June 11, 1963 E. H. WILEY 3,093,430

GAS AND VAPOR FILLING METHOD FOR ELECTRIC LAMPS OR SIMILAR DEVICES

Filed April 25, 1961 2 Sheets-Sheet 1

Fig. 1.

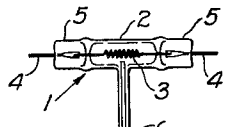


Fig. 2.

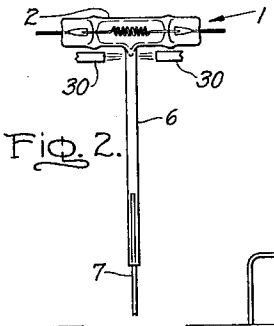
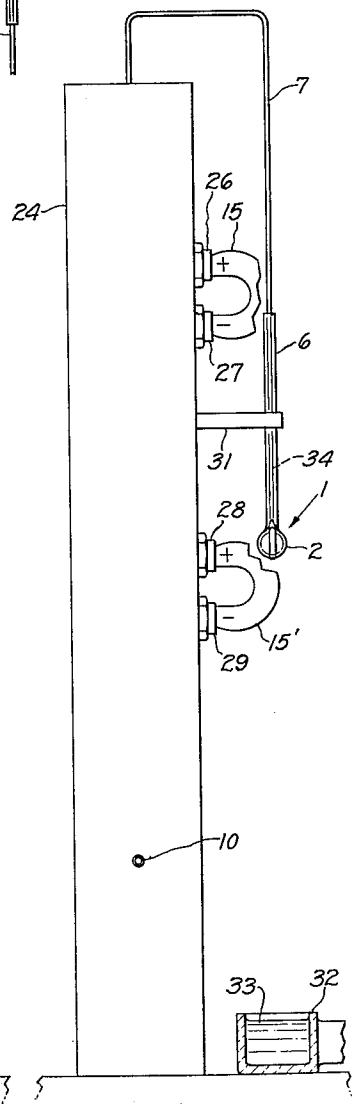
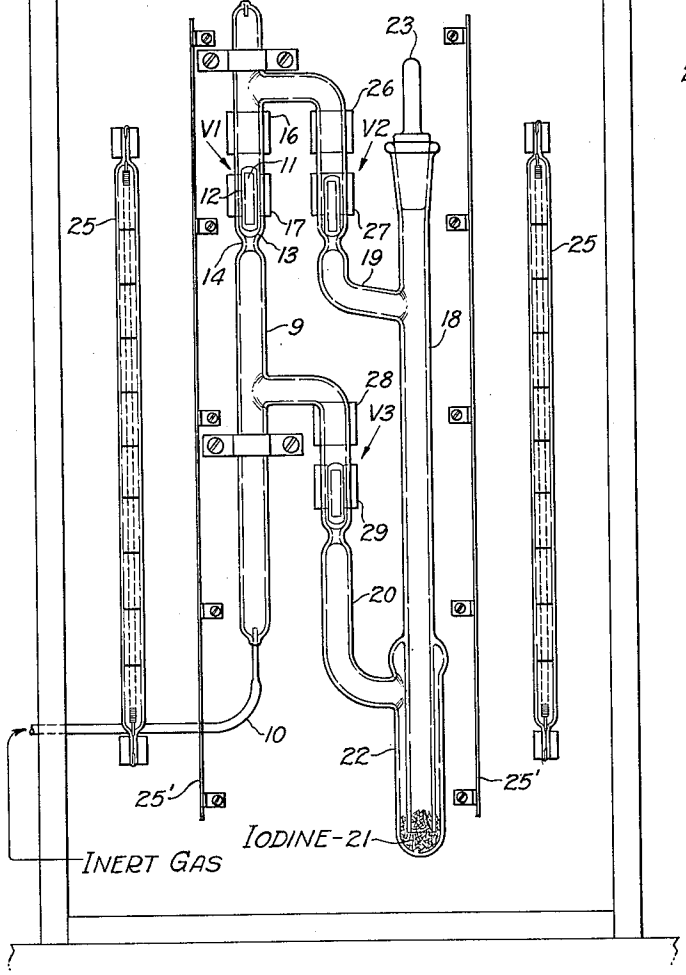


Fig. 3.





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Fig. 4.

