W. R. BURROWS.

MACHINE FOR MAKING INCANDESCENT LAMPS.

APPLICATION FILED MAY 23, 1906.

1,013,124.

Patented Jan. 2, 1912.

4 SHEETS—SHEET 1.

Fig. 7.

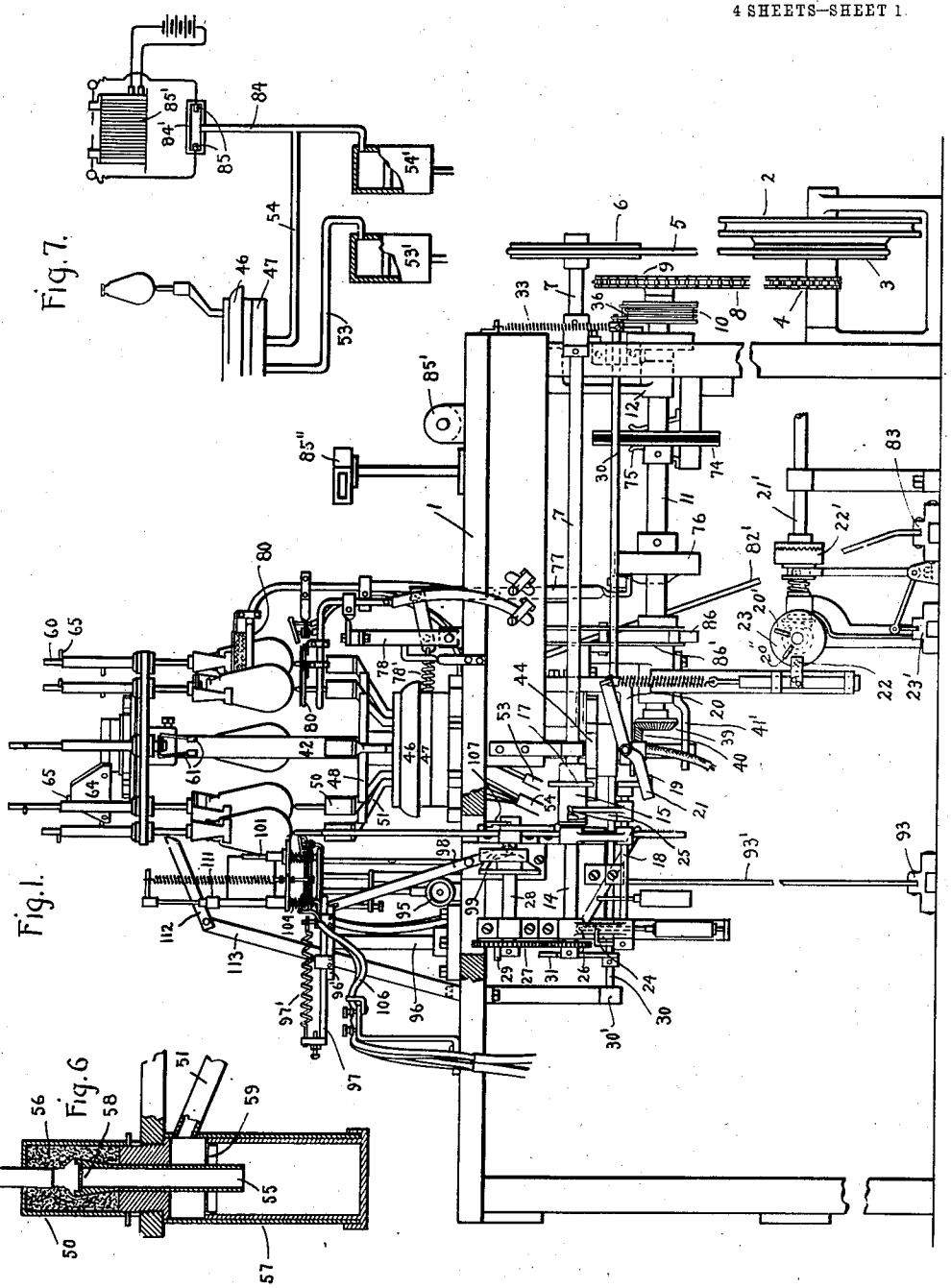


Fig. 1.

Fig. 6

Witnesses

J. Ellis Glen.

Helen Orford

Inventor.

William R. Burrows

by Albert G. Davis

Atty.

W. R. BURROWS.

MACHINE FOR MAKING INCANDESCENT LAMPS.

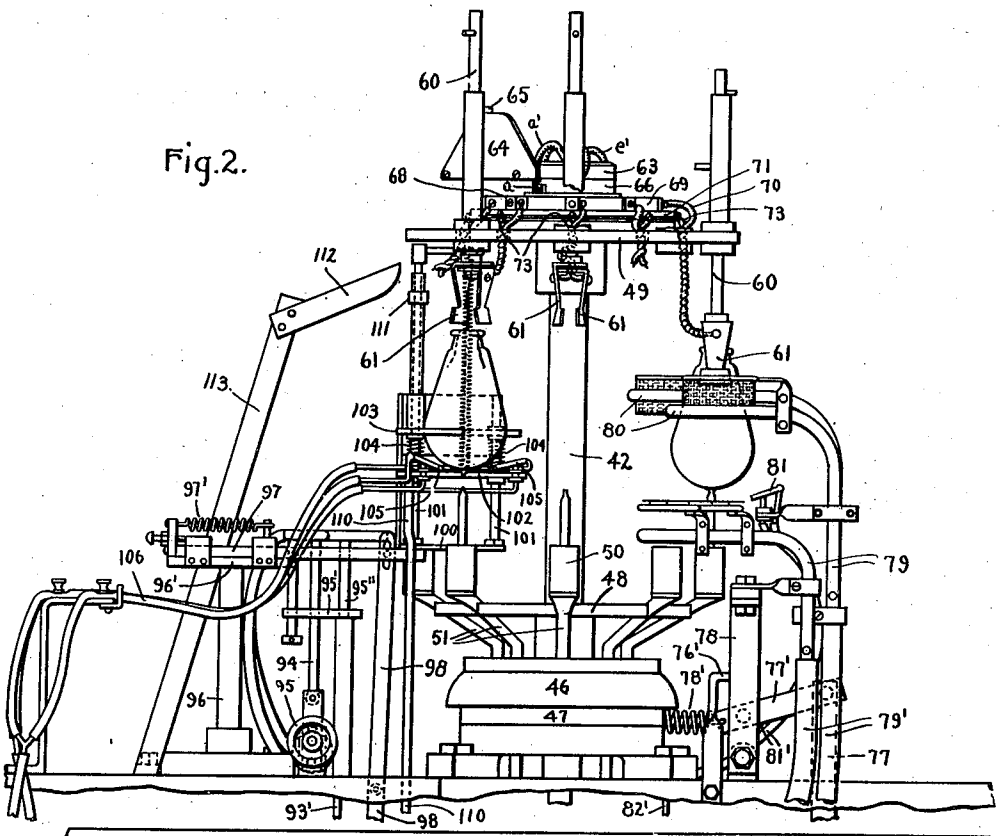
APPLICATION FILED MAY 23, 1906.

1,013,124.

Patented **Jan. 2, 1912.**

4 SHEETS—SHEET 2.

Fig.2.



