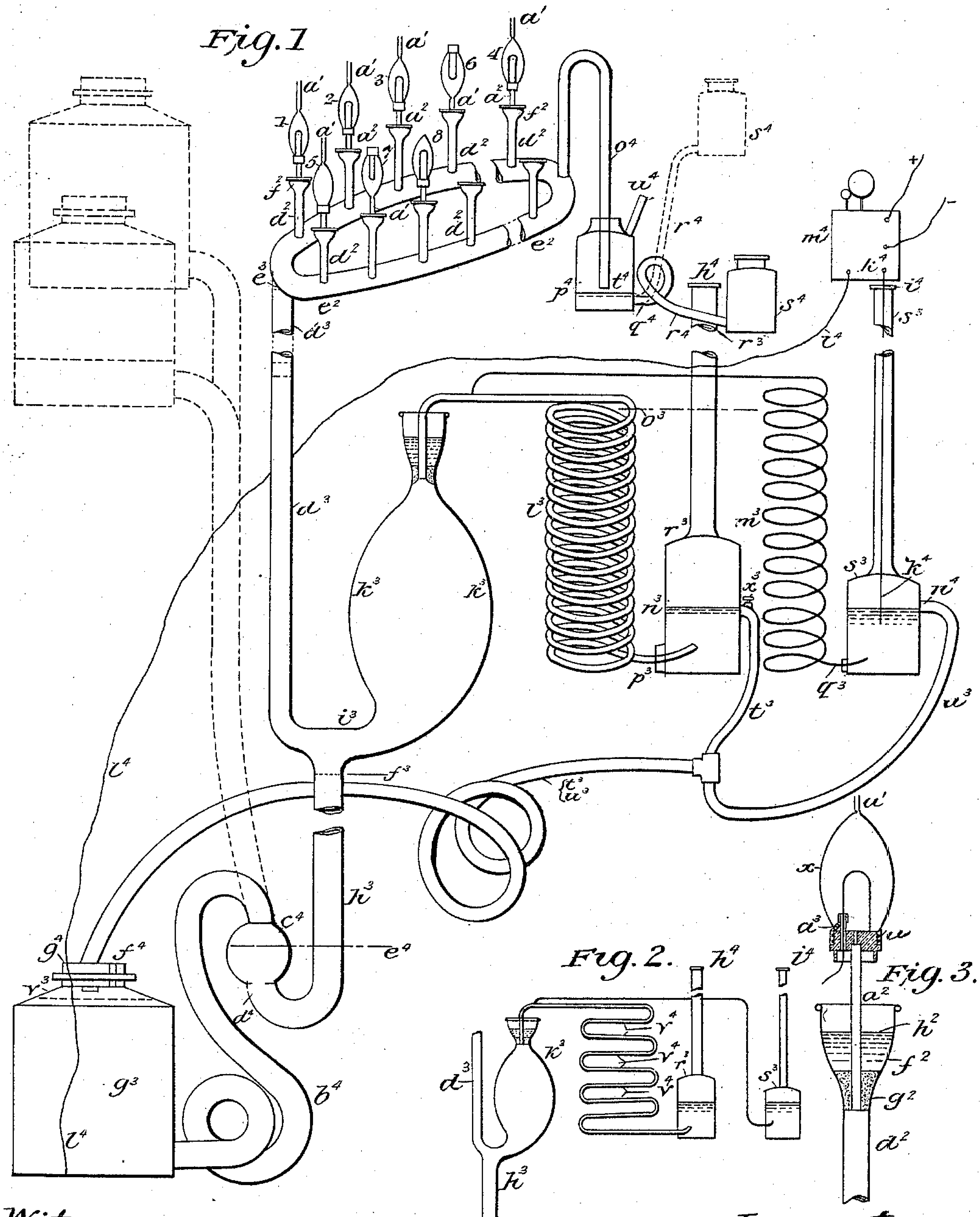
(No Model.)

