(No Model.) 3 Sheets—Sheet 1.

# H. & F. G. A. SCHULZE-BERGE.

## AIR PUMP.

No. 428,638. Patented May 27, 1890.

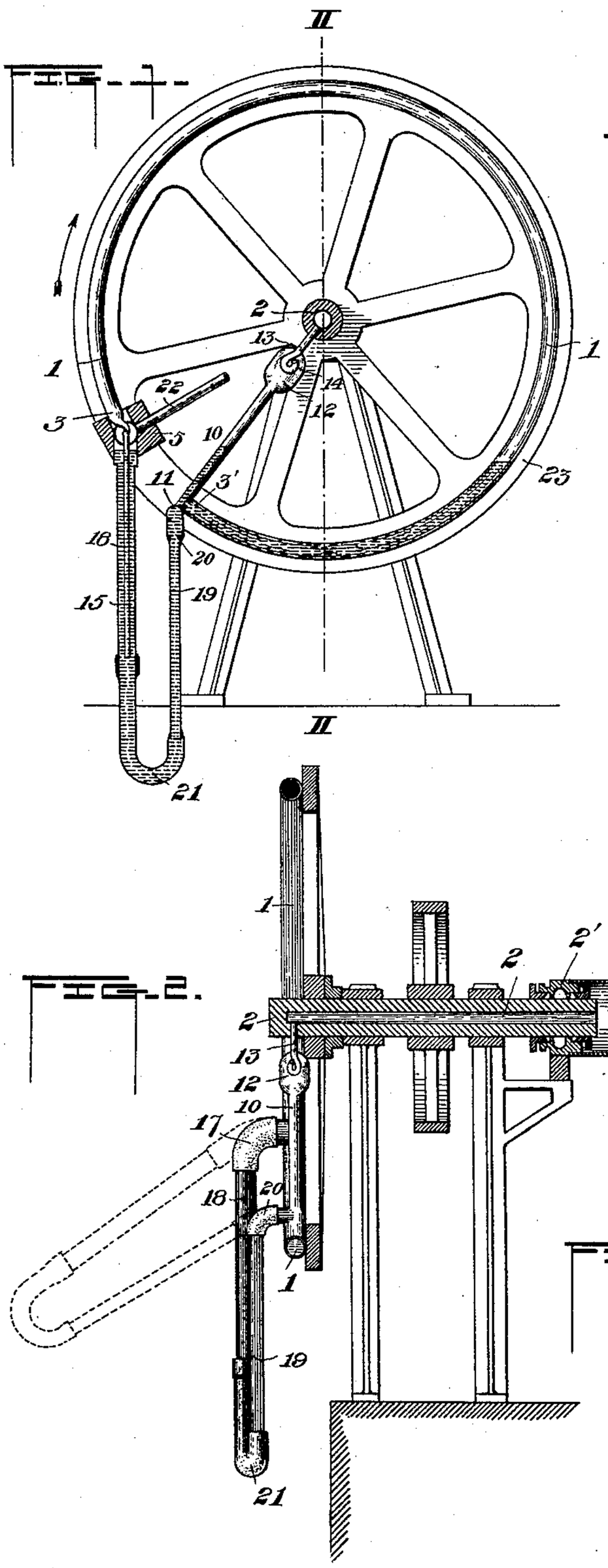


FIG. 1.