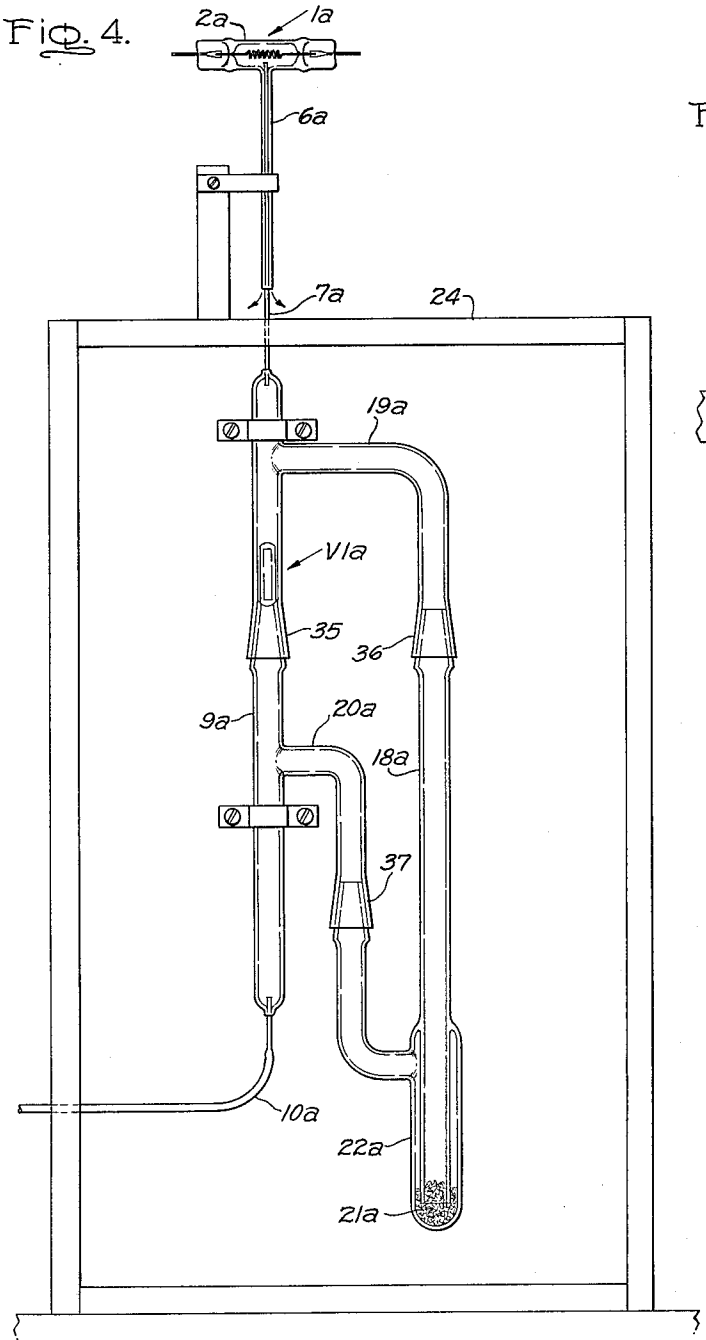
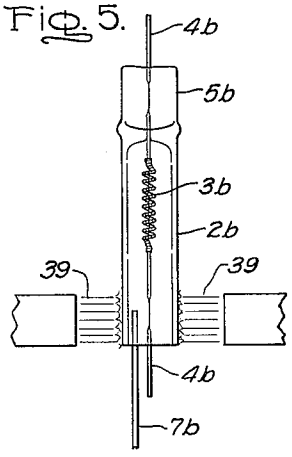


Fig. 5.



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GAS AND VAPOR FILLING METHOD FOR ELECTRIC LAMPS OR SIMILAR DEVICES

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5 Claims. (Cl. 316—24)

This invention relates to the manufacture of electric lamps or similar devices comprising a sealed envelope containing a filling of inert gas and active vapor.

In recent years there has been introduced on the market a type of incandescent electric lamp containing a filling of inert gas and a quantity of iodine which functions as a regenerative getter to prevent blackening of the lamp envelope by vaporized particles of the tungsten filament. The introduction of the iodine into the envelope presents problems because of its corrosive and other reactive properties. Conventional lamp making equipment has required some type of vacuum pumping or exhaust operation for the removal of air from lamp envelopes. The iodine-containing lamp also requires the removal of air before the iodine and other fill gases are introduced. However, the portions of the system containing the iodine for introduction into the lamp must be closed off from the pump portion of the system in a manner which will prevent the iodine vapor from getting into the pump portion. Although it is possible to use cold traps and materials which will not react with the iodine, the problems are much greater than with conventional lamp making equipment in which iodine is not used.

