Oct. 7, 1958 A. G. FOOTE ET AL 2,855,265

LAMP SEALING METHOD AND APPARATUS

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Fig. 1.

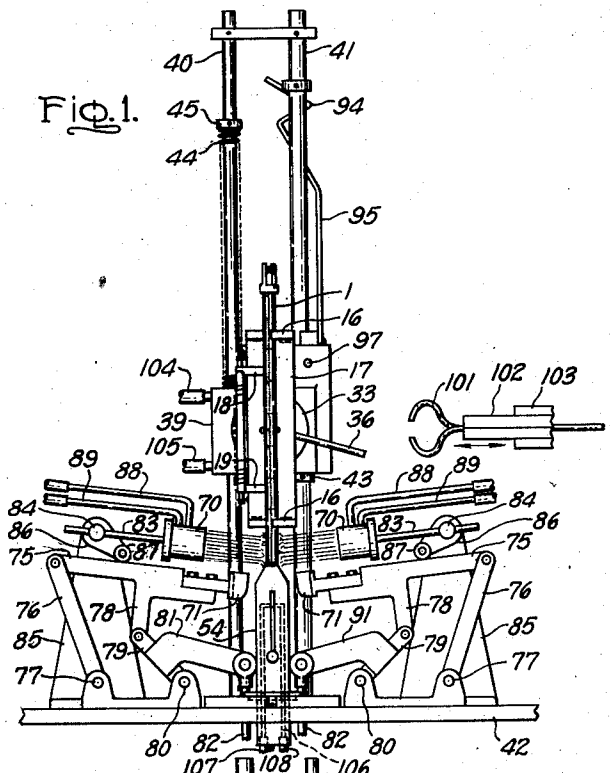


Fig. 2.

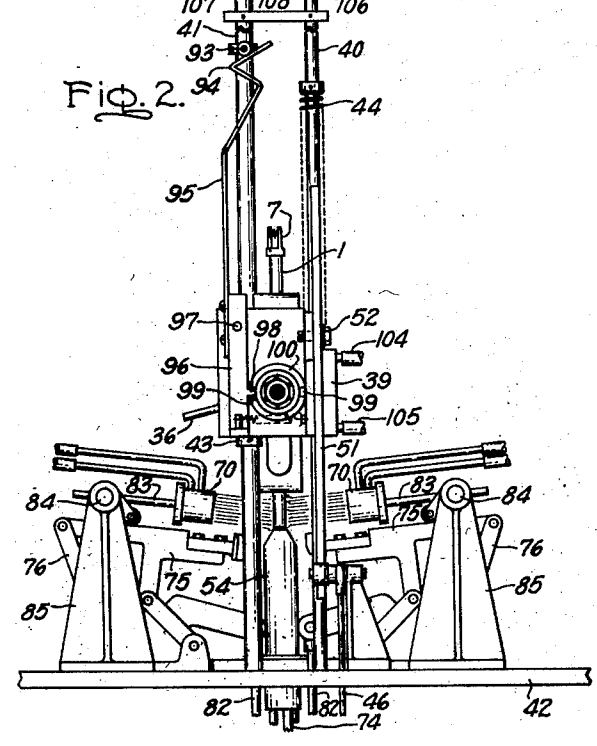
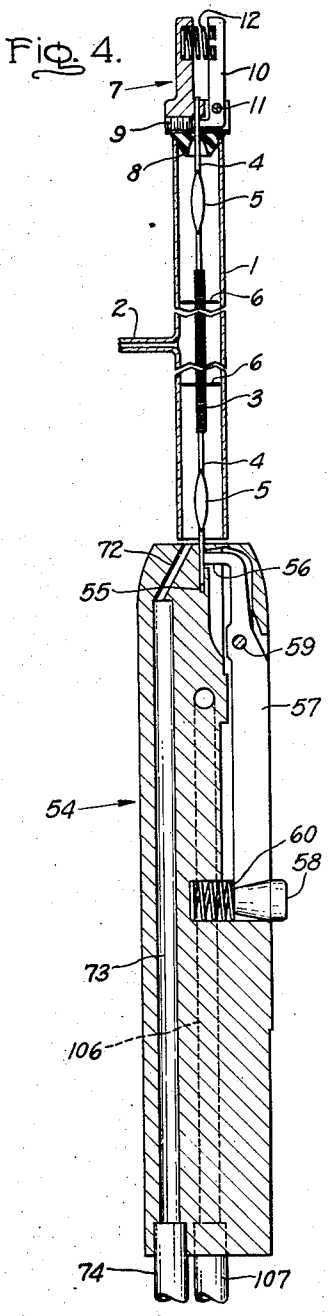


