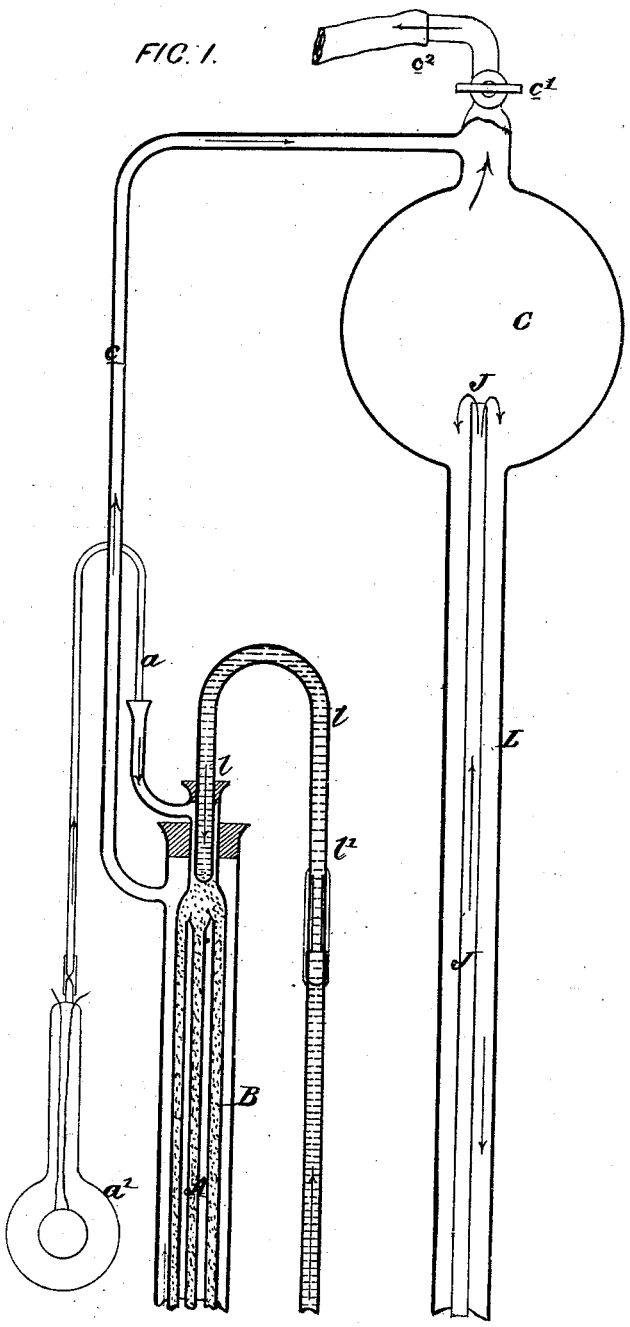
(No Model.) 4 Sheets—Sheet 1.

C. H. STEARN.

MERCURIAL AIR PUMP.

No. 265,641. Patented Oct. 10, 1882.

FIG. 1.



Witnesses.

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(No Model.) 4 Sheets—Sheet 2.

C. H. STEARN.

MERCURIAL AIR PUMP.