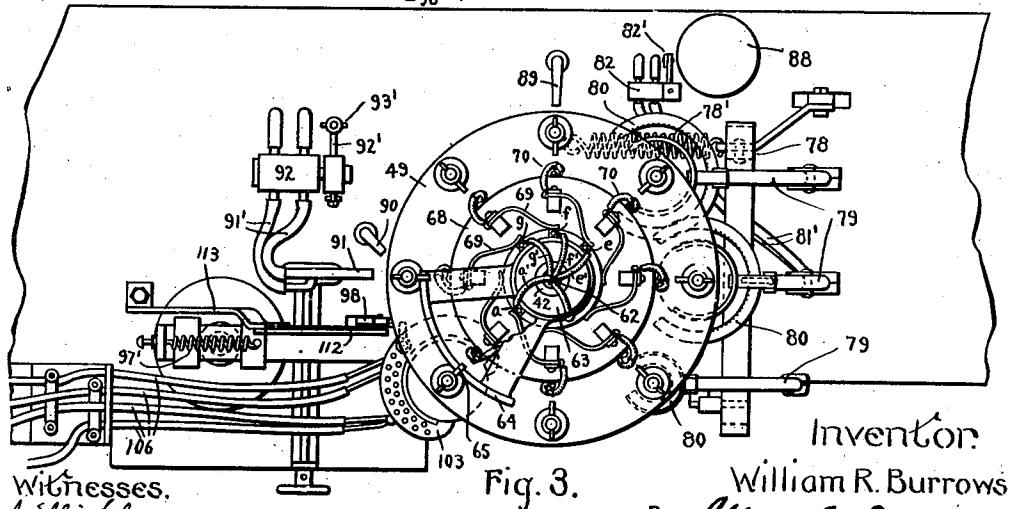


Fig. 3.

Witnesses.

J. Ellis Glen.

Helen Orford

Inventor

William R. Burrows

By Albert G. Davis

Atty.

W. R. BURROWS.

MACHINE FOR MAKING INCANDESCENT LAMPS.

APPLICATION FILED MAY 23, 1906.

1,013,124.

Patented Jan. 2, 1912.

4 SHEETS—SHEET 3.

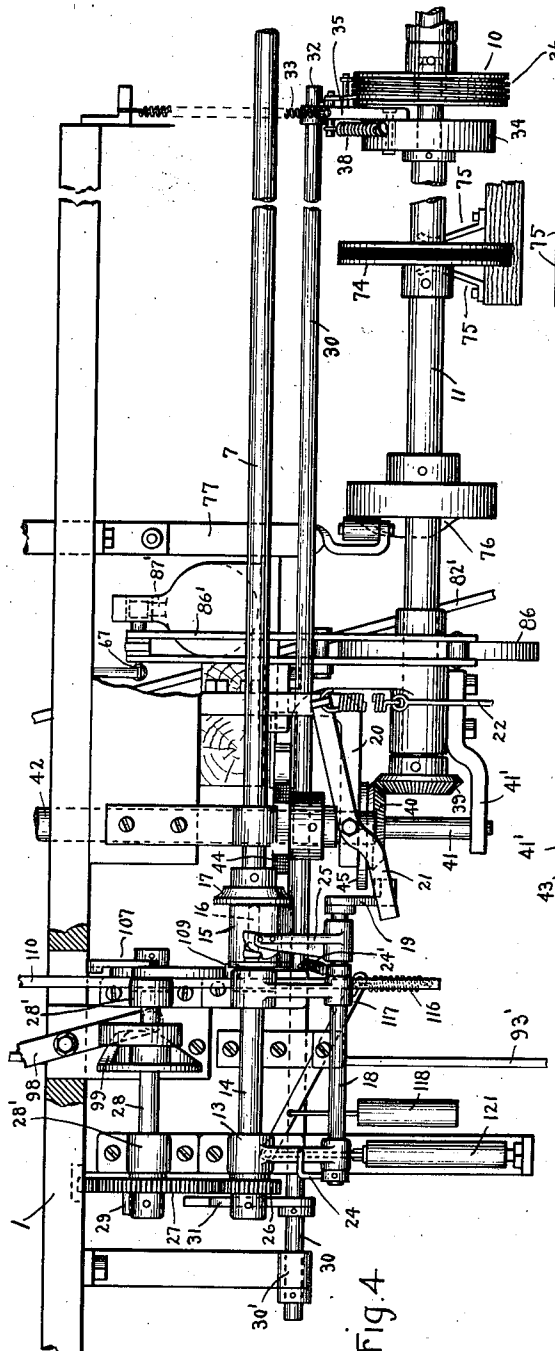


Fig. 4

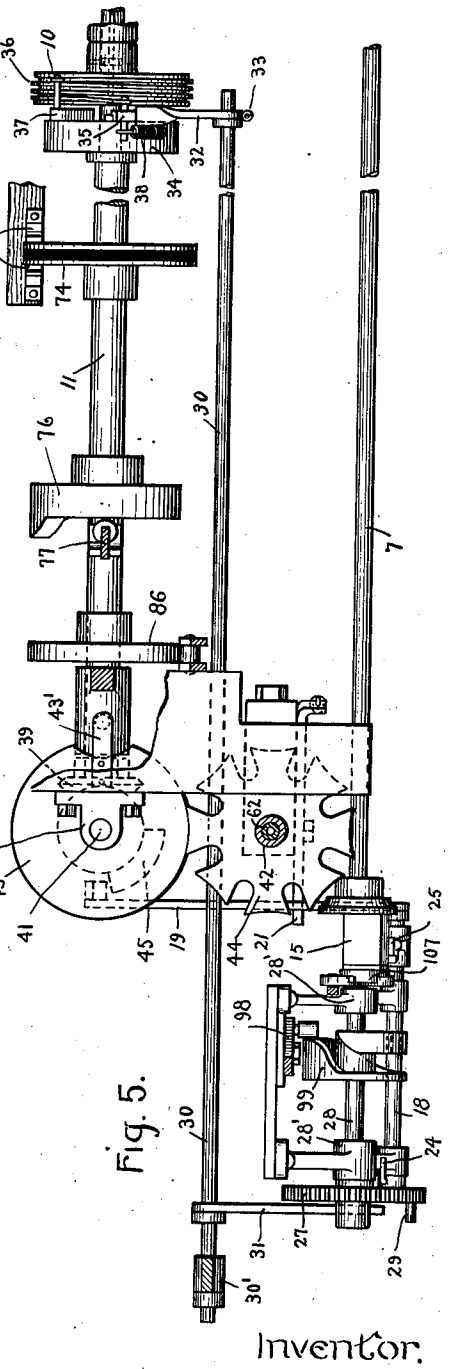


Fig. 5.

Witnesses

J. Ellis Glen

Helen Orford

Inventor.

William R. Burrows

By Albert G. Davis

Atty

W. R. BURROWS.

MACHINE FOR MAKING INCANDESCENT LAMPS.

APPLICATION FILED MAY 23, 1906.

1,013,124.

Patented Jan. 2, 1912.

4 SHEETS—SHEET 4.

Fig. 8.