Fig. 4.



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Fig. 6.

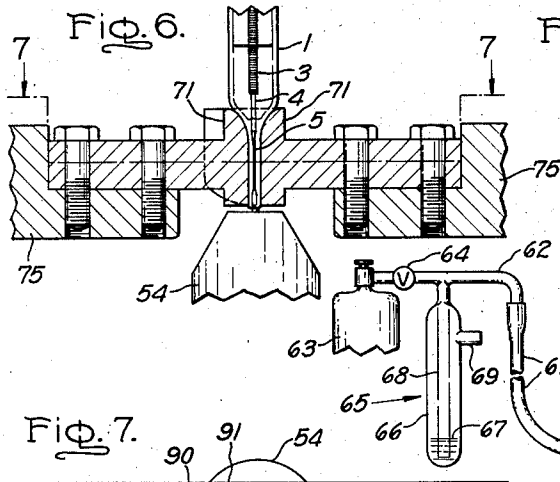


Fig. 3.

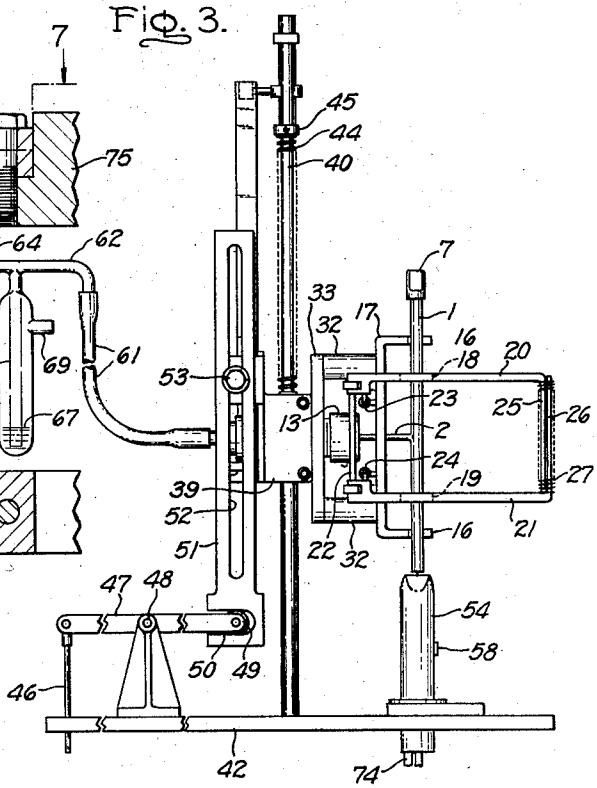


Fig. 7.

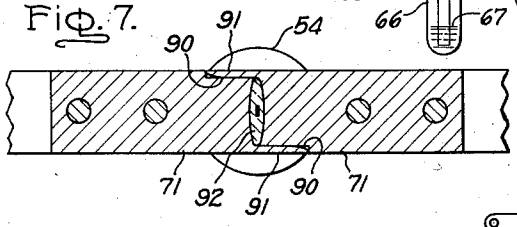
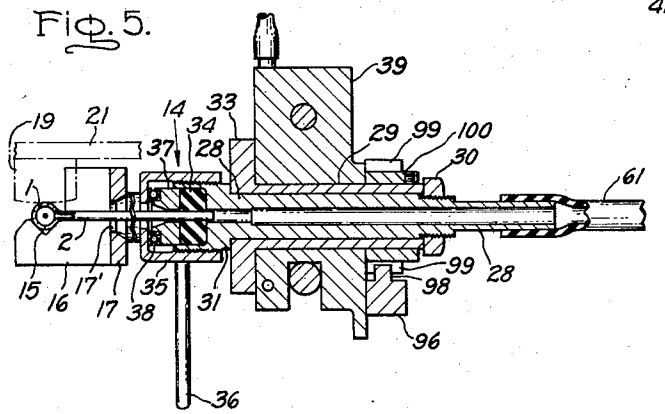


Fig. 5.



