F. L. O. WADSWORTH.

APPARATUS FOR EXHAUSTING INCANDESCENT LAMPS.

APPLICATION FILED MAR. 17, 1906.

945,823.

Patented Jan. 11, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

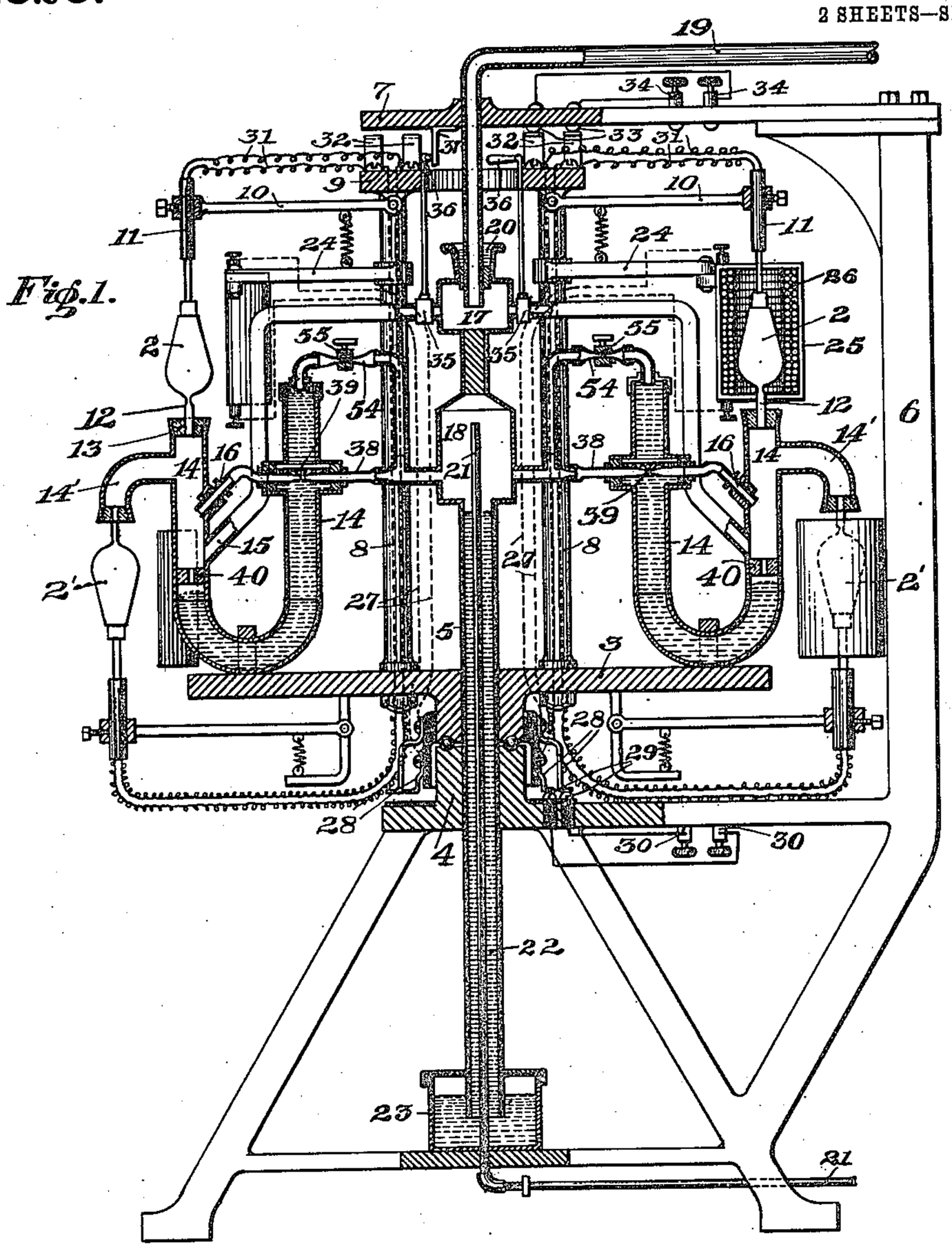
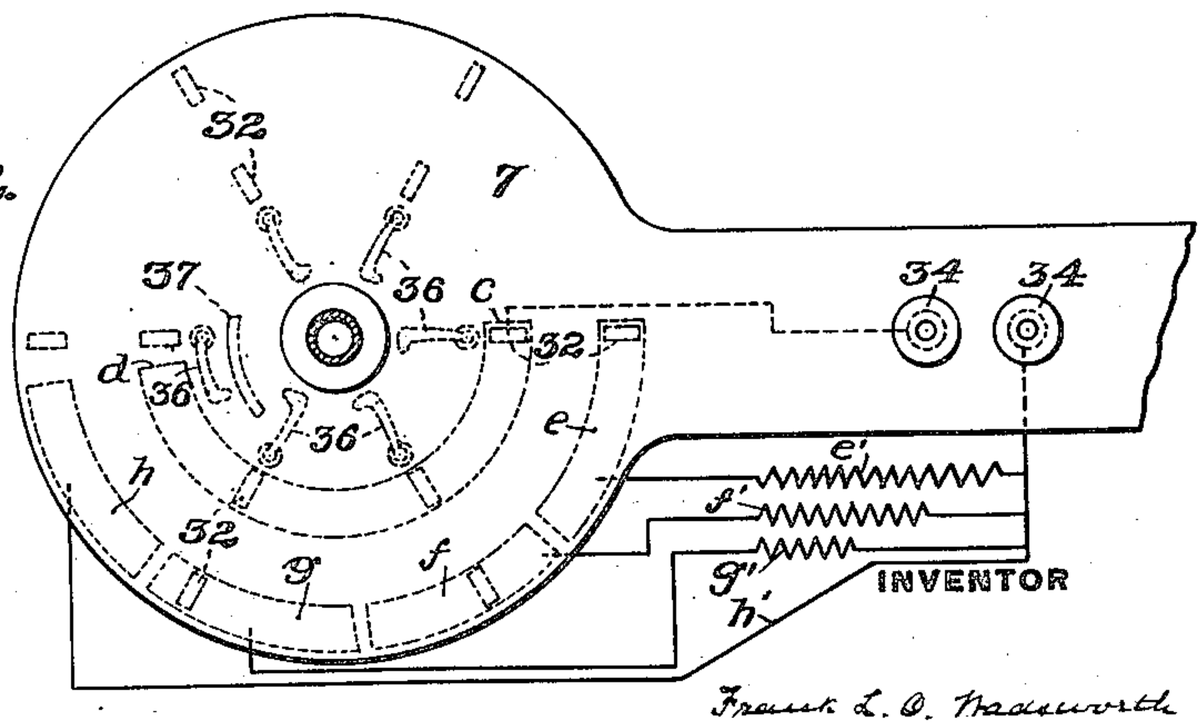


