July 16, 1940. A. BONNEY, JR., ET AL 2,208,113

MANUFACTURE OF LAMPS

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Fig. 1.

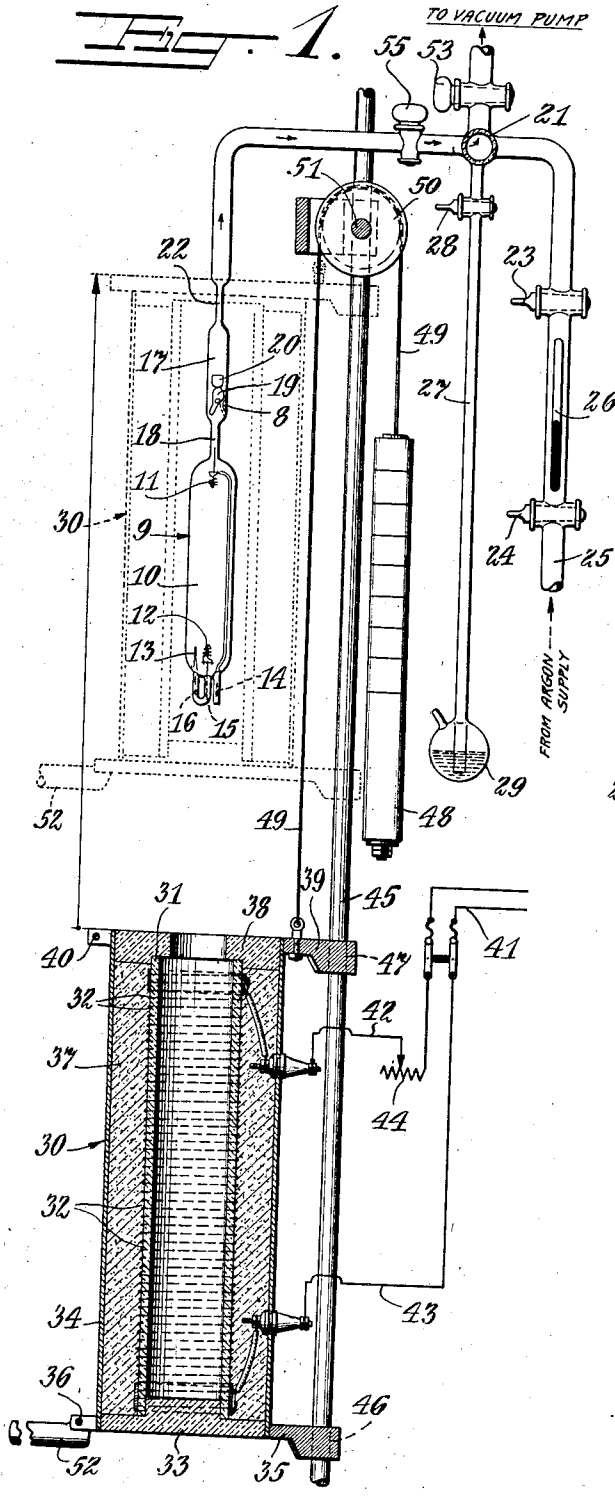
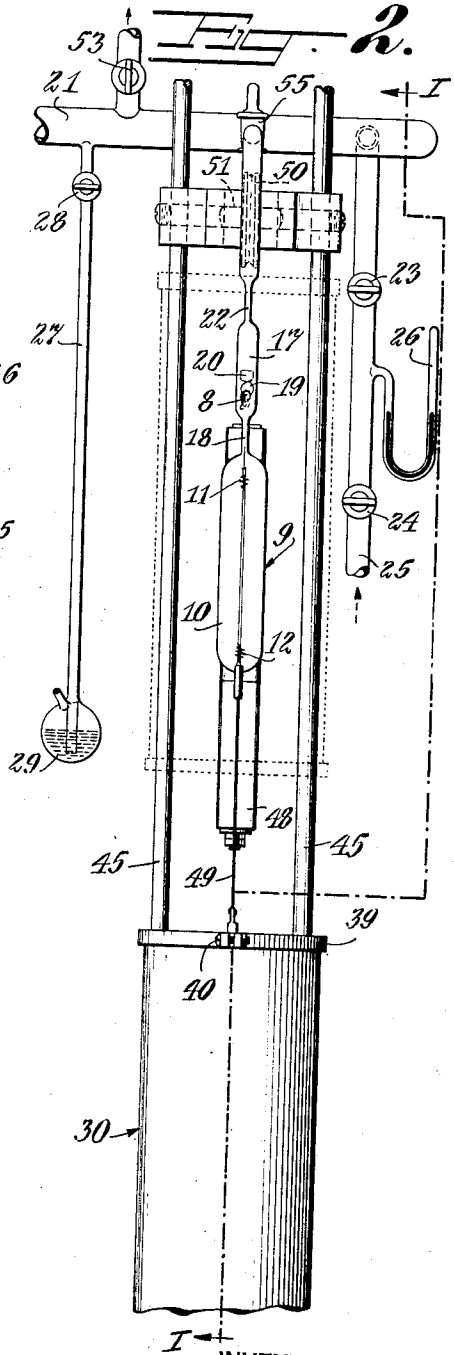