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LAMP SEALING METHOD AND APPARATUS

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Application May 17, 1956, Serial No. 585,519

5 Claims. (Cl. 316—31)

Our invention relates to a method and apparatus for sealing and gas filling electric lamps or similar devices. The invention is particularly concerned with the manufacture of lamps of the type comprising an elongated tubular envelope of vitreous material having a filament extending therethrough and connected to lead-in conductors sealed in the ends of the envelope. Such a construction is embodied, by way of example, in tubular heat lamps comprising a tubular envelope of vitreous material such as fused silica or quartz having a coiled filament of tungsten extending therethrough and connected to lead-in conductors of molybdenum wire, for example, having portions thereof sealed in the ends of the envelope which is filled with an inert gas such as argon.

The conventional practice in assembling electric lamps is to first seal the filament assembly into the lamp envelope and then subject the envelope to an exhaust schedule followed by introduction of the gas filling. The sealing and exhaust operations are usually performed as separate operations on combination machines or on separate machines. It is an object of the present invention to eliminate entirely the exhaust schedule and thereby reduce drastically the time and equipment required in the production of the lamps.

In accordance with one aspect of our invention the assembly of the lamp is materially simplified by employing a flushing process wherein the envelope, containing the filament assembly, is flushed with an inert gas which is to constitute the final gas filling. The air in the envelope is displaced by the inert gas and the ends of the envelope are fused and sealed about the respective lead-in conductors after which the envelope is sealed off to retain the gas therein as the permanent filling gas.

In accordance with another aspect of the invention, the process is implemented by the provision of apparatus comprising a rotatable chuck for receiving a gas supply tube connected to the lamp envelope and which permits successive sealing of both ends of the lamp envelope without interrupting continuity of the flow of inert gas and which avoids the possibility of contaminating the lamp atmosphere.

Further features and advantages of our invention will appear from the following detailed description and from the drawings wherein:

Fig. 1 is a front elevation of apparatus embodying our invention;

Figs. 2 and 3 are a rear elevation and a side elevation, respectively, of the apparatus;

Fig. 4 is a fragmentary elevation in section and on an enlarged scale, showing the lamp parts in assembled relationship with a lead-wire chuck at the lower end thereof and a cap member at the upper end thereof for plugging the end of the lamp envelope and supporting the filament assembly therein;

Fig. 5 is a horizontal section through the assembly of rotatable chuck and lamp bulb holder; and

Figs. 6 and 7 are, respectively, side and plan views in

section, the Fig. 7 section being taken along the lines 7—7 of Fig. 6, showing pinch-clamp jaws for sealing the ends of the envelope.

The assembly of lamp parts as illustrated herein, and shown most clearly in Fig. 4, comprises a tubular envelope 1 of quartz, for example, having a gas supply tube 2, also of quartz, extending laterally outward from the midportion of the envelope. The envelope contains a filament assembly consisting of a coiled tungsten filament 3 having attached to each end thereof a lead-in conductor consisting of a molybdenum wire 4 having a flattened portion 5 intermediate its length. The filament is provided with a plurality of spaced disks 6 of tantalum which are secured to the filament and which serve the dual functions of supporting the elongated filament in spaced relation from the walls of the envelope and also serving as a getter in the finished lamp to absorb deleterious gases.

The first step in the assembly is to thread an apertured cap 7 over one of the lead wires 4 and push a rubber stopper portion 8 of the cap into the end of the envelope to plug that end and close it off from the atmosphere. The lead wire 4 is gripped between an adjustable screw 9 in the body of the cap and the end of a clamping lever 10 which is pivoted on a pin 11 and held in a normally closed position by the expansion of a spring 12.

