This invention is a novel sealing-in and exhausting apparatus, useful for example in the manufacture of incandescent or other electric lamps, including radio tubes, where a single incandescent or bulb element has to be fused or sealed to an inner or stem element, following which the lamp has to be exhausted of air and finally sealed or tipped-off; it being understood that reference to exhausting includes filling, since some lamps require to be filled with inert or other gases. The invention relates to the combination apparatus and as well to novel features of each branch thereof.

The general object of the present invention is to afford a quick acting apparatus which will deliver a large production with efficiency and accuracy. A further object is to simplify substantially the complication of known machinery employed for similar purposes, especially for the consecutive purposes of sealing-in and exhausting. A detail object is to provide a special vacuum closure device or coupling means for the ready and quick coupling of the glass exhaust pipe of the usual incandescent lamp with the exhausting connections. Other and further objects and advantages will be explained in the hereinafter following description of an illustrative embodiment of the invention or will be understood to those conversant with the subject.

In the accompanying drawing Figure 1 is a vertical section of a part of a sealing-in and exhausting machine taken centrally through one of the individual units or heads of which there are a series arranged to receive and handle successive lamps.

Fig. 2 is a section on an enlarged scale showing the rubber coupling plug and surrounding parts; while Figs. 3 and 4 are similar drawings of modified forms thereof.

It has already been known to effect in succession the sealing-in and exhausting of a series of incandescent lamps in a single machine; but this has usually been done by passing the succession of lamps first around one circuit or orbit for the sealing-in operation and then around another circuit or orbit for the exhausting and tipping-off or final sealing operations, involving a manual or mechanical shifting of each lamp from a head or holding means of the first series to one of the second series. With the present invention a traveling carriage or rotary turret is used, but a novel head or holding means is provided, adapting the apparatus for the performing of the sealing-in and thereafter the exhausting and the final sealing of each lamp without the need of such shifting from one head or holder to another. The advancing carriage or turret being known in the art will be here disclosed only in part, sufficiently for the full disclosure of the novel head or holding means hereof.

In the drawing the lamp bulb a is shown as having an extended skirt b, and the skirt to be subsequently severed in the process of sealing-in or fusing the bulb element to the lamp stem c. The stem element c is shown as of the usual form having near its lower end a cylindrical portion with a flare or skirt d, and extending therebelow an exhaust pipe e, its passage connecting through the stem to the interior space within the bulb.

The traveling carriage 5 may be in the nature of a turret rotary about a vertical axis which may be assumed to be some distance to the left. The carriage or turret may support a large number of heads or holding means, in circular series, so that the turret may advance step by step, or continuously, bringing in succession each head, and therefore each lamp, to each of the successive positions or stages of operation.

The turret 6 is shown as having an outward extension 6 in the nature of a cylindrical bracket, barrel or vertical bearing, to which are fitted certain of the elements to be described. At the lower part of the turret is shown an outwardly extended bracket 7 and somewhat above that a similar bracket 8, both rigid with the turret.

Within the cylindrical extension or barrel 6 of the turret are contained a number of preferably concentric parts, which for convenience will be termed sleeves, and which may be described as follows, commencing with the outermost thereof. The first or outer sleeve 10 is adapted to rotate in the cylindrical barrel 6 of the turret, and it has an upper flange 11 overlying the barrel and a pulley 12 attached to its lower end below the barrel. The pulley is a means of rotation and may be driven by a belt 13 conveniently power operated, the purpose thereof being to maintain the lamp bulb and stem elements in rotation during their heating and sealing-in.

The second or bulb supporting sleeve or member 15 is splined to, so as to rotate with, sleeve 10, while being capable of lifting and lowering movements in relation thereto. In other words the sleeves 10 and 15 are rotatable in unison, the former being vertically fixed and the latter vertically slideable. The sleeve 15 is formed with a shoulder 17 resting upon the flange 11 of the sleeve 10. Above the shoulder 17 the sleeve 15...
carries a horizontal disk 18 which forms the bottom member of a rotary frame 19, having upstanding frame rods near the periphery and a connecting member 20 near the top ends of the rods; which top member 20 may be a ring or C-shaped part into which the lamp bulb a may readily be inserted, and having for example three supporting points 21 adapted to hold the bulb substantially in the position indicated. For lifting and lowering the second sleeve 15 and the rotary bulb supporting frame 19, there is indicated a mechanical member 23 in the nature of a fork or track, operatively connected to a power source with proper timing to effect the desired movements.