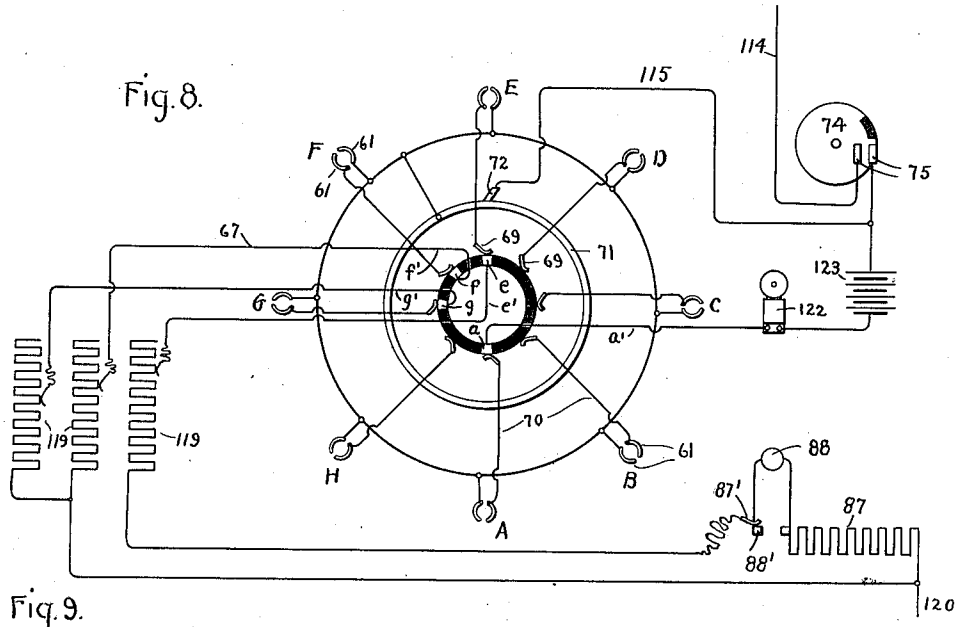


Fig. 9.

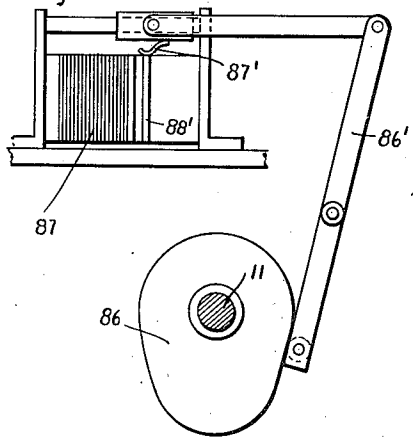


Fig. 10

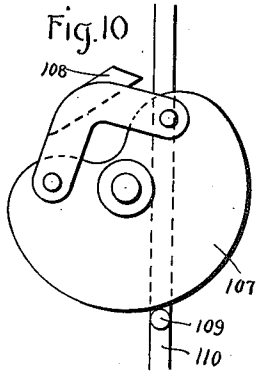


Fig. 11

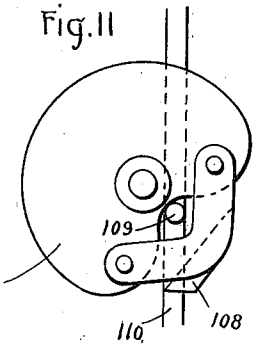


Fig. 12

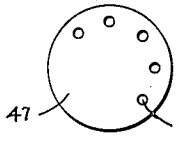


Fig. 13.

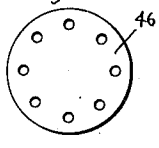
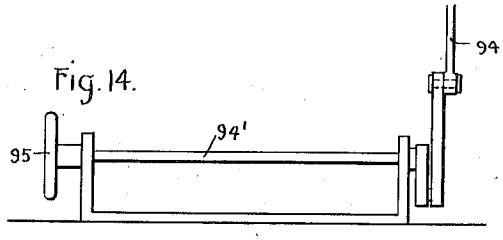


Fig. 14.



Witnesses

J. Ellis Glen.

Allen Alford

Inventor:

William R. Burrows

by Albert G. Davis

Atty.

UNITED STATES PATENT OFFICE.

WILLIAM R. BURROWS, OF NEWARK, NEW JERSEY, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

MACHINE FOR MAKING INCANDESCENT LAMPS.

1,013,124. Specification of Letters Patent. Patented Jan. 2, 1912.

Application filed May 23, 1906. Serial No. 318,307.

To all whom it may concern:

Be it known that I, WILLIAM R. BURROWS, a citizen of the United States, residing at Newark, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Machines for Making Incandescent Lamps, of which the following is a specification.

This invention relates to machines for use in the manufacture of incandescent lamps, and the object of the invention is to provide a machine for performing certain steps in the manufacture of such lamps which have heretofore been performed by hand, thus effecting a considerable reduction in the cost of production of such lamps.

My invention involves a machine which may be termed a combined exhausting and sealing-off machine, as the function of the machine is to receive the lamp bulbs after the stems carrying the filaments have been mounted therein, exhaust the air from the bulbs both by mechanical pumps and the chemical process, and finish them by sealing-off the connection through which the air is exhausted so that after leaving the machine, the bulbs are ready to receive the bases.

In the exhaustion of incandescent lamp-bulbs it has been common heretofore to employ two pumps, a "rough" pump for effecting the preliminary exhaustion and a "final" pump for increasing the degree of vacuum. I prefer to employ two such pumps and in combination therewith a valve, the movable member of which is actuated by suitable power-driven devices to connect the pumps successively to the bulbs, a rotatable frame being arranged to support a plurality of the bulbs and carry them around into position for exhaustion by the pumps and by the chemical process and for sealing-off. The devices for sealing-off are automatic in their action and operate to apply heat to the proper point in the connection between the bulb and tubulature and then move the bulb, tubulature and flame relatively with great delicacy, so as to close the connection to the bulb and form only a small tip. This feature of my invention is of great importance; it enables an unskilled operator to seal-off lamps very quickly, whereas heretofore this step in the manufacture of the lamps has been performed far more slowly by hand and by operators having considerable skill in the art of glass-working. The various operations incident to the exhaustion and sealing-off of the lamps proceed in regular order as the bulbs are carried around by the rotatable frame from the starting position to the position where the completed bulbs are removed, and as the operator has few duties to perform, the work is done very rapidly and hence at small cost.

The novel features which I believe to be characteristic of my invention will be definitely indicated in the claims appended hereto.

I have illustrated the preferred embodiment of my invention in the accompanying drawings, in which—

Figure 1 is a front view of the machine broken away in part; Fig. 2 is a similar view on a larger scale of the upper part of the machine; Fig. 3 is a top view of the same; Fig. 4 is a front view of a portion of the operating mechanism below the table; Fig. 5 is a top view of the same; Fig. 6 is a detail view in section of a modified form of support for a lamp bulb; Fig. 7 is a diagrammatic detail view of the vacuum indicator; Fig. 8 is a diagram of the electrical connections; Fig. 9 is a detail view of the rheostat; Figs. 10 and 11 are views showing two positions of the cam for raising the sealing-off mechanism; Figs. 12 and 13 are views of the movable and stationary members of the valve; and Fig. 14 is an elevation of the adjusting mechanism for the heater for effecting the chemical exhaustion.