The lamp assembly is then mounted in the apparatus by inserting the end of the supply tube 2 into a port at the head of a horizontal rotatable chuck 14 (Fig. 5) a distance sufficient to bring the envelope 1 into notches 15 in jaws 16 on the U-shaped arm portion 17 of a holder, so that the envelope 1 is located vertically or normal to the axis of chuck 14. The tube 2 is threaded through a slot 17' in the arm 17. The envelope is clamped in the notches 15 by jaws 18 and 19 (Figs. 3 and 5) which are mounted on arms 20 and 21 respectively which are independently pivoted on a pin 22 mounted in brackets on the arm 17 and are biased to closed position by springs 23 and 24 connected between pins on said arms 20—21 and on said bracket 17. The movable arms 20 and 21 have co-extending end portions 25 and 26 which are loosely coupled together by a coiled spring 27 to form a handle portion by which the operator holds the arms 20—21 in open position during insertion of the lamp into the chuck 14 and jaws 16. The independent arrangement of arms 20 and 21 assures a firm grip of each jaw 18 and 19 against the envelope 1 in case of slight variations in diameter of the envelope.

As shown in Fig. 5 the chuck 14 comprises a spindle portion 28 which is secured to a sleeve 29 by a nut 30 which clamps the enlarged head end 31 of the spindle to said sleeve 29. The bracket portion 17 of the lamp holder is also secured to said sleeve 29 through stud members 32 projecting from extended portions of a flange 33 on the end of the sleeve 29 whereby the lamp holder 17—20—21 is rotatable with the chuck 14.

The port portion of the rotatable chuck 14 comprises a resilient rubber washer 34 located in a cavity in the enlarged head end 31 of the spindle 28. The washer 34 is compressed against the supply tube 2 by a cap 35 which is threaded on the spindle 28 and is turned by a handle 36 to press a metal washer member 37, through ballbearing 38, against the washer 34.

The sleeve 29 is rotatably mounted in a supporting block member 39 which is slidably mounted on columns 40 and 41 extending vertically upward from a bed or table 42. The said block 39, together with the rotatable chuck 14 and lamp holder 17—20—21 constitutes a head which is normally urged downward along the columns 40—41 toward a stop collar 43 on column 41 by its own

weight supplemented by a spring 44 which surrounds the column 40 between the block 39 and a collar 45. At the time the lamp assembly is mounted in the apparatus, the head assembly is in a raised position from that shown in Figs. 1–3, having been elevated by operation of a connecting rod 46 (Fig. 3) which is pivotally connected to one end of a lever 47 which is pivoted at 48 and is connected through a roller 49 at its other end to a slot 50 in a link 51 secured to the block 39. To accommodate lamps of different length, the link 51 is adjustable on the block 39 through a slot 52 and is fastened thereto by a bolt 53.

When the lamp assembly has been inserted into the chuck 14 and holder 17—20—21, and the supply tube 2 tightly connected in the chuck by compression of washer 34, the assembly is lowered by upward movement of connecting rod 46, and the support block 39 comes to rest on the stop collar 43. At this time the lower end of the envelope 1 approaches the top of a lead wire chuck 54 which extends vertically from the table 42 in an axis aligned with the jaws of the bulb holder 17—20—21 and normal to the axis of rotatable chuck 14. Before the assembly reaches its lowermost position the operator holds it so that the envelope 1 is spaced a small distance above the chuck 54; the operator then grasps the lead wire 4 at that end with a pair of tweezers and threads it into an axial aperture 55 (Fig. 4) in the upper end of the chuck. While inserting the lead-wire into the chuck, the operator holds the upper end 56 of a clamping lever 57 in an open position by pressing against a button 58 on the lower end thereof to pivot the lever about a pin 59 against the action of a spring 60 which normally biases the lever to a closed position. The head assembly is then lowered to its lowermost position wherein the block 39 rests on the stop collar 43 and the lower end of envelope 1 comes to rest a short distance, such as a few millimeters, about the top of the chuck 54.

