June 8, 1965 R. M. ANDERSON ETAL 3,188,162

METHOD OF MAKING FLASH LAMPS

Original Filed July 9, 1959

3 Sheets-Sheet 1

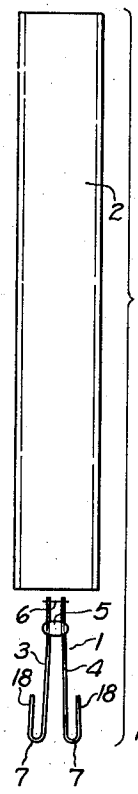


Fig. 1.

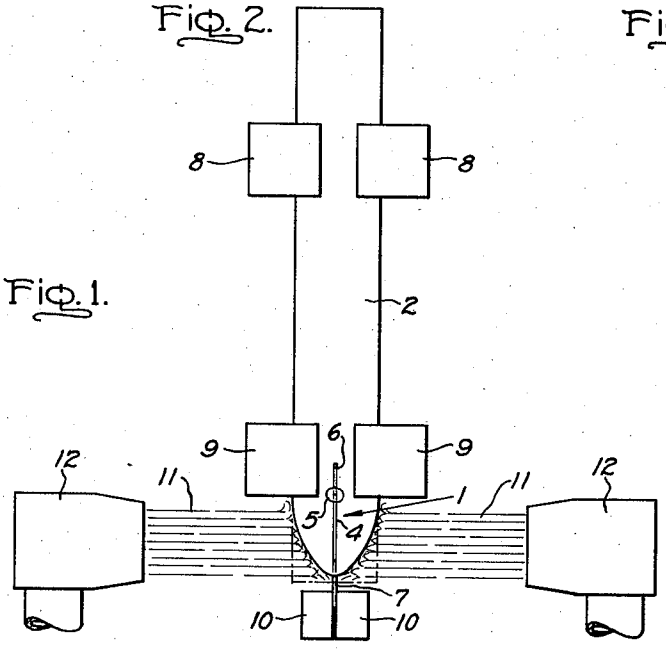


Fig. 2.

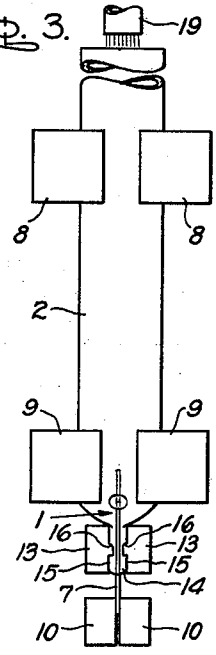


Fig. 3.

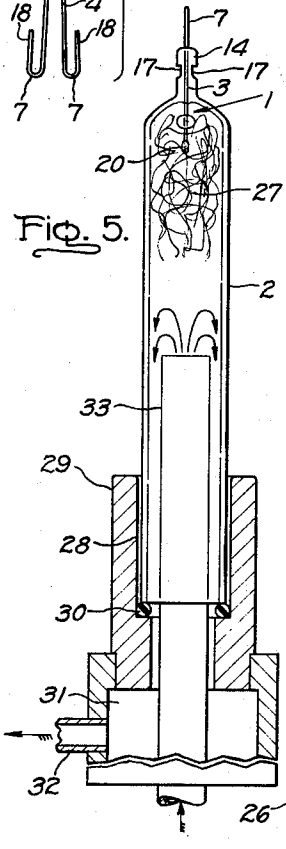


Fig. 5.

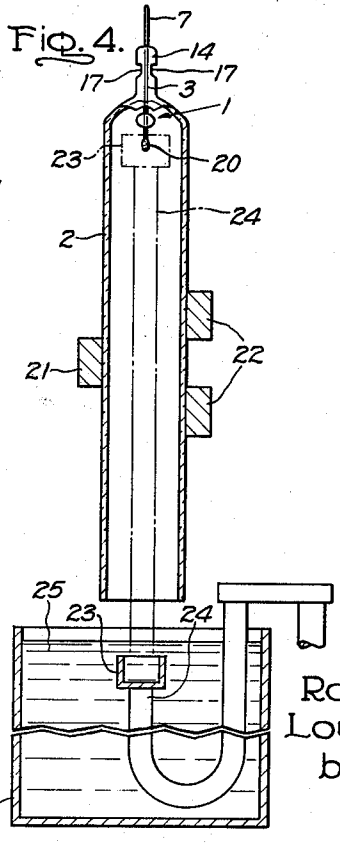


Fig. 4.

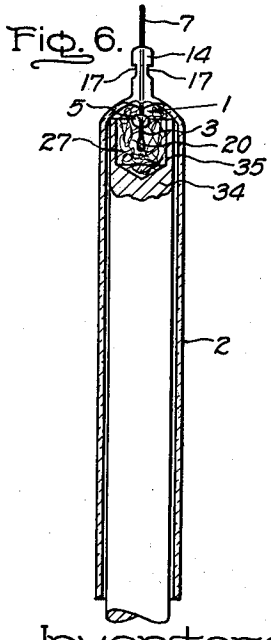


Fig. 6.

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Fig. 7.

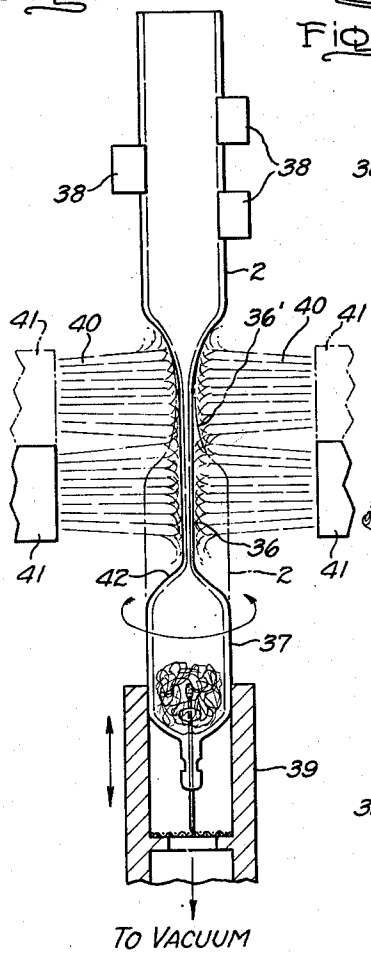


Fig. 8.