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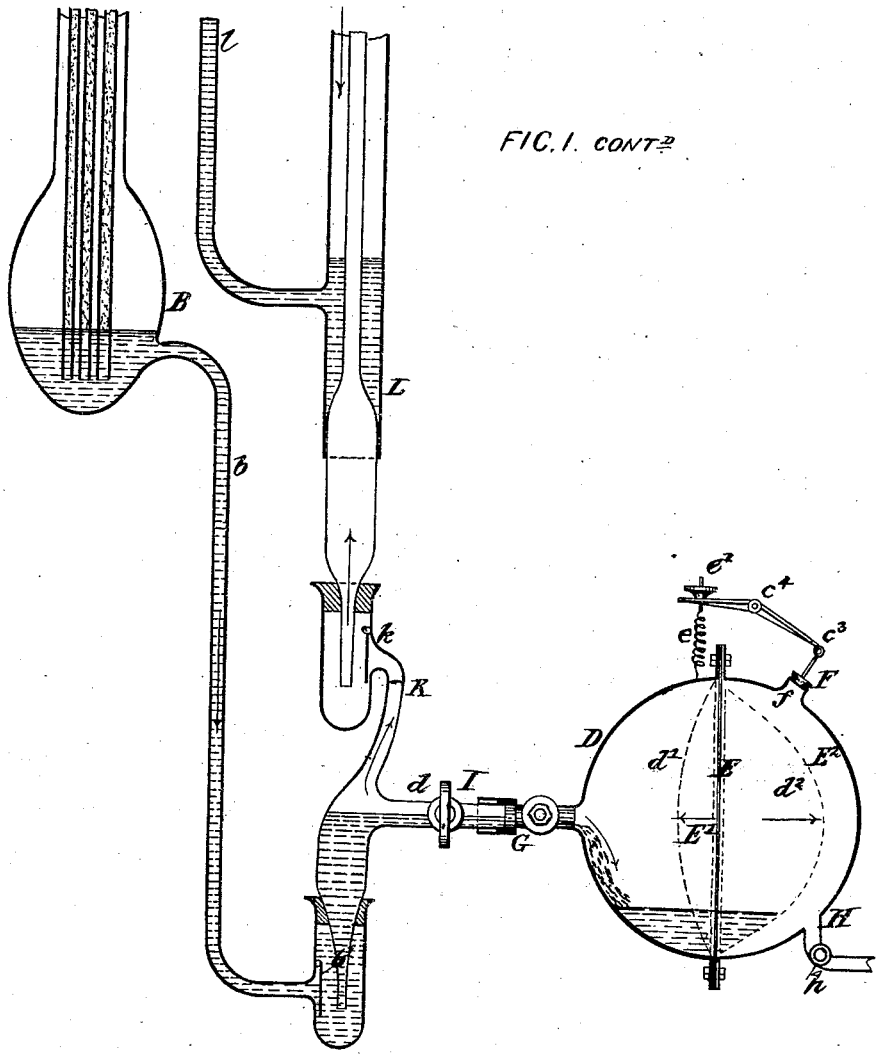