A flow of inert gas, preferably argon in this case, is then started into the envelope 1 by way of the supply tube 2, chuck spindle 28, flexible hose 61 and conduit 62 from a suitable source which may be a tank 63 of the compressed gas. The flow is started by opening a valve 64 in the conduit 62 which also has connected thereto a relief valve means 65 in the form of a bottle 66 containing a suitable liquid 67, such as butyl-phthalate, into which extends a tube 68 connected to the conduit 62, the bottle 66 being vented to the atmosphere by a side tube 69. The flowing argon gas displaces the air from the envelope 1 in a stream flowing out the lower end of the envelope.

Shortly after starting the flow of argon gas, heating of the lower end of the envelope 1 is begun by a pair of burners 70 (Figs. 1 and 2) located at opposite sides of the chuck 54. When the said end of the envelope has been heated to sufficiently plastic condition it is compressed and sealed about the adjacent lead wire 4 by a pair of pinch jaws 71. The argon may flow, in a typical case, for a period of some 15 seconds or so before the end of the envelope is pinched and sealed by the jaws 71. At the time the envelope end is sealed, a flow of inert gas, such as nitrogen is directed against the portion of the lead wire 4 projecting from the envelope in order to protect it from oxidation, it having been previously protected by the flow of argon gas. The nitrogen gas is directed at the lead wire through the inclined terminal portion 72 (Fig. 4) of a longitudinal passage 73 in the chuck 54, which passage is connected to a source of nitrogen gas by a conduit 74. Upon sealing of the lower end of the envelope, the pressure of argon in the envelope is prevented from rising sufficiently to distort the plastic seal area, by virtue of the pressure relief valve 65 (Fig. 3) which limits the pressure in the envelope to just slightly above atmospheric depending upon the height of the liquid 63 above the lower end of the tube 68.

As shown in Figs. 1 and 2 the pinch jaws 71 are each carried by a cradle member 75 which is pivoted at its back end to one end of a link 76 which is pivoted at its other end on a pin 77 in a lug on the table 42. The cradle also has a depending arm portion 78 which is pivotally connected to one end of a link 79 which is pivoted in a lug on the table 42. To effect the pinching operation, the cradle 75 is rocked forwardly and upwardly by an arm 81 which is attached at one end to the link 79 and is pivotally connected at its other end to a push rod 82 which may be pulled down by a foot pedal. The burners 70 are each carried by a rod 83 which is attached to a pin 84 which is journalled in a bracket 85 on the table 42. The burner is supported by and movable upwardly with the cradle 75 by virtue of an arm 86 having one end thereof fixed to the pin 84 and carrying at its other end a roller 87 which bears on the top surface of cradle 75. The burners in this case are supplied with oxygen and hydrogen through conduits 88 and 89. As herein illustrated, the pinch clamp jaws 71 are each provided with an undercut portion 90 (Fig. 7) at one side and a cooperating extension 91 on the other side to form a complete enclosure for the compressed seal portion 92 of the envelope.

After the seal has been formed, the jaws 71 are retracted to the position shown in Figs. 1 and 2 (the flow of gases in burners 70 being reduced to maintain a keep-alive flame) and the head assembly of block 39, rotary valve 14 and lamp holder 17—20—21 is raised along the columns 40—41 by depressing the connecting rod 46. In the course of this upward movement, the rotary valve and lamp holder assembly is released for rotary movement by engagement of a roller 93 (Fig. 2) on column 41 with the cam portion 94 of an arm 95 extending upwardly from a latch 96. The said latch 96 is pivoted on a pin 97 in block 39 and has a tooth 98 (Figs. 2 and 5) engageable with each of a pair of diametrically opposed notches 99 in a collar 100 which is secured to the back end of the sleeve 29.