Fig. 2.



WITNESSES

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2 SHEETS—SHEET 2.

Fig. 3.

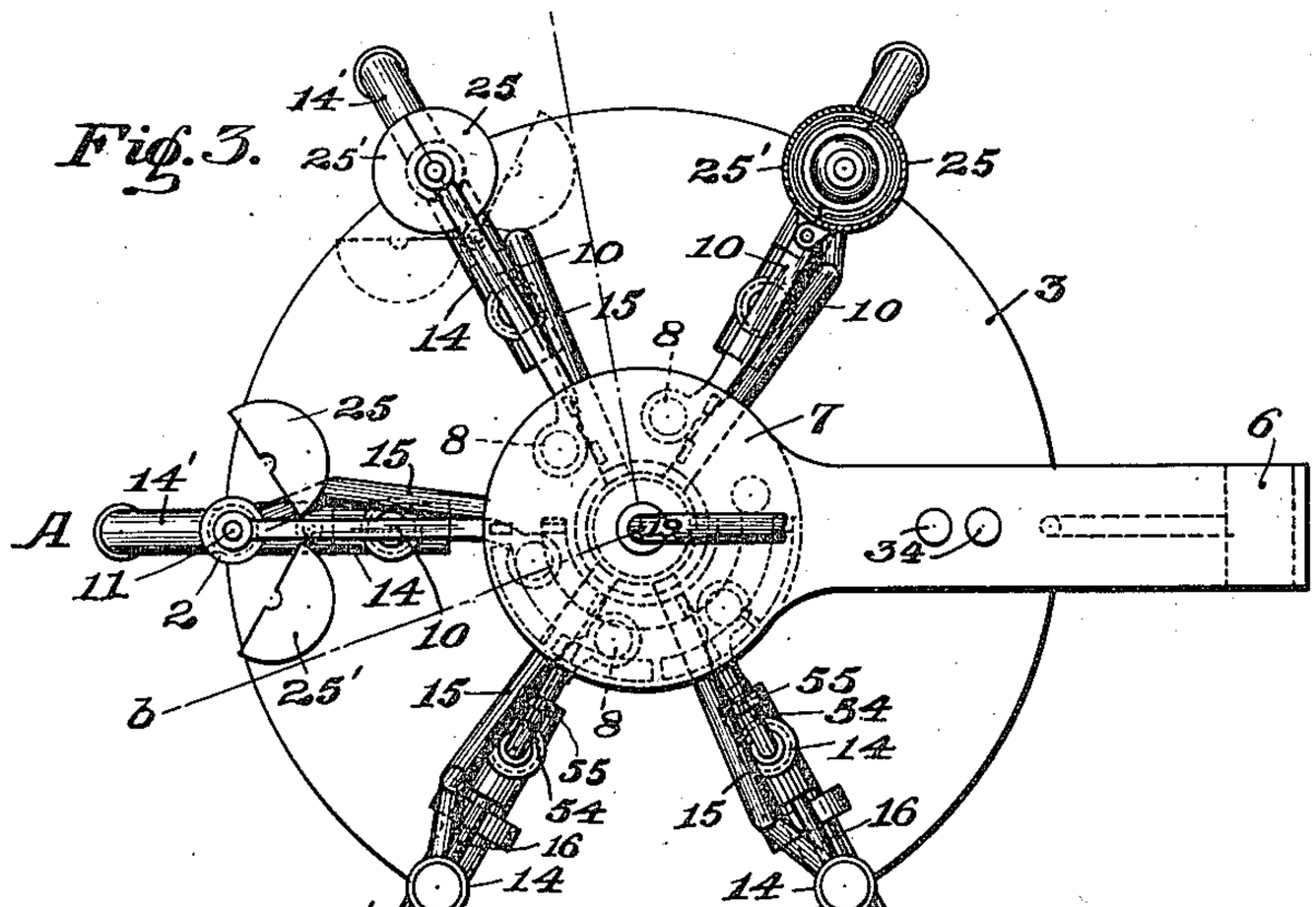


Fig. 4.