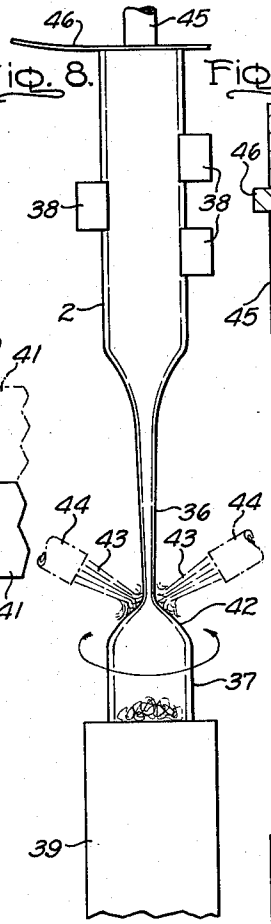


Fig. 9.

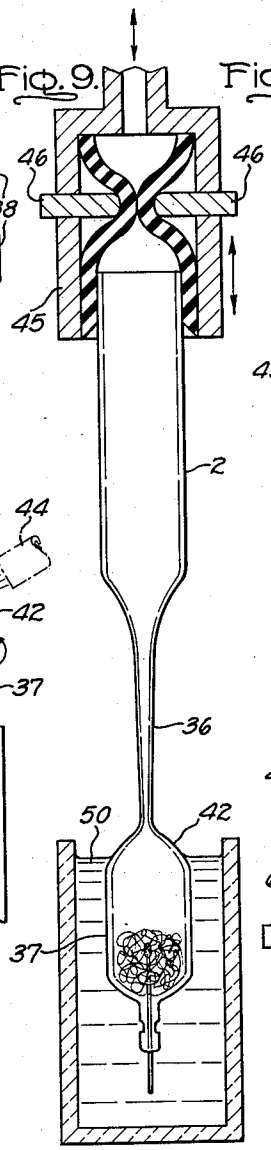


Fig. 10.

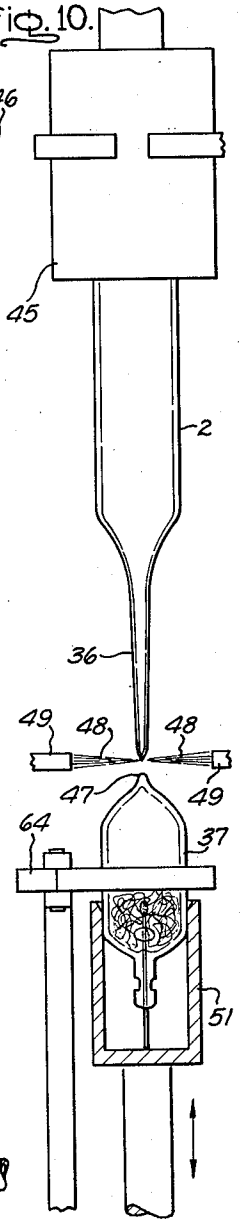
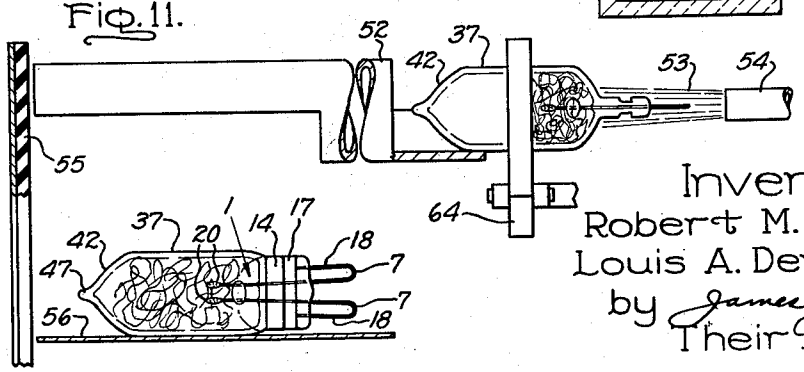


Fig. 11.



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Fig. 12.

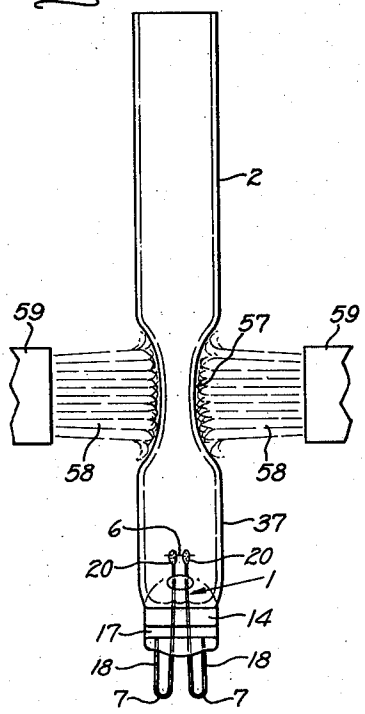


Fig. 13.

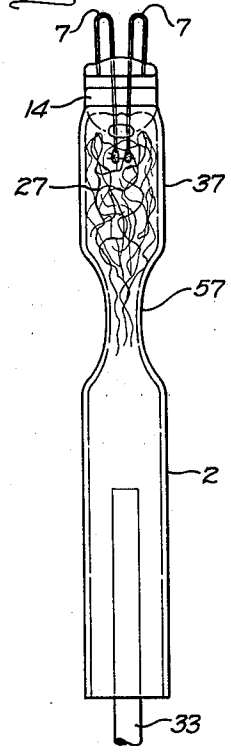


Fig. 14.