Within the second or bulb supporting member or sleeve 15, and splined to rotate with it, while capable of independent vertical movement, and a third member or sleeve 25 serving to support the stem element e. This is in the nature of a thin walled tube or cylinder, the upper end of which extends considerably above the second sleeve, where it is provided with a hollow end piece 26 at the top of which is attached a top piece 27 also cylindrical and located to receive and support the lower or flared end of the lamp stem, as indicated. The top piece or stem support 27 is hollow and serves to conduct an air stream into the lamp stem element at certain times, as will be described; and it has perforations or orifices 28 conducting air into the lamp stem element; such air serving to assist in cutting off the lower portion of the bulb, and at other times to effect cooling.

At its lower end the third or stem supporting sleeve 25 has an enlargement 30 in the nature of a flange, which may be engaged in the groove of a track or cam 31 timed to effect lifting and lowering of the third sleeve and connected parts at certain portions of the cycle. The cam or track 31 may be fixed and operated by reason of the advancing travel of the turret and head. The hollow space within the end piece 26 is large enough to permit lowering of the sleeve 25 and stem support 27 without conflict with the parts within.

Inside of the three sleeves mentioned, and spaced therefrom, is shown a fourth sleeve 33, in the nature of a thin walled tube, its lower end extending below the said other sleeves and having a threaded connection to the fixed bracket 8, where the sleeve is locked to the bracket by a nut 34, so that the sleeve remains vertically fixed during operations. The sleeve 33 has a top piece 35 in the form of a hollow cylinder removable and replaceable upon the sleeve by access from above. For this purpose the top piece 35 may have threaded engagement with the upper end of the sleeve 33. This arrangement provides a small internal shoulder 36 at the top end of the tubular sleeve 35, although such shoulder or stop might be otherwise provided. The top piece 35 has first a converging or contracted portion 37 and then a flared portion 38 at the extreme top forming an easy entrance for the exhaust pipe e of the lamp stem. The interior surface of the contracted portion 37 is generally conical but preferably taper curved, or bell-shaped, for purposes of pressure to compress a sealing plug next to be described.

Inside of the top piece 35 of the sleeve 33 and contacting the pressure piece 37 is a resilient or bell rubber coupling or plug 40. This is shown as having a vertical passage 41 through its axis, which passage is somewhat larger than the exhaust pipe e, so that the pipe may be loosely and easily inserted, and removed. The plug also at one end, or preferably both ends, is bell-shaped or conical, thus presenting a top bevel or bell 42 and a lower bevel or bell 43, the top bevel engaging the bell-shaped contraction or pressure piece 37 already mentioned, while the lower bevel of the plug engages the bell-shaped top end or pressure piece 45 of the fifth sleeve about to be described, the sides of top piece 35 confining the cylindrical or central part of the plug.

The fifth sleeve 46 is a tubular member containing a central suction passage, and it extends vertically preferably in sliding contact with the fixed fourth sleeve 33. The upper end of the fifth sleeve is formed with a slight enlargement or pressure piece 45 affording a bell-shaped contact surface for the coupling plug 40 and affording also a shoulder which normally rests on top of the shoulder 38 of the fourth sleeve. The fifth or inner sleeve 46 extends downwardly beyond all of the other concentric sleeves and at its lowest end is preferably formed with an extension 47 of reduced exterior diameter. At the shoulder thus produced there is provided a disk 48. The sleeve 46 and pressure piece 45 are preferably vertically moveable relatively to the sleeve 33 and pressure piece 37 to compress and release the coupling plug, but the arrangement might be reversed and the sleeve 33 shifted for the purpose.

The inside sleeve or tube 46 forms a pneumatic connection between vacuum-producing apparatus and the lamp, the exhaust pipe e of which is extended through the coupling plug into the tube 46. The vacuum connections may comprise a vertical tube 50 in line with the extension 47, a soft rubber coupling 51 surrounding both of them for air-tight connection. At the lower end of the vacuum tube 50 is a moisture trap 52 and from this extends leftward a horizontal tube 53 extending to a substantially central vacuum chamber or suction source, not shown. The elements 46 to 53 are intended to have a slight vertical movement, and this is permitted by a slight flexing of the long radial suction tube 53 and a resilient rocking of the rubber coupling 51.