FIG. 1. CONT^D

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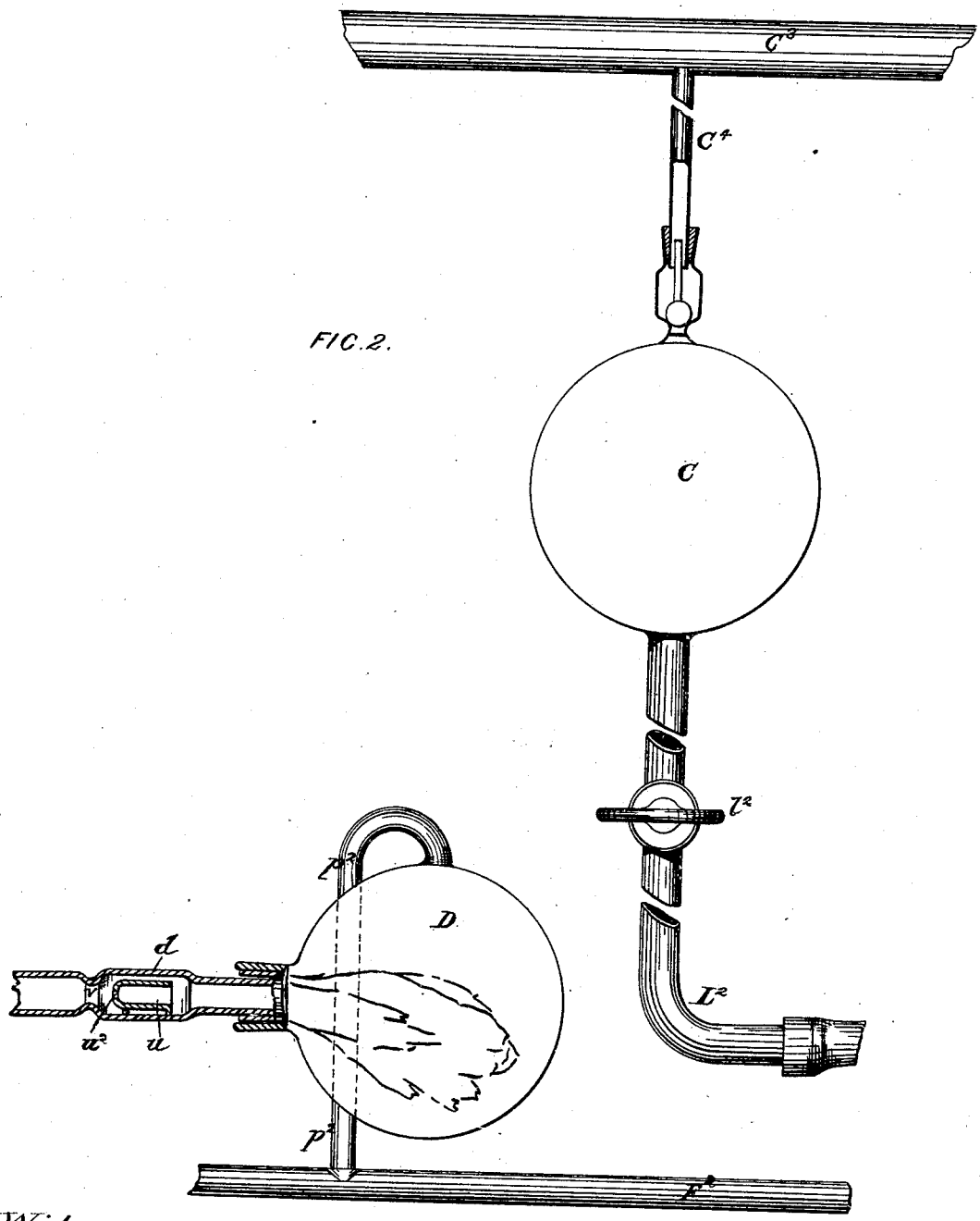
(No Model.) 4 Sheets—Sheet 3.

C. H. STEARN.

MERCURIAL AIR PUMP.

No. 265,641. Patented Oct. 10, 1882.

FIG. 2.



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(No Model.) 4 Sheets—Sheet 4.

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MERCURIAL AIR PUMP.

No. 265,641. Patented Oct. 10, 1882.

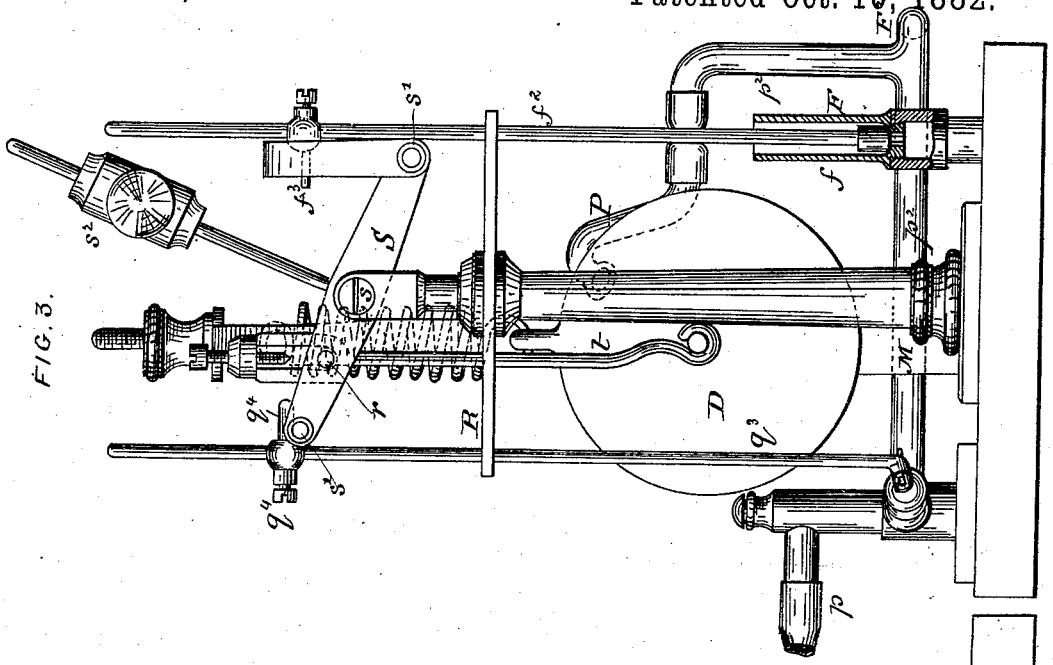

FIG. 3.