Accordingly, it is an object of the invention to provide a method of manufacuring lamps of high quality and filled with inert gas and active vapor without the necessity of preliminary exhausting of the envelope. It is a further object to provide a method which will assure the introduction into the envelope of a predetermined vapor pressure of the iodine.

Further features and advantages of the invention will appear from the following detailed description and from the drawing, wherein:

FIG. 1 is a somewhat diagrammatic front elevation of equipment for carrying out a gas and vapor filling method in accordance with the invention;

FIG. 2 is a fragmentary elevation showing the relationship of the lamp, flush tube and tipping off torch in the final steps of the process;

FIG. 3 is a side elevation of a modification of the apparatus shown in FIG. 1;

FIG. 4 is a diagrammatic front elevation of a somewhat modified form of gas and vapor filling equipment; and

FIG. 5 is an elevation of a partially completed lamp illustrating a modified process in accordance with the invention.

Generally speaking, in accordance with one aspect of the invention, the lamp envelope is flushed with inert gas to expel the atmosphere therein, and iodine vapor is introduced into the envelope with continued flushing to establish a desired density of iodine vapor, after which flushing is terminated and the envelope is sealed to retain the inert gas and iodine vapor therein as the final gas filling. More particularly, in accordance with a preferred procedure, particles of iodine are heated to a predetermined temperature in a chamber to maintain therein a desired vapor pressure of the iodine, the lamp envelope is flushed with inert gas flowing through a path bypassing the chamber, the flow of inert gas is then diverted through the chamber and into the lamp envelope for a period of time sufficient to establish an equilibrium density of the iodine vapor in the lamp envelope, after which flushing is terminated and the envelope is sealed off.

Referring to FIG. 1 of the drawing, the lamp 1 illustrated therein may be of the type disclosed and claimed in Patent 2,883,571, Fridrich et al., and comprises a tubular envelope 2, preferably of quartz, having a coiled tungsten wire filament 3 extending axially thereof and connected at respective ends to lead-in conductors 4 which extend through and are heremetically sealed in compressed seal portions 5 at the ends of the envelope. The envelope 2 is provided with a quartz fill tube or tubulation 6 extending laterally therefrom. The internal parts of the lamp, including the filament 3, may be cleaned up by a preliminary operation wherein envelope 2 is flushed with wet forming gas (20% hydrogen and 80% nitrogen) while the filament 3 is heated to incandescence by application of a suitable potential thereacross, immediately after which the lamp is flush filled as described hereinafter.

To begin the flush filling operation, the fill tube 6 is threaded over a flush tube 7, of molybdenum for example, and is held in the spring fingers of a clamp 8 at an elevation such that the flush tube or needle 7 projects slightly into the envelope 2. At this time, inert gas, such as nitrogen, argon etc., is flowing through the flush tube 7 from a glass column 9 which is supplied with the gas from a supply conduit 10. The flush tube 7 and supply tube 10 (of copper, for example) are sealed by hermetic metal-to-glass seals to the top and bottom of the column 9. The column 9 has therein a suitable valve arrangement V1, here illustrated as comprising an iron armature 11 enclosed in a glass tube 12 having an accurately ground bottom end which is adapted to engage tightly with the cooperating seat portion 13 of a constriction 14 in the interior of the column 9. While lamps are being made the valve V1 is normally held open, for example by a magnet which may be a permanent magnet like that shown at 15 in FIG. 3 and which is held with its poles in engagement with respective pole pieces 16 and 17 which are arranged to hold the armature 11 in an elevated position.

A supply of iodine vapor is contained in a chamber comprising a vertical glass column 18 which is connected by side arms 19 and 20 to the column 9, and which is isolated from the gas flow in column 9 by valves V2 and V3 which are like valve V1 and are located in the arms 19 and 20. At least the valve V2 is normally closed. The valve V3 need not necessarily be closed during normal use of the equipment; it may be held normally opened by a permanent magnet 15' (FIG. 3). The column 18 extends downward into a supply of iodine granules 21 at the bottom of a reservoir 22 connected to arm 20. The upper end of the column 18 may be fitted with a removable stopper 23 for replenishing the supply of iodine particles.