Fig. 2.



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Fig. 3.

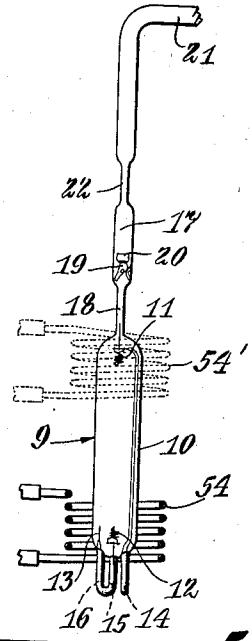



Fig. 4.

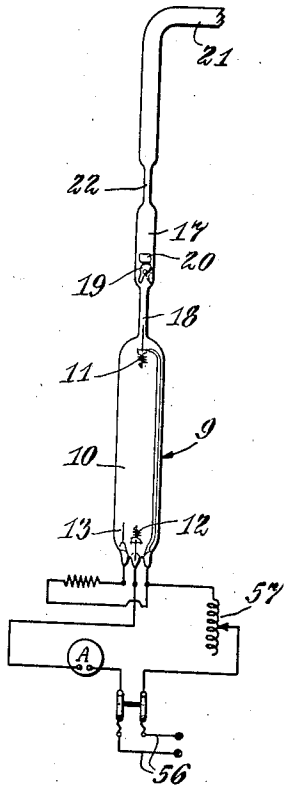



Fig. 7.

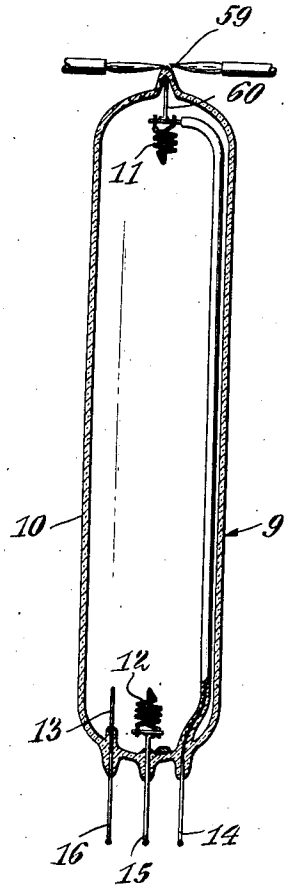



Fig. 5.

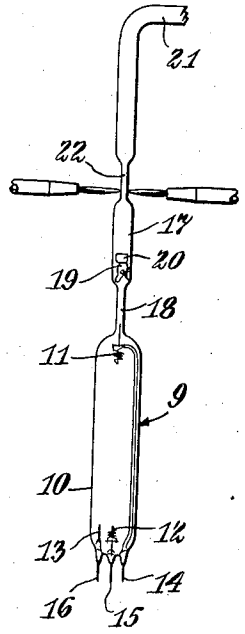
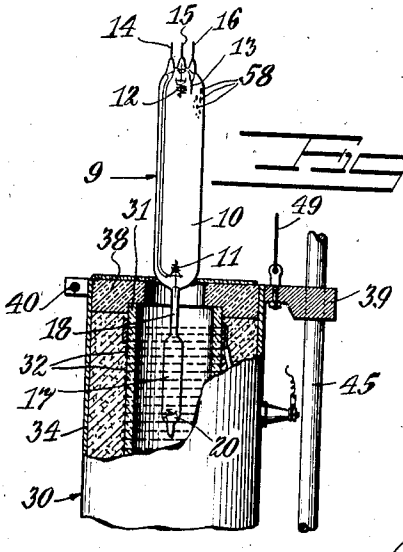



Fig. 6.