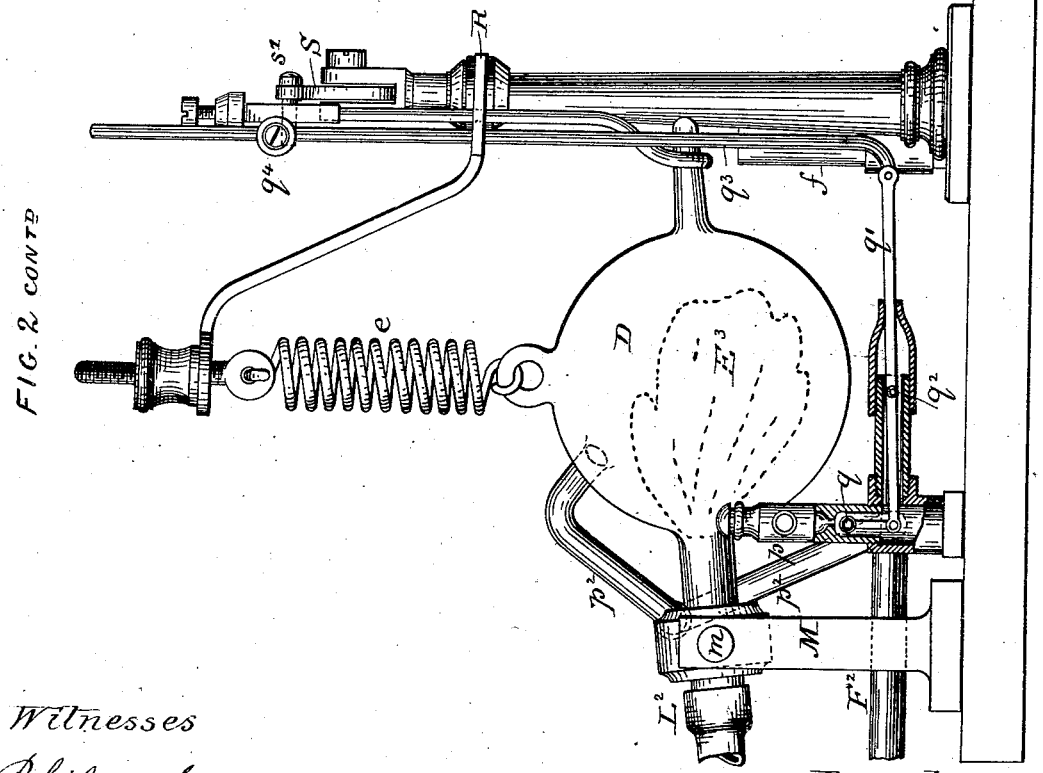

FIG. 2 CONTD

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UNITED STATES PATENT OFFICE.

CHARLES HENRY STEARN, OF NEWCASTLE-UPON-TYNE, ENGLAND.

MERCURIAL AIR-PUMP.

SPECIFICATION forming part of Letters Patent No. 265,641, dated October 10, 1882.

Application filed May 15, 1882. (No model.) Patented in England November 15, 1881, No. 5,000.

To all whom it may concern:

Be it known that I, CHARLES HENRY STEARN, a subject of the Queen of Great Britain, and residing at Osborne Road, in the borough and county of Newcastle-upon-Tyne, England, have invented certain Improvements in Mercurial Air-Pumps, (for which I have obtained a patent in Great Britain, No. 5,000, dated November 15, 1881,) of which the following is a specification.