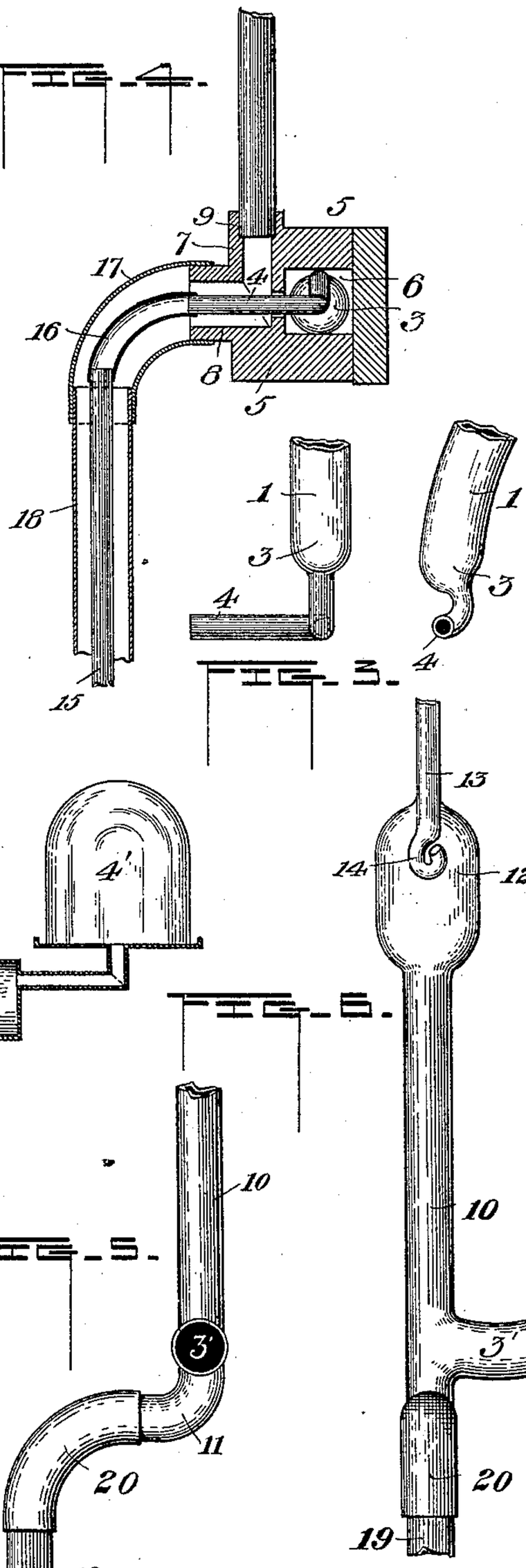


FIG. 3.




FIG. 4.




FIG. 2.




FIG. 5.




FIG. 6.

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(No Model.) 3 Sheets—Sheet 2.

# H. & F. G. A. SCHULZE-BERGE

## AIR PUMP.

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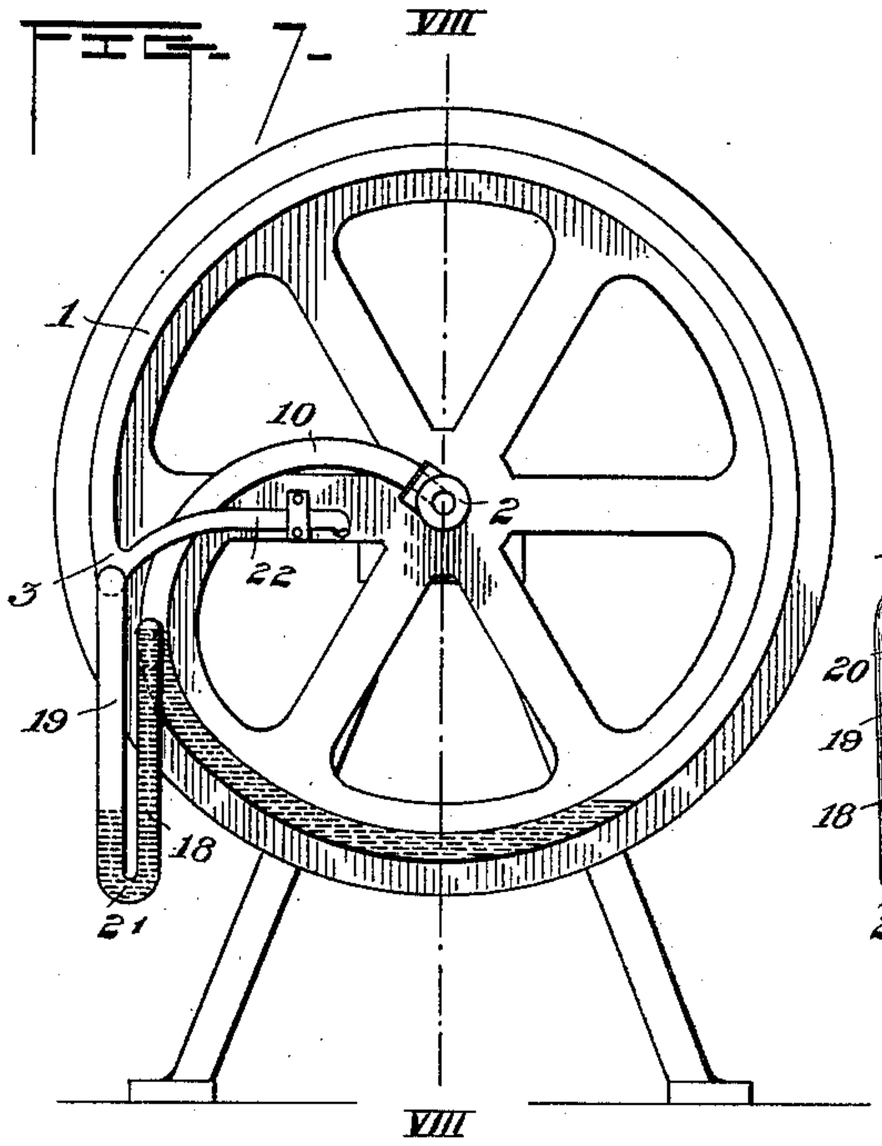
FIG. 7.