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# UNITED STATES PATENT OFFICE

2,208,113

## MANUFACTURE OF LAMPS

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Application February 27, 1937, Serial No. 128,156

14 Claims. (Cl. 176—2)

This invention relates to the manufacture of lamps and, more particularly, to a method of exhaust for gaseous discharge lamps which involves a simplification of the schedule, and an improvement in the quality of the product.

The principal object of our invention generally considered is to manufacture electronic devices, such as high intensity mercury vapor lamps, while employing a simplified exhaust treatment which results in improvement in the quality of the product.

Another object of our invention is the heat treatment of lamps, or other electronic devices such as high intensity mercury vapor devices, when filled with an inert gas at such a pressure that the envelopes thereof can be made hotter without deformation.

A further object of our invention is the manufacture of lamps comprising electrodes coated with emission mixtures, such as alkaline earth metal carbonates, on such as exhaust schedule that said carbonates are at least partially decomposed during the exhausting operation.

A still further object of our invention is the manufacture of high intensity mercury vapor lamps and other electronic devices, in which electrodes coated with emission mixtures are sealed in vitreous vessels, on an exhaust schedule involving the filling of such vessels with an inert gas, such as argon, and baking at higher than normal temperatures, made possible by the presence of said gas, so that not only is a more effective heat treatment and degasification of the envelope and enclosed parts secured, but the emission mixtures are at least partially reduced to the desired form.

Other objects and advantages of the invention, relating to the particular arrangement and construction of the various parts, will become apparent by reference to the following description and accompanying drawings in which:

Fig. 1 is an elevational view, partly in vertical section, of apparatus which may be employed in practicing our invention, including an electrically heated oven.

Fig. 2 is an elevational view, looking from the left, of the apparatus shown in Fig. 1.

Fig. 3 is a fragmentary view showing means for applying high frequency heating to a lamp.

Fig. 4 is a diagrammatic view illustrating a lamp connected to a circuit for further treatment.

Fig. 5 is an elevational view illustrating a lamp being initially tipped off.

Fig. 6 is a fragmentary elevational view, shown partly in vertical section, and illustrating the apparatus for introducing mercury into the lamp bulb.

Fig. 7 is a vertical sectional view of the lamp after completion, except for basing, and also illustrating the final tipping off.

Referring to the drawings in detail, like parts being designated by like reference characters, there is shown a lamp 9 having a glass envelope 10, suitable for use in the manufacture of a high intensity mercury vapor lamp. Said envelope has main electrodes 11 and 12, preferably coated initially with alkaline earth metal carbonates, and a starting electrode 13 sealed thereinto. Leads to said electrodes, in the present embodiment, are brought out at one end of the envelope as indicated at 14, 15, and 16, said leads being shown covered with asbestos, or other heat insulating sleeves, in order to protect them during the manufacturing operations. The envelope and enclosed electrodes and leads may be constructed like the corresponding parts of the device disclosed in the Gustin application Serial No. 75,745, filed April 22, 1936, and owned by the assignee of the present application.

In order to allow for finally introducing a desired quantity of mercury into the envelope 10, there is provided a supplemental tube 17 communicating with the envelope 10 by means of an exhaust tube 18. Said supplemental tube contains a glass or frangible capsule or pellet 19, holding the desired quantity of mercury, conveniently held away from the exhaust tube 18 by an inwardly extending bulge or contraction 8 in the tube 17, and a ball or weight 20, for liberating the mercury from said capsule when desired. The supplemental tube 17 is in turn connected to the exhaust manifold 21 by means of an exhaust tube 22.