J. W. T. OLÁN.

GAS EXHAUSTING APPARATUS.

No. 585,831. Patented July 6, 1897.



Witnesses.

Chas. H. Baker.

R. A. Balderson.

Inventor.

Johan W. Th. Olán

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JOHAN W. TH. OLÁN, OF NEW YORK, N. Y.

GAS-EXHAUSTING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 585,831, dated July 6, 1897.

Original application filed March 13, 1893, Serial No. 465,761. Divided and this application filed June 5, 1897. Serial No. 639,573. (No model.)

To all whom it may concern:

Be it known that I, JOHAN W. TH. OLÁN, a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Gas-Exhausting Apparatus, of which the following is a specification.

My invention relates to certain new and useful improvements in exhausting apparatus, and is designed particularly for use in connection with the exhausting of the bulbs of incandescent electric lamps.

The invention was originally described and claimed in my pending application for patent in United States, filed March 13, 1893, Serial No. 465,761, for improvements in the manufacture of incandescent lamps, and the present application is a divisional one of the former, in view of the Commissioner's decision as gazetted May 4, 1897. Special attention is therefore called to the following abstract of said decision: "If a divisional application covering the exhausting apparatus is filed, it will be at once taken up for consideration. As the claims therefore have already been passed upon favorably by the Commissioner, they will be allowed at once, unless some reason not disclosed by the record should appear."

In the accompanying drawings, Figure 1 represents a perspective view of apparatus embodying my invention. Fig. 2 represents a modified form thereof. Fig. 3 represents, on a larger scale and in section, my preferred means for hermetically connecting the lamp-bulbs to the exhausting apparatus.

Similar letters and figures of reference indicate similar parts throughout the several views.

Referring to the drawings, e^2 indicates a tubular metal ring carrying a series of nipples d^2, to which the lamps 1, 2, 3, 4, 5, 6, &c., are adapted to be attached. The tubes or nipples d^2 are preferably of metal and are secured to the ring e^2 by soldering or the like, each one being provided at its top with a widened opening f^2, into which a tube a^2, communicating with the lamp-bulb, extends and passes through the rubber packing g^2, which is pressed down firmly into the widened neck of the tube or nipple, whereupon a body of mercury h^2 or other suitable liquid is placed within the widened end f^2, so as to exclude the air from the joint and complete the hermetic seal.

The tube d^3 communicates with the hollow interior of the tube e^2 at the point e^3, and at its lower end communicates with the lower end of a vacuum chamber or receptacle k^3 by means of a cross connection i^3. The height of the tube d^3 from a point indicated by the line f^3 upward is twice as great as the highest barometric column of the liquid employed in the apparatus and contained in the vessel g^3. When said liquid is mercury, which I prefer to use, the height of the tube d^3 between the line f^3 and the point of connection e^3 is about 1.9 meters—*i. e.*, nearly two meters. When, however, another liquid is used—for instance, a heavy oil or other suitable fluid—the height of the tube d^3 must be altered correspondingly.

The vessel k^3 is made of thick glass, iron, or other strong material and is suitably fixed and protected. The containing volume of the vessel may vary at convenience, but is preferably not less than ten times and not more than one hundred times the combined volumes of the interiors of the tube d^3, the ring e^2, and all of the lamps which are to be exhausted by means of the apparatus. The vessel k^3 communicates at its extreme upper end with the two spiral tubes l^3 and m^3. The vertical height of each of said spirals between the lines n^3 and o^3 is somewhat greater than the height of a barometric column of the liquid used in the apparatus—that is to say, about one meter when mercury is used. The lower ends of said spiral tubes enter through hermetic seals p^3 and q^3 into the vessels r^3 and s^3, respectively, said vessels being provided with upper prolonged necks which rise to a level with the point e^3 and above the upper ends of the spiral tubes l^3 and m^3.