For maintaining the iodine vapor in the chamber 18 at a desired pressure, the entire system, with the exception of the end of the flush tube 7, may be enclosed in an enclosure 24 having its front wall removed in FIG. 1 and containing suitable heating means such as a pair of quartz infrared lamps 25 at opposite sides of the enclosure. The lamps 25 are preferably located behind sheet metal strips 25' which fill the width of the enclosure 24 and terminate short of the top and bottom thereof. The coolest part of the system is the bottom of the reservoir 22 which is maintained at a suitable temperature, for example about 100° C., to cause sublimation of the iodine particles 21. The remainder of that portion of the system which is exposed to iodine vapor is at a somewhat higher temperature, and condensation of the iodine therein is thereby prevented.

After permitting the inert gas to flow through column 9 and flush tube 7 for a time sufficient to expel the atmosphere from the envelope 2, the valve V1 is closed and valve V2 is opened (valve V3 being also opened at this

time in case it is not held normally open) to cause the inert gas to flow from the column 9 through arm 20, reservoir 22, column 18, arm 19 and flush tube 7 into the envelope 2. The iodine vapor in the chamber 18 is thus entrained in the inert gas and is carried therewith into the envelope 2, the previous filling of inert gas being expelled through the fill tube 6 around the flush tube 7. The flow of inert gas and iodine vapor is maintained until the vapor in envelope 2 comes to an equilibrium density which may be indicated by a constant color density. Preferably at the time the flushing is started, the lamp envelope 2 is heated moderately by a torch for example, to about the same temperature as the chamber 18 to avoid condensation of iodine in the lamp envelope.

It will be understood that valve V1 may be closed and valve V2 opened by shifting the magnet 15 from the pole pieces 16 and 17 of valve V1 to the corresponding pole pieces 26 and 27 of valve V2. Also, in case valve V3 has been in closed position, it may be opened at the same time by application of magnet 15' to the pole pieces 28 and 29 associated with said valve V3. Actually, as stated above, valve V3 may be held in open position throughout use of the apparatus in making a series of lamps. However, it is provided in order to be able to close off the iodine chamber 18 when the apparatus is not being used in the production of lamps.

After the flow of gas and iodine vapor has been maintained for a time sufficient to establish an equilibrium density of iodine vapor in the lamp envelope 2, the lamp is raised in the holder 8 to withdraw the upper end of the flush tube 7 from the envelope 2 and retract it to an intermediate point in the length of the fill tube 6, as illustrated in FIG. 2. At this time, the valve V2 may be closed and valve V1 opened to maintain a flow of inert gas through the flush tube 7 and the lower end of the fill tube 6, thereby preventing ingress of atmospheric air into the lamp envelope. The fill tube 6 may then be tipped off close to the envelope 2 by a flame from a tipping torch 30. If desired, the lamp envelope 2, or at least a portion thereof, may be cooled sufficiently below room temperature to cause an added amount of inert gas to be drawn into the envelope before the fill tube 6 is tipped off. The cooling may be effected by a clamp previously chilled in liquid nitrogen and applied to the envelope 2. The increased gas content results in a pressure above atmospheric when the envelope subsequently reaches room temperature.

In a preferred procedure illustrated in FIG. 3, the flush tube 7 is extended to the rear of the enclosure 24 to extend downward and the lamp 1 has its fill tube 6 threaded upward onto the flush tube 7 and held in clamp 31. The flushing steps are carried out in the manner described above. When the flushing mixture of inert gas and iodine vapor has come to an equilibrium, the lamp 1 is pulled down in the clamp 31 to stop the flushing process, and the envelope 2 is partially immersed in a container 32 of liquid nitrogen 33 which is lifted to the elevation of the lamp. The valve V2 is then also closed and valve V1 opened to assure that no additional iodine vapor is drawn into the envelope. With the inert gas still flowing, additional gas is drawn into the cooled envelope 2 and the fill tube 6 is then tipped off at a point a substantial distance from the envelope 2, as indicated by dotted line 34, to keep the heat of the tipping operation away from the envelope 2. The fill tube 6 is then tipped off close to the envelope 2 with the envelope still partly immersed in the liquid nitrogen so as to be at least as cold, and preferably colder, than during the first tipping off at the point 34. Thereby, at room temperature, the pressure of the inert gas filling is somewhat above atmospheric for example about 800 mm. Hg.