My said invention relates to improvements in mercurial air-pumps, such as those known as the "Sprengel" pump, the "Geissler" pumps, and the like pumps, which require the periodical return of mercury from one level to another, and has reference to the arrangement of an automatic feed, by which the mercury employed therein is periodically returned to the higher level of its original source, whereby a continuous action of the pump is obtained in a most economical manner. By this means the reservoir of large dimensions ordinarily employed is dispensed with, and only a very small vessel substituted therefor, which is intermittently replenished by an automatic device, hereinafter described. Greater uniformity and celerity of action are also attained, owing to the reduction of the length of the exhausting portion of the pump and the keeping of the mercury in sealed exhausted vessels during the period of its circulation. In this manner the mercurial portion of each pump may be rendered entirely independent of others when combined in a general system, there being one or more air-pumps in connection with each mercurial pump or system of mercurial pumps, while the complete seclusion of the injurious mercurial vapors evolved prevents the contamination of the atmosphere in the neighborhood of the pump, which is so dangerous to the operators. The automatic supply or return of the mercury to its elevated reservoir or receiver, as before mentioned, is effected by utilizing the pressure of a fluid, such as that of the external atmosphere, by causing or allowing it to intermittently act upon the fallen mercury to return it to the said elevated reservoir or receiver, as hereinafter described.

In order that my said invention may be fully understood, I shall now proceed more particularly to describe the same, and for that purpose shall refer to the accompanying drawings, and to the letters and figures marked thereon.

Figure 1 is a vertical section of a mercurial air-pump to which my said invention is applied, the pump to which it is shown as being applied being of the Sprengel type; and Figs. 2 and 3 are respectively a side elevation, partly in section, and a front elevation of a somewhat modified form of pump, especially adapted to control a connected system of pumps.

A, Fig. 1, is the compound mercurial fall-tube, composed of a number of branches—three, as shown—which, in consequence of the combination therewith of my improvements, may be of less height than the barometric column, the said tube passing through a closely-fitting india-rubber or other air-tight stopper into the outer tube B, which latter communicates with the upper receiver, C, by the tube *c*, and is in communication at its lower end with the lower receiver, D, through the tubes *b* and *d*. The upper receiver, C, communicates by means of a cock, c', and flexible or other suitable tube, c^2, with a mechanical or other air-pump aspirator or exhausting apparatus, and as soon as a sufficient or a partial vacuum is obtained within the apparatus the stop-cock c' is closed, so as to sever the communication of the receiver C with such exhausting device. Instead of the stop-cock c', a valve may be employed. The lower receiver, D, which may be constructed either of glass, iron, or other material not injuriously acted upon by the mercury, is of any convenient shape and construction. As illustrated it is formed as a spherical chamber of two separate united hemispheres, supported by a spring, *e*, adjustably attached to one arm of the lever turning on the center c^4, supported by a standard or standards, as shown, the said receiver having an india-rubber or other flexible diaphragm, E, extending between and subdividing the receiver into two compartments, d' d^2.

F is a valve or stopper, of conical or of other convenient form, ground to fit air-tightly the seating in the opening *f*, provided at the side of the said receiver in any convenient position—for instance, in the position shown in the drawings. This valve F is maintained closed so long as the lower receiver, D, is empty or suf-

ficiently light to permit its being held in its raised position by the spring *e;* but when a certain amount of the fallen mercury has accumulated in the said receiver, then it (the receiver) descends slightly, turning upon the rocking joint G, so as to open the valve F and establish communication with the external atmosphere. The degree of tensile elasticity of the spring *e* may be adjusted as varied by means of the screw-nut *e'*, so as to counterbalance any desired variable degree of weight in the receiver D. It will be understood that according to my arrangement the valve F and its support c^3 are free to turn on the center c^4, (which center may be carried by the framing of the pump,) and derive their motion from the movement of the receiver D, which the seating of the valve formed in the aperture in the receiver D causes to rise or fall bodily to or from the valve, so as to automatically open or close the passage into the receiver, as required.

The rocking joint G may be of any description that will constitute a center for the receiver D to slightly fall and rise upon without interfering with its permanent communication with the main portion of the apparatus.