Two flexible tubes of strong rubber or other suitable material—as, for instance, the branch tubes t^3 and u^3 and the vessels r^3 and s^3—communicate with the upper air-space v^3 above the mercury in the vessel g^3. The outlet from the vessel r^3 is provided with an air-tight stop-cock x^3. The vessel g^3 is larger in volume than the combined volumes of the tube b^4, which connects the lower end of said vessel with the vessel c^4, the tube h^3, the conduit i^3, the vessel k^3, the spirals l^3 and m^3, &c., so that said vessel g^3 without being filled may contain fully as much liquid as could be contained in all the remaining parts of the apparatus in communication therewith up to the point e^3. When the liquid employed in the vessel g^3 is mercury, a layer of oil is put in on top thereof. Through the strong flexible rubber tube b^4 the vessel g^3 communicates from its bottom with the widened space or vessel c^4 of the tube h^3, which is curved at its lower end. The space c^4 must be able to contain more liquid than the tube h^3 itself from the line f^3 to its lower end—that is, to the line d^4. The length of the tube h^3 from the line f^3 to e^4 must correspond to and be equal to one barometric column of the liquid used in the apparatus, c^4 being thus a barometric well. All of the tubes and connections, as well as the stop-cock x^3, must be sufficiently strong to withstand safely the pressure of somewhat more than two atmospheres.

Through a hole f^4 in the stopper g^4 the external air has free admittance to the interior of the vessel g^3. The air has also free admittance to the vessels r^3 and s^3 through the necks h^4 and i^4, respectively. When a conducting liquid—such, for instance, as mercury—is used in the apparatus, two metal wires k^4 and l^4, which, if connected, will complete the electric circuit of the electric bell m^4 and cause it to ring, are introduced in connection, the one, k^4, with the conducting liquid of the vessel s^3, and the other, l^4, with the conducting liquid of the vessel g^3, said wire l^4 extending down to the bottom of g^3, inasmuch as the liquid in said vessel will vary as to level. The liquid in the vessel s^3 will likewise vary as to its level, but will never be lower than the outlet n^4 into the tube u^3, for which reason the wire k^4 need only to extend below said outlet.

A tube o^4 is hermetically sealed to the ring e^2 and is somewhat longer than a barometric column of mercury. Its lower end enters hermetically into the vessel p^4 and extends downwardly therein to a point just above where the vessel p^4 has an outlet q^4, from which a tube r^4 communicates with another vessel s^4, which can be raised and lowered as desired. The vessel s^4 contains a sufficient quantity of mercury to fill the tube o^4, and in addition to this about half of the vessel p^4 or so much thereof as to securely seal the opening t^4 of the said tube o^4. It will of course be understood that any suitable means may be employed for raising and lowering the vessel g^3 at will.