FIG. 4 illustrates a system which has also been employed to successfully fill lamps with inert gas and reactive vapor. In this figure, parts corresponding to those in FIG. 1 are similarly numbered with the addition of the letter "*a*." During use of the apparatus, the fill gas (usually nitrogen or argon) is allowed to flow continuously from a source of supply through the conduit 10*a* into the column 9*a* of the glass system, from which it may flow past the valve V1*a*, normally kept open by a magnet as in FIG. 1, and through the flush tube or needle 7*a* into the lamp envelope 2*a*. With the valve V1*a* closed, the inert gas is diverted through the side arm 20*a* and reservoir 22*a* containing the iodine particles 21*a* and through the column 18*a*, arm 19*a* and flush tube 7*a* into the lamp envelope 2*a*. In this case, the glass system is provided with three standard taper glass joints 35, 36 and 37 which make it possible to dismantle the system for the purpose of adding iodine particles. These joints are preferably assembled dry without any sealant. In this condition, some gas may leak to the outside, but the continuous internal pressure prevents atmospheric air from entering the system.

To fill a lamp, the fill tube 6*a* of the lamp is lowered onto the flush tube 7*a* with the tube 7*a* projecting slightly into the lamp envelope 2*a*. With the valve V1*a* opened with a magnet, the atmosphere in the lamp envelope 2*a* is flushed out by inert gas flowing into the envelope through flush tube 7*a* and out through the fill tube 6*a*. The lamp may be baked out at this time by heating the envelope 2*a* with a torch, the evolved impurities being swept out by the flowing gas. Then, with the valve V1*a* closed, iodine vapor is added to the inert gas now flowing through the reservoir 22*a* which is heated to form iodine vapor which is swept into the lamp envelope 2*a*, the column 18*a* and arm 19*a* being maintained at a sufficiently high temperature to avoid recondensation of the iodine vapor. With an excess of iodine vapor in the lamp 1*a*, the lamp is raised to withdraw the flush tube 7*a* into a lower position in the fill tube 6*a* so that the gas flowing from the flush tube 7*a* no longer enters the envelope 2*a* but is expelled out the lower end of the fill tube 6*a*. Then, with the valve V1*a* opened and the iodine supply no longer being heated, the lamp 1*a* is again lowered on the flush tube 7*a* sufficiently to flush out the excess iodine vapor, after which the lamp is again raised to effectively lower the flush tube 7*a* within the fill tube 6*a* sufficiently to stop flushing the envelope 2*a*. The lamp is then sealed by tipping off the fill tube 6*a* with a torch at a point above the upper end of the flush tube 7*a*.

In a modification of the steps of introducing iodine into the lamp in the FIG. 4 system, the lamp is cooled sufficiently, after bake out, so that all iodine evaporated at ambient temperatures (about 25° C., for example) and swept into the lamp by the inert fill gas can be condensed in the lamp envelope 2*a* and accumulated to obtain a sufficient quantity even though the density of iodine vapor at any time is well below the desired density in the lamp. Then, after condensation of a sufficient amount of iodine, the lamp is raised as described above and reheated to evaporate all the condensed iodine after which the quantity is adjusted as described above by flushing out the excess with the inert fill gas.

In a simplified system, a small quantity of iodine granules was introduced into the lamp envelope 2, and the atmosphere was flushed out with inert gas flowing through a small flush tube (like tube 7 in FIG. 1) inserted into the fill tube 6 of the lamp. After retracting the flush tube to a point where it no longer projected into the envelope 2 but still projected into the fill tube 6 to keep the atmospheric air flushed out, the lamp envelope 2 was heated to evaporate all the iodine particles into a vapor. The lamp was then lowered on the flush tube sufficiently to flush out part of the iodine vapor to leave only the amount desired, as measured by the observed color density. The lamp was then again raised to where the flush tube extended only part way through the fill tube 6, and the fill tube 6 then sealed off with a torch leaving the lamp with the desired inert gas and iodine vapor filling therein.

The process may also be adapted to the manufacture

of tipless lamps, as illustrated in FIG. 5. The partially completed lamp has only one of its lead-in conductors 3*b* sealed into a compressed seal portion 5*b* at one end of the envelope 2*b* which is open at its other (lower) end. The lamp envelope 2*b* may be flushed and filled with inert gas and iodine vapor in general accordance with the procedure described above in connection with FIG. 1. Thus, the envelope 2*b* is flushed with inert gas through a flush tube or needle 7*b* projecting a short distance into the lower open end of the envelope, to expel the atmosphere back through the open end of the envelope. Then, as in the FIG. 1 system, the supply of inert gas may be diverted through a chamber containing iodine vapor of predetermined vapor pressure to thereby conduct a mixture of the inert gas and iodine vapor through the flush tube 7*b*. In the meantime the lower end of the envelope 2*b* may be heated to softening temperature by burner flames 39. When the iodine vapor density in the envelope 2*a* has come to equilibrium, a relative longitudinal movement may be effected between the envelope 2*b* and the flush tube 7*b* to withdraw the tube 7*b* from the envelope, and immediately thereafter the softened lower end of the envelope may be compressed and hermetically sealed about the lower lead-in conductor 4*b* to retain the inert gas and iodine vapor filling in the envelope 2*b*. The supporting and retracting operations of the flush tube 7*b* may be effected on equipment similar to that disclosed in Patent 2,900,771, Levand modified by incorporation of the iodine vapor supply system illustrated in FIG. 1 of the present application.