Referring first to Figs. 1, 4 and 5, indicates the top of a table or bench on the upper and lower sides of which most of the operating mechanism of the machine is supported. At the side of the table a pulley 2 is mounted on a shaft and arranged to be driven from a suitable source of power, and secured thereto is a pulley 3 and a sprocket 4. A belt 5 runs on pulley 3 and also on a pulley 6, mounted on a shaft 7, to communicate continuous rotary motion to shaft 7. A chain 8 runs on sprocket 4 and also on a sprocket 9, to communicate continuous rotary motion to sprocket 9 and to a clutch-member 10 secured thereto, the sprocket and clutch-member being loose upon a shaft 11, mounted in suitable bear-

ings 12. Mounted for rotation in bearings 13 is a shaft 14 in axial alinement with shaft 7, and secured on the end of this shaft is a member 15, having an opening therethrough parallel to its axis, in which a pin 16 is adapted to move. This pin is pressed by a suitable spring in a direction to cause its end to enter one of a plurality of openings in a disk 17, secured on the end of shaft 7. Mounted in bearings formed integral with the bearings 13, is a shaft 18, on the end of which is secured a crank 19. Pivoted on an arm 20 depending from the under side of the table is a lever 21, which is connected to a sliding link having a projection 22 thereon. A disk 23 provided with projections or teeth 20′ and 20″ is geared to shaft 21′ driven in any desired manner and a clutch 22′ operated by a pedal 23′ is arranged to disengage the disk operating mechanism from the shaft when the pedal is pressed by the operator. Secured on shaft 18 is an arm 25, the end of which is inclined on one side and is adapted to cooperate with the head of the pin 16 which extends out beyond the periphery of the member 15 through a slot communicating with the opening in which the pin is adapted to move. The arrangement of this mechanism is such that when shaft 18 is rocked by teeth 20′ and 20″ engaging projection 22, the free end of arm 25 is raised free of the head of pin 16, and the spring presses pin 16 forward until its end enters an opening in disk 17, thereby clutching shaft 7 in driving relation to shaft 14. When projection 22 is released, a spring 24′ connecting a stud on shaft 18 to a stationary part rocks shaft 18 back to its initial position this movement being limited by an arm 24 on the end of shaft 18, until the free end of arm 25 lies close to the periphery of member 15, and as shaft 14 is nearing the completion of one revolution, the head of pin 16 engages the inclined side of arm 25 and rides up the incline, thus withdrawing pin 16 from clutching relation to disk 17 and bringing shaft 14 to rest after it has made one complete revolution.

On the end of shaft 14 is a pinion 26 meshing with a gear 27 on a shaft 28 which is mounted in suitable bearings 28′ directly above shaft 14; on the side of gear 27 is a pin 29, and extending into the path of movement of this pin is an arm 31 carried by a shaft 30 which is arranged to rock in suitable bearings 30′ depending from the table 1. Gear 27 has twice as many teeth as pinion 26, so that every second revolution of shaft 14 causes pin 29 to move the free end of arm 31 downward and immediately release the same, thus rocking shaft 30. On the opposite end of shaft 30 is secured a clutch-operating lever 32, one end of which is connected to the table 1 by a coiled spring 33, which serves to turn the shaft 30 back to its original position, when arm 31 is released by pin 29. The other end of lever 32 is adapted to operate an arm 35 pivoted upon the side of a disk 34 secured upon the shaft 11. The free end of arm 35 is secured to one end of a strip 36 wound spirally upon the clutch-member 10 and connected at its other end to a block 37 secured on disk 34. A spring 38 connects the free end of arm 35 with a stud on disk 34 and operates, when arm 35 is released, to turn the arm on its pivot, and thus draw the spirally-formed strip 36 tight upon the clutch-member 10 in order to connect the clutch-member in driving relation to shaft 11. It will be seen that every second revolution of shaft 14 rocks shaft 30 in its bearings, lifting the end of arm 32 and permitting spring 38 to tighten the clutch-strip 36 upon clutch-member 10, and thus effecting rotation of shaft 11; as shaft 30 is turned back to its initial position immediately, the end of lever 32 is brought down upon the periphery of disk 34, and as shaft 11 completes one revolution, the end of lever 32 engages arm 35 and turns it on its pivot, thus loosening the strip 36 and bringing shaft 11 to rest.

On the end of shaft 11 is a bevel gear 39 meshing with a bevel gear 40 having the same number of teeth as gear 39 and secured upon a vertical shaft 41 carried by suitable bearings 41′. A hollow shaft 42 is mounted in suitable bearings parallel to and directly in front of the upper portion of shaft 41. Mounted on shafts 41 and 42 are the members 43 and 44 of an intermittent gear, the member 43 having a single tooth 43′, and the member 44 having the same number of teeth as the rotary frame has receptacles for lamp bulbs. Secured on shaft 41 directly above the bevel gear 40 is a disk having a projection 45 which, when the shaft is rotated crosses the path of movement of the end of the crank 19; projection 45 is of such shape that it prevents movement of crank 19 by pedal 23′, until the tooth 43′ of gear 43 has actuated and disengaged the gear 44.

The shaft 42 is extended up through the table 1 and carries the movable member 46 (Fig. 13) of a valve, the stationary member 47 (Fig. 12) of which is secured upon the top of the table. Above the valve-member 46 shaft 42 carries a frame consisting of two plates 48 and 49, on the former of which are secured a plurality of supports 50 for lamp bulbs. In the present instance I have shown eight of these supports. Each of these supports may consist of a metallic cylinder in which is a rubber gasket adapted to receive the tubulature of a bulb and connect it with a pipe 51. The pipes 51 from the several supports 50 extend down to and are connected with openings in the movable member 46 of the valve, these openings

being spaced apart equally concentric with the valve-member, as shown in Fig. 13. The stationary member 47 of the valve is provided with five openings adapted to aline with five of the openings in the movable member 46, as shown in Fig. 12. One of these openings in the stationary member 47, indicated at 52 (Fig. 12) is connected by a pipe 53 with the rough pump; the other four openings in the stationary member 47 are connected by a pipe 54 with the final pump or pumps.