When the lamps to be exhausted are put in place and hermetically sealed upon the tubes or nipples d^2, the vessel g^3 is lifted to its highest position, (indicated in dotted lines,) in order to bring the upper level of the mercury contained therein on a level with o^3. Consequently the mercury in tube d^3 will rise to the same height. The mercury will also thereby fill the vessel k^3, and consequently the air contained in said vessel will be driven out through the spirals until when all the air is driven out mercury alone will run through said spirals and will fill the vessels r^3 and s^3. When the level of the mercury in the vessels r^3 and s^3 has reached the same level of e^3 or that of the mercury in the vessel g^3, the fall of mercury will of course stop, as the respective columns of mercury are then balanced. The height of the vessel s^4 is thereupon so altered that mercury will run into the vessel p^4, so as to close the opening of the tube q^4 thereof, but not the opening of the tube o^4. Dry hydrogen gas or nitrogen gas is thereupon introduced through the tube u^4 and will enter the ring e^2 and the lamps through the tube o^4 and drive out all the air. The lamp-filaments may thereupon be heated by an electric current during the uninterrupted flow of the hydrogen or nitrogen until the hydrogen or nitrogen alone is contained in the ring e^2 and the lamp-globes. The tubes a', which open freely into the atmosphere at the upper ends of the bulbs, are thereupon fused and pressed together, so as to shut off all admission of air to the interior of the apparatus through said tubes, and when this has been effected the vessel s^4 is then lifted still higher, so as to cause a quantity of mercury to run into the vessel p^4 sufficient to close the opening t^4 of the tube o^4. The vessel g^3 is thereupon again lowered to its lowest position. (Shown in Fig. 1.) The mercury will thereupon run back into the vessel g^3 through the tubes t^3 and u^3 until it reaches the level of the outlet-tubes of the vessels r^3 and s^3, respectively. The mercury in the vessel k^3 will run back through the conduit i^3 and tubes h^3 and b^4 into the vessel g^3 until the vessel k^3 is emptied. Inasmuch as barometric seals are thereby formed by the spirals l^3 and m^3, as well as by the tubes o^4 and h^3, no air can in any way gain access to the vessel k^3; but the nitrogen or hydrogen gas which is contained in the lamp-bulbs to be exhausted and in the ring e^2 will, inasmuch as the mercury from the tube d^3 has run down into the tube h^3, at once expand and occupy not only the lamp-bulbs and ring e^2, but the tube d^3, the conduit i^3, and the vessel k^3. Supposing now the vessel k^3 has a volume ninety-nine times as great as the conduit i^3, tube b^3, ring e^2, and the bulbs to be exhausted, then ninety-nine parts of the gas from said portions of the apparatus will enter the vessel k^3 and only one part will remain in the said conduit-ring and bulbs. Therefore when the vessel g^3 is again raised to a height which brings its mercury-level a little above the spirals, said ninety-nine parts of the gas will thereupon, as hereinbefore described with reference to the air, be driven out through the spirals and only the one part will remain. It is therefore evident that for each such manipulation of the vessel g^3 up and down in the manner described the apparatus will exhaust from the lamp-bulbs and the ring e^2 ninety-nine one-hundredths of what remains of the gas at the beginning of each manipulation, leaving only one one-hundredth behind. Thus if the first manipulation, when the air was driven out from the vessel k^3, be not considered the remaining quantity of gas in the bulbs and ring e^2 after the first effective manipulation of the vessel g^3 in the manner described will be one one-hundredth of the original quantity of gas. After the second manipulation the residue will be one one-hundredth of what remained after the first manipulation, or one ten-thousandth of the original quantity of gas, and so on until, after the tenth manipulation, the residual gas in the bulbs and ring e^2 will be one-quintillionth of said original quantity. The same result will be obtained after twenty such manipulations should the vessel k^3 be only nine times the volume of that of the ring e^2 and the lamp-bulbs together. It is of course evident that the bulbs exhausted to such a degree can be regarded for all practical purposes as inclosing an absolute vacuum, and even speaking theoretically the remaining gas can scarcely be considered as a quantity, but rather as a result of mathematical calculation. The following considerations will serve to shown that the said degree of exhaustion is practically a perfect vacuum. Suppose, for instance, a carbon filament of one-twentieth of one square millimeter in section and of a length of one hundred millimeters to be inclosed in a lamp-bulb containing originally one liter of pure oxygen gas which had been thereafter exhausted to the aforesaid degree. Thereafter if all of the remaining oxygen gas were to attack said filament along a portion equal to one-tenth of its length and by renewed decomposition and oxidation afresh once every second it would still take more than nine hundred and seventy million years for the remaining trace of oxygen gas to consume but one-third of the filament at said section thereof. No further demonstration is necessary to show that both practically and theoretically the vacuum produced by my apparatus can, humanly speaking, be regarded as an absolute one.