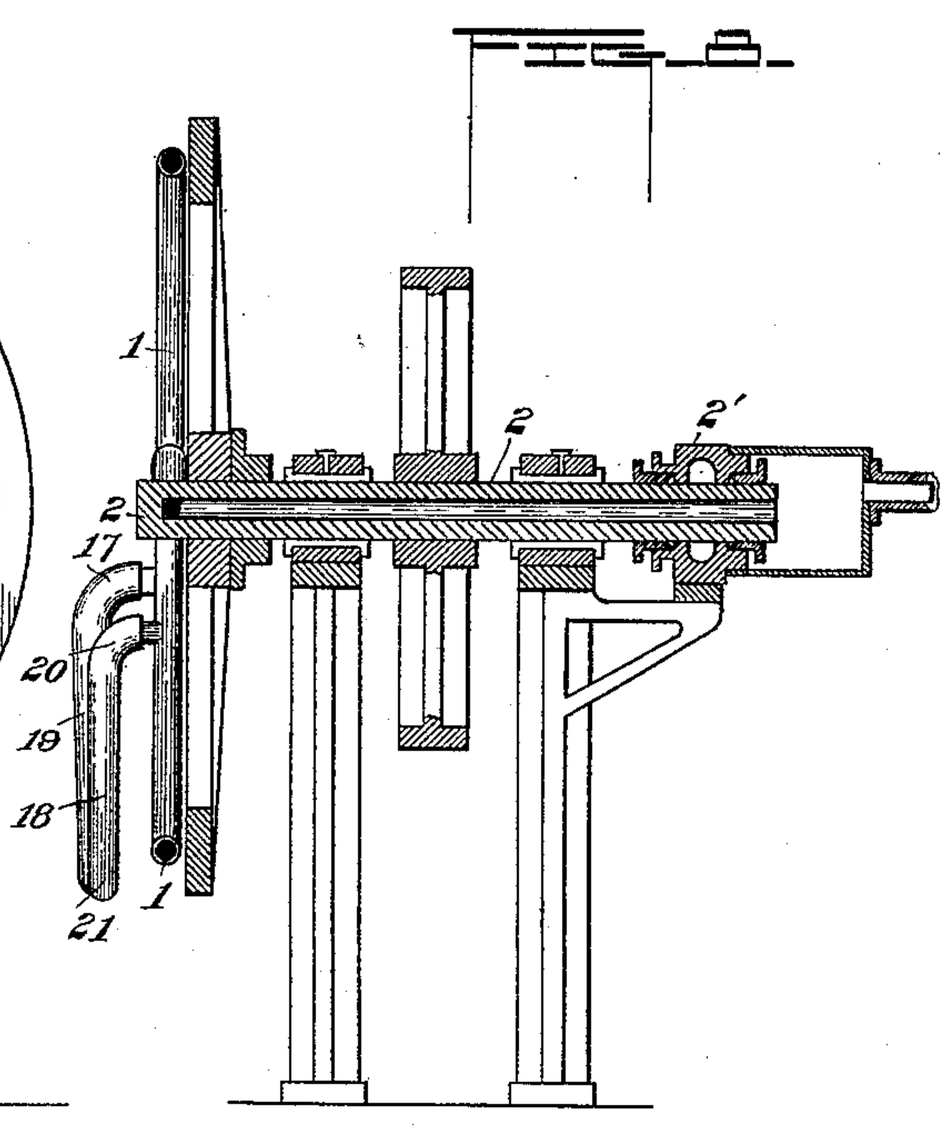
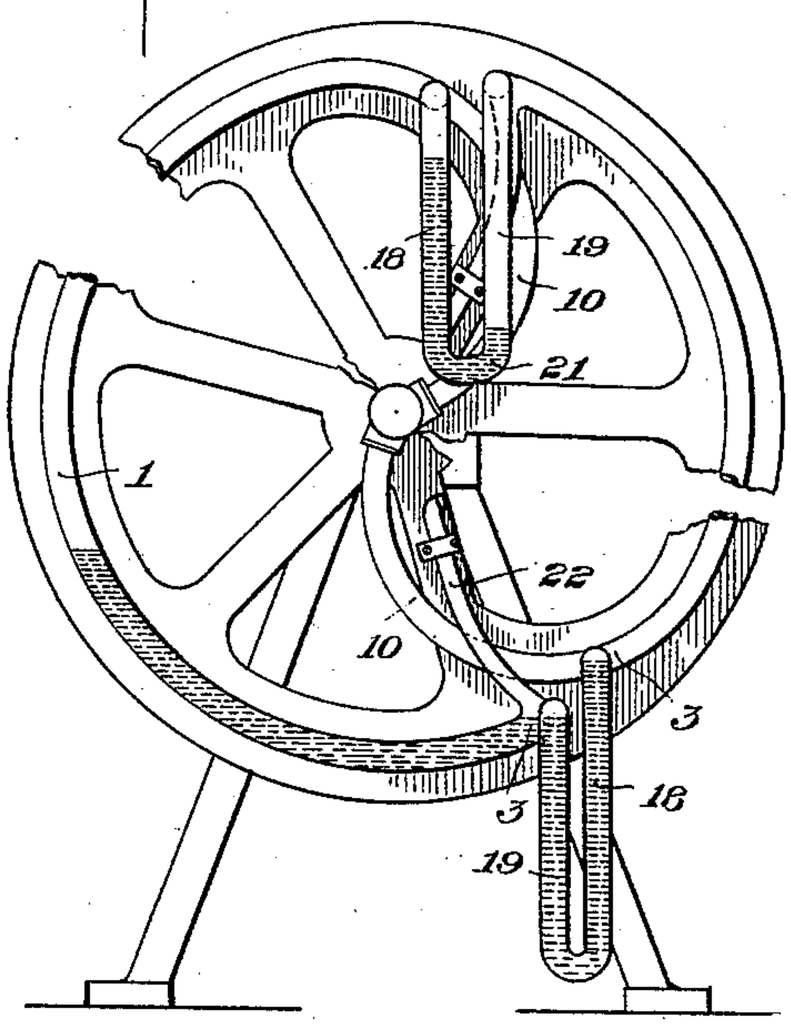




