisterns large and shallow is to give a large capacity for a slight height of column, and this construction possesses the further advantage, when combined

with the well and the lower end of the vacuum-chamber, of providing a mercury trap between the bulbs much shorter and of greater capacity than is possible with the connection below referred to.

In all forms of mercurial pumps with which I am familiar the vacuum-chamber and mercury bulb or cistern are spherical, while the connections between them are of considerable length and more or less contracted, retarding the flow of mercury and thereby requiring a much longer time to exhaust a vessel than would be required were the connections shorter and larger. This objection is entirely avoided by my construction, and I gain an increased exhausting capacity of pump without additional cost of mercury.

This pump is self-adjusting and does not require constant adjustment of the stroke of the piston to compensate for varying pressures, or the expansion of either the mercury or the power-transmitting liquid between the mercury and pistons as in prior forms of pumps, for the expanded mercury has ample accommodation in the vacuum-chamber when not under pressure and in the mercury bulb when under pressure, and in neither case will it interfere in the slightest with the perfect operation of the pump.

In practice I prefer to have the pump double and utilize the same cylinder for both ends of the pump, although it is not necessary that each end of the pump should operate upon so as to exhaust from the same vessel, for they may be independently connected with and exhaust from two separate vessels.

A pump constructed in accordance with my invention combines in the maximum degree simplicity, durability, and efficiency, while it is compact in form and economical in construction, a double pump being worked at the same expense of mechanical energy heretofore required for the operation of a single pump.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a mercurial air-pump, the combination, with the cylinder and the piston thereof, of a mercurial reservoir, a liquid filling for the passages and cylinder between said piston and the mercury in the reservoir, a vacuum-chamber, the walls of which extend into the reservoir below the surface of the mercury provided with an inlet-opening and a float-valve therefor co-operating with so as to be seated and unseated by the mercury passing through said chamber, substantially as described.

2. In a mercurial air-pump, the combination, with the cylinder and the piston thereof, of a mercurial reservoir, a liquid filling for the passages and cylinder between said piston and the mercury in the reservoir, a vacuum-chamber the walls of which extend into the reservoir below the surface of the mercury provided with an inlet-opening, a float-

valve therefor co-operating with so as to be seated and unseated by the mercury in passing through said chamber, a mercurial bulb constituting a discharge-chamber connected with and above said vacuum-chamber, and a weighted float-valve in said bulb of greater specific gravity than the mercury contained therein, but adapted and arranged to be unseated by the passage of the mercury and air from the vacuum-chamber into the bulb, substantially as described.

3. In a mercurial air-pump, the combination, with the vacuum-chamber, an inlet-opening therefor, and a removable valve-seat, of a float-valve comprising a ball and a cup for holding said ball of greater diameter than the valve-seat, substantially as described.

4. In a mercurial air-pump, the combination, with the cylinder, the piston thereof, the cistern, mercury partially filling said cistern, and a liquid filling for the cylinder, and passages between said piston and the mercury in the cistern, of the pipe R, constituting a vacuum-chamber and extending into the cistern below the surface of the mercury therein, substantially as described.

5. In a mercurial air-pump, the combination, with a mercurial reservoir, of a piston-chamber opening directly into said reservoir, and a liquid filling for said chamber, substantially as and for the purpose described.

6. In a mercurial air-pump, the combination, with the vacuum-chamber, of the internal

pipe U, provided with a valve-seat W on the end thereof, of the ball Y, arranged to close the end of said pipe, cup X, containing said ball, guides *a* for said cup, disk *b*, located between said cup and its support, and wings *d*, extending laterally from said disk, substantially as described.

7. In a mercurial air-pump, the combination, with the mercurial cistern O, pillar Q, located centrally in said well, pipe R, the end of which extends below and surrounds the upper end of the pillar, the internal pipe U, located within the pipe R and terminating above the pillar, and a valve-seat W thereon, of the ball-valve Y, arranged to close the end of said pipe, cup X, containing said ball, guides *a* for said cup-disk *b*, located between said cup and the upper end of the pillar, and wings *d*, extending laterally therefrom, substantially as described.

8. In a mercurial air-pump, the combination, with the vacuum-chamber, of the mercurial bulb S, provided with a removable cap *k*, a removable valve-seat *e*, and a hollow tube *g*, confined between said valve-seat and cap and provided with openings *i*, of the valve *f*, and the mercurial cylinder *h*, resting upon said valve and working in the tube *g*, substantially as described.

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