The vertical movement of the sleeve 46 is for the purpose of effecting a sealing as between it and the exhaust pipe e of the lamp, the rubber plug 40 constituting the sealing connection between them. The pipe e being inserted loosely into the axial bore of the rubber plug, it is only necessary to effect sealing to cause a compression of the plug by the lifting of the sleeve 46, its belled top end or pressure piece 45 and the belled pressure piece 37 producing a diagonal camming action by which the rubber is displaced inwardly into intimate contact with the exhaust pipe. In this way the top end 45 of the sleeve 46 seals itself by its upward pressure against the rubber plug, and at the same time causes the sealing of the latter against the exhaust pipe, so that the sleeve and the pipe becomes effectively coupled to each other. The piece 37 is merely a complementary pressure piece, no sealing against it or top piece 35 being necessary.

Vertical movement of the sleeve 46 for this sealing purpose may be effected as follows. Below the disk 48 is shown a thrust bearing 56, the disk resting upon the bearing and the bearing resting upon the upper disk member 57 of a disk cam, this in turn resting upon a lower cam member or disk 59 fixedly supported on the bracket 7.

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The division line between the cam disks 57 and 58 being inclined it is only necessary to rotate the upper disk 57, thereby to raise it and the thrust bearing, the fore-facing upward the sleeve 46 and its top or coupling end 45. An operating arm 59 is shown extending outwardly from the rotary cam disk 57; and this may be swung by hand, or by a timed mechanism, such as a pin 60 mounted on an arm 61 on an upright shaft 62 having suitably timed power connections, although the operating arm 59 might coact directly with roller devices operative by reason of the indexing or shifting movements from position to position.

A fixed air supply passage or tube 65 is shown adapted to conduct air of moderate compression to an air passage 66 in the turret 5, this passage leading to an annular chamber 67 and thence through perforations 68 in the first sleeve 10, thence through an annular chamber 69 beneath the second sleeve 15, thence through perforations 70 in the third sleeve 25, which sleeve conducts the air up into the hollow end piece 26 which in turn distributes it to the lamp stem and the lower part of the bulb as already described.

In lieu of disclosing in full the mechanical connections, operating cams and other timing means, a statement of the preferred timing and operation will now be afforded in such manner that a machine can be constructed of the rotary or turret type according to this invention by the mere proper designing of the operating connections.

In the drawing the parts are shown in the following positions. The second sleeve 15 carrying the frame 19 which supports the lamp bulb is in its lowered position. The third sleeve 25 which carries the support 27 for the lamp stem is in its raised position. The fifth sleeve 46, which is a suction tube, is in its lowered position, so that the pressure pieces 37 and 45 are separated and the coupling plug 40 is uncompressed, and the lamp stem exhaust pipe e sets loosely in the position shown. As the entire head passes around its circuit or orbit the following successive operations take place, not necessarily at successive stations, but substantially in the order about to be recited.

The sealing-in may be performed with the parts in the disclosed position. Heat, as of gas flames, softens the bulb skirt, and contracts it, and unites the bulb with the stem flare, while the skirt becomes detached, as usual. During the sealing-in the pulley 12 is rotated, so rotating the bulb and stem, distributing the heat and ensuring a symmetrical result. The exhaust pipe e rotates freely within the plug 40 during sealing-in.

The sealing-in is now completed, but, preferably, to improve the character of the union between bulb and stem, the joint is stretched slightly by hand. To accomplish this the rotation is stopped, and immediately the exhaust pipe e is gripped by the coupling plug as next described, and therewith the second sleeve 15 and frame 19 are lifted slightly, as ¼ inch, to lift the bulb relatively to the stem before the soft glass has set. The skirt of the bulb has been detached during the fusing and has dropped upon the disk 18 to await subsequent extraction or removal.

The making of the exhausting connections by the coupling plug may be as follows. The fifth sleeve 46 is lifted, as by the cam 57 and arm 59, so as to compress the resilient plug 40 and thus make a tight connection between the sleeve 46 and the pipe e. As constructed this rise may be in the neighborhood of ¾ inch; but it is sometimes desirable, as when testing tightness of connections, to close entirely the rubber plug coupling, without pipe therein, in which case the arm 59 may be swung so far that the cam 57 will lift the sleeve 46 to a maximum lift of ¾ inch. The compressing of the plug now securely holds the glass exhaust pipe e, and the lamp stem and bulb, until released.