Upon disengagement of the tooth 98 from notch 99, the cap 7 is removed from the upper end of the envelope 1 and the assembly of rotary valve 14 and lamp holder 17—20—21 is revolved through 180 degrees by the operator to invert the lamp. Thereupon, the head assembly is again lowered to the position shown in Figs. 1–3, the latch tooth 98 having engaged the other of the opposed notches 99 in collar 100. The hose 61 is of sufficient length and flexibility to absorb the rotation. During all this time the flow of argon gas is maintained to drive out any air that may have become pocketed in the end of the envelope 1 which was originally uppermost. The operator then repeats the operations of threading into the chuck 54 the lead wire 4 which is now lowermost, turning up the supply of gas to the burners 70 to heat the envelope 1 to a plastic condition, and then operating the pinching jaws 71 and turning on the flow of nitrogen through passage 73.

Upon completion of the second seal, and with the argon pressure still maintained, the lamp and the head assembly are raised, and the envelope 1 is sealed or tipped off by fusing and severing the supply tube 2 at a point closely adjacent the envelope. The sealing may be effected by a gas torch 101 (Fig. 1) having a pair of opposed jets and which may be hand held or mounted on a slide 102 in a bracket 103 supported from the table 42.

Although the pressure in envelope 1 is slightly above atmospheric, the tipping off operation is readily effected by the torch 101 without blowing out the plastic seal; this is due, presumably, to the viscosity of the quartz and the pressure of the gas streams from the torch. In this manner, the final pressure of the argon filling in the envelope is approximately 500–600 millimeters at room temperature, depending upon the length of the envelope 1. Longer envelopes will have a slightly higher pressure due to the fact that they are not as highly heated for their full length by the sealing burners 70 as are the shorter envelopes, the pressure being dependent, of course, upon

the temperature. It will be evident that the pressure may be adjusted to any desired degree, and for pressures substantially above atmospheric the tipping off operation may be effected by the use of pinching jaws as is well known in the art or by freezing the argon gas in the envelope.

The argon flow is then shut off by the valve **64** and the rotatable chuck **14** and holder assembly **17—20—21** is rotated 180 degrees back to its initial position, and the residue of supply tube **2** is removed from the chuck **14** preparatory to the start of another cycle.

The support block **39** is preferably cooled by circulation of water through internal passages therein (not shown) by way of conduits **104** and **105**; and the lead wire chuck **54** is also cooled by circulation of water through a U-shaped passage **106** by way of conduits **107** and **108**.

To recapitulate briefly, the lamp parts are first assembled as shown in Fig. 4 by threading the filament **3**, with its attached disks **6** and lead wires **4**, into the envelope **1**, with the lead wires extending from respective ends of the envelope. One end of the envelope is then plugged and the adjacent lead wire **4** is gripped by application of the cap member **7** thereto. Then with the head assembly of block **39**, chuck **14** and lamp holder **17—20—21** in a raised position from that shown in Figs. 1–3, the lamp assembly is mounted by holding open the arms **20—21** and inserting the supply tube **2** into the port portion **34—35** at the head of the chuck **14** and bringing the envelope **1** into the notches **15** in jaws **16**, followed by closing of the arms **20—21** to cause the jaws **18—19** thereon to clamp against the envelope. The said head assembly is then lowered and the lead wire **4** at the lower end of the lamp is threaded into the aperture **55** in the lead wire chuck **54** (Fig. 4) and clamped therein by the end **56** of the lever **57**.

A flow of argon gas is then started through the envelope from a supply tank **63** (Fig. 3) by way of valve **64**, conduit **62**, hose **61**, spindle **28** of chuck **14** and supply tube **2**, the gas escaping through the space between the lower end of envelope **1** and the chuck **54**. The full flow of gas is then started into the burners **70** and is continued for a time sufficient to heat the lower end of the envelope **1** to a plastic condition after which the pinching jaws **71** are caused to close upon the envelope to seal it. Immediately upon pinching the end of the envelope a flow of nitrogen gas is started through the passage **73** in chuck **54** and is directed through the end **72** of said passage upon the exposed end of lead wire **4** to prevent it from oxidizing. The pressure of argon gas in the envelope is prevented from rising sufficiently to distort the seal by virtue of the relief valve **65** (Fig. 3).