FIG. 9.



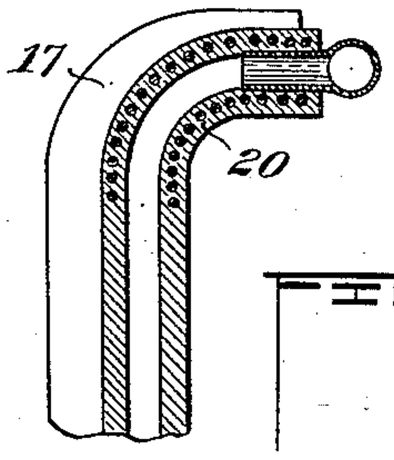
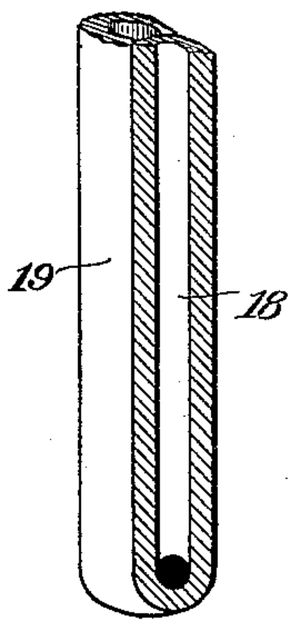




FIG. 10.

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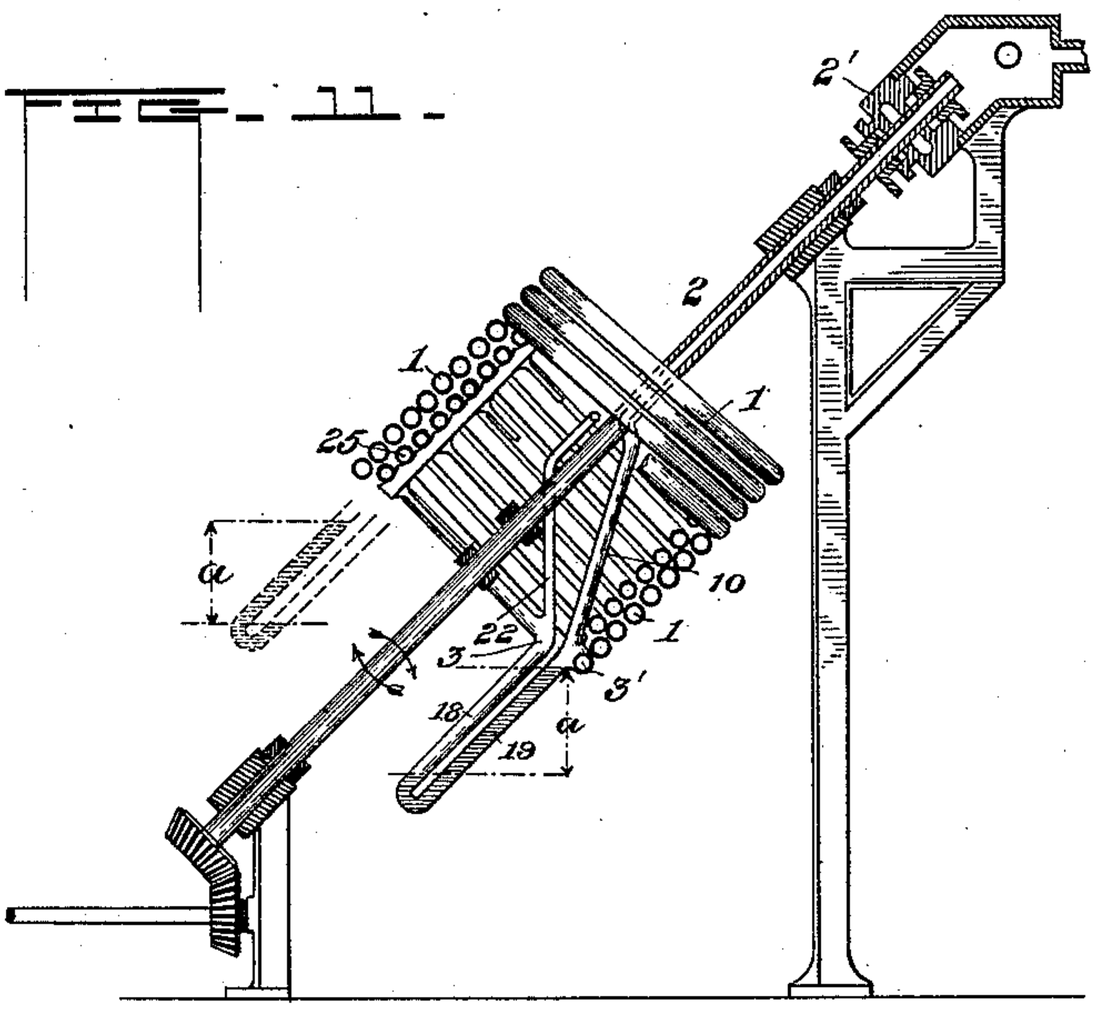