After connection to the manifold 21 and preliminary evacuation through open stop cocks 53 and 55, the lamp bulb 10 is desirably tested for leaks with a high-frequency coil. If no leaks are found, an inert gas, such for example, as prepurified tank argon gas, is admitted by opening valves or stop cocks 23 and 24 and permitting the flow of gas from the supply pipe 25 until 760 m. m. pressure in the bulb 10 is indicated by the mercury seal 27 when the stop cock 28 is opened. The desired pressure is shown when the level of the mercury in the tube 27 drops to the level of the mercury in the pool 29. The gauge 26 serves to indicate only relatively low gas pressures.

The next step in our exhaust method, after shutting the stop cocks 23 and 24, is to raise the individual oven 30 over the bulb 10, and tube 17

containing the mercury capsule and breaker, and bake about four minutes at a temperature preferably between 775 and 825° C., while the vent through the stop cock 28 is left open to the atmosphere, thereby avoiding the danger of excessive pressure. The baking temperature may be measured in any suitable manner, as by a thermo-couple, not shown, in the empty oven 30 at the middle of the zone occupied by the lamp bulb 10.

Each oven 30 desirably comprises a refractory insulating tube 31, wound with high resistance wire 32, with insulating material between the turns. The tube is desirably wound with a smaller number of turns per inch adjacent the upper portion than at the middle and lower portion, in order to equalize the temperature. The tube is desirably supported on a bottom asbestos disc 33 with its lower end portion fitting an upstanding boss thereof, inside of a casing 34, which may be formed of galvanized iron. The disc 33 is secured in place by clamping the galvanized iron casing 34 therearound by means of a bottom casting 35 tightened by means of a set screw 36.

The space between the tubing 31 and the casing 34 is desirably filled with refractory heat-insulating material 37, and the top of the annular space between the tubing 31 and the casing 34 is closed by means of top asbestos disc 38. The top portion of the casing 34 is clamped to the disc 38 by means of top casting 39, tightened by means of a set screw 40. Energy is carried to the winding 32 from the source of supply 41 through conductors 42 and 43, variable resistance 44 being employed to regulate the heat of the furnace.

Vertical supporting rods 45 pass through corresponding apertures 46 and 47 in the castings 35 and 39, and said furnace is provided with a counterweight 48 connected thereto by means of a cable 49 passing over pulley 50, rotatably mounted on shaft 51 extending between the supporting rods 45, only one of which is illustrated. In this way the furnace 30 may be readily raised and lowered by means of handles 52, only one of which is illustrated, and will stay in any position desired.

After the lamp has been baked out, as heretofore described, the stop cock 28 is closed and the oven 30 dropped rapidly. As soon as the lamp bulb 10 loses visible redness, the stop cock 53 is opened to start exhausting said bulb. If the bulb is too cool when the mercury vacuum pump is opened, lamp quality will suffer due to reabsorption of gases by the lamp parts. If the bulb is too hot, it may collapse.

When the lamp bulb 10 coils clear indicating a good vacuum, all of the individual stop cocks 55 are desirably shut off at the manifold, except that to the one bulb to be treated, and high frequency is applied to the lamp 9, as indicated in Fig. 3, by means of the coil 54. The power of the coil 54 is such that the electrode surrounded thereby reaches a bright yellow color at final treatment. When high frequency is first applied to an electrode, a bright flash of ionized gas is indicated momentarily. As soon as the electrode begins to be visibly red, this ionization disappears and a column of blue gas shows in the bulb 10. This indicates that carbon dioxide is being generated from the electron emission material on the electrode undergoing treatment. Treatment should be continued until this gas disappears and the high-frequency coil 54 removed just as a very bright white ionization occurs around the electrode. It is important to discontinue treatment immediately the white flash occurs to avoid bulb discoloration.

The bottom electrode 12 and the auxiliary electrode 13, away from the exhaust tube, are desirably first treated to reduce the reabsorption in treating the second main electrode 11. In order to complete the electrode treatment after treating the second electrode, we return the coil 54 to the first electrode 12, gradually raising the temperature to a bright yellow, but still using care to avoid bright white ionization flash of gas. As gas is driven off, a point is reached when the supply of remaining gas flashes out in a manner similar to that in a vacuum type incandescent lamp on flash aging. Treatment should now be alternated between the electrodes until they show no further evolution of gas.