I use the spirals l^3 and m^3 in order to secure a speedy and easy removal of the gas from the vessel k^3. The spiral form permits the use of a wider conduit than a straight vertical tube. If such a vertical tube were used of desirable width, the mercury running out from the vessel k^3 would have a tendency to run through the gas instead of forcing it out, which would retard the operation; but in the spiral tube the gas will, so to speak, be expelled ahead of the mercury. When, however, only small quanties of gas are to be exhausted, the spiral tube may be replaced by a conveniently narrow vertical tube. Especially may this be the case in reference to the spiral m^3, whose bore is meant to be very fine. When the gas-exit from the vessel k^3 does not require to be too wide, I may also employ a tube of zigzag form, as shown in Fig. 2, to replace the spiral e^3. The gas will be removed through said tube under the same favorable conditions as in the spiral, except at the relatively short bends. The rush of the mercury, when it has filled from above a portion of the zigzag tube in question, will, however, readily enough break up the quantities of gas which have a tendency to stop at the bends, so as to make them pass into the parts v^4 of the tubes between the bends, and thereby the bends will present no serious obstacle to the removal of the gas through the zigzag tube.

The spiral tubes and the zigzag tubes are of course conveniently supported upon some suitable base or frame, especially when made of glass, so that they may be able to withstand the weight and force of the mercury when running through from above when the vessel g^3 is elevated, as well as the weight of the barometric column of mercury arising thereon from below or remaining thereon when after one expulsion of gas from the vessel k^3 the vessel g^3 is again lowered. I preferably make use of the wider spiral l^3 at the beginning of the exhausting process, but when toward the end of the process the remaining quantity of gas becomes very small I close the outlet-cock x^3 of the vessel r^3, when, after having raised the vessel g^3, the level of the mercury in r^3 stands higher than the top of the spiral l^3. Thereafter the gas from the vessel k^3 will be driven out only through the spiral m^3, which must always be made of glass or insulating material when the bell m^4 is used in connection with the apparatus. Every time that all of the gas, in consequence of a manipulation of the vessel g^3, has been driven out of said spiral, the bell m^4 will begin to ring, inasmuch as metallic connection between the wires k^4 and l^4 will be complete, since no quantity of gas causes interruption of the mercury column within the spiral. When the bell has rung, I therefore need not await the rising of the mercury in the vessel s^3. The manipulations of the vessel g^3 can be speedily continued and the exhaustion process finished. It need scarcely be said that instead of the bell m^4 any electromagnetic device—for instance, a needle or pointer or other annunciator energized by the current produced in k^4 and l^4—can be used. As the entire apparatus works absolutely, the degree of exhaustion will be known from the size of the vessels k^3 and g^3 compared to the volume of the ring e^2 and the bulbs to be exhausted and from the number of manipulations of the vessel g^3. When the vacuum in the bulbs, after the necessary number of manipulations with the vessel g^3, has been made practically absolute, as before demonstrated, the bulbs are sealed and finished by directing a small blowpipe-flame against the tubes a^2 and cautiously fusing the walls of said tubes together. The bulbs are thereupon detached from the exhausting apparatus, and the ends of the tubes a' and a^2, beyond the points where they have been fused or soldered together, are removed, whereupon the lamps are ready to receive their outside fixtures.

One very important feature of my invention consists in the fact that the liquid mercury employed in the apparatus is completely inclosed during its circulation, passing from the vessel g^3 through the tubes b^4 and h^3, conduit i^3, vessel k^3, and spirals l^3 and m^3 to vessels r^3 and s^3, and from said vessels through the tubes t^3 and u^3 back to the vessel g^3, whereby the supply of mercury in the vessel g^3 is furnished anew at the same rate at which it has previously been given out. Moreover, as the outside air communicates with the interior of the apparatus only at the narrow openings in the vessels r^3, s^3, and g^3, the mercury cannot in any substantial degree poison the atmosphere of the room where the process is being conducted, and the health of the operator carrying on the process will not be in danger.

Having thus described my invention, what I claim is—

1. The combination with the vacuum-chamber, of a tube communicating with the base of said chamber and leading to the lamps to be exhausted, a tube likewise communicating with said base, said tube being bent at its lower end and widened to form a barometric well, and being of a length sufficient to contain a barometric column of the liquid employed, and a liquid-receptacle open at the top and connected to the bent-up end of the tube; substantially as described.