The third sleeve 25 and the stem support 27, which up to this point have engaged or supported the lamp stem, are now moved down by means of the track or cam 31 to a substantial extent, for example ¾ inch to 1 inch. This important step exposes and gives access to a substantial extent of the glass exhaust pipe for the purpose of subsequent heating and tipping-off. The coupling meanwhile firmly supports the lamp by the pipe e, while the bulb is still steadied by the support 15. Exhausting of air may now be effected, in connection with a gage for the purpose of determining the perfection of the sealing-in operation, and for detecting any possible leaks or defects; following which the complete or final exhausting is effected, which may take considerable time and extend around a considerable portion of the orbit.

The tipping-off may now be performed by the application of flames or other source of heat to the exposed length of glass pipe e between the stem c and the lowered support piece 27. This heating may extend through a substantial extent of orbit. Towards the completion of this operation the second sleeve 15 and frame 19 may be lifted, for example by another ¼ inch, so as to stretch out the molten glass and insure the proper final sealing at the tipping-off point; and this may be followed by a further lifting, for example ¼ inch, thus insuring proper and complete severing of the glass pipe.

These steps complete the essential operations. Following them the completed product may be lifted out automatically or otherwise, and the bulb skirt b removed in a suitable way, and a gripper moved in to take hold of the top of the detached section of glass pipe e, and thereby remove it; the removal of the left over skirt and pipe end being preferably effected by the lifting of a single gripper device. After the removing gripper has taken hold of the glass pipe the fifth sleeve 46 may be caused to descend to its lowest position, as shown, thus to release the rubber plug 40 from the coupling pressure and allow the exhaust pipe. Finally the second sleeve 15 and frame 19 may be returned downward to initial position ready to receive the next bulb, while the third sleeve 25 and support 27 may be returned upward to initial position to receive the next stem.

The vacuum closure device, including the rubber coupling plug 40, is shown in enlarged scale in Fig. 2 and this exhibits certain practical advantages not presented by prior known structures such as the elastic washer or coupling illustrated in the patent of Huywood 844,275 of April 7, 1908. A very effective coupling means of long life is afforded by the present improvement. The bell shape of the pressure pieces 37 and 45, especially the latter, is of advantage. This affords a small area of contact, initially practically a line contact, between the pressure piece and the conical end of the plug. The surfaces of 37 and 45 are highly polished so as to slide easily over the rubber, and a cam or wedge action is afforded. By the relative lifting of the pressure piece 45 the plug is subjected, not to a mere axial or longitudinal squeezing pressure, but to a diagonal com-
pression adjacent the conical ends of the plug. The forces distorting the rubber therefore tend to converge upon that part of the glass pipe which is about midway of the length of the plug. The wedging or camming action therefore is of special character, and not haphazard, and gives a very effective sealing of the glass against the glass pipe; while by the pressure of the portion 45 of sleeve 46 against the under side of the plug the sleeve or tube effects its own sealing. The glass pipe and the metal tube thus become effectively coupled to each other for the exhausting step. The distorting portion and flow of the paste-like substance is so effective that it is found that the plug can be closed and sealed, though empty and containing no pipe, by the constraining of its passage to closed condition.

The described construction provides corner spaces 44 of substantial size between the outer peripheries of the plug, the outer wall 35 and the pressure pieces. These voids are of value, especially in respect to the lower end of the plug, since they prevent the abrasion and wear of the rubber and otherwise is bound to take place by the repeated sliding of the pressure piece 45 up and down within the wall 35, tending to cut and start the disintegration of the rubber if shaped to fill corner pieces 44. The sealing action as between the plug and the sleeve 46 is an endwise sealing by reason of the rising movement of the latter; the sealing between the plug and the glass pipe is a contracting or radial sealing action.