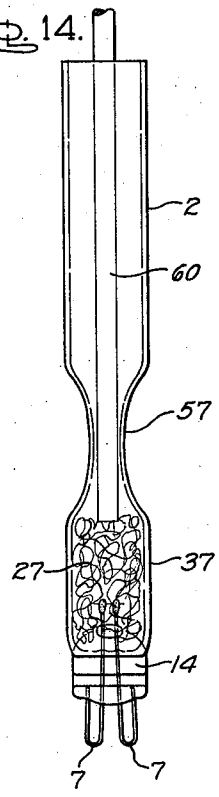
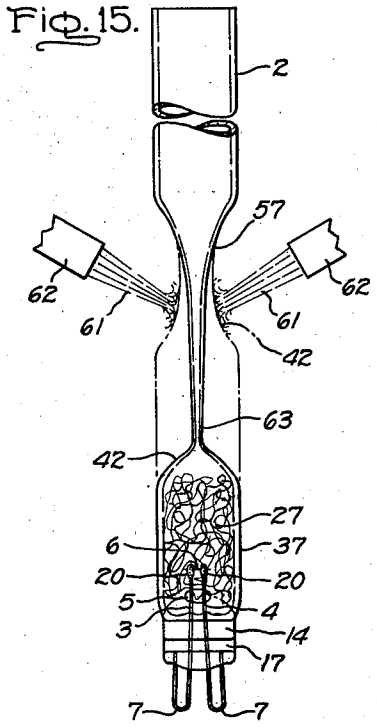


Fig. 15.



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3,188,162

METHOD OF MAKING FLASH LAMPS

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Continuation of application Ser. No. 826,032, July 9, 1959. This application Feb. 23, 1961, Ser. No. 91,279
14 Claims. (Cl. 316—20)

This is a continuation of application Serial No. 826,032, filed July 9, 1959, and now abandoned.

This invention relates to a method of making a flash lamp of the type comprising a sealed glass bulb containing a quantity of readily combustible light-producing material and a filling of a combustion-supporting gas which, on ignition of the combustible material, reacts therewith to produce a momentary flash of actinic light of high intensity.

Flash lamps of the above-described type in general use at present are customarily provided with an ignition mount structure comprising a pair of lead-in wires which are sealed into the lamp bulb and are connected to an ignition filament located within the bulb. The filament and adjacent portions of the lead-in wires are coated with a suitable heat-sensitive fulminating or primer material which, on heating of the filament by the passage of an electric current therethrough, is ignited or set off to thereby initiate, in turn, the reaction of the light-producing materials within the bulb.

In the manufacture of such type flash lamps, it has been the customary practice heretofore to utilize glass bulbs of the single ended type, i.e., one having a single neck end opening, into which neck opening the lamp mount is sealed. With such a manufacturing procedure, however, because of the necessity for applying the primer material to the lamp mounts before they are sealed into the single ended lamp bulb, care must be exercised to insure against the transfer to the primer coating of too much of the heat attending the mounts sealing-in operation, either by radiation or conduction of the heat through the lead-in wires. Otherwise, the primer coating will flake off the lead-in wires and filament and thus render the lamp inoperative, or else will be ignited and cause the premature flashing of the lamp. To avoid the occurrence of such an undesired result, therefore, it has been necessary heretofore to maintain the primer coatings on the lamp mount spaced an appreciable distance from the region of sealing of the mount into the glass bulb. Such a requirement, however, imposes an arbitrary limitation on the minimum size of lamp bulb which can be employed for the lamp from a practical manufacturing standpoint.

It is an object of our invention, therefore, to provide a novel method of making a flash lamp of the general character referred to hereinabove which will enable the practical high-speed production manufacture of flash lamps of much smaller size than possible heretofore.

Another object of our invention is to provide a simple and inexpensive method of making a flash lamp of the general character referred to hereinabove and which does not impose any limitation on the minimum size of glass bulb which may be employed for the lamp.

Still another object of our invention is to provide a method of making a flash lamp constructed for cartridge loading in a holder clip so as to be bodily slidable therethrough in a direction transversely of the lamp bulb axis.

Briefly stated, in accordance with one aspect of the invention, the manufacture of a flash lamp of the type referred to is accomplished by first sealing into one end of a glass tube, so as to close off the said tube end, an unprimered lamp mount, i.e., one comprising a pair of lead-in wires connected to the ends of a filament but not as

yet provided with the conventional primer material coating on the filament and adjacent portions of the lead-in wires. Following the sealing of the lamp mount into one end of the glass tube, the primer material is then applied to the filament and associated inner ends of the lead-in wires of the mount through the open other end of the glass tube, after which the combustible filamentary material is then introduced into the glass tube through its open end and is positioned adjacent the sealed end thereof, the glass tube then exhausted and filled through its open end with combustion-supporting gas to a suitable pressure, and the glass tube finally sealed off at an intermediate portion of its length located between its open end and the combustible material disposed therein to thereby form a hermetically sealed glass enclosure and complete the fabrication of the lamp bulb assembly.

According to a further aspect of the invention, the glass tube is heated and constricted at a region intermediate its ends subsequent to the application of the primer material to the filament and lead-in wires in the glass tube through the open end thereof, and the glass tube is then sealed or tipped-off at its said constricted region. The formation of the major portion of the constriction in the glass tube may be performed either before or after the introduction of the combustible material into the glass tube.

Further objects and advantages of our invention will appear from the following detailed description of species thereof and from the accompanying drawings.

In the drawings,

FIG. 1 is an elevational view of the glass tube and lamp mount parts which are employed in the manufacture of a flash lamp in accordance with the method comprising our invention.

FIGS. 2–11 illustrate the successive steps involved in the manufacture of a flash lamp according to the invention, the illustrated steps being as follows:

FIGS. 2 and 3 show the sealing of the lamp mount into one end of the glass tube.

FIG. 4 illustrates the application of the primer or fulminating material to the lead-in wires and filament of a lamp mount.

FIG. 5 shows the introduction of the filamentary combustible material into the glass tube.

FIG. 6 shows the compacting of the charge of filamentary combustible material within the glass tube into the sealed end thereof.