After treating one lamp, its manifold stop cock 55 may be closed and the remaining lamps, if any, similarly treated with high frequency electric current by induction.

The lamp under treatment is then preferably connected to a 230-volt A. C. line 56, preferably in series with a reactance and variable resistance 57, or other means for obtaining a current of 2 to 5 amperes, which may be indicated by ammeter A, as shown in Fig. 4. Inert gas, such as 18 to 20 m. m. of prepurified tank argon, is then admitted through the stop cocks 23 and 24, and exhaust tube 22, and an arc through the lamp 9 started with spark coil at about 4½ amperes. The lamp should be burned about one minute at about 4½ amperes, and the current then reduced to about 3 amperes for about two minutes. After this burning, the lamp should show a uniform milky-blue glow with a purple glow at each electrode. The current is then reduced to about 2 amperes, cut off, and the stop cock 55 immediately opened to the mercury pump and the lamp 9 exhausted to a clear coil.

The vacuum pump is then shut off and inert gas, such as argon, again admitted through stop cocks 23 and 24 until atmospheric pressure is shown on the mercury column 27.

The stop cocks 23 and 24 are now desirably again shut off and the oven 30 raised over the lamp 9 and auxiliary tube 17 which are allowed to bake for about two minutes at a temperature of from 775 to 825° C., the vent through the mercury seal 29 being left open to the atmosphere. After the lamp has been subjected to this second baking, the stop cock 28 to the mercury line is closed and the oven 30 dropped rapidly. As soon as the lamp loses visible redness, the vacuum line to the mercury pump is opened through the stop cocks 53 and 55. Similar precautions are to be observed as in connection with the exhausting after the first baking.

When the lamp 9 coils clear, all the individual stop cocks 55 are preferably shut off at the manifold, except that to the one lamp being treated, and high frequency again applied, as indicated in Fig. 3, by means of the coil 54. The gas evolved by baking the parts is, of course, much less than in the first treatment and care should be taken to avoid bright ionization. As a final check, the high frequency coil should be rapidly alternated between the two electrodes, between the positions 54 and 54', as indicated in Fig. 3, allowing the electrode color to reach as near a bright yellow as possible, in order to catch evidence of the last traces of gas.

The lamp under treatment is then connected, as before, to a 230-volt A. C. line 56, preferably in series with a reactance and variable resistance

57, or other means for obtaining current of 2 to 5 amperes, as shown in Fig. 4. Prepurified tank argon is admitted to 6 to 8 m. m. pressure. The arc in the lamp 9 is started at about 3 amperes and the lamp burned for about three minutes. The current is then cut off and the lamp exhausted to clear coil.

The pump may then be shut off the line, as by closing stop cock 53, and prepurified tank argon gas admitted to a pressure of from 7 to 9 m. m. of mercury after the lamp has been cooled to about 60° C. The lamp is then again operated in the circuit, as shown in Fig. 4, at about 3 amperes, and if the color indicates that the gas has been removed from the electrodes, the lamp may be tipped off, as indicated in Fig. 5. It is not necessary to use liquid air traps in connection with the aforedescribed schedule.

The lamp 9 is then desirably inverted so that the supplemental or capsule tube 17 extends downward, as shown in Fig. 6, and shaken up and down, or otherwise moved, so that the steel ball or weight 20 will strike the capsule 19 and break it. The capsule tube 17 and the end of the bulb 10 are then inserted in the electrically operated oven 30, as shown in Fig. 6, while the latter is heated to a temperature of from 350 to 400° C. The capsule tube 17 is heated until all the mercury is evaporated therefrom and condensed in the cool portion of the bulb 10, as indicated at 58. Care should be used to see that the bulb is not cracked by too rapid heating, and that all the mercury is driven out of the capsule tube 17.

The bulb is now desirably reversed from the position shown in Fig. 6 to that shown in Fig. 7 and tipped-off at 59, as indicated in Fig. 7, keeping said tip as small as possible. An asbestos sleeve is desirably placed over the molybdenum lead or support 60 to the electrode 11 to prevent over heating. The lamp is then complete, except for the basing operation.