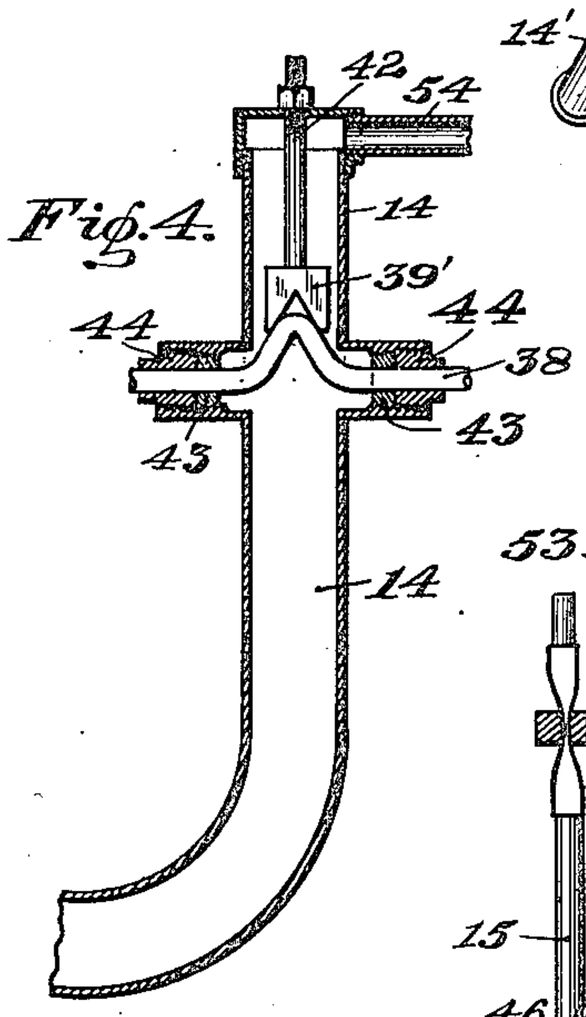


Fig. 5.

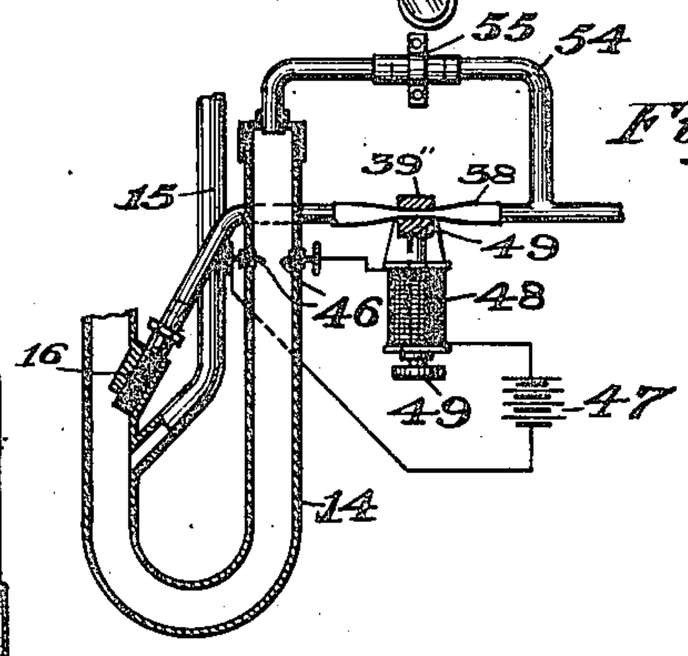
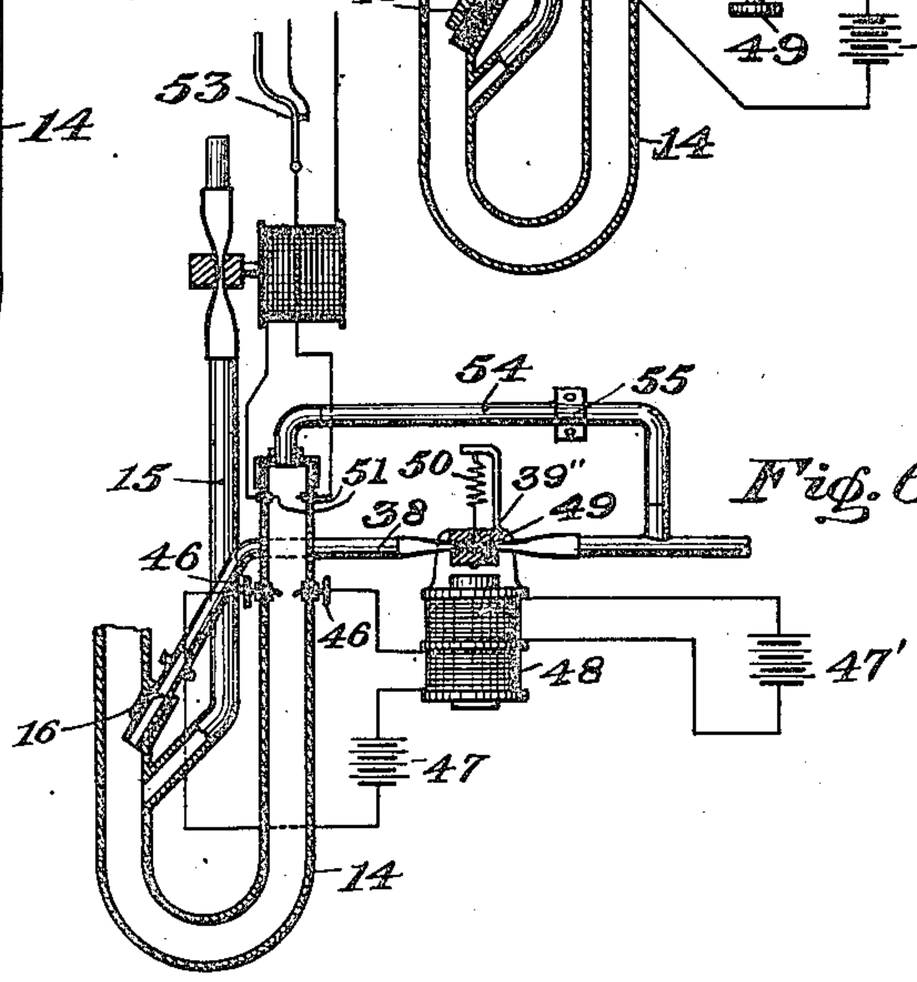