FIG. 7 shows the drawing of a constriction in the glass tube intermediate its ends to form the bulb of the finished lamp.

FIG. 8 shows the reshaping of the dome portion of the lamp bulb.

FIG. 9 shows the exhausting of the lamp bulb and the introduction of a combustion-supporting gas filling thereinto.

FIG. 10 shows the tipping-off of the lamp bulb from the glass tube.

FIG. 11 shows the decompacting and redistribution of the filamentary combustible material within the lamp bulb.

FIGS. 12 to 15 illustrate the successive steps involved in making a flash lamp according to a modified method of manufacture comprising our invention, the illustrated steps being as follows:

FIG. 12 illustrates the formation of a preliminary constriction in the glass tube intermediate its ends to form the sealed end portion of the tube into a bulb.

FIG. 13 shows the introduction of the filamentary combustible material into the preliminarily constricted glass tube.

FIG. 14 shows the clearing of loose strands of com-

bustible material from the interior space of the mid-region of the constricted section of the glass tube, and

FIG. 15 illustrates the further attenuation of the mid-portion of the tube constriction to form it into an exhaust tubulation of a size small enough to be readily tipped off.

Referring to the drawings, in the manufacture of a flash lamp in accordance with the method of our invention, a lamp mount 1 of the general type shown in FIG. 1 is first sealed into one end of a glass tube 2 so as to close the said tube end. As shown, the lamp mount 1 is similar in construction to the type of lamp mount conventionally employed in the manufacture of butt-seal type incandescent lamps and comprises a pair of lead-in wires 3, 4 which are rigidly held together in closely spaced side-by-side relation by a bead 5 of suitable insulating material such as glass. Connected across the inner ends of the lead-in wires 3, 4 is an ignition filament 6 of straight (i.e., uncoiled) tungsten wire. The outer ends of the lead-in wires 3, 4 are bent back upon themselves or retroverted to thereby form double-leg open loop shaped outer end portions 7 lying in the plane of the lead-in wires and adapted to serve as the terminal contacts for the finished lamp. To provide an understanding of the relatively small size of flash lamp which can be produced by the use of the method according to the invention, the glass tube 2 in the particular case illustrated may have a length of around 3 inches with an outside diameter of approximately 7/16 inch and an inside diameter of 3/8 inch. The particular lamp mount 1 illustrated may have a total overall length, from the outer ends of the looped terminal contact portions 7 to the filament-carrying inner end of the lead-in wires, of around 3/4 inch, and a total overall width across the outer ends of the looped terminal contact portions 7 of around 5/16 inch.

The sealing of the lamp mount 1 into the end of the glass tube 2 as described above is accomplished by assembling and supporting the lamp mount and the glass tube in proper sealing relationship, as shown in FIG. 2, with the filament-carrying end of the mount disposed within the glass tube and the lead-in wires 3, 4 extending into the glass tube more or less centrally thereof with their looped or hook-shaped outer end portions 7 extending for the greater portion of their length (e.g., all but about 1/16 inch or so of their length) outwardly beyond the end of the glass tube. In their sealing position, the glass tube 2 and the lamp mount 1 are supported in vertical position, the glass tube being held in place by upper and lower pairs of spring-loaded jaws 8 and 9, respectively, and the lamp mount being held in place by a pair of spring-loaded jaws 10 which grip the loop-shaped terminal contact ends 7 of the mount lead-in wires 3, 4.

With the lamp mount 1 and the glass tube 2 thus held in sealing position as described above, the lower end of the glass tube is suitably heated and softened, as by opposed pairs of gas fires 11 directed thereagainst from gas burners 12 positioned on diametrically opposite sides of the glass tube. When the glass at the lower end of the glass tube 2 has been softened to the required degree and collapsed around the lead-in wires 3, 4, it is compressed between a pair of opposed jaws 13, as shown in FIG. 3, so as to press the soft glass tightly around the lead-in wires 3, 4 and form a hermetic seal therebetween and at the same time form the softened lower end of the glass tube into a flattened stem press portion 14 which then closes or seals off the said lower end of the glass tube. As shown, the opposed pressing faces 15 of the stem press forming jaws 13 are preferably formed with raised cross ribs 16 which extend parallel to one another preferably in directly opposed relation and form parallel guide grooves 17 in the flat sides of the stem press for guiding the lamp through a lamp holder magazine. The inserted position of the lamp mount 1 into the glass tube 2 at the time of sealing thereinto is such as to insure that the free ends of the retroverted legs 18 (FIG. 1) of the lead-in wires 3, 4 reenter the glass of which the stem press 14 is formed so as to be firmly anchored therein as shown in FIG. 11, thus providing added support for the loop-shaped terminal contact portions 7 of the lead-in wires which protrude from the finished stem press.

While the portion of the side wall of the glass tube immediately adjoining the stem press 14 is still in a heated and softened state from the stem press forming operation, it is preferably reshaped or rounded out by the introduction of heated air under pressure into the tube through the open upper end thereof from an air nozzle 19 disposed above the upper end of the glass tube.

Following the sealing of the lamp mount 1 into one end of the glass tube 2 and the resultant closure or sealing of the said tube end, a quantity of primer or fulminating material is applied, through the open other end of the glass tube 2, onto the filament 6 and adjacent portions of the lead-in wires 3, 4 of the lamp mount 1 to thereby form small beads 20 of such primer material on the lead-in wires. The primer material 20 may be of any suitable composition such as conventionally employed in flash lamps and consisting, in general, of a mixture of one or more readily ignitable metal powders such as zirconium or magnesium and a powdered oxidizing agent such as potassium perchlorate, bonded together by a suitable binder such as a 2–5% solution of nitrocellulose in amyl acetate. For best results, however, and particularly where the ignition filament 6 is of a diameter of the order of 0.7 mil, it is preferred that the primer material 20 be of the particular composition disclosed and claimed in U.S. Patent 2,756,577, Anderson, issued July 31, 1956, and assigned to the assignee of the present invention, and comprising a mixture of from 60–90% zirconium, 1–8% magnesium, and 9.35% potassium perchlorate. The primer material 20 is applied to the filament 6 and lead-in wires 3, 4 of the lamp mount in the form of a paste having the proper viscosity to form primer beads 20 on the lead-in wires of the desired size.