2. The combination with the vacuum-chamber, of a liquid-reservoir, a barometric tube and well leading from the base of the vacuum-chamber, and opening into the base of the reservoir, a second barometric column and well leading from the top of the vacuum-chamber, and a return-conduit leading from the second well to the top of the reservoir.

3. An exhausting apparatus, having an air-outlet port provided with a barometric seal, said seal being contained within a vessel of a height sufficient to contain a barometric column of the liquid employed.

4. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, and a spiral tube leading from the top of the vacuum-chamber and having a liquid barometric seal at its end; substantially as described.

5. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, a tube leading from the top of the vacuum-chamber and having a barometric liquid seal at its end, and a return-conduit from said barometric liquid seal said return-conduit leading into the top of said liquid-receptacle into an air-space above the mercury-level therein; substantially as described.

6. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, and a tube of gradual descent leading from the top of the vacuum-chamber and having a barometric liquid seal at its end; substantially as described.

7. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, a tube leading from the top of the vacuum-chamber and having a barometric liquid seal at its end, and an additional tube of smaller size also communicating with the top of the vacuum-chamber and having a barometric liquid seal at its end; substantially as described.

8. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, a tube leading from the top of the vacuum-chamber and having a barometric liquid seal at its end, and an additional tube of smaller size also communicating with the top of the vacuum-chamber and having a barometric liquid seal at its end, and return-conduits from both of said barometric seals to the liquid-receptacle; substantially as described.

9. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, a tube leading from the top of the vacuum-chamber and having a barometric liquid seal at its end, and an additional tube of smaller size also communicating with the top of the vacuum-chamber and having a barometric liquid seal at its end both of said liquid barometric seal tubes being of gradual descent; substantially as described.

10. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, and a tube of gradual descent leading from the top of the vacuum-chamber and having a barometric liquid seal at its end, and an additional tube of smaller size also communicating with the top of the vacuum-chamber and having a barometric seal at its end, both of said liquid barometric seal tubes being spiral; substantially as described.

11. The combination with the vacuum-chamber, of a liquid-receptacle communicating with its base, a tube likewise communicating with said base and leading to the lamps to be exhausted, a tube leading from the top of the vacuum-chamber and having a liquid barometric seal at its end, and an electric

annunciator one of whose terminals is connected with the liquid in the seal and the other with the liquid in the said receptacle; substantially as described.

12. The combination with the exhausting apparatus for a group of lamps, of a tube for supplying gas to drive out the air from the lamp-bulbs prior to the exhausting operation, a well into which said tube extends and a liquid-supply receptacle communicating with said well whereby said tube may be barometrically sealed after the gas has been admitted; substantially as described.

13. The combination with the exhausting apparatus for a group of lamps, of a tube for supplying gas to drive out the air from the lamp-bulbs prior to the exhausting operation, a well into which said tube extends and an upwardly and downwardly movable liquid-supply receptacle communicating with the bottom of said well whereby on raising the supply-receptacle the tube will be barometrically sealed and on lowering it the tube will be unsealed; substantially as described.

14. In an exhausting apparatus the combination of a vessel g^3 adapted to be moved up and down and hermetically communicating from its bottom with a flexible tube b^4, said tube b^4 hermetically communicating from above with a chamber c^4 of a tube h^3, the length of which between lines f^3 and e^4 as shown, corresponds to a barometer-column of a liquid used in the apparatus, h^3 communicating hermetically through a tube d^3 with one or more lamp-globes to be evacuated as well as with the lowest portion of a vessel k^3, said vessel k^3 hermetically communicating from its top with vessels r^3 and s^3 and said vessels r^3 and s^3 communicating through outlets, as shown, and tubing t^3 and u^3 with the air-space v^3 of vessel g^3, substantially as described.

Signed at Washington, in the District of Columbia, this 5th day of June, A. D. 1897.

JOHAN W. TH. OLÁN.

Witnesses:

H. D. GORDON,

F. R. GORDON.