Fig. 6.



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APPARATUS FOR EXHAUSTING INCANDESCENT LAMPS.

945,823. Specification of Letters Patent. Patented Jan. 11, 1910.

Application filed March 17, 1906. Serial No. 306,579.

To all whom it may concern:

Be it known that I, FRANK L. O. WADSWORTH, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a certain new and useful Improvement in Apparatus for Exhausting Incandescent Lamps, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a vertical cross section through the center of the apparatus; Fig. 2 is a plan view of the top plate thereof; Fig. 3 is a plan view of the apparatus as a whole; Figs. 4, 5 and 6 are sectional elevations showing modifications.

The general object and purpose of my invention is to increase the rapidity and convenience of the operation of exhausting incandescent lamp bulbs.

A further object is to provide apparatus by means of which the successive operations are performed automatically.

In the drawing 2 represents the lamp bulbs being exhausted; 3 represents the table or support on which the lamp bulbs and the pump connections leading therefrom are mounted; 4 is the stand which supports the table 3 and on which the table is arranged to rotate about the central hollow axis or column 5. This stand 4 has on one side a vertical column 6 which supports a top table 7, which is shown in detail in Fig. 2, the purpose of which will hereafter be specifically described.

On the table 3 are mounted a number of hollow posts 8, 8, joined at the top by a ring 9 and carrying each a pivotally supported arm 10, 10, at the outer end of which are short vertically adjustable stems 11, 11, which serve as supports for the leading-in wires of the bulbs 2, 2. These bulbs are provided with the usual tubulature 12, 12, which are inserted in rubber corks 13 in one end of U-tubes 14, 14, supported on and rotating with the table 3. These U-tubes are provided, just below the connection with the lamp tubulatures, with two branched tubes 15, 16, one leading to a central pump chamber 17, at the top of the hollow vertical column 5, and the other leading to a second central pump chamber 18 which forms part of the central opening of the hollow vertical column 5. The two branches of the U-tube are partially filled with mercury or some liquid of high specific gravity, and, in the form shown in Fig. 1, the branch tube 16 passes through the arm of the U-tube remote from the lamp connection, this part of the tube being formed of a length of tubing 38, of rubber or other collapsible material, one side of which rests against a knob or projection 39 on a bar extending from side to side of the U-tube just above the rubber tube 38. In some convenient point of the U-tube may be inserted a diaphragm 40 with a narrow central opening which serves as a check or choke valve to prevent the too rapid passage of the mercury or other fluid from one branch of the U-tube to the other.