The application of the primer material 20 to the lamp mount 1 may be performed in the manner illustrated in FIG. 4. As there shown, the glass tube 2 is held in a vertical position with its open end down in a pair of opposed holder jaws 21, 22, and the primer paste is applied to the inner ends of the lead-in wires 3, 4 and the filament 6 by a vertically movable applicator cup or dipper 23 carried at the upper end of a lift rod 24. The lift rod 24 is vertically reciprocable to carry the applicator cup 23 from a lowered position in which it is submerged in a reservoir 25 of the primer paste material in a container 26, upwardly into the open lower end of and through the glass tube 2 to a raised position in which the lower end portions of the lead-in wires 3, 4 and the filament 6 connected thereacross, are immersed in the primer paste material contained within the applicator cup 23. The viscosity of the primer paste material in the reservoir 25 may be readily controlled by the amount of amyl acetate or other solvent for the nitrocellulose binder present in the reservoir of primer paste.

After the application and drying of the beads 20 of primer material on the lamp mount 1, a quantity of readily combustible material 27 such as is conventionally employed in flash lamps as the light-producing medium therefor, is then introduced into the glass tube 2 through the open end thereof and positioned adjacent the sealed or closed end of the tube in which the lamp mount 1 is sealed. The combustible material 27 may be composed of any readily combustible metallic material such as aluminum, magnesium, or zirconium, or alloys thereof, and is preferably of filamentary form such as fine wire, ribbon, or fine cut strands such as that commercially known as shredded foil and produced by the method and apparatus described and claimed in U.S. Patents 2,297,368 and 2,331,230, Rippl et al. As shown in FIG. 5, the combustible material 27 is preferably in the form of shredded foil and may be conveniently introduced into the glass tube 2 in the manner disclosed and claimed in U.S. Patent

2,347,046, Geiger et al., the open end of the glass tube being inserted in a tube-receiving passageway 28 of a loading head 29 which connects the open end of the glass tube, through a rubber seating ring or gasket 20, to a vacuum chamber 31 which is connected, in turn, by a conduit 32 to a source of vacuum. A feed tube 33, through which the combustible material 27 is fed into the glass tube 2, extends in air-tight manner through the wall of the vacuum chamber 31 and up through the glass tube-receiving passageway 28 thereof so as to extend part way into the interior of the glass tube 2 when it is inserted in the loading head 29 and seated in place on the seating ring 30 therein. With the glass tube 2 thus inserted in the loading head 29, a flow of air is then created, by the source of vacuum, through the feed tube 33 and out its discharge end located within the glass tube 2 (as shown by the arrows in FIG. 5) and thence cut through the open end of the glass tube and through the passageway 28 and vacuum chamber 31 into the vacuum conduit 32. By then presenting the charge or quantity of combustible material 27 which is to be introduced into the glass tube to the intake end of the feed tube 33, the suction therein and flow of air therethrough will then draw the charge of combustible material into and transport it through the feed tube 33 and discharge or release the combustible material into the interior space of the glass tube and position it adjacent its sealed or closed end, as shown in FIG. 5.

As introduced into the glass tube 2 by the above-described loading method, the greater portion of the combustible material 27 is located adjacent the sealed or closed end of the glass tube 2. However, there are apt to be a few loose or free-hanging strands of combustible material which extend a considerable distance from the main body thereof through the glass tube 2 from its sealed end and which therefore might interfere with the subsequent operation of heating and constricting the glass tube at a region intermediate its ends, the loose strands of combustible material either becoming embedded in the softened glass which is to be constricted and subsequently tipped off and thereby contaminating the tip-off seal so as to render it non-gas tight and thus cause a defective lamp, or else becoming ignited by the heat of the softened glass so as to prematurely ignite the charge of combustible material within the glass tube 2. Accordingly, to prevent such an occurrence, the combustible material in the glass tube is compacted or wadded into a confined region of the tube immediately adjacent its sealed end, as shown in FIG. 6. This compacting or compressing of the charge of combustible material into a confined region of the glass tube 2 immediately adjacent its sealed or closed end may be performed by inserting a suitable ram or compacting tool 34 into the open end of the glass tube 2 and moving it therethrough until its inserted end practically engages with the sealed or closed end of the glass tube. As shown in FIG. 6, the inserted end of the compacting ram is provided with a recess 35 to accommodate the lead-in wires 3, 4, glass bead 5 and filament 6 of the lamp mount 1 which projects into the glass tube 2 from the stem press 14.

With the combustible material 27 thus compacted into the sealed or closed end region of the glass tube 2, the glass tube is then in readiness for the next operation in which the glass tube is constricted intermediate its end, as shown at 36 in FIG. 7, whereby the portion of the glass tube between its sealed or closed end and the said constriction 36 is, in effect, formed into the bulb 37 of the finished flash lamp. As shown in FIG. 7, the constricting of the glass tube intermediate its ends may be accomplished by supporting the glass tube in a vertical position, with its sealed or closed end down, in upper and lower holders 38 and 39, respectively, which are mounted for rotation so as to rotate the glass tube about its axis, and then heating and softening the intermediate region of the glass tube between the two holders 38 and 39 by directing gas fires 40 thereagainst from gas burners 41. As shown, the upper holder 38 may consist of opposed pairs of jaws while the lower holder 39 may consist of a vacuum chuck which is connected to a source of vacuum. When the intermediate section of the glass tube 2 which is to be constricted has become heated and softened to the proper degree, and partially collapsed as indicated at 36' in FIG. 7, the lower chuck 39 is moved downwardly to pull the sealed end of the glass tube held therein downwardly along with the said holder 39, thereby drawing and attenuating the heated and softened intermediate section of the glass tube into a thin constriction or attenuated portion 36 and form the lower end portion of the glass tube into a bulb 37 for the finished lamp, the constricted section 36 serving as an exhaust tubulation on the bulb 37 for subsequent exhausting of the bulb therethrough and introduction of a gas filling thereinto. As shown in FIG. 7, the burners 41 are moved down along with the lower chuck 39 during the tube attenuation operation in order to maintain the portion of the glass tube immediately adjacent the dome 42 of the bulb portion 37 sufficiently plastic to cause it to be drawn into a thin and substantially straight-sided tube extending from the dome 42 of the bulb 37.