In Fig. 6 I have shown a modified form of support for a lamp bulb. In this form a tube 55 is provided, extending from the gasket 56 in the cylinder 50, down into a casing 57, having a removable bottom, and the tube 51 is sealed into the upper end of the casing 57. At the upper end of tube 55 is a screen 58 which serves to catch any small particles of glass which may be drawn from the bulb by the pumps, and in the casing 57 between the lower end of tube 55 and the connection of the tube 51 is a screen 59 of very fine mesh, which serves to catch oil and vapor. The plate 49 of the frame carried by shaft 42 has eight openings therethrough and a rod 60 is freely movable vertically in each of these openings. Each of the rods 60 carries at its lower end two insulated metallic clips 61. Extending up through the hollow shaft 42 is a stationary hollow shaft 62 carrying at its upper end a disk 63 to which is secured a cam 64. Each of the vertically movable rods 60 carries a pin 65 which is adapted to engage and ride over the surface of cam 64. Secured to the under side of disk 63 is the stationary member of a commutator 66 consisting of insulating material with four conducting segments *a*, *e*, *f* and *g* therein, each of which is connected to a wire *a'*, *e'*, *f'* and *g'* extending up through the stationary hollow shaft 62. Secured to the plate 49 of the rotatable frame is a disk 68, on which eight brushes 69 are mounted equi-distant from each other on blocks of insulating material and adapted to bear on the periphery of the stationary member of the commutator. Each of these brushes is connected by a flexible wire 70 to one of the pair of insulated clips 61 mounted on one of the rods 60. Directly under disk 68 and movable therewith is an insulated ring 71 of conducting material, and mounted in position to bear on the inner surface of this ring is a brush 72 carried by stationary shaft 62 and connected to a wire running down through the hollow shaft. The ring 71 is connected by flexible wires 73 to the other one of the clips 61 on each of the rods 60. Mounted on shaft 11 is a controller for the circuits through the commutator 66 and consisting of a disk 74 on shaft 11 and stationary brushes 75 coöperating therewith. In the disk 74 is an insulating segment which is so positioned that it comes under one or both of the brushes 75 just before the tooth 43' on the gear 43 engages and actuates the gear 44, and remains under the brush until tooth 43' is disengaged from gear 44 so that the circuits through commutator 66 are held open while gear 44 and the rotatable frame are being moved, the purpose of this being to open the circuit at the disk 74 rather than at the commutator 66. Mounted on shaft 11 is a cam 76 with which coöperates a pivoted lever 77 which extends up beyond the top of table 1 and is connected by a link 77' to a frame 78 pivoted on studs mounted on the top of the table, and a spring 78' is connected at one end to frame 78 and at the other to a stud on top of the table to move frame 78 in the direction opposite to that effected by cam 76 against a stop 76'. Secured on this frame 78 are pipes 79 connected by flexible tubes 79' with a gas supply and carrying at their upper ends suitable burners 80, each of which is arranged to partially encircle a bulb carried on the rotatable frame (Fig. 3) and apply heat thereto. Mounted on the pipe 79 of the middle one of these three heaters is a small blow-pipe burner 81 which is so disposed that the flame therefrom will play on the point of connection of the tubulature and bulb which is in this position on the rotatable frame. Gas and air are supplied to this burner by flexible tubes 81' in which is a valve 82 having a movable member which is connected by a crank and link 82' to a pedal 83.

Referring now to Fig. 7, I will describe the devices which I employ for indicating the leakage of air to a bulb. The bulb which is being heated by the middle one of the three heaters 80 is connected by the valve members 46 47 and tube 54 to the final pump 54' and communicating with the connection to this pump is a branch pipe 84 having an enlargement 84' at its end into which two sparking electrodes 85 are sealed. A spark coil of any suitable construction, indicated diagrammatically at 85', is connected to the electrodes 85. The enlargement 84' is mounted at the back of a long box 85'' open at its forward end and having its interior walls blackened. This box is mounted in a position convenient for the operator to look into the box, and the color of the discharge between the electrodes 85 indicates the condition of the vacuum within the lamp which is connected to the pump 54'. If air is leaking into the bulb the discharge between the electrodes 85 will appear of such a different color that the operator will know immediately that the bulb is defective and by pressing pedal 83 the flame from the blow-pipe burner 81 will be brought to bear upon the connection of the bulb and

tubulature and the connection sealed so that this bulb will be disconnected from the pumps.

Mounted on shaft 11 is a cam 86 (Fig. 9) with which coöperates a pivoted lever 86′ arranged to operate the movable contact 87′ of a slide wire rheostat 87. This rheostat is provided with an additional contact 88′ between which and the first contact of the rheostat the lamp 88, mounted on table 1, is connected.

Mounted to coöperate with the bulb which is in the support 50 at the back of the machine is a cooler 89 connected to a source of supply of compressed air and in position to direct a blast of air against the bulb. In the second position before the bulb comes in front of the operator, is a burner 90. For this position is also provided a blow-pipe burner 91 supplied with gas and air by flexible pipes 91′ extending through a valve 92, the movable member of which is connected by a crank 92′ and link 93′ to a pedal 93. The burners 90 and 91 are adapted to play upon the tubulature of a lamp to volatilize the chemical therein, and as it is necessary that a considerable portion of the tubulature be heated for this purpose, burner 91 is arranged for vertical adjustment, it being carried by a rod 94 connected by a connecting rod to a crank on a shaft 94′ (Fig. 14) provided with an operating handle 95, a guide strip 95′ on rod 94 being arranged to slide upon a guide 95″.

Mounted on the table 1 is a standard 96 carrying at its upper end a horizontal strip 96′ having thereon guides in which a support 97 is arranged to slide horizontally toward and away from the bulb on the frame in the position next before coming in front of the operator. A spring 97′ connects a block on the end of support 97 with a stud on one of the guides secured on the strip 96′ to normally press support 97 forward toward the bulb. Connected to support 97 by a pin and slot connection is pivoted lever 98, which at its lower end engages the periphery of a cam 99 carried by the shaft 28; this cam and lever and spring 97′ are adapted to move support 97 and the parts carried thereby back and forth upon the horizontal strip 96′ between the positions illustrated in Figs. 1 and 2. Secured to the forward end of support 97 is an arc-shaped plate 100 from which extend upwardly a plurality of rods 101, on which a horizontally disposed arc-shaped plate 102 is adapted to slide vertically. Above plate 102 is another plate or bulb holder 103 also horizontally disposed and arranged to slide vertically on the rods 101, and between this plate and plate 102, springs 104 are coiled about the rods 101. The plate 103 is shaped to form a support for a lamp bulb (Fig. 3). Mounted on plate 102 are a plurality of blow-pipe burners 105, which are arranged at such an angle that the flames therefrom play upon the point of connection of the bulb and tubulature. These burners are supplied with gas and air by long flexible tubes 106.

Mounted on shaft 28 is a cam 107 shown in detail in Figs. 10 and 11. This cam has a depression therein and secured on the cam directly over this depression is a guide strip 108, which is spaced from the bottom of the depression a sufficient distance to permit slight movement between the opposite surfaces of a pin 109 carried by a rod 110 which is movable vertically in suitable guides. Rod 110 is extended below pin 109 and its lower end is connected preferably by a spring 116 to a pivoted lever 117. The other end of this lever carries a weight 118 and also is pivotally connected to the plunger of a dash-pot 121 the cylinder of which is secured upon an arm depending from the framework. The upper end of rod 110 is adapted to engage the bottom of the plate 102 and raise the same and the parts supported thereby. One of the sleeves formed integral with the plate or bulb holder 103 and which supports the plate so as to permit vertical motion thereof on the rods 101, is extended upward and near its upper end carries a projection 111 and arranged to coöperate with this projection is a guide 112 carried by a support 113 mounted on table 1.

The electrical connections to the bulbs carried by the frame are illustrated diagrammatically in Fig. 8. Wire 114 indicates the connection to the positive side of an electric circuit and is connected to one of the brushes 75 bearing on the movable member 74 of the controller, and from the other one of these brushes a wire 115 leads to the stationary brush 72 bearing on the ring 71 carried by the upper plate 49 of the rotatable frame. As above described this ring is connected to one of the clips 61 of each of the pairs carried by the rods 60. The other clip 61 on each of the rods 60 is connected to one of the brushes 69. The positions of the bulbs when the frame is at rest is indicated by the letters A to H. The brushes 69 corresponding to the clips for the bulbs in the positions A, E, F and G are in contact with the conducting segments a, e, f and g in the stationary member 66 of the commutator. From the segments f and g, wires f' and g' extend to adjustable resistances 119 and from these resistances to the negative wire 120 of the circuit. The wire e' from the contact e extends to a similar adjustable resistance 119 and from the terminal of this resistance to the movable contact 87′ of the slide-wire rheostat 87, the other side of which is connected to the negative wire 120. The fourth conducting segment a in the stationary member 66 of the

commutator, is connected by wire a' to wire 115 and connected in wire a' is an electrically-operated bell 122, and a battery 123 of sufficient strength to operate bell 122.