The lamp and the head assembly of block **39**, chuck **14** and lamp holder **17—20—21** is then raised along the columns **40—41** whereupon the chuck **14** is released for rotation by engagement of the cam portion **94** of latch **96** with roller **93** on column **41**. The said chuck **14**, together with the lamp holder, is rotated 180 degrees and the cap **7** is removed, thereby inverting the lamp while continuing the flow of argon gas through the envelope to flush out any air remaining therein. The head assembly, with the lamp, is then lowered along columns **40—41**, the lowermost lead wire **4** is threaded into the lead wire chuck **54**, the head is brought to its lower-most position shown in Figs. 1–3 with the block **39** resting on stop collar **43**, and the lower end of the envelope is heated by burners **70** and pinched by jaws **71**, followed by a flow of nitrogen through passage **74** in chuck **54**. Then, with the argon pressure maintained, the envelope **1** is sealed off by fusing and severing the supply tube **2** with the torch **101** to thereby complete the manufacture of the lamp with the argon gas sealed therein as the permanent filling gas.

While we have illustrated and described one embodiment of our invention it will be understood that various modifications may be made therein within the spirit and scope of the invention as set forth in the appended claims.

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

1. Apparatus for sealing and gas filling an electric lamp comprising a tubular envelope of vitreous material having a supply tube extending laterally outward from its midpoint and a filament extending through the envelope and having lead wires attached thereto and projecting from the ends of the envelope, said apparatus comprising a rotatable chuck, an inert gas supply conduit connected to said chuck, means mounting said chuck for rotation about its axis, holder means mounted for rotation with said chuck and including jaw members arranged in an axis normal to the axis of said chuck and adapted to grip and support said envelope with its axis normal to the axis of said chuck and with its supply tube engaged in said chuck, means for gripping the lead wire at one end of the envelope and for plugging said end of the envelope, a lead wire chuck arranged in alignment with an axis normal to the axis of said rotatable chuck so as to be coincident with the axis through the jaws of said holder means for gripping the lead wire at the other end of said envelope, means to releasably lock said rotatable chuck in either of two rotative positions 180 degrees apart and such that the jaws of said holder means, and the lamp therein, are in alignment with the lead wire chuck, heater means and pinch clamp means mounted adjacent said lead wire chuck for heating the adjacent end of said envelope to a plastic condition and clamping it about the adjacent lead wire, said rotatable chuck being arranged in its mounting means for rotation through 180 degrees, upon release of said lock means, to permit reversing the lamp for sealing its said one end.

2. Apparatus for sealing and gas filling an electric lamp comprising a tubular envelope of vitreous material having a supply tube extending laterally outward from its midpoint and a filament extending through the envelope and having lead wires attached thereto and projecting from the ends of the envelope, said apparatus comprising a rotatable chuck, an inert gas supply conduit connected to said chuck, means mounting said chuck for rotation about its axis, holder means mounted for rotation with said chuck and including jaw members arranged in an axis normal to the axis of said chuck and adapted to grip and support said envelope with its axis normal to the axis of said chuck and with its supply tube engaged in said chuck, means for gripping the lead wire at one end of the envelope and for plugging said end of the envelope, a lead wire chuck arranged in alignment with an axis normal to the axis of said rotatable chuck so as to be coincident with the axis through the jaws of said holder means for gripping the lead wire at the other end of said envelope, means to releasably lock said rotatable chuck in either of two rotative positions 180 degrees apart and such that the jaws of said holder means, and the lamp therein, are in alignment with the lead wire chuck, heater means and pinch clamp means mounted adjacent said lead wire chuck for heating the adjacent end of said envelope to a plastic condition and clamping it about the adjacent lead wire, said rotatable chuck being arranged in its mounting means for rotation through 180 degrees, upon release of said lock means, to permit reversing the lamp for sealing its said one end, and burner means for sealing and severing said supply tube at a point adjacent the envelope while the supply tube remains connected to said rotatable chuck and to said gas supply conduit.