FIG. 12.

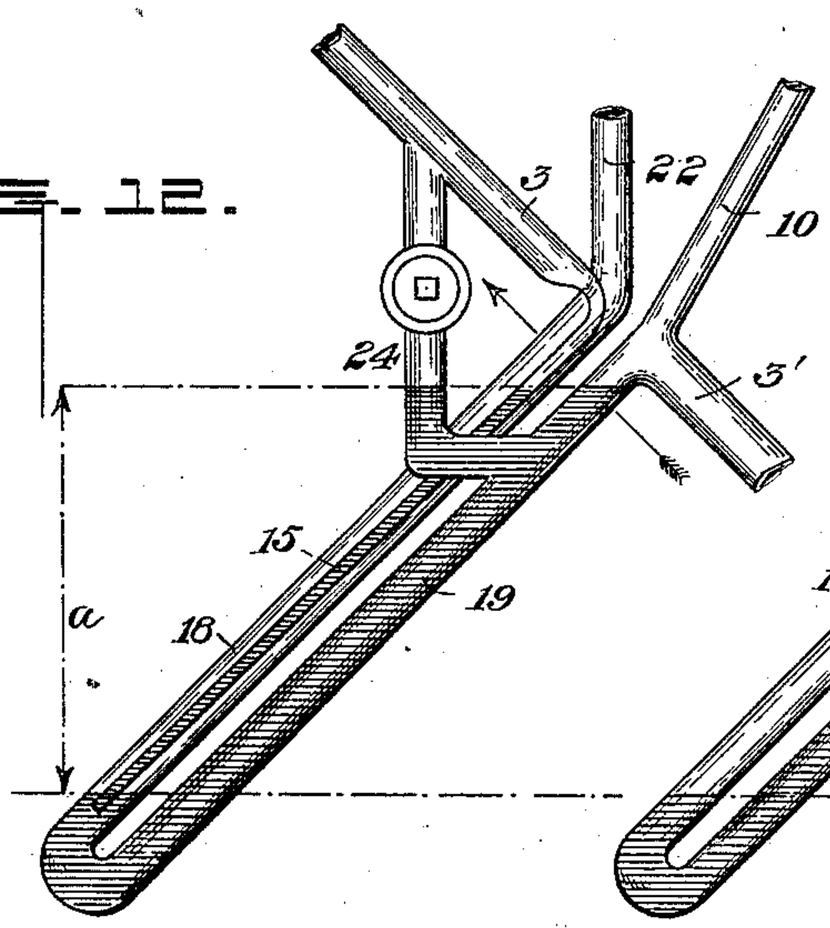
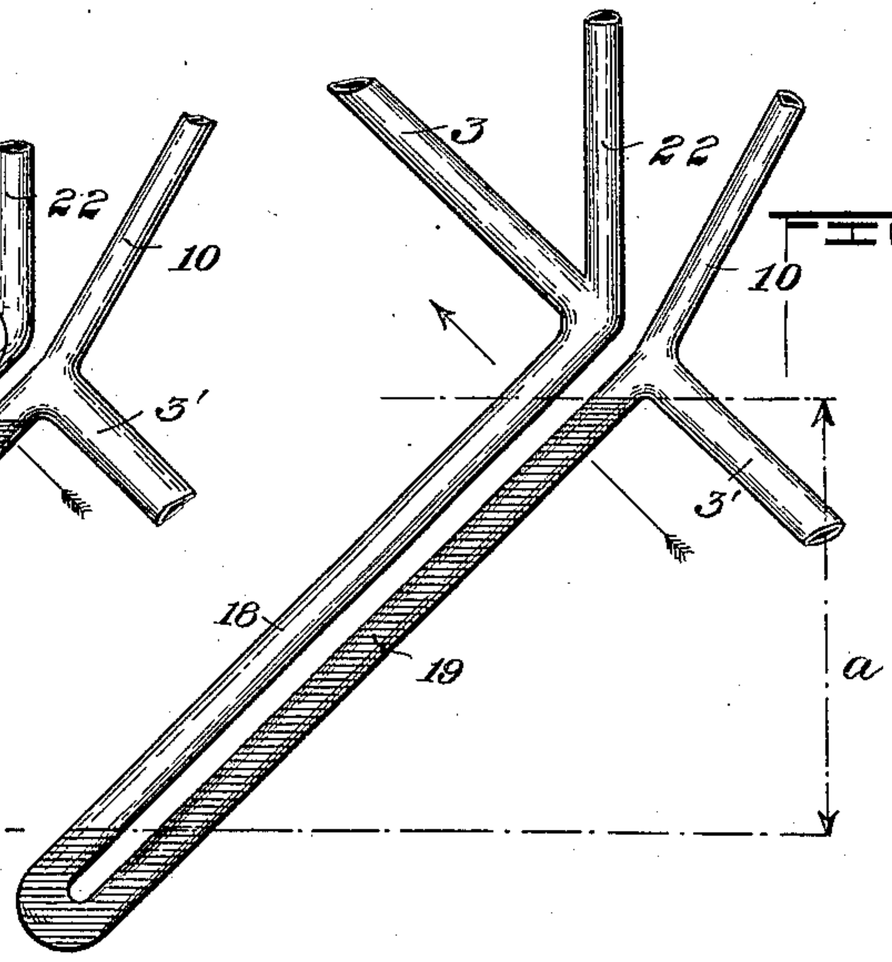