The operation of the machine as thus constructed will now be described. The bulbs to be exhausted and sealed-off have the stems carrying the filaments sealed to the necks of the bulbs and connected to the other end of the bulbs are the tubulatures through which the air is exhausted. On the inner walls of these tubulatures is the chemical which is volatilized to complete the exhaustion of the bulbs. The operator bends the two leading-in wires of a bulb down along the side of the bulb diametrically opposite each other and inserts the end of the tubulature in the support 50 which is in front of her in the position A, forcing the end of the tubulature down into the gasket in the support a sufficient distance to make a good air-tight connection thereto. Also she permits the rod 60 directly above the support 50 to drop down until the insulated clips 61 thereon embrace the neck of the bulb between them and make contact with the two leading-in wires. If this contact is imperfect, that is, if one of the clips 61 is in contact with both of the leading-in wires, the bell 122 will ring and call the operator's attention to the defective mounting of the parts. This is done by the completion of a circuit from battery 123 through wire 115 to brush 72, ring 71 to one of the clips 61 for the lamp, then through the leading-in wire to the other clip, to segment a, wire a' and bell 122 and back to the battery. If the leading-in wires are each in contact with only one of the clips 61, the current from battery 123 would have to pass through the filament in the bulb which, on account of its high resistance, would prevent the passage of sufficient current to actuate bell 122.

The bulb having been positioned properly between the gasket in the support 50 and the clips on the rod 60, tooth 20″ on disk 23 engages projection 22 thus operating the lever 21, rock shaft 18 and arm 25 and causing shaft 14 to make one revolution in the manner above described. This one revolution of shaft 14 turns shaft 28 through one-half of a revolution and the pin 29 on gear 27 thereon operates arm 31 to rock shaft 30 and operate the clutch for shaft 11, thus causing shaft 11 to make one complete revolution. In doing so shaft 11 actuates lever 77 to turn frame 78 on its pivots and carry the heaters 80 back from the rotatable frame. When these heaters have reached the back position, the tooth 43′ engages a tooth of gear 44 and turns the gear and the shaft 42 on which it is secured one-eighth of a revolution and at the completion of this movement the cam 76 permits frame 78 to be moved back to its original position by the spring 78′. This brings the first one of three heaters 80 into position for heating the bulb which the operator inserted in its support and which is in position B and the operator proceeds to insert another bulb in the support which is then in front of her in a similar manner. When the rotatable frame is turned through one-eighth of a revolution in this manner, the movable valve-member 46 is turned to such a position that the opening therethrough to which the pipe 51 leading to the bulb now in position B is connected, is carried into alinement with the opening 52 in the stationary valve member 47, which latter is connected by the pipe 53 to the rough pump 53′ and this pump draws most of the air from the bulb. The half revolution made by shaft 28 also actuates the sealing-off mechanism, as does also the next half revolution of shaft 28 effected by tooth 20′ engaging the projection 22, but this second half revolution does not cause a revolution of shaft 11, and consequent turning movement of the rotatable frame, as the pin 29 on gear 27 does not engage lever 31 in the second half revolution. The manner in which the sealing-off mechanism is actuated, will be described in detail hereinafter. After this second engagement of projection 22 and the mounting of another bulb in the support in front of the operator, shaft 21′ continues to revolve and tooth 20″ again engages projection 22, thus moving the heaters back, turning the frame through one-eighth of a revolution, and moving the heaters forward again as above described. This brings the bulb which was first inserted to the position C and turns the movable valve-member 46 to such a position that the opening to which this bulb is connected alines with the first of the four openings in the stationary valve member which are connected by pipe 54 to the final pump 54′. The bulb is heated by the middle one of the heaters 80 and the operator by glancing into the box 85″ determines whether or not the bulb is properly sealed, if it is not so sealed, she presses pedal 83, thus turning on the flame from the blow-pipe burner 81 and sealing-off the lamp. Tooth 20′ now rocks shaft 18 to operate the sealing-off mechanism which, as above pointed out, does not actuate the rotatable frame. After this has been done and another bulb has been placed in the support in front of the operator, tooth 20″ again causes shaft 18 to be rocked and the frame turned again through one-eighth of a revolution while the burners 80 are held in the retracted position. This carries the bulb which was first inserted, to the position D, where it is acted upon by the third of the heaters 80 and also by the final pump. Tooth 20′ then engages projection 22 to actuate the

sealing-off mechanism, and another bulb having been inserted in the support in front of the operator, tooth 20″ engaging projection 22 again carrying the bulb which was first inserted, to the position E, in which the cooler 89 plays upon the bulb to reduce its temperature from that necessary for exhausting by the mechanical pumps to which it was raised by burners 80 to a temperature which will permit intense incandescence of the filament without causing overheating and collapse of the bulb.

When the frame is moved to carry the bulb to the position E, the brush 69, to which one of the clips 61 for the bulb is connected, engages the segment *e* of the commutator and as shaft 11 nears the completion of the revolution which effected the turning of the frame to carry the bulb to the position E, the cam 86 thereon actuates the lever 86′ to move the movable contact 87′ of the rheostat, from the contact 88′ to the coils of the rheostat and over the same and then back to its original position, this backward movement being effected by a suitable spring shown at 67, Fig. 4. As the head comes to rest before the cam 86 actuates the movable contact of the rheostat the circuit of the filament of the bulb in the position E is first completed from the positive wire 114 to contact 75, disk 74, contact 75, wire 115, brush 72, ring 71, contact 61 to one of the leading-in wires, through the filament to the other leading-in wire, and the other contact 61 and back to the brush 69, segment *e*, wire *e′*, rheostat 119 to movable contact 87′, lamp 88, rheostat 87 and negative lead 120. As cam 86 actuates the movable contact 87′ of the rheostat, the lamp 88 on the table 1 is first cut out of circuit and after it the coils of the rheostat 87; when these have all been cut out, the filament of the bulb on the frame is glowing much above normal incandescence, the purpose of this being to drive gases out from the various joints between the filament and the supports therefor, and immediately thereafter the movable contact of the rheostat returns to its normal position. After the filament has been "worked" in this way, and after tooth 20′ has operated to actuate the sealing-off mechanism and another bulb has been inserted in the support in front of the operator, tooth 20″ again engages projection 22 and the frame rotated one-eighth of a revolution carrying the bulb which was first inserted to the position F. In this position, as also in the positions E, D and C, the connection of the bulb to the final pump is maintained as the stationary valve-member 47 is provided with four openings to aline with the opening of the movable valve-member in each of these positions and connected to the final pump by pipes 54. In the position F the circuit of the filament is completed from the ring 71 through the filament as before to the segment *f* and then through wire 67 and rheostat 119 to the negative side of the circuit. After tooth 20′ operates to actuate the sealing-off mechanism and supplying a bulb to the support in front of the operator, tooth 20″ again rocks shaft 18 and carries the lamp from position F to the position G in which the lamp is disconnected from the pumps and the chemical in the tubulature is volatilized for perfecting the vacuum. In the position G the burner 90 plays upon the tubulature as does also the flame from the blow-pipe burner 91 when the operator presses the pedal 93 to actuate the valve 92 and thus supply gas and air to the burner. The operator also manipulates handle 95 to cause the flame from burner 91 to play over the whole length of the tubulature and at the same time watches the effect of the volatilization of the chemical, and when the bluish discoloration in the bulb has disappeared she releases pedal 93, thus cutting off the supply to burner 91. After this has been done and tooth 20′ again operates to actuate the sealing-off mechanism and a bulb has been inserted in the support in front of the operator, tooth 20″ again operates to rotate the frame through one-eighth of a revolution as before, thus carrying the bulb from the position G to the position H for sealing-off. In moving to this position, the pin 65 on the rod 60 for the bulb engages the cam 64 and the cam raises the rod to lift the clips 61 away from the bulb as shown in Fig. 2. Tooth 20′ again engages projection 22, thus causing shaft 14 to make one complete revolution and shaft 28 one-half a revolution, this latter being the one-half revolution in which the pin 29 does not actuate the lever 31. The first part of this half revolution of shaft 28 rotates cam 99 far enough to permit lever 98 to turn on its pivot and thus allow spring 97′ to move the support 97 and all of the sealing off parts carried thereby forward from the position shown in Fig. 1 until the arc-shaped bulb holder 103 is directly under and in axial alinement with the bulb in position H. Cam 107 on shaft 28, which was in the position shown in Fig. 10 when the parts were at rest, turns with cam 99 and when cam 99 has permitted the forward movement of the sealing-off devices, cam 107 approaches the position shown in Fig. 11; as the turning movement of shaft 28 continues the strip 108 on cam 107 engages pin 109 and raises rod 110 vertically and the upper end of the rod engages the lower side of plate 102 and moves it upward upon the rods 101. As the springs 104 which support the bulb holder 103 rest upon plate 102, the bulb holder 103 is also raised and the inner walls thereof engage the bulb.