3. Apparatus for sealing and gas filling an electric lamp comprising a tubular envelope of vitreous material having a supply tube extending laterally outward from its midpoint and a filament extending through the envelope and having lead wires attached thereto and projecting from the ends of the envelope, said apparatus comprising a rotatable chuck, an inert gas supply conduit connected to said chuck, means mounting said chuck for rotation about its axis, holder means mounted for rotation with said chuck and including jaw members arranged in an axis

normal to the axis of said chuck and adapted to grip and support said envelope with its axis normal to the axis of said chuck and with its supply tube engaged in said chuck, means for gripping the lead wire at one end of the envelope and for plugging said end of the envelope, a lead wire chuck arranged in alignment with an axis normal to the axis of said rotatable chuck so as to be coincident with the axis through the jaws of said holder means for gripping the lead wire at the other end of said envelope, means to releasably lock said rotatable chuck in either of two rotative positions 180 degrees apart and such that the jaws of said holder means, and the lamp therein, are in alignment with the lead wire chuck, heater means and pinch clamp means mounted adjacent said lead wire chuck for heating the adjacent end of said envelope to a plastic condition and clamping it about the adjacent lead wire, said lead wire chuck having a passage therein arranged to be directed toward the lead wire held thereby to supply a flow of inert gas about the portion of the lead wire projecting from the envelope, said rotatable chuck being arranged in its mounting means for rotation through 180 degrees, upon release of said lock means, to permit reversing the lamp for sealing its said one end.

4. Apparatus for sealing and gas filling an electric lamp comprising a tubular envelope of vitreous material having a supply tube extending laterally outward from its midpoint and a filament extending through the envelope and having lead wires attached thereto and projecting from the ends of the envelope, said apparatus comprising a rotatable chuck, an inert gas supply conduit connected to said chuck, support means mounting said chuck horizontally for rotation about its axis, holder means arranged to support said envelope in a vertical position with its supply tube engaged in said chuck, said holder means being mounted for rotation with said chuck, means for gripping the lead wire at the upper end of the envelope and for plugging said end of the envelope, a lead wire chuck arranged below said rotatable chuck to be in vertical alignment with said holder means for gripping the lead wire at the lower end of the envelope, means to releasably lock said rotatable chuck in either of two rotative positions 180 degrees apart and with the said holder means arranged to hold the lamp vertically in either of said positions in alignment with said lead wire chuck, heater means and pinch clamp means mounted adjacent said lead wire chuck for heating the lower end of the envelope to a plastic condition and clamping it about the

adjacent lead wire, said support means being mounted for vertical movement away from the lead wire chuck, and means operable upon said vertical movement of the support means to release said lock means to free said rotatable chuck for rotation through 180 degrees to permit reversing the holder means and the lamp held thereby for sealing its other end.

5. Apparatus for sealing and gas filling an electric lamp comprising a tubular envelope of vitreous material having a supply tube extending laterally outward from its midpoint and a filament extending through the envelope and having lead wires attached thereto and projecting from the ends of the envelope, said apparatus comprising a rotatable chuck, an inert gas supply conduit connected to said chuck, support means mounting said chuck horizontally for rotation about its axis, holder means arranged to support said envelope in a vertical position with its supply tube engaged in said chuck, said holder means being mounted for rotation with said chuck, means for gripping the lead wire at the upper end of the envelope and for plugging said end of the envelope, a lead wire chuck arranged below said rotatable chuck to be in vertical alignment with said holder means for gripping the lead wire at the lower end of the envelope, means to releasably lock said rotatable chuck in either of two rotative poistions 180 degrees apart and with the said holder means arranged to hold the lamp vertically in either of said positions in alignment with said lead wire chuck, heater means and pinch clamp means mounted adjacent said lead wire chuck for heating the lower end of the envelope to a plastic condition and clamping it about the adjacent lead wire, said support means being mounted for vertical movement away from the lead wire chuck, and means operable upon said vertical movement of the support means to release said lock means to free said rotatable chuck for rotation through 180 degrees to permit reversing the holder means and the lamp held thereby for sealing its other end, and burner means for sealing and severing said supply tube at a point adjacent the envelope while the supply tube remains connected to said rotatable chuck and to said gas supply conduit.

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