The passage and tube H, controlled by a cock, *h*, and arranged at the bottom of the lower receiver, is for establishing communication with another mechanical air pump or exhauster of any convenient kind, while the cock I on the tube *d* is for cutting off the connection between the main part of the apparatus and the said lower receiver, if desired.

The lower receiver, D, is in communication with the upper receiver or reservoir, C, through the curved tube K and the narrow vertical tube J, which passes up the center of the outer tube L, on or to the top of which the said receiver C is formed or attached. The lower end of this outer tube L communicates with the upper part of the interior of the compound fall-tube A by means of the tube *l*, through which the mercury is fed to the pump, an air trap or traps of the usual construction being provided in any convenient position—for example, as indicated at *l'*.

a is the ordinary exhaust-tube, connected at the top of the fall-tube A, attached at its opposite extremity to the chamber globe or the like *a'*, which it is required to exhaust.

The valve *b'* at the end of the tube *b* opens toward the receiver D, so as to allow the fallen mercury to flow at the proper time into the said receiver, but not return therefrom. The valve of *k*, provided at the top of the curved tube K, opens away from the receiver D, so as to allow the mercury thus collected to ascend the tube J, communicating with the upper receiver C, but prevent the return of the said mercury. Assuming that a sufficient quantity of mercury has been introduced into the lower receiver, D, the said receiver is thereby caused to overcome the tension of the spring *e*, and slightly descends, turning about the joint G and turning the support c^3 about the center c^4, so as to open the valve F. The air-pump, in connection with the pipe c^2, which is kept continually acting by an engine, then partially exhausts the air from the upper receiver or reservoir, C, the tubular casing B, the receptacle *a'* to be exhausted, and their intermediate connections. The external atmospheric pressure enters the lower receiver by the valve F, and by impinging upon the elastic diaphragm E and causing it to distend in the direction indicated by the dotted line E' forces the mercury through the pipes *d* and K (stop-cock I being opened) up the small tube J into the upper receiver, C, whence it descends by the tubular connection L, and then passes by the tube *l* to the compound fall A, and acting therein in the manner in which it acts in mercurial pumps of the ordinary kind. As the mercury is thus automatically caused to ascend to a higher level, so the lower receiver, D, obviously becomes gradually higher until it is brought up by the spring *e*, and the valve F is again closed against the entrance of the atmospheric air, in the manner already described. When the lower receiver, D, is thus emptied of mercury and the valve F closed the pump or aspirator, in connection with the tube H, is brought into operation, and the air is exhausted from the one side of the elastic diaphragm, which is thereupon caused to recede to the position indicated by the dotted line at E^2, and the mercury then flows from the bottom of the tube B through the tube *b*, through the valve *b'* and tube *d*, back to the lower receiver, D. Upon the return of the mercury the valve F is again opened by the descent of the receiver, owing to its increased weight, as before described, and thus this recurrent cycle of operations is continuously and automatically maintained as long as the pump or pumps are put in connection with the upper and lower receivers, C and D, at the proper intervals.

It will be understood that the valve F should be so constructed and proportioned that it will be opened at the proper moment by the weight of the lower movable receiver, D—that is, when it contains its maximum amount of mercury—and the extreme height of the apparatus or elevation of the upper receiver, C, be within the limits of a barometric column, for the reason that the pressure of the atmosphere which is utilized to raise the mercury from the lower to the upper receiver obviously would not suffice to raise the mercury a greater distance than the height of the barometric column. The bottom of the tube B should be at a level above that of the lower receiver, D.

The intermittent actuation of the valve F for the admission of atmospheric air upon the flexible diaphragm may be effected by the use of an electro-magnet, the circuit of which is completed upon the mercury reaching a determined level in the lower receiver, D, and thus attracting the valve at its curvature; or other equivalent devices may be substituted for those hereinbefore described—as, for example, a counter-

weight may be used in lieu of the spring *e;* or the lever of a stop-cock may be actuated by such or equivalent means for effecting substantially the same end.