FIG. 13.

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# UNITED STATES PATENT OFFICE.

HERMANN SCHULZE-BERGE, OF ROCHESTER, PENNSYLVANIA, AND FRANZ G. A. SCHULZE-BERGE, OF BROOKLYN, NEW YORK.

## AIR-PUMP.

SPECIFICATION forming part of Letters Patent No. 428,638, dated May 27, 1890.

Application filed December 30, 1889. Serial No. 335,466. (No model.)

*To all whom it may concern:*

Be it known that we, HERMANN SCHULZE-BERGE, of Rochester, Pennsylvania, and FRANZ G. A. SCHULZE-BERGE, of Brooklyn, New York, citizens of the Empire of Germany, have invented a new and useful Improvement in Air-Pumps, of which the following is a specification.

Our invention consists in the combination of a rotary air-pump with a valve formed by a liquid seal, and is illustrated in the accompanying drawings, in which—

Figure 1 is a front elevation partly in section. Fig. 2 is a vertical section on the line II II of Fig. 1. Figs. 3 to 6 show in detail different parts of the apparatus. The figures on Sheet 2 illustrate a modification of the apparatus. Fig. 7 is an elevation thereof partly in section. Fig. 8 is a vertical section on the line VIII VIII of Fig. 7. Fig. 9 is an elevation similar to Fig. 7, showing the parts in two positions, each different from that illustrated in Fig. 7. Fig. 10 is an enlarged view of the pipes 18 19 and the flexible joints 17 and 20, the pipe 18 and joint 20 being shown in longitudinal section. The figures on Sheet 3 illustrate another modification of the apparatus. Fig. 11 is a side elevation partly in section. Figs. 12 and 13 show details of Fig. 11.

Like symbols of reference indicate like parts in each.