From the pump chamber 17 connection is made to a large pump, of the type usually used for preliminary exhaustion of lamp bulbs, through a tube 19 which passes through, and rotates in an air tight mercury or equivalent packing joint 20 at the top of the pump chamber 17. Near the point of union between these tubes and the central pump chamber are valves 35, 35, the stems of which pass upward and are supported by the ring 9 and terminate in handles 36, 36. These valves are normally held open by the action of suitably arranged springs but may be closed in certain positions of the table by cam or cams 37 arranged on the lower side of the top table 7 of the apparatus. A second tube 21 passes up through the bottom of the hollow axis 5 into the pump chamber 18 and serves to connect this chamber with a second pump of construction capable of giving a much higher degree of exhaustion than the first pump which is connected to the tube 19. This pump chamber 18 and the tube 21 leading into it are sealed by a mercury valve of the usual construction consisting of a barometric column of mercury 22 communicating with the mercury cistern 23 into which the lower end of the hollow column 5 dips and through the bottom of which the tube 21 passes to the corresponding pump. This system of connections enables the entire table with its U-tubes and lamp supports to be rotated easily about the fixed connections leading to the pumps without any danger of leakage at the rotating joints, the mercury valve forming in particular a most perfect vacuum joint known, and being at the same time one that can be most readily and easily opened

for the purpose of cleaning or repair. On each of the vertical posts 8 is mounted a second arm 24 which serves to support at its outer end a box 25, which is constructed in two parts 25, 25′ and arranged to close around the lamp bulbs 2. On the inside of each half of the box are arranged heating coils 26, suitably mounted on asbestos, or other suitable material, and adapted to raise the temperature in the interior of the box surrounding the lamp bulb to any required degree. The current for this purpose is introduced into the box by wires 27, the circuit of which is closed and opened by the closing and opening of the box, which wires lead to brushes 28, 28, mounted on the hub of the table 3 and contacting with fixed collecting rings 29, 29, on the opposing face of the stand 4. These collecting rings 29, 29, are connected with binding posts 30, 30, which are in turn connected to any suitable electric circuit. The leading-in wires of the lamps 2 are similarly connected by wires 31, 31, to pairs of brushes 32, 32, mounted on the ring 9 and contacting with collecting rings 33, 33, fixed on the lower face of the top table 7 and connecting through suitable resistances with binding posts 34, 34, on the same table. Neither of the collecting rings 29, 29, or 33, 33, are continuous, but are interrupted at suitable intervals; thus the connecting rings 29, 29, extend through about three-quarters of a complete circle over an interval between the positions represented by the dotted lines a^{19} and b^{19} of Fig. 3, the collecting rings 33, 33, are likewise interrupted, as shown in plan view in Fig. 2. The inner ring of this pair may be continuous from the point c to the point d, but the outer one is divided into segments e, f, g, h, each segment insulated from the preceding one and connected through successively diminishing resistances e', f', g', h', with a common binding post 34.

In addition to the lamp connections, supports, and heating boxes, as above described, the apparatus may be provided with a second series of similar devices adapted to support and coöperate with a second series of lamp bulbs 2′, connected with the pumps before described, through branch elbow connections 14′ of the U-tubes 14. This second series of bulbs and coöperating devices are shown in Fig. 1 and may or may not form a part of the complete apparatus as above described.

The operation of the apparatus is as follows: The operator inserts a lamp bulb 2 at any convenient point around the table, say for example, at the point indicated by A. At this point the connection to both pumps is closed, that to the large pump being shut off by the action of the cam 37 on the handle 36 of the valve 35, and that to the small pump being closed by the collapse of the rubber tube connection 38, under the pressure of the mercury or fluid, which at this time is forced into and completely fills the inner branch of the U-tube, through which this connection passes, by the pressure of atmospheric air in the front branch of the U where the lamp is being inserted. The operator then closes the box 25 about the lamp bulb, which closes the circuit 27, and revolves the table to the left so as to bring the next U-tube connection to the point in front of him, inserts another lamp and repeats the operation. In the meantime the valve handle 36 of the large pump connection to the U-tube in which the first lamp was inserted has passed the cam 37, the valve has been mechanically opened by the action of its spring, and the large pump begins to exhaust the air from the bulb and the open space in the front branch of the corresponding U-tube. As this exhaustion is continued, the pressure in this open space is diminished and when it reaches a point less than that corresponding to the initial difference in height of the liquid in the two branches of the U-tube, the column of liquid in the front branch will begin to rise and that in the rear branch fall, and, as this operation continues, the forward column of liquid will gradually rise above and shut off the opening into the branch tube 15, and by this action automatically close off the connection to the large pump, the amount of liquid in the tube being so regulated that this connection is completely closed just before the time when the large pump has reached the limit of its exhaustion. The length of the inner branch of the U-tube is so regulated, or the position of the rubber joint 38 within such tube is so arranged, that just at the time the liquid has risen in the front braneh of the U enough to shut off the large pump connection, as just described, it has fallen sufficiently in the inner branch to relieve the pressure on the rubber tube connection sufficiently to allow the same to open and permit the second pump to automatically come into operation. As the pumping is continued with this second pump, the liquid continues to rise in the front branch of the U until it finally covers up and shuts off also the opening into the branch connection 16 communicating with this second pump. In order to control the position of the lower end of the branch tube 16, in relation to the branch connection 15, the former is provided with a threaded nipple at the lower end as shown, and by adjusting this nipple, the distance between the branch openings 15 and 16 is so regulated that this second closure takes place at the time when the second pump has reached its practical limit of exhaustion, this limit being either that required for the final vacuum in the lamp, or in other cases that required for such a final step of exhaustion as is carried out in a com-

bined mechanico-chemical system of exhaust.