From the foregoing disclosure, it will be seen that we have described a method of exhaust for gaseous discharge lamps in which the emission mixture and metal parts are treated at the same time the glass parts are degassed. This is made possible by heating the glass of the bulb while the same is filled with an inert gas, thereby making it possible to get the glass much hotter without deformation. The permissive gain in temperature by this method is approximately 100° C., with a hard or high softening point material such as 172 glass now customarily used for mercury lamps, so that a temperature of from 775 to 825° C., may be employed. At this temperature, high enough to anneal the glass, carbonates of emission material are decomposed, at least in part, thereby making it unnecessary to heat by high frequency for as long a time.

A further advantage lies in the fact that when the lamp is re-evacuated, the inert gas carries the gases evolved from the parts out at such a rate that they cannot be readily reabsorbed by the parts of the lamp and exhaust system. The necessity for liquid air traps is eliminated by this process which is equally effective for other electronic devices where emission mixtures are employed. It will, therefore, be seen that by so treating electronic devices, not only is the simplification of the exhaust schedule permitted, but a very decided improvement in quality results.

Although a preferred embodiment of our invention has been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

We claim:

1. The method of manufacturing electronic devices, comprising bulbs enclosing electrodes coated with the carbonates of alkaline earth metals, which comprises filling each bulb with argon at approximately atmospheric pressure, baking each bulb at such a temperature that the carbonates are partially decomposed, allowing each bulb to cool, exhausting each bulb, treating the electrodes in each bulb to further degasify them, admitting argon to each bulb, operating each device with a discharge current, exhausting each bulb, repeating the admission of argon, baking and degasification, admitting argon at reduced pressure, operating each device with discharge current, introducing mercury into each device, and tipping off.

2. The method of manufacturing high intensity mercury vapor lamps comprising filling each lamp bulb with argon at approximately atmospheric pressure, baking each lamp, allowing each lamp to cool, exhausting each bulb, treating the electrodes in each bulb to degasify it, admitting argon to each bulb, operating each lamp with a discharge current, exhausting each bulb, repeating the admission of argon, baking, and degasification, admitting argon, operating each lamp with a discharge current, introducing mercury into each lamp, and tipping off.

3. The method of manufacturing high intensity mercury vapor lamps comprising filling each lamp bulb with argon at approximately atmospheric pressure, baking each lamp approximately four minutes at a temperature from 775 to 825° C., allowing each lamp to cool until it loses visible redness, exhausting each bulb, treating the electrodes in each bulb with high frequency to degasify it, admitting from 18 to 20 m. m. of argon to each bulb, operating each lamp with a discharge current of about 4½ amperes for about one minute, operating at about 3 amperes for about two minutes, reducing the current to 2 amperes, cutting off the current, exhausting each bulb, repeating the admission of argon, baking, exhausting, and high-frequency degasification, admitting argon to a pressure of 7 to 9 m. m., operating each lamp with a discharge current of about 3 amperes, introducing the desired quantity of mercury into each lamp, and tipping off.

4. An adjustable oven for baking lamps comprising a refractory insulating open ended tube differentially wound with high-resistance wire, whereby the terms are farther apart near the top to equalize the temperature, insulating material between the turns of said wire, means supporting said tube, comprising a disc carrying an upstanding boss around which the lower end portion of said tube fits, a metal casing enclosing said tube and supporting means, heat-insulating material between said tube and casing, means for closing the upper end of the annular space between said tube and casing while leaving the upper end of the tube open, vertical supporting rods, means slidable over said rods and engaging upper and lower portions of said oven, a pulley, a counterweight, means extending from said counterweight over said pulley and secured to said oven for holding it in adjusted position, and means for energizing said winding for securing the desired temperature in said oven.