In the modification shown in Fig. 3 the plug 40 is made with a conical shape at its lower end only, the pressure piece 37 at the top of the end piece 35 being shaped accordingly. Also the tapered contour of the lower end of the plug is curved rather than strictly conical, and the lower pressure piece 45 is of a special curvature, affording corner spaces 44 differing from those in Fig. 2. In the modification of Fig. 4 the coupling plug 40 is conical at its upper but not at its lower end, and the upper pressure piece 37 is shaped accordingly. The compressing action is strictly vertical at the lower end of the plug, although diagonal at the upper end by reason of the wedging shape of the plug and pressure piece.

In Fig. 5 the double cone of Fig. 2 is replaced by another tapered form, with spherical curvature, and the entire plug may be substantially spherical, with a diametrical passage, and preferably with an axial protrusion near one, preferably the lower, end to ensure that the passage stands vertical. In these and the main figures the coupling plug is shown of soft tough rubber; but it is clear that any compressible composition adapted to sealing contact is usable, and in using the word rubber it is intended to include any rubber substitutes or equivalents.

There has thus been described a sealing-in and exhausting apparatus according to the principles of the present invention; but since many matters of combination, construction, arrangement and design may be variously modified without departing from the principles of the invention it is not intended to limit the invention to such matters except so far as set forth in the appended claims.

What is claimed is:

1. In sealing-in and exhausting apparatus a head in which the operations of sealing-in, exhausting and tipping-off are performed, comprising a holder for the lamp bulb, a holder for holding the lamp stem in position in longitudinal alignment with the bulb, means for rotating the bulb and stem holders in unison during sealing-in, and means for shifting one of the holders relatively to the other after sealing-in to expose the exhaust pipe of the stem for the tipping-off or final sealing thereof after exhausting the lamp therethrough.

2. In sealing-in and exhausting apparatus a head in which the operations of sealing-in, exhausting and tipping-off are performed comprising an exhausting passage, a holder for the lamp bulb, a support for gaging the lamp stem position in relation to the bulb, means for rotating said holder and support in unison during sealing-in, a means for coupling the exhaust pipe of the stem to the exhausting passage and thereby holding the stem after sealing-in, and means for retracting said gaging means after sealing-in to expose the exhaust pipe of the stem for the tipping-off or final sealing thereof after exhausting the lamp therethrough.

3. In sealing-in and exhausting apparatus a head in which the operations of sealing-in, exhausting and tipping-off are performed, comprising an exhausting passage, a holder for the lamp bulb, a holder for the lamp stem in sealing-in position in longitudinal alignment with the bulb, means for rotating the bulb and stem holders in unison during sealing-in, a coupling for coupling the exhaust pipe of the stem to the exhausting passage and means for operating it to effect such coupling after the sealing-in and means for longitudinally shifting said stem holder after sealing-in to expose the stem exhaust pipe for the tipping-off or final sealing thereof after exhausting the lamp therethrough.

4. Apparatus as in claim 3 and wherein the bulb holder and the stem holder are carried on concentric rotary sleeves relatively shiftable.

5. Apparatus as in claim 3 and wherein the bulb holder and the stem holder are carried on concentric rotary sleeves relatively shiftable, and the means for operating the coupling comprises pressure pieces mounted respectively on the exhausting passage and a sleeve concentric therewith.

6. In sealing-in and exhausting apparatus a head in which the operations of sealing-in, exhausting and tipping-off are performed, comprising a holder for vertically supporting the lamp bulb, and a vertical sleeve carrying it, a holder for holding and gaging the lamp stem in vertical position in longitudinal alignment with the bulb, and a vertical sleeve within said first sleeve carrying the stem holder, a rotary sleeve exterior to said sleeves for rotating them and thereby the bulb and stem holders in unison during sealing-in, means for vertically shifting one of the sleeves and holders relatively to the other after sealing-in to expose the exhaust pipe of the stem for the tipping-off or final sealing thereof after exhausting the lamp therethrough, a vertical exhaust passage or tube, inside of said sleeves, a coupling for coupling said exhaust passage to the exhaust pipe before the exhausting and for releasing the latter after the tipping-off, said coupling comprising a compressible plug surrounding the exhaust pipe, a pressure piece on the exhaust passage contacting the plug, an opposing pressure piece above the plug, a sleeve surrounding the passage and carrying the opposing pressure piece, and means for effecting relative vertical movement between the passage and sleeve for causing sealing pressure of the plug on the passage and pipe.