It will be evident that various modifications, omissions and changes may be made in the practice of the process within the spirit and scope of this invention.

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

1. The method of expelling an undesired atmosphere from the envelope of an electric lamp or similar device and filling it with inert gas and active vapor which comprises removing the atmosphere from the envelope by flushing it out with a flow of inert gas, introducing an active vapor into the envelope and continuing the flushing with inert gas to establish a desired equilibrium density of the active vapor in the envelope, cooling at least a portion of the envelope sufficiently to condense the active vapor and to increase the density of the inert gas by admitting an additional quantity of inert gas into the envelope, and sealing the envelope with the inert gas and active vapor retained therein as the final gaseous filling.

2. The method of expelling an undesired atmosphere from an envelope and filling it with an inert gas and an iodine vapor which comprises heating a quantity of iodine to a predetermined temperature in a chamber to create a definite vapor pressure thereof, expelling the atmosphere from the envelope by conducting the inert gas through a path bypassing said chamber and flowing into and through said envelope, diverting the flow of inert gas through said chamber and thence into and through said envelope to carry a mixture of gas and entrained iodine vapor into the envelope, maintaining the flow of mixed gas and iodine vapor for a time sufficient for the iodine vapor to achieve equilibrium density, cooling at least a portion of the envelope substantially below ambient room temperature while terminating the flow of iodine vapor into the envelope and maintaining communication between the interior of the envelope and the flow of inert gas to prevent ingress of atmospheric air and to thereby condense the iodine vapor in the envelope and increase the density of the inert gas in the envelope, and sealing the envelope with the mixture of gas and vapor retained therein.

3. The method of expelling an undesired atmosphere from an envelope and filling it with an inert gas and an active vapor which comprises heating a substance capable of evolving said vapor to a predetermined temperature in a container to create a definite vapor pressure thereof, expelling the atmosphere from the envelope by conducting the inert gas through a path bypassing said chamber and flowing into and through said envelope, diverting the flow of inert gas through said chamber and thence into and through said envelope to carry a mixture of gas and entrained vapor into the envelope, maintaining the flow of mixed gas and vapor for a time sufficient for the active vapor to achieve equilibrium density, cooling at least a portion of the envelope substantially below ambient room temperature while terminating the flow of active vapor into the envelope and maintaining communication between the interior of the envelope and the flow of inert gas to prevent ingress of atmospheric air and to thereby condense the active vapor in the envelope and increase the density of the inert gas in the envelope, and sealing the envelope with the mixture of gas and vapor retained therein.

4. The method of expelling an undesired atmosphere from and filling with inert gas and active vapor an envelope having a fill tube projecting therefrom which comprises heating a substance capable of evolving said vapor to a predetermined temperature in a chamber to create a definite vapor pressure thereof, expelling the atmosphere from the envelope by conducting the inert gas through a path bypassing said chamber and through a hollow needle projecting through said fill tube into the interior of said envelope to expel the atmosphere through said fill tube around said flush tube, diverting the flow of inert gas through said chamber and thence through said needle into said envelope to carry a mixture of gas and entrained vapor into the envelope, maintaining the flow of mixed gas and vapor for a time sufficient for the active vapor to achieve equilibrium density, effecting a relative movement of said envelope and needle in a direction to withdraw the end of said needle from the envelope to a point intermediate the length of the fill tube while maintaining the gas flow through said needle to prevent ingress of air into said envelope, and tipping off the said fill tube at a point beyond the end of the needle toward the envelope to thereby seal the envelope with the mixture of gas and vapor retained therein.

5. The method set forth in claim 4 wherein, prior to the last named step of tipping off the fill tube, the said envelope is cooled to a temperature substantially below ambient room temperature to thereby condense the active vapor in the envelope and draw an additional quantity of the inert gas into the envelope.

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