As the gasket into which the tubulature of the bulb extends, holds the tubulature, the bulb is not raised by plate or bulb holder 103, but instead springs 104 are compressed somewhat. When the parts are in this position the flames from the burners 105 play upon the point of connection between the bulb and tubulature and soften the glass at this point. As the glass is softened the rod 110 is raised vertically by the weight 118, this movement being made smooth and regular by spring 116 and dash-pot 121, and the pin 109 on rod 110 moving between the strip 108 and the bottom of the depression in cam 107, and this upward movement of rod 110 by weight 118 raises plates 102 and 103 and the bulb supported on bulb holder 103 to stretch the softened glass and finally break the same. The tubular formation of this connection to the bulb is, of course, closed as soon as the glass begins to soften so that when the two glass parts are severed the tubulature is closed at its end and the opening to the bulb is closed leaving a small tip. Immediately after the glass is broken the springs 104 raise bulb holder 103 and the bulb carried thereby as there is then nothing to hold the springs under compression. It will be observed that this movement of the bulb is independent of the burners 105 so that the bulb is carried away from the flames and there is therefore no danger of heating the end of the bulb so much that the vacuum within the bulb would draw the end wall in and collapse the bulb. The sealing-off of the bulb having been effected in this manner, tooth 20′ engages projection 22 causing one revolution of shaft 14 and one-half revolution of shaft 28, this being the half revolution of shaft 28 in which pin 29 does actuate lever 31. Before pin 29 engages lever 31, however, cam 107 acts on pin 109 to lower rod 110 and then cam 99 operates lever 98 to slide support 97 and the sealing off parts carried thereby back from the position shown in Fig. 2 to that shown in Fig. 1. If plates 102 and 103 do not slide down upon the rods 101 into their initial position by gravity, the projecting pin 111 mounted on the sealing off parts engages guide 112 and the plates are forced down thereby as the support 97 is slid back by lever 98. As the movement of shaft 28 continues pin 29 actuates lever 31, thus rocking shaft 30, causing shaft 11 to make one revolution and turning the frame one-eighth of a revolution. This brings the support 50 which carried the bulb which was sealed-off back to the starting position A and the operator removes the tubulature which was used therefrom, mounts another bulb in its place and removes the completed bulb from its support on bulb holder 103. When the support moves to position A from position H cam 64 permits the rod 60 corresponding to the support to drop down to its normal position in readiness for mounting the new bulb.

When the machine is in operation, all of the eight supports 50 carry bulbs and one or more steps in the operations of exhausting and sealing-off lamps are being performed on each bulb. At the position A the used tubulatures are removed and bulbs inserted. At B the bulb is connected to the rough pump and heated. At C and D the bulb is connected to the final pump and heated. At E the bulb is connected to the final pump and cooled and also it is "worked," that is the filament is caused to glow above normal incandescence to drive out the gases. At F the bulb is connected to the final pump and the filament glows at about normal incandescence. At G the chemical in the tubulature is volatilized to perfect the vacuum. And at H the bulb is sealed off. Once in every revolution of shaft 21′ tooth 20′ moves the sealing-off devices forward into position and they then operate automatically to seal off a bulb. Once also during the same revolution tooth 20″ moves the sealing-off devices back and also moves the heaters 80 back, then turns the bulb-carrying frame, the movable valve-member and the movable member of the commutator around one step and then moves the heater 80 forward again and operates the movable contact 87′ of the rheostat. The duties of the operator involve only mounting the bulbs in position, removing them when completed, a glance at the vacuum indicator as each bulb comes to the position C and the adjustment of the heater 91 for each bulb in the position G.

It will readily be seen that the use of a machine substantially as that shown herein for performing the operation of exhausting and sealing-in effects a great saving in the cost of production of lamps as these two steps in the process of making the lamps are performed rapidly and without an intermediate handling of the bulbs and also as the machine can be operated by an unskilled laborer instead of one having considerable skill as has been required heretofore particularly for sealing-off the bulbs. This latter operation has heretofore been done by hand and required a skilled operator because the flame for softening the glass must be applied at just the right point in order to form as small a tip as possible without endangering the bulb by heating its end too much. My machine performs this operation automatically, manipulating the parts with such delicacy that a small tip is formed and dangerous heating of the bulb prevented. This is effected by moving the bulb and tube relatively as soon as the glass is softened to stretch and finally break the softened glass and then moving the bulb and flames rela-

tively. The sealing-off of the bulbs therefore does not require any of the operator's time and as the duties of the operator are few and require little time, the machine can be run quite rapidly.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a lamp making machine, a support for a bulb, a pump, automatic means for connecting the pump with a bulb in said support, a heater mounted in position to cooperate with the tubulature of the bulb in the support, and means for at will moving said heater to direct the flame thereof against any desired part of the tubulature.

2. In a lamp making machine, a rotatable frame, a plurality of supports for bulbs carried thereby, a pump, means for connecting the pump to the bulbs in said supports, a heater, means for rotating the frame to bring the tubulatures of the bulbs in the supports thereon before the heater, and means for at will moving said heater to direct the flame thereof against any desired part of the tubulatures.

3. A machine for making incandescent lamps comprising a movable frame, a support for a bulb carried thereby, a current carrying member mounted on said frame to move into and out of engagement with the leading in wires of a bulb in said support, and means whereby said member is automatically moved away from the bulb at a predetermined point in the movement of said support.

4. A machine for making incandescent lamps comprising a movable frame, a support for a bulb carried thereby, a rod having contacts thereon and mounted on said frame to move in alinement with said support to carry the contacts into and out of engagement with the leading in wires of the bulb in said support, and a stationary cam for lifting said rod away from a bulb in the support at a predetermined point in the travel of said frame.