7. In sealing-in and exhausting apparatus a head
in which the operations of sealing-in, exhausting and tipping-off are performed, comprising a holder for vertically supporting the lamp bulb, and a vertical sleeve carrying it, a holder for holding and gaging the lamp stem in vertical position in longitudinal alinement with the bulb, and a vertical sleeve within said first sleeve carrying the stem holder, a rotary sleeve exterior to said sleeves for rotating them and thereby the bulb and stem holders in unison during sealing-in, means for lifting the bulb holder to stretch the exhaust pipe during tipping-off.

9. In sealing-in and exhausting apparatus a head in which the operations of sealing-in, exhausting and tipping-off are performed, comprising a holder for vertically supporting the lamp bulb, and a vertical sleeve carrying it, a holder for holding and gaging the lamp stem in vertical position in longitudinal alinement with the bulb, and a vertical sleeve within said first sleeve carrying the stem holder, a rotary sleeve exterior to said sleeves for rotating them and thereby the bulb and stem holders in unison during sealing-in, means for vertically shifting one of the sleeves and holders relatively to the other after sealing-in to expose the exhaust pipe of the stem for the tipping-off or final sealing thereof after exhausting the lamp therethrough, a vertical exhaust passage or tube, inside of said sleeves, a coupling for coupling said exhaust passage before the exhausting and for releasing the latter after the tipping-off, and means for lifting the bulb holder to stretch the exhaust pipe during tipping-off; said coupling comprising a compressible plug surrounding the exhaust pipe, a pressure piece on the exhaust passage contacting the plug, an opposing pressure piece above the plug, a sleeve surrounding the passage and carrying the opposing pressure piece, and means for effecting relative vertical movement between the passage and sleeve for causing sealing pressure of the plug on the passage and pipe.

10. Apparatus as in claim 7 and wherein is means for lifting the bulb holder to stretch the exhaust pipe during tipping-off.

11. In a lamp sealing-in and exhausting apparatus, a head in which the operations of sealing-in, exhausting and tipping-off are performed, comprising an exhausting passage, means for holding the lamp bulb in position during sealing-in, exhausting and tipping-off, means for holding the lamp stem in proper position in relation to the bulb during sealing-in, means for rotating both said holding means in unison during sealing-in, means for lifting the bulb holding means to stretch the fused connection between bulb and stem during sealing-in, means arranged for coupling the exhaust pipe of the stem to the exhausting passage and thereby holding the stem after sealing-in and cessation of rotation, and means for retracting said stem holding means after sealing-in to expose the exhaust pipe of the stem for the tipping-off or final sealing thereof after exhausting the lamp therethrough.

12. Apparatus as in claim 11 and wherein is means for lifting the bulb holding means to stretch the exhaust pipe during tipping-off.

13. In a lamp sealing-in and exhausting apparatus, a head in which the operations of sealing-in, exhausting and tipping-off are performed, comprising an exhausting passage, means for holding the lamp bulb in position during sealing-in, exhausting and tipping-off, means for holding the lamp stem in proper position in relation to the bulb during sealing-in, means for rotating both said holding means in unison during sealing-in, means arranged for coupling the exhaust pipe of the stem to the exhausting passage and thereby holding the stem after sealing-in and cessation of rotation, and means for retracting said stem holding means after sealing-in to expose the exhaust pipe of the stem for the tipping-off or final sealing thereof after exhausting the lamp therethrough, and means for lifting the bulb holding means to stretch the exhaust pipe during tipping-off.

14. In a machine for exhausting lamps by the glass exhaust pipes thereof, a head comprising means for holding a lamp by its bulb, an exhaust passage, and means for the fluid-tight coupling of the exhaust pipe to the exhaust passage, comprising an upright tube constituting part of the passage, a soft rubber plug tapered at both ends and with a vertical passage large enough for the easy insertion and removal of the pipe, and its rotation therein, the tube top end constituting a pressure member with bell-shape flare bearing upwardly against the lower end of the plug, a surrounding wall or sleeve confining laterally the rubber plug, an abutment or pressure member on said surrounding wall and bearing downwardly against the upper end of the plug, and having a bell-shape flare, for compression of the plug into sealing contact with the tube and the pipe, and means for effecting relative movement between the said tube and the said wall and abutment.

VICTOR ANDERSON.
DONALD G. TRUMETER.