Following the formation of the constriction 36 in the glass tube 2 intermediate its ends so as to form the bulb 37 of the finished lamp, the dome portion 42 of the bulb 37 is then preferably reshaped or rounded out so as to have a more uniform shape from lamp to lamp and present a better appearance. The rounding out of the dome 42 of the bulb 37 may be performed in the manner shown in FIG. 8 by directing gas fires 43 from gas burners 44 against the dome portion 42 of the bulb 37 at a region immediately adjacent its junction with the constricted section 36 of the glass tube 2 so as to reheat and soften the said dome portion, and then directing a stream or puff of heated air downwardly into the open end of the glass tube 2 to distend the softened dome 42 a slight degree serving to round out the softened glass of the dome. As shown, the puff of heated air may be directed downwardly into the glass tube 2 from an air nozzle 45 which may be carried by a flexible spring finger or supporting plate 46 which engages with the upper end of the glass tube 2 to close off the tube at its upper end.

The glass tube 2, including the bulb portion 37 thereof, is next exhausted through its open end and a suitable combustion-supporting gas filling such as oxygen, at a suitable pressure, is then introduced into the glass tube through its open end. The exhausting and gas filling of the glass tube 2 may be performed in the manner customary in the lamp-making art, as shown in FIG. 9, wherein the open end of the glass tube 2 is inserted into an exhaust head 45 of a conventional type lamp exhausting and gas filling machine, the exhaust head 45 being connected in an air tight manner to the open end of the glass tube 2 and being alternately connected first to an exhaust or vacuum line to effect the exhausting of the glass tube 2, and then being connected to a source of combustion-supporting gas to effect the introduction of the said gas into the glass tube. When the proper amount of oxygen or other combustion-supporting gas has been introduced into the glass tube 2 through the exhaust head 45, the pinch clamp 46 in the exhaust head is then closed and the lamp bulb then tipped or sealed off as indicated at 47 in FIG. 10 to hermetically seal the bulb, by directing gas fires 48 from gas tipping-off burners 49, against the constricted section 36 of the glass tube at a region closely adjacent the dome end 42 of the bulb 37.

Where it is desired to provide the lamp bulb 37 with a gas filling pressure greater than atmospheric, the glass tube 2 may in such case be first filled with gas, prior to tipping-off the bulb 37, to a pressure around or slightly above atmospheric pressure and the bulb portion 37 then submerged in a bath 50 (FIG. 9) of a suitable very low temperature liquid coolant such as liquid nitrogen for instance, as shown in FIG. 9, to cool the gas in the bulb

portion 37 to a correspondingly low temperature considerably below that of the ambient so as to, in effect, contract the gas in the bulb portion 37 of the glass tube. The lamp bulb 37 is then tipped off in the customary manner, as shown in FIG. 10, while the gas in the lamp bulb 37 is still in its cooled state. When the cooled gas in the sealed off lamp bulb 37 then subsequently rises to ambient or room temperature, the resultant expansion of the gas in the bulb then causes the pressure of the gas to increase relative to its initial filling pressure, the degree of such pressure increase depending, of course, on the degree of the said temperature rise of the gas filling in the bulb.

After the sealing or tipping-off of the lamp bulb 37, as shown in FIG. 10, the charge of filling of combustible material 27 in the lamp bulb, which material up to this point has been in a compacted condition and positioned adjacent the sealed or stem press end of the lamp bulb, is then decompacted and repositioned and redistributed partly into the dome end 42 of the finished lamp bulb 37 so as to be more evenly distributed throughout the interior space of the bulb. This decompacting or fluffing out and redistribution of the combustible material 27 within the lamp bulb 37 may be accomplished in the manner shown in FIG. 11. As there shown, the lamp bulb 37, upon being tipped off and disconnected from the remainder of the glass tube 2 in the exhaust head 45, drops into a vertically reciprocable holder cup 51 from which the bulb is then transferred, by a jaw-type swinging transfer arm 64, to a position dome end first at the entrance end of and aligned with a guide tube 52 into and through which the lamp bulb 37 is then propelled at relatively high velocity by directing an air jet 53 thereagainst from an air nozzle 54. The guide tube 52 then directs the rapidly moving lamp bulb 37 dome end first against a rubber-padded striker plate 55 located opposite the exit end of the guide tube. The sudden impact of the bulb 37 against the striker plate 55 causes the filling of combustible material 27 within the bulb to be jarred forwardly within the bulb so as to be decompacted and repositioned and redistributed, by its own inertia, partly into the dome end 42 of the bulb. After striking the impact plate 55, the lamp bulb 37 may be allowed to drop into a collecting receptacle or, as shown, onto a conveyor belt 56 for transport to another location for the conduct of further operations on the lamp, such as testing and inspection, outside lacquering of the bulb, or packaging. If desired, also, the loop-shaped outer portions 7 of the lead-in wires 3, 4 protruding endwise from the stem press 14 of the lamp may at this time be bent around oposite sides of the flattened stem press 14 to thereby form the finished terminal contacts for the lamp. This bending of the protruding loop-shaped portions 7 of the lead-in wires 3, 4 around the opposite sides of the stem press 14 may, however, be performed at any stage in the fabrication of the lamp following the sealing-in of the lamp mount 1 into the one end of the glass tube 2. Thus, it may be conveniently performed immediately after the application of the primer material 20 to the lamp mount 1 and before the introduction of the combustible material 27 into the glass tube 2.