In Fig. 1 the annular tube 1 is the rotary vessel of the pump, mounted upon a frame and revoluble around the axle 2. The shape of the end 3 of this tube, as shown in Fig. 3, is somewhat contracted, bending first inwardly, then outwardly, and ending in the horizontal part 4. (Shown in Fig. 4.) This horizontal part is some inches long, and is vertical to the plane of the annular vessel 1. A block 5, of wood, hard rubber, or other suitable material, fastened to the frame of the pump, is illustrated in section in Fig. 4. The open space at 6 embraces the above-mentioned end of the tube 1. A channel 7 is bored into this block, ending in the short tubes 8 and 9. The other horizontal part 4 of the end of the annular tube 1 passes through the wall of this channel, as shown in Fig. 4, and ends concentrically with the opening of the tube 8. To the other end 3′ of the annular tube 1, Fig. 1, a tube 10 is attached. (Shown more particularly in Figs. 5 and 6.) The lower part of tube 10 is bent horizontally, as in Fig. 5, and in cross-section at 11 in Figs. 1 and 2. The upper part of tube 10 leads to a glass bulb 12, and through the opposite end of this bulb passes the tube 13, which terminates in an open end at 14. The other end of the tube 13 leads to the interior of the axle 2 of the pump, which axle is hollow and is closed at the front end, as shown in Fig. 2. The opposite end of the axle is open and is connected by an air-tight stuffing-box 2′ to a stationary horizontal tube, to which may be attached the vessel 4′ to be exhausted. A tube 15, Figs. 1 and 4, is connected by a flexible and air-tight joint 16 to the end 4 of the annular tube 1. A wider tube 18 is similarly connected by a flexible joint 17 to the tube 8, so that the tube 15 passes down in the interior of the tube 18. Another tube 19, Fig. 5, is connected by a flexible joint 20 to the horizontal end 11 of the tube 10. The lower ends of the tubes 18 and 19 are connected by a flexible tube 21, Fig. 1. The tube 15 is preferably made about as long as the direct distance between the ends 3 and 3′ of the tube 1 and the additional length of the height of a barometric column of mercury, while the tubes 18 and 19 are somewhat longer than the tube 15. A tube 22 forms a prolongation of the tube 9, Figs. 1 and 4, and is open at the upper end.

The flexible joints mentioned above may be formed by rubber tubes, the strength of which can be increased by wire spirals placed inside or embedded in the material of the tube. Any other flexible and air-tight material may, however, be employed instead of rubber.

When the interior of the apparatus is open to atmospheric pressure, a quantity of mercury is introduced, sufficient to fill the channel formed by the tubes 18, 21, and 19 and a certain part of the annular tube 1.

It will be readily understood how the device attached to the ends of the annular tube will act as a perfect air-valve, allowing the air exhausted to escape into the open atmos-

phere and preventing any return or regress of the same.

Let the open end of the axle be connected with a vessel 4′ to be exhausted, Fig. 2, and then let the apparatus be rotated in the direction of the arrow in Fig. 1. The mercury will proceed in the opposite direction in the tube 1, and when the end 3′ of the tube 1 is raised to a certain vertical height a partial vacuum there will be formed, and the air will expand from the vessel to be exhausted into the tube 1. At the same time the pressure of the air contained between the end 3 and the mercury-level 23 is increased and causes the mercury in the tube 15 to sink to the lower end of this tube, when the air will find its way into the tube 18, and will escape through the mercury of this tube to the tube 22, and thence to the open atmosphere. The pressure which is necessary to drive the air out of the lower end of the tube 15 must be counterbalanced by the column of mercury contained in the tube 1, and the sweep and width of this tube, as well as the quantity of mercury contained therein, must be selected suitably for the purpose. It may be remarked that less pressure is required to drive the air out of the tube 15, as described, if this tube be brought into an inclined position, as shown in dotted lines in Fig. 2, than when it keeps the vertical position. By further rotating the apparatus in the same direction the mercury will pass through the tubes 15, 18, 21, and 19 and begin a new turn of its circulation, by which means the air exhausted during the first turn will be removed through the tube 15 and another quantity of air will be drawn from the axle of the pump. During each revolution of the pump the valve itself undergoes a turning or dangling motion, since in the condition shown in Fig. 1 the tube 18 is at the left and the tube 19 at the right, while, as is easily understood, after half a revolution the tube 18 will be at the right and the tube 19 at the left. This motion goes on without difficulty on account of the flexibility of the joints 16, 17, and 20. Any mercury which might during the rotation of the apparatus run over from the tube 19 while the prolongation 10 of this tube is in a downwardly-inclined position will be gathered in the bulb 12, and will run back therefrom when the tube 10 approaches again its initial position. After each rotation of the pump the pressure of the vacuum in its interior has decreased a certain amount, and since at the same time the full pressure of the atmosphere acts upon the level of the mercury contained in the tube 18 this level will be depressed; but if the length of the tube 15 be properly chosen the said level can never reach the lower end of the tube 15, and then it is evident that outside air can never find its way through the liquid seal into the interior of the pump while the apparatus is working. The interior volume of the pump-vessel may be considerably increased if the tube 1 is not shaped as a simple ring, but as a spiral, consisting of a number of convolutions similar in circumference to the sweep of the ring.

The tubes of the apparatus described may be made of glass, iron, or any suitable material. The tube 15 must not be too wide in diameter; otherwise the mercury would not be able to press the air down through the tube; but the several tubes of this kind may be attached at the same time to the end 3 of the main tube in order to increase the speed of the flow of mercury through the valve.