5. In an exhausting machine, a support for a bulb, contacts for making electrical connection to the leading-in wires of a bulb in said support, and means for giving an indication when said electrical connection is improperly made.

6. In an exhausting machine, a support for a bulb, contacts for making electrical connections to the leading-in wires of a bulb in said support, an electrically-operated indicating device, and means for causing said device to give an indication when one of said contacts is in engagement with both of the leading-in wires.

7. In an exhausting machine, a plurality of supports for bulbs, a valve having a movable member, a pump, connections between the valve and the pump and bulb supports, means for operating the movable valve-member to connect the pump to the bulbs in said supports, and a burner mounted in position to coöperate with the tubulature of a bulb held in a support to seal-off the bulb if defective, and means for at will bringing said burner into sealing off relation to the bulb.

8. In a machine for making incandescent lamps, a rotatable frame, a plurality of supports for bulbs carried thereby, a rod movable in axial alinement with each of said supports, and two insulated metallic clips carried by each of said rods and flared out into position to make contact with the leading-in wires of a bulb when the rod is pressed and the leading in wires are bent down along the bulb on opposite sides thereof.

9. A lamp making machine having means for supporting a bulb and its tubulature, means for exhausting a bulb, a heater for softening the glass at the connection between the bulb and tubulature, means for moving both the bulb and heater to keep the tubulature hot as said tubulature softens, and means for automatically moving the bulb relatively both to the tubulature and to said heater to seal off when the glass is completely softened.

10. A lamp making machine having means for supporting a bulb and its tubulature, means for exhausting the bulb through the tubulature, a heater for softening the glass at the connection between the bulb and tubulature, and means for automatically moving the bulb and heater relatively to the tubulature and then moving the bulb relatively to both the heater and the tubulature to seal off when the glass is softened.

11. A lamp making machine having means for supporting a bulb and its tubulature, means for exhausting a bulb through the tubulature, a heater for softening the glass at the connection between the bulb and tubulature, and means for moving the bulb and tubulature relatively and then moving the bulb and heater relatively.

12. A lamp making machine having supports for a bulb and its tubulatures, means for exhausting the bulb through the tubulature, a heater for softening the glass at the connection between the bulb and tubulature, and automatic means dependent on softening of the glass for first moving the bulb away from the tubulature and then away from both the tubulature and said heater to effect the seal.

13. A lamp making machine having supports for the bulb and its tubulature, means for exhausting the bulb through the tubulature, a heater for softening the glass at the connection between the bulb and tubulature, means for moving both said heater and said bulb away from said tubulature,

and a spring arranged to move the bulb-support and heater relatively to complete a seal when the glass is fully softened.

14. A lamp making machine having means for supporting a bulb and its tubulature, means for exhausting the lamp through the tubulature, a heater for softening the glass at the connection between the bulb and tubulature, a weight mounted to exert a pressure to move the bulb and tubulature relatively to each other, and additional means for moving said bulb relatively both to the tubulature and to the heater when the glass is softened.

15. A lamp making machine having means for supporting a bulb and its tubulature, means for exhausting the bulb through the tubulature, a heater for softening the glass at the connection between the bulb and tubulature, means for moving the bulb and tubulature relatively when the glass is softened, means for further moving the bulb relatively to both tubulature and heater to complete the seal, and a retarding device regulating the movement of the parts.

16. A lamp making machine having means for supporting a bulb and its tubulature, means for exhausting the bulb through the tubulature, a heater for softening the glass at the point of connection between the bulb and tubulature, a weight, means actuated thereby for moving both the bulb and the heater relatively to the tubulature but in substantially unchanged relation to each other when the glass is first softened, and a spring for then moving the bulb relatively to the heater when the tubulature is completely fused.

17. A lamp making machine having a support adapted to receive the tubulature of a bulb and hold the same, means connected to said support for exhausting the bulb through the tubulature, a plate, a heater mounted thereon, a bulb holder yieldingly supported on said plate, and means for moving said plate and the heater and bulb-holder supported thereon relatively to the bulb held in said tubulature support until the bulb engages said bulb-holder and depresses the same.

18. A lamp making machine having a support adapted to receive the tubulature of a bulb and hold the same, means connected to said support for exhausting the bulb through the tubulature, a plate, a heater mounted thereon, a bulb-holder yieldingly supported on said plate, means for moving said plate to carry the bulb-holder mounted thereon into axial alinement with the bulb held in said tubulature support, and means for moving the plate and bulb relatively until the bulb engages the bulb-holder and depresses the same.

19. A lamp making machine having a support adapted to receive the tubulature of a bulb and hold the same, a heater for softening the glass at the connection between the bulb and tubulature, a bulb holder, a movable member for bringing the bulb-holder into supporting relation to the bulb and moving the bulb as the tubulature softens, and resilient means between said bulb-holder and said member for moving the bulb-holder relatively to the tubulature support when the glass is softened by the heater.

20. A lamp making machine having a support adapted to receive the tubulature of a bulb and hold the same, means connected to said support for exhausting the bulb through the tubulature, a plate, a heater mounted thereon, a bulb-holder yieldingly supported on said plate, means for moving said plate and the heater and bulb-holder supported thereon relatively to the bulb held in said tubulature support until the bulb engages said bulb-holder and depresses the same, and additional means for raising said plate and the parts supported thereon when the heater softens the glass.

21. A lamp making machine having a support adapted to receive the tubulature of a bulb and hold the same, a plurality of rods mounted parallel to the axis of a bulb held by said support, a plate movable on said rods, a heater mounted on said plate, a bulb-holder also movable on said rods, springs supporting the bulb-holder on said plate, and means for moving the plate and the parts carried thereby axially of the bulb held in said tubulature support.

22. A sealing-off machine having a frame, a plurality of supports for bulbs carried thereby, sealing-off devices, means for moving said frame and sealing-off devices relatively to bring the bulbs carried by the frame into operative relation to the sealing-off devices successively, means for moving the sealing-off devices into and out of position for operating upon a bulb, and means for operating the sealing-off devices.

23. A lamp making machine having a rotatable frame, a plurality of supports for bulbs carried thereby, exhausting means connected to said supports to exhaust the bulbs, sealing-off devices, means actuated by the operator for at will moving said devices into operative relation to a bulb supported on the frame, and means actuated by the operator for at will moving said devices away from the frame and then rotating the frame through a definite angle.

24. A lamp making machine having a support adapted to receive the tubulature of a bulb and support the same, means for exhausting the bulb through the tubulature, a bulb-holder, a heater, means for moving the bulb-holder into position for supporting the bulb in said tubulature support and the heater into position for heating the connection between the bulb and tubulature, and

means for moving the bulb holder and heater relatively to the tubulature support and then moving the bulb holder relatively to said heater when the glass is softened.

25. A lamp making machine comprising a rotatable frame, a plurality of supports thereon each adapted to receive the tubulature of a bulb and support the same, means connected to said supports to exhaust each bulb through its tubulature, a bulb-holder, a heater, means for moving the bulb-holder into position for heating the connection between the bulb and its tubulature, means for moving the bulb holder and heater relatively to the tubulature support and for further moving the bulb holder relatively to the heater when the glass is softened, and means for moving the heater, the bulb holder and the bulb carried thereby away from the frame.

In witness whereof, I have hereunto set my hand this 21st day of May, 1906.

WILLIAM R. BURROWS.

Witnesses:

LOUISE SCHELL,

WM. J. DESMOND.