5. The method of manufacturing high-intensity mercury vapor lamps comprising disposing a lamp, including a bulb and electrodes, a tube containing mercury being connected thereto, above a vertically movable upwardly-opening

oven, counterweighted and adapted to alternately receive and be removed from said lamp, filling the bulb with argon at a desired pressure, moving said oven upwardly until it encloses said lamp, energizing said oven to cause the lamp to be baked for a desired length of time at a suitable temperature lowering said oven to expose said lamp and allow it to cool until it loses visible redness, exhausting the lamp, treating the electrodes with high-frequency current for degasification purposes, admitting argon into the bulb, operating said lamp with a relatively high discharge for a suitable length of time and then with a lower discharge for a greater length of time, further reducing the current flow through said lamp, cutting off said current, exhausting the bulb, repeating the admission of argon, again raising said oven to enclose said lamp and cause the same to be again baked, repeating the high-frequency degasification, again admitting argon at a desired pressure to the bulb, operating said lamp with a desired discharge current, applying the oven over the connected tube containing mercury, in order to cause a desired amount of said mercury to be introduced into said bulb, and tipping off.

6. The method of manufacturing electronic devices comprising hard glass bulbs enclosing electrodes which carry alkaline earth metal carbonates, including the step of filling the bulbs with an inert gas, applying heat externally to said bulbs to raise them to a degassing temperature in excess of 775° C., to soften the bulb material and transform said carbonates to oxides, and admitting mercury thereto.

7. The method of manufacturing electronic devices which include hard glass bulbs enclosing electrodes which carry alkaline earth metal carbonates, comprising filling said bulbs with inert gas at approximately atmospheric pressure, applying heat externally to said bulbs, while under atmospheric pressure to raise them to a degassing temperature in excess of 775° C., in order to anneal the bulb material and change said carbonates to oxides, and afterwards admitting a desired quantity of mercury thereto.

8. The method of manufacturing electronic devices comprising bulbs enclosing electrodes coated with carbonates of alkaline earth metals, which comprises filling each bulb with inert gas at approximately atmospheric pressure, baking each bulb, allowing to cool, exhausting, heating the electrodes to effect degasification thereof, again admitting inert gas to each bulb, operating each device with a discharge current, introducing mercury into each device, and tipping off.

9. The method of manufacturing lamps, each including a bulb and electrodes coated with earth metal compounds, comprising exhausting each bulb, treating the electrodes with high frequency current in order to decompose the compounds and degasify them, admitting inert gas into said bulb, operating the lamp with a relatively high discharge for a predetermined length of time and then at a lower discharge for a greater length of time, further reducing the current flow through said lamp, terminating said current flow, exhausting the bulb, again admitting inert gas, baking said lamp, and repeating the high frequency degasification.

10. The method of manufacturing electronic devices which employ hard glass bulbs and electrodes comprising the carbonates of electron-emission material, comprising filling said bulbs with an inert gas, and heating to a degassing temperature in excess of 775° C., so that said bulbs would deform if the gas were not present, whereby the added effect, of decomposing said carbonates to the desired oxides while the bulbs are degassed, is obtained.

11. The method of manufacturing electronic devices which employ hard glass bulbs and electrodes comprising heat-decomposable compounds of electron-emission material, comprising filling said bulbs with an inert gas at approximately atmospheric pressure, and degassing said bulbs by heating to a temperature in excess of 775° C., so that they would deform if the gas were not present, thereby securing the added effect of decomposing said compounds to the desired emission material while degassing.

12. The method of manufacturing electronic devices, comprising hard glass bulbs enclosing emission mixtures, including the step of filling the bulbs with an inert gas, applying heat externally to said bulbs to raise them to a temperature in excess of 775° C., to soften and anneal said bulbs and simultaneously decompose said mixtures, and afterwards admitting mercury.

13. The method of manufacturing electronic devices, which include emission mixtures enclosed in hard glass vessels, comprising filling said vessels with inert gas at approximately atmospheric pressure, applying heat externally to said vessels to raise them to a temperature in excess of 775° C., to soften said vessels and simultaneously effect at least partial decomposition of said mixtures, and admitting mercury thereto.

14. The method of manufacturing an electronic device, which includes electrodes having alkaline earth metal carbonates thereon enclosed in a hard glass vessel, which comprises filling said vessel with argon at approximately atmospheric pressure, applying heat externally to said vessel to raise it to a temperature in excess of 775° C., to soften said vessel and simultaneously effect at least partial decomposition of said carbonates, and finally introducing mercury into said vessel.

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