By the valve, as described, both ends of the tube 1 are protected by a liquid seal against any access of outside air. In case the tube 15 be omitted, only the end 3′ of the tube 1 would be protected. Still with a suitably-chosen quantity of mercury the device would act as a practical valve, the air being pressed out of the end 3 of tube 1 directly to the atmosphere. This is represented in Figs. 7 to 10 on Sheet 2 of the drawings.

By reference to the operations of the air-pump described in Fig. 1, the working of the modification represented in Figs. 7 to 10 needs no further explanation.

The apparatus represented in Fig. 11, in which the rotary pump-vessel 1 has the shape of a double spiral coil mounted upon an inclined hollow axle 2 by means of a spider and ribs 25, is similar in operation to the apparatus shown in Fig. 1, but differs therefrom in the respect that the air-valve or vessel containing the liquid seal is rigidly connected with the pump-vessel. The axle 2, which makes connection with the vessel to be exhausted by the air-tight stuffing-box 2′, has an inclined position. The degree of inclination may vary, but is preferably about forty-five degrees. The same inclination is given to the vessel of the air-valve 18 19, so that the inclination of this vessel remains unaltered during the rotation of the apparatus, as indicated by the trap shown in dotted lines, and disconnected from the apparatus in Fig. 11. The length of the shanks of the valve must be in this case so much greater than in the apparatus represented in Fig. 1 that the vertical difference between the upper end and lower end of this tube resembles the whole length of the corresponding tubes in Fig. 1, and correspondingly surpasses the length of a barometric column of mercury, which is indicated by the vertical difference in the level marked *a*. In the same proportion the diameter of the sweep of the tube 1 must be increased comparatively with the diameter of the ring in Fig. 1. The air valve or trap is illustrated more particularly in Figs. 12 and 13.

Referring to Figs. 11 and 12, the tube 10 terminates in the hollow axle 2, while the tube 22 is open and leads to the atmosphere. This tube is made long enough to prevent any mercury from running out. A shunt-tube 24 is shown in Fig. 12, which may serve the purpose of increasing the speed of the flow of

mercury from the end 3 to the end 3′ of tube 1. While generally closed during the rotation of the apparatus, it can be opened when the air has been driven out by the liquid-piston through the tube 15 and closed again when the liquid-piston has passed through the shunt. This shunt may contain a stop-cock or a rubber tube adapted to be closed by a pinch-cock or some equivalent device.

In the valve represented in Fig. 13 the tube 15 and the shunt 24 are dispensed with. As a consequence of this the outside or atmospherical air has access to the end 3 of the tube 1, while access of the open atmosphere to the end 3′ of the tube 1, connecting with the vessel to be exhausted, (by means of the tube 10 and shaft 2,) is permanently prevented by the liquid in the trap and by the liquid-piston traveling in the spiral 1 in the opposite direction to the arrows, which indicate the rotation of the air-pump.

In Fig. 11 the air valve or trap is joined to the ends 3 and 3′ of the double spiral coil at the lower end of the coil—that is, in direction toward the driving-gear; but it is evident that such ends 3 and 3′ of the spiral coil can be located at the upper end of the coil toward the stuffing-box 2′. In the latter case the valve or air-trap may be located within the drum or space formed by the spiral coil around the shaft 2, thus decreasing the height of the apparatus.

If other liquids be employed instead of mercury in the apparatus described, the dimensions of the apparatus can be selected according to the specific gravity of the liquid used.

We claim—

1. The combination, with a rotary mercurial air-pump revoluble in bearings, of an air-valve consisting of a trap or vessel containing a liquid seal, substantially as and for the purposes described.

2. In a rotary air-pump, the combination, with a rotary curved tube, of a trap containing a liquid seal connecting the ends of the tube, a pipe 15, extending from one end of the tube into said trap, and an exhaust opening or pipe 22, leading to the atmosphere, the other end of the tube being adapted to be connected with the vessel to be exhausted, substantially as and for the purposes described.

3. The combination, with a rotary mercurial air-pump formed of a circular or spiral tubular vessel revoluble in bearings, of an air-valve consisting of a trap containing a liquid seal, said vessel being normal to its axis of rotation, substantially as and for the purposes described.

4. In a rotary air-pump, the combination of a tubular vessel containing a liquid-piston with an inclined axle or shaft revoluble in stationary bearings and an air-valve consisting of a trap containing a liquid seal and connecting the ends of the tubular vessel, substantially as and for the purposes described.

In testimony that we claim the foregoing as our invention we have signed our names, in presence of two witnesses, this 2d day of September, 1889.

HERMANN SCHULZE-BERGE.
FRANZ G. A. SCHULZE-BERGE.

Witnesses:
WM. SWANSBORO,
JOSEPH WATERS.