Fig. 2 of the accompanying drawings represents in side elevation and Fig. 3 in front elevation a modification of the hereinbefore-described arrangement, wherein the valve for the admission of the air to the receiver D is upon a pipe opening into the said receiver, and is operated by a rod separate from the spring *e*. In this arrangement here shown a bag, E^3, is substituted for the diaphragm E described in the first arrangement; but a diaphragm may be used in place of the bag, if preferred. The modification may be employed with each mercurial pump; but it is especially adapted for use with a system of pumps communicating by pipes or passages with the air-inlet and the air-exhaust pump, aspirator, or the like. From Fig. 2 it will be understood how it may be applied to any convenient number of such pumps combined in a system. Where the one receiver D is used to actuate the valves for admitting air to and exhausting air from a number of receivers D of mercurial pumps combined in a system, the column of the mercury in communication with the receiver D which actuates the said valves may be an independent column with an upper receiver, C^2, in communication with the air-exhaust pipe common to the upper receivers of all the mercurial pumps; or the said column of mercury may be that of one of the pumps in the system.

I will now describe the mechanism for opening the valves according to this modification.

The receiver D is hinged to the standards M by the joint at *m*, so as to be capable of turning thereon without destroying the communication of its bag with the pipe L^2, which pipe is in communication with the said flexible bag E^3, contained in the said receiver D. The pipe to the air-pump is marked F^2, and from it are branches, as at p^2, leading into each of the receivers D of the system. *q* is the valve in closing and opening the passage of the said pipe, the said valve being opened and closed by the lever *q'* turning on the center at q^2, the other end of the said lever being connected to the rod q^3, sliding in the cross-piece R, and furnished with an adjustable projection, q^4. A tube at *f* is in communication at one end with the outer air and at the other with a pipe communicating with the interior of the receiver. A valve, F, carried by a rod, f^2, rests upon a seating in this pipe *f*, the said rod sliding in the cross-piece R and carrying an adjustable projection, f^3. A rocker-lever, S, turns upon a center pin, *s*, on the cross-piece R, the said lever S carrying at each end a tappet, *s' s'*, the one of which is in the path of the projection q^4 and the other of which is in the path of the projection f^3.

Connected to the receiver D is a rod, *t*, with a slotted upper end engaging with a pin, *r*, on one arm of the rocker-lever S, which lever carries a counter-weight at s^2. When air, by the action of the pump, is exhausted from the receiver D, the mercury descending into the bag E^3 so weights the receiver D, as before described with regard to the first-described arrangement, that the said receiver descends and through the rod *t* pulls the rocker-lever S over until counter-weight s^2 passes the vertical line, when it carries over the said lever S, and by causing one of the tappets *s'* to come into contact with the under side of the projection f^3 lifts the rod f^2 and raises the valve F from its seat, when atmospheric air passes into the receiver D and drives the mercury out from the bag and up to its original source as described, with regard to the first arrangement, the tappet *s'* at the other end of the said rocker-lever S at the same time, by coming into contact with the upper side of the projection q^4, operating the lever *q'* to close the valve *q* and cut off communication with the air-pump. When the receiver D ascends the rocker-lever S is pushed by the rod *t* over in the other direction, and when the counter-weight s^2 passes the vertical line it brings over the said rocker-lever, so that the tappet *s'* on the one end closes the air-valve F, and at the same time opens the valve *q* of the air-pump, when air is again drawn from the receiver D through the pipe F^2, as before described.

As before stated, this mechanism for opening the air inlet and exhaust valves may be applied to each individual mercurial pump; or where a number of mercurial pumps are combined in a system there may be only one receiver provided with the said mechanism actuating the valves of main air inlet and exhaust pipes which are common to all the mercurial pumps in the system, each pump being provided with a stationary lower receiver, D, for receiving the mercury and returning it to its original elevation, as hereinbefore described, there being a branch pipe from the main air inlet and exhaust pipe to each such receiver, for causing air to pass into the receivers to press up the mercury, and for enabling the air to be withdrawn to allow the mercury to enter the said receptacle or the chamber or bag contained in the same. The lower receiver, D, which actuates the mechanism for opening and closing the valves, may have a separate column of mercury; or it may be actuated by the column of mercury of one of the pumps of the system.