It will be understood that the successive stages of the pumping operation are reached for each lamp while the table is being slowly rotated, and new lamps continually added by the operator at the initial station A. While these pumping operations are going on, lamp bulbs are also being heated gradually by the effect of the current passing through the collecting rings 29, 29, brushes 28, 28, and connecting wires 27, 27, into the heating coils 26 of the boxes 25 surrounding the bulbs, and, by varying the angular position and arc of contact of these collecting rings, the heating can be carried on or interrupted or varied at will during any desired stage or stages of the pumping operation. Likewise, through the action of the contact rings 33, 33, and the resistance coils *e'*, *f'*, *g'*, *h'*, connected in series with the segments thereof, current can be gradually introduced and successively increased or varied at will through the filament of the lamp, and the latter thus gradually "worked up" and finally brought to a high incandescence during the final stages of the exhaustion. The diameter of the table, or the total number of lamps thereon, is so arranged that for any given system of mechanical exhaustion the operation has been completed by the time the table has made one complete revolution and any given lamp has been brought again to the station at which it was first placed in the apparatus. At this point, if the exhaustion has been completed by the pumps, the box is opened, the exhausted bulb is sealed off with a blowpipe flame in the usual manner and the short end of the sealed off tubulature removed. When the sealed end of the tubulature is removed, the pressure of the atmospheric air entering the outer arm of the U-tube, depresses the mercury or fluid therein and forces it up into the inner arm of the U, thus compressing the rubber valve connection 38 already described and immediately sealing off the small pump. The same operation is automatically carried out in the same manner in case any lamp breaks at any time during the exhausting operation, thus cutting off this particular lamp without affecting the operation or action on the other lamps on the apparatus. If the final exhaustion is completed by a chemical process, this last step is likewise completed at the station A just before the lamp is sealed off. In any case, after sealing off the lamp, and removing the end of the tubulature, a new lamp is inserted, and the operation continued as before.

In the modification shown in Fig. 4, the form of the collapsible valve joint at 38 is changed by bending the portion of the rubber pipe within the U-tube into a V form constructing the upper block 39' of a corresponding form, and mounting this block on an adjustable stem 42 passing through the upper end of the inner arm of the U-tube 14. This construction enables the point at which the tube connection 38 opens and closes under the pressure of the fluid column, to be adjusted easily and accurately for liquids of different density, without changing the position of the branch tube 16. This figure also shows in greater detail one form of rubber packing joints which may be used to form an air tight connection between the rubber pipe 38 and the walls of the U-tube 14. In the form here shown this packing consists of tapered soft rubber corks or washers 43, 43, which fit over the pipe 38 and are forced down into their seats and into intimate contact with the pipe by means of screw plugs 44, 44.

In the modifications shown in Figs. 5 and 6 the clamp which shuts off the small pump is operated electrically instead of mechanically by the movement of the mercury column in the U-tube 14. For this purpose I seal a pair of contact points 46, 46, into the tube at about the same point as that occupied by the collapsible mechanical tube valve of Figs. 1 and 4. These points are in circuit with a battery 47 or other suitable source of electrical power and the coils of an electromagnet 48.

The coils of the electromagnet 48, the armature bar 49 of which is adapted to bear against the rubber tube 38 and clamp the same against the fixed bar 39'' is mounted on the frame-work of the electromagnet. When the mercury or other fluid fills the inner branch of the U-tube 14, the contact points 46 are covered, the circuit is closed through the electromagnet, and the rubber tube is clamped and closed between the armature of the latter and the fixed bar 39''. In the form shown in Fig. 5 a single coil is used on the electromagnet, and when the circuit is broken by the recession of the mercury column below the contact points 46, the armature of the electromagnet is released, and falls away from the rubber tube 38 allowing the same to open and establish communication between the lamp bulb and the small pump. In the form shown in Fig. 6 the same result is secured, but in a slightly different way, the electromagnet being in this case wound with two equal and opposing circuits connected with independent batteries 47 and 47'. The circuit from the battery 47 is closed through the contact points 46 in the manner just described, while the circuit from the battery 47' is closed continually through the opposing coil of the electromagnet. When both circuits are closed, the electromagnet fields are opposed and compensatory one to the other, and the armature 49 is lifted away from the poles by the spring 50 clamping the rubber

tube 38 between itself and the opposing bar 39''. When the circuit is broken by the fall of the mercury column, the field due to the lower winding of the electromagnet is destroyed, the field from the opposed upper winding comes into action, attracting the armature 49 and unclamping and opening the rubber tube 38. If desired, a similar system of clamping can be applied to the branch tube 15 leading to the large pump, the contact points 51 for this clamping circuit being placed correspondingly higher in the inner branch of the U-tube 14. In this case it will be necessary to unclamp and open this tube connection when the operation is first started, by an external switch 53 in the circuit of the electromagnet and keep this switch open until under the action of the large pump, the mercury in the tube 14 has fallen below and uncovered the points 51. This switch can be opened either by hand or by the action of a cam similar to that employed at 36, 37, for opening the mechanical valve 35. The advantage of employing this electrical clamp valve in place of the mechanical valve 35 is that the large as well as the small pump, will be automatically and almost instantly shut off in case any particular lamp bulb breaks or atmospheric air is by any other cause admitted into the outer pump connections.