Instead of introducing the filling 27 of combustible material into the glass tube 2 prior to the constricting or attenuation thereof intermediate its ends, the said filling 27 of combustible material may be introduced into the glass tube after first forming a major part of the tube constriction or attenuation 36, and then, after the introduction of the filling 27 of combustible material into the glass tube 2, completing the formation of the constriction or attenuation to reduce it to a size sufficiently small to be readily tipped off. FIGS. 12–16 illustrate this alternative lamp manufacturing procedure. As there shown, the glass tube 2, after the sealing-in of the mount 1 into one end of the tube and the application of the primer material 20 to the sealed-in mount as shown in FIG. 4, is then preliminarily constricted or attenuated at a region intermediate its ends, as shown at 57 in FIG. 12, by suitably heating and softening the said intermediate tube region, as by directing gas fires 58 thereagainst from gas burners 59, and then drawing the opposite ends of the glass tube axially away from one another until the softened intermediate section of the glass tube is reduced to a size, for example, at least 3/32 to 1/8 inch or so in inside diameter, which is still large enough, however, to permit the subsequent introduction of the filling of combustible material 27 into the glass tube, and through the said preliminary constriction 57 therein into the sealed end or bulb portion 37 of the glass tube, in the manner described above in connection with FIG. 5. After the formation of the preliminary constriction 57 in the glass tube 2, the filling 27 of combustible material is then introduced into the glass tube through its open end, as shown in FIG. 13, so as to be located within the bulb end portion 37 of the glass tube. The introduction of the filling 27 of combustible material into the constricted glass tube 2 may be performed in the same manner described above in connection with FIG. 5. After the introduction of the filling 27 of combustible material into the glass tube, a push rod 60 is then inserted through the open end of the glass tube 2 and through the constriction 57 therein so as to push any loose or free-hanging stands of the combustible filling material 27 that may be present in the mid-region of the constriction 57 into the bulb portion 37 of the glass tube. This insures against the presence of loose or free-hanging strands of the combustible filling material 27 within the mid-region of the constricted section 57 such as might become embedded in the glass, during the subsequent softening and drawing-out of the said mid-region of the constriction 57 to further constrict it into an exhaust tubulation of small enough size to permit the tipping-off thereof. Such embedded strands of combustible material in the glass exhaust tubulation would be apt to contaminate the tipping-off seal so that it would not be gas tight, thereby resulting in a defective lamp.

With the interior space within the narrowest or mid-region of the constricted section 57 of the glass tube 2 thus cleared of any loose strands of combustible material or shredded foil 27, the constricted section 57 of the glass tube is then reheated and softened, within that region thereof where the narrowest portion of the constriction begins to flare out to form the dome 42 of the lamp bulb 37, by directing gas fires 61 thereagainst from gas burners 62. When the glass of the constriction 57 is thus in a softened condition, the opposite end portions of the glass tube 2 are then displaced axially away from each other to thereby draw out and attenuate the softened portion of the constriction 57 into a thin exhaust tubulation 63 of a size suitable for tipping-off. The glass tube is then exhausted and gas-filled and finally tipped off, in the manner such as described and shown in FIGS. 9 and 10, to thereby complete the manufacture of the lamp bulb assembly. However, if desired, the dome 42 of the bulb portion 37 of the glass tube 2 may be rounded out, in the manner as described above in connection with FIG. 8, after the formation of the exhaust tubulation 63 and before the exhausting and gas filling of the glass tube.

Since, with the modified manufacturing procedure of FIGS. 12 to 15, the combustible material 27 need not be substantially entirely compacted or wadded into one end of the glass tube prior to the tube constricting operation, as is the case in the previously described method shown in FIGS. 1–11, there is therefore no need for decompacting and redistributing the combustible material 27 within the lamp bulb 37, in the manner such as described in FIG. 11, after the completion of the bulb tipping-off operation. Moreover, by forming the major portion 57 of the constriction 63 in the glass tube 2 before the combustible material is introduced thereinto, the heat ordinarily required to soften the glass tube so as to enable the drawing of the said preliminary constriction 57 therein then will not result in the heating of the combustible material 27 in the glass tube to a temperature which, in those cases

where the combustible material 27 is constituted of zirconium, will cause the combustible material to discolor and thus present a poor, burnt-like appearance. In addition, because there is no need, with the modified flash lamp manufacturing procedure of FIGS. 12–15, of first wadding or compacting substantially all of the combustible material into one end of the glass tube 2 and subsequently decompacting the combustible material 27 to reposition it into a loosely arranged and more evenly distributed mass within the bulb 37, the combustible material 27 in flash lamps made by the modified procedure of FIGS. 12 to 15 therefore is more uniformly or evenly distributed within the lamp bulb 37 with the result that such lamps possess a higher average light output and also a uniform light center length from the base end of the lamp.

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

1. The method of making a flash lamp comprising the steps of sealing a lamp mount, comprising a pair of lead-in wires having a filament connected thereacross, into one end of a glass tube to form a sealed end thereon with the said filament located a short distance inwardly of the glass tube from its said sealed end, applying through the open other end of said glass tube a quantity of primer material onto the filament and the adjacent portions of said lead-in wires, introducing into the glass tube through its said open end and positioning adjacent the said filament a quantity of readily combustible metallic material, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and sealing off an intermediate portion of the length of said glass tube located between its said open end and the said combustible material.

2. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon, applying through the open other end of said glass tube a quantity of primer material onto a portion of the said lead-in wires within the glass tube, introducing into the glass tube through its said open end and positioning adjacent its sealed end a quantity of readily combustible metallic material, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material.

3. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon, applying through the open other end of said glass tube a quantity of primer material onto a portion of the said lead-in wires within the glass tube, introducing into the glass tube through its said open end and positioning adjacent its sealed end a quantity of readily combustible metallic material, heating to a plastic condition and constricting and reshaping a portion of the said glass tube intermediate its ends to form a uniformly rounded dome end on that portion of the glass tube containing the said combustible material, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material.

4. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon, applying through the open other end of said glass tube a quantity of primer material onto a portion of the said lead-in wires within the glass tube, introducing into the glass tube through its said open end and positioning adjacent its sealed end a quantity of readily combustible metallic material, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends, reheating and reshaping the region of the said constricted portion of the glass tube adjacent the tubular portion thereof containing the said combustible material to form a uniformly rounded dome end on said tubular portion, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the said tubular portion of the glass tube containing the said combustible material.

5. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon with the said lead-in wires extending a short distance only into said glass tube from its sealed end, applying through the open other end of said glass tube a quantity of primer material onto the inner end portions of the said lead-in wires within the glass tube, introducing into the glass tube through its said open end and positioning adjacent its sealed end a quantity of readily combustible metallic material, heating to a plastic condition and constricting a portion of said glass tube intermediate its ends but sufficiently removed from the said combustible material and primer material to be out of ignition range thereof by the heat radiated from said heated glass tube portion, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material.

6. The method of making a flash lamp comprising the steps of sealing a lamp mount, comprising a pair of lead-in wires having a filament connected thereacross, into one end of a glass tube to form a sealed end thereon with the said filament located a short distance inwardly of the glass tube from its said sealed end, applying through the open other end of said glass tube a quantity of primer material onto the said lead-in wires and in contact with the said filament, introducing into the glass tube through its said open end and positioning adjacent its sealed end a quantity of readily combustible metallic material, heating to as plastic condition and constricting a portion of the said glass tube intermediate its ends, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material.

7. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon, applying through the open other end of said glass tube a quantity of primer material onto a portion of the said lead-in wires within the glass tube, introducing into the glass tube through its said open end a quantity of readily combustible metallic material, compacting the said combustible material into the end portion of said glass tube immediately adjacent its said sealed end, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends but sufficiently removed from the said combustible material and primer material to be out of ignition range thereof by the heat radiated from said heated glass tube portion, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material, and then decompacting and repositioning the said combustible material throughout the interior space of the sealed glass tube.

8. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon, applying through the open other end of said glass tube a quantity of primer material onto a portion of the said lead-in wires within the glass tube, introducing into the glass tube through its said open end a quantity of readily combustible metallic material, compacting the said combustible material into the end portion of said glass tube immediately adjacent its said sealed end, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends but sufficiently removed from the said combustible material and primer material to be out of ignition range thereof by the heat radiated from said heated glass tube portion, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material, and then sharply impacting the lamp in an endwise direction, with its tipped-off end first, to cause the said compacted combustible material to decompact and reposition itself by its own inertia throughout the interior space of the sealed glass tube.

9. The method of making a flash lamp comprising the steps of positioning within one end of a glass tube a lamp mount comprising a pair of lead-in wires interconnected at their inserted inner ends by a filament, heating to a plastic condition and compressing the said end of the glass tube about the said lead-in wires to seal them into and form an external stem press on the glass tube closing off the said one end thereof, applying through the open other end of said glass tube a quantity of primer material onto the said inner ends of the lead-in wires and in contact with the said filament, introducing into the glass tube through its said open end and positioning adjacent its sealed end a quantity of readily combustible metallic material, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and tipping-off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material.

10. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon, applying through the open other end of said glass tube a quantity of primer material onto a portion of the said lead-in wires within the glass tube, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends, introducing into the glass tube through its said open end and positioning in loosely arranged form therein between its said sealed end and its said constricted portion a quantity of readily combustible metallic material, exhausting and introducing into the said glass tube through its said open end a combusion-supporting gaseous medium, and then heating and tipping off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material.

11. The method of making a flash lamp comprising the steps of sealing a lamp mount structure comprising a pair of lead-in wires into one end of a glass tube to form a sealed end thereon, applying through the open other end of said glass tube a quantity of primer material onto a portion of the said lead-in wires within the glass tube, heating to a plastic condition and preliminarily constricting a portion of the said glass tube intermediate its ends, introducing into the said glass tube through its said open end and positioning in loosely arranged form therein between its said sealed end and its said preliminarily constricted portion a quantity of readily combustible metallic material, heating the said preliminarily constricted portion of the glass tube to a plastic condition and drawing it into a small diameter exhaust tubulation, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and tipping off the said exhaust tubulation portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material.

12. In a method of making a flash lamp, the steps of inserting a mount structure comprising a pair of lead-in wires carrying a filament into the interior of a glass tube, forming one end of the glass tube around the lead wires to provide a sealed end thereon with said filament located a short distance inwardly of the glass tube from its sealed end, introducing into the glass tube through its open end and positioning adjacent the said filament a quantity of readily combustible metallic material, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, and then heating and sealing off the glass tube at an intermediate portion of its length located between its said open end and the said combustible material.

13. In a method of making a flash lamp, the steps of inserting a mount structure comprising a pair of lead-in wires carrying a filament into the interior of a glass tube, forming one end of the glass tube around the lead wires to provide a sealed end thereon, introducing into the glass tube through its other open end a quantity of readily combustible metallic material, compacting the said combustible material into the end portion of said glass tube immediately adjacent its sealed end, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, heating and tipping off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material to complete the lamp and then sharply impacting the lamp in an endwise direction with its tipped off end first to cause the said compacted combustible material to decompact and reposition itself by its own inertia throughout the interior space of the sealed glass tube.

14. In a method of making a flash lamp, the steps of inserting a mount structure comprising a pair of lead-in wires carrying a filament into the interior of a glass tube, forming one end of the glass tube around the lead wires to provide a sealed end thereon, introducing into the glass tube through its other open end a quantity of readily combustible metallic material, compacting the said combustible material into the end portion of said glass tube immediately adjacent its sealed end, heating to a plastic condition and constricting a portion of the said glass tube intermediate its ends, exhausting and introducing into the said glass tube through its said open end a combustion-supporting gaseous medium, heating and tipping off the said constricted portion of the glass tube to thereby hermetically seal the tubular portion thereof containing the said combustible material to complete the lamp and then decompacting the combustible material to reposition it throughout the interior space of the sealed glass tube.

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