In Fig. 2 I have shown the lower receiver, D, which actuates the valves, as being provided with an independent column of mercury in the tube L^2, having at top the upper receiver, C, in communication by the branch pipe C^4 with the main pipe C^3, leading to the air-pump or aspirator, similar branch pipes, C^4, leading from all the upper receivers of the mercurial pumps of the system into the said pipe C^3. I have also shown a lower receptacle, D, of one of the pumps of the system, the said lower receptacle communicating by the branch pipe p^2 with the main air inlet and exhaust pipe F^2 common

to the lower receivers of all the mercurial pumps of the system, each lower receiver communicating by a similar branch pipe, p^2, with the said main pipe F^2.

I have not shown a complete pump in Figs. 2 and 3, as it is not necessary for the understanding of this description. It will readily be understood that they will have a position in relation to their receivers like that described with reference to Fig. 1.

It is desirable that, while the passage of the mercury from the lower receiver to the upper receiver of the pumps is slow, its return to the lower receiver be as rapid as possible. In order to effect this there is placed between the lower receiver and the pump proper a small tube or annular piece, u, with a passage between its outer side and the inside of the tube d, leading to the bag E^3 of lower receiver. A small hole, u^2, is made through this annular piece u. The mercury passing from the lower receiver presses the said piece u forward to bear against a seat at v, and consequently the mercury can only pass slowly through the small opening u^2 therein. When the mercury returns, however, the said annular piece u is moved back, and the mercury can pass rapidly through the space around the outer side of the said annular piece.

The tube L^2 is provided with a cock or valve, l^2, to regulate the rise and fall of the mercury, to synchronize with the rise and fall of the mercury in the pumps of the system. A similar cock may be used on the corresponding tubes of the mercurial pumps of the system.

The flexible diaphragm or bag in the receptacle D may be dispensed with, and atmospheric air be caused to act directly upon the mercury in the lower receiver, D, in which case the orifice of the tube d opening into the receiver should be so situate as to be always sealed by the mercury.

Although I have described the pressure upon the diaphragm or mercury in the receiver as being obtained from the ordinary pressure of atmospheric air, yet it will be understood that it may be obtained in an analogous manner from other fluid or fluids.

I claim—

1. In a mercurial air-pump, the combination of the upper receiver, lower receiver connected therewith, and means for automatically bringing into operation the pressure of a fluid—such as air—to raise the mercury from the lower to the upper receiver, substantially as described.

2. The combination, with the upper receiver, of a lower receiver connected therewith, and provided with a valve adapted to open automatically when a suitable amount of mercury has accumulated therein, substantially as described.

3. In a mercurial air-pump, the combination of a fall-tube of less height than the barometric column, the upper receiver, and the lower receiver, provided with an automatic valve for admitting air at the proper moment, substantially as described.

4. The combination, with the upper receiver and connecting pipes and tubes of a mercurial air-pump, of a lower receiver, spring supporting said receiver, flexible diaphragm or similar device dividing said receiver into two chambers, and an automatic valve operated by the rise and fall of said receiver for admitting a suitable fluid, such as atmospheric air, capable of exerting pressure upon said diaphragm into said receiver, substantially as described.

5. The lower receiver, connected with the other parts of the mercurial air-pump in the manner explained, supported on an elastic or flexible joint, as explained, so as to rise or fall as it becomes lighter or heavier, and provided with a valve which is automatically closed and opened by the rise and fall of the said receiver, substantially as and for the purposes set forth.

6. The combination, with the upper receiver and connecting-tubes, as specified, of the lower receiver, supported so as to be capable of falling and rising as it increases or diminishes in weight, and means, substantially as described, for putting said receiver, when it descends, into communication with the outside air, and for connecting it, when it rises, with the exhaust-pipe, as and for the purposes specified.

7. The combination, with the upper and lower receivers of a mercurial air-pump and the pipe or tube connecting them, of a check-piece in said pipe or tube, constructed and arranged substantially as described, to allow the mercury to pass rapidly into the lower receiver, but to cause it to return slowly to the upper receiver, as set forth.

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

C. H. STEARN.

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