In order to provide ready means for the exhaustion of the air from the inner branch of the U-tube 14, I provide a secondary pump connection 54 entering the upper end of the inner arm of the U and communicating with the small pump chamber 18. This branch connection can be closed and is normally closed by the action of a clamp 55.

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

1. In apparatus for exhausting incandescent lamps, the combination of a fluid pressure column, an air pump connected with said column, said column having a socket for the reception of the tubulature of an incandescent lamp bulb; devices arranged in the column adapted to open and close an electric circuit, a device for closing connection between the socket and the air pump, an electric circuit connected with the opening and closing devices of the column and with the devices for closing the connection between the air pump and the socket; substantially as specified.

2. In apparatus for exhausting incandescent lamp bulbs, the combination of a fluid pressure column, a device for heating and drying incandescent lamp bulbs, means for connecting said heating device with the electric circuit during a predetermined interval, an air exhausting device connected with the column, and circuit opening and closing devices arranged in the column and connected with the electric circuit to control the operation of said exhausting device; substantially as specified.

3. In apparatus for exhausting incandescent lamp bulbs, the combination of a fluid pressure column, an air exhausting device connected with said column and having a socket for the reception of the tubulature of an incandescent lamp bulb, an electric circuit connected with a source of electric energy and adapted to be connected with the leading-in wires of the incandescent lamp bulb, and devices arranged in the column to vary the strength of the electric current through the lamp in successive stages at predetermined intervals; substantially as specified.

4. In apparatus for exhausting incandescent lamp bulbs, the combination of a fluid pressure column, an air pump connected with the column and with a socket adapted to receive the tubulature of an incandescent lamp bulb, said socket being connected with the column beyond the air pump connection so that when the fluid has risen in the column to a certain point, the connection between the socket and the air pump shall be interrupted; substantially as specified.

5. In apparatus for exhausting incandescent lamp bulbs, the combination of a socket adapted to receive the tubulature of an incandescent lamp bulb, two or more air pumps connected with the socket, devices for closing the connections between each of the air pumps and the socket, a fluid pressure column connected with one of the said air-pumps, an electric circuit connected with a source of electric energy and with the devices for opening and closing the connections between the pumps and the socket, and a device arranged in the column and adapted to open and close the circuit whereby the connection of the socket with one of the pumps is interrupted and with the other of the pumps is opened; substantially as specified.

6. In apparatus for exhausting incandescent lamp bulbs, the combination of a fluid pressure column, a socket adapted to receive the tubulature of a lamp bulb, a heater adapted to heat the lamp bulb, two air pump connections with the column, an electric heating circuit connected with a source of electrical energy and with the lamp heating device, means to open and close the heating circuit at predetermined intervals, a lighting circuit connected with a source of electric energy and adapted to be connected with the leading-in wires of the lamp bulb, and means to open and close the lighting circuit; substantially as specified.

7. In apparatus for exhausting incandes-

cent lamp bulbs, the combination of a socket adapted to receive the tubulature of a lamp bulb, a roughing pump connected with the socket, a fluid pressure column connected with the socket below the connection with the pump whereby when the fluid in the column reaches a certain point, it shall close the connection between the pump and the socket, a finishing air pump connected with the socket, and with said fluid pressure above said roughing pump connection whereby when the fluid rises in the column to a certain point it shall close the connection between the small pump and the socket; substantially as specified.

8. In apparatus for exhausting incandescent lamp bulbs, the combination of a socket adapted to receive the tubulature of a lamp bulb, a roughing pump connected with the socket, a fluid pressure column connected with the socket below the connection with the pump whereby when the fluid in the column reaches a certain point, it shall close the connection between the roughing pump and the socket, a finishing air pump connected with the socket, and with the fluid pressure column above the roughing pump connection whereby when the fluid rises in the column to a certain point it shall close the connection between the finishing pump and the socket, a device for closing the connection between the roughing pump and the socket, a device for opening the connection between the small pump and the socket, a circuit connected with a source of electrical energy and with the pump connection opening and closing devices, and a device arranged in the fluid pressure columns and adapted to close the circuit; substantially as specified.

9. In apparatus for exhausting lamp bulbs, a movable carrier having a series of supports for supporting the lamp bulbs, a pump chamber connected with the movable carrier, means for exhausting the bulbs connected with said chamber, a liquid seal between the pump chamber and the exhausting means, and devices for bringing the bulbs successively into communication with the exhausting devices and controlled by the movement of the carrier.

10. In apparatus for exhausting lamp bulbs, a movable carrier having a series of supports for supporting the lamp bulbs, devices for heating the bulbs, means actuated by the carrier for bringing said devices into operation, and devices controlled by the movement of the carrier for exhausting the bulbs; substantially as specified.

11. In apparatus for exhausting lamp bulbs, a device for exhausting the bulb, a device for heating the bulb, means for controlling said heating device, a device for bringing the filament to incandescence, and a conduit for the flow of a liquid under the action of atmospheric pressure, said liquid controlling the successive operations of exhaustion; substantially as specified.

12. In apparatus for exhausting lamp bulbs, the combination of a U-tube adapted to contain a liquid, a socket communicating with the U-tube, and an air pump communicating with the U-tube and controlled by the flow of said liquid; substantially as specified.

13. In apparatus for exhausting lamp bulbs, a heater for heating the lamp bulbs comprising a box formed of hinged sections, each section being provided with an electric heating device, and means for controlling the circuit by the opening and closing of the box; substantially as specified.

14. In apparatus for exhausting lamp bulbs, a heating device for heating the lamp bulbs consisting of a box formed of hinged sections adapted to open and close an electric circuit by the opening and closing of the sections, an electric heater contained in the box, and an electric circuit leading to the heater; substantially as specified.

15. In apparatus for exhausting lamp bulbs, the combination of a tube adapted to contain a liquid under pressure, a socket for the tubulature of the lamp communicating with the tube, an air pump communicating with the socket by means of a conduit passing through said tube, and a collapsible portion in the conduit within said tube; substantially as specified.

16. In apparatus for exhausting lamp bulbs, the combination of a socket for the tubulature of the lamps, an air pump communicating with the socket, a tube adapted to contain fluid under pressure, a collapsible tube in the conduit leading from the socket to the pump, a clamp for compressing the collapsible tube, and devices connected with the fluid pressure tube and adapted to operate the clamp when a certain pressure shall have been established in the fluid pressure tube; substantially as specified.

17. In apparatus for exhausting lamp bulbs, a movable carrier having a series of sockets adapted to receive the tubulatures of lamp bulbs and an electric circuit adapted to be connected with the leading-in wires, a pump chamber adapted to communicate with the series of sockets and controlled by the movable carrier, and a tube leading from the pump chamber to the air-pump; substantially as specified.

18. In apparatus for exhausting lamp bulbs, a movable carrier having a series of sockets adapted to receive the tubulature of a lamp bulb, a series of heating devices adapted to heat the lamp bulbs after the tubulature has been inserted in the sockets, and electric circuits adapted to generate heat

in the heating devices controlled by the movement of the carrier; substantially as specified.

19. In apparatus for exhausting lamp bulbs, a movable carrier having a series of sockets adapted to receive the tubulatures of lamp bulbs, an electric circuit adapted to be connected with the leading-in wires, a pump chamber communicating with the series of lamp sockets and connected with the movable carrier, a tube leading from the pump chamber to a primary or roughing air pump, a secondary pump chamber connected with the movable carrier and communicating with the series of sockets, a tube leading from the secondary pump chamber to a secondary or fining pump, and devices for automatically closing connection between the primary pump and the sockets, and opening communication between the secondary pump and the sockets; substantially as specified.

20. In apparatus for exhausting lamp bulbs, a movable carrier having a series of sockets adapted to receive the tubulatures of lamp bulbs, an electric circuit having branches of different resistance adapted to be connected successively with the leading-in wires and controlled by the movement of the carrier, a pump chamber communicating with a series of lamp sockets and connected with the movable carrier, a tube leading from the pump chamber to the air-pump, and a liquid seal between said tube and the pump chamber; substantially as specified.

21. In apparatus for exhausting lamp bulbs, a movable carrier having a series of sockets adapted to receive the tubulatures of lamp bulbs, an electric circuit adapted to be connected with the leading-in wires, a pump chamber communicating with the series of sockets and connected with the movable carrier, a tube leading from the pump chamber to a primary or roughing air-pump, a secondary pump chamber connected with the movable carrier and communicating with the series of sockets, a tube leading from the secondary pump chamber to a secondary or finishing pump, devices for closing connection between the primary pump and the sockets and opening communication between the secondary pump and sockets, and an electric circuit for communicating power to these opening and closing devices; substantially as specified.

22. In apparatus for exhausting lamp bulbs, a movable carrier having a series of sockets communicating with an air-pump and adapted to receive the tubulatures of lamp bulbs, in combination with electric heating devices for heating the bulbs, electric circuits leading to the heating devices, and a device for supplying current from the terminals on the fixed stand of the apparatus during predetermined intervals, to the circuit on the movable carrier; substantially as specified.

23. In apparatus for exhausting lamp bulbs, the combination of a fluid pressure tube adapted to contain liquid, a socket for the reception of the tubulatures of lamp bulbs, a primary or roughing pump and a secondary or fining pump communicating with the fluid pressure tube adjacent to the socket, a device for opening communication between the secondary pump and the fluid pressure tube, electric circuit for communicating power to the opening device, and contact points arranged in the fluid pressure tube adapted to make or break the electric circuit; substantially as specified.

24. In apparatus for exhausting lamp bulbs, the combination of a fluid pressure tube adapted to contain liquid, a socket for the reception of the tubulatures of lamp bulbs, a primary or roughing pump communicating with the fluid pressure tube adjacent to the socket, a device for opening communication between the secondary pump and the fluid pressure tube, and a device for closing communication between the primary pump and the fluid pressure tube, electric circuits for communicating power to the opening and closing devices and contact points arranged in the fluid pressure tube adapted to make or break the electric circuits; substantially as specified.

In testimony whereof, I have hereunto set my hand.

FRANK L. O. WADSWORTH.

Witnesses:

JAMES R. BAKEWELL,

C. E. EGGERS.