

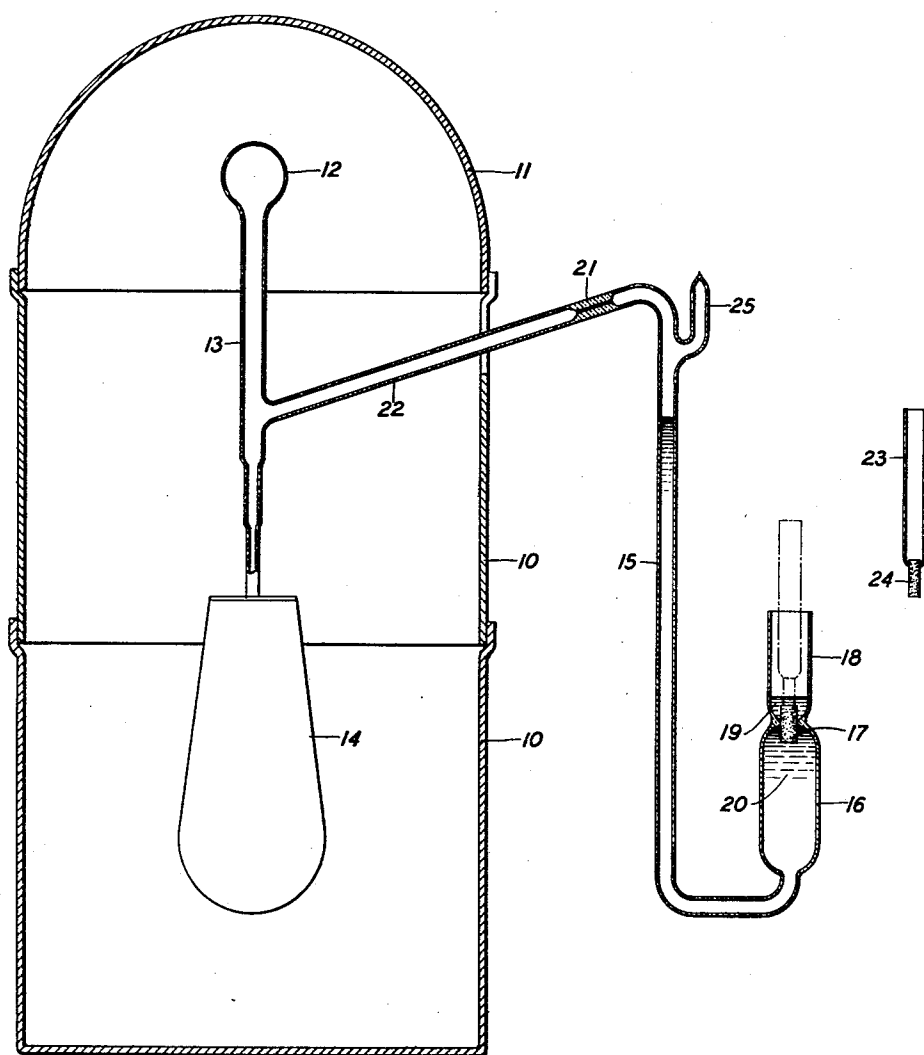
July 18, 1933.

D. S. BOND

1,918,244

MANUFACTURE OF VAPOR ELECTRIC DEVICES

Filed Sept. 9, 1930



INVENTOR
D. S. BOND

BY

Walter C. Kiesel

ATTORNEY

UNITED STATES PATENT OFFICE

DONALD S. BOND, OF BROOKLYN, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

MANUFACTURE OF VAPOR ELECTRIC DEVICES

Application filed September 9, 1930. Serial No. 480,654.

This invention relates to the manufacture of vapor electric devices and more particularly to the method and apparatus for introducing vapor forming substances into electric discharge devices.

An object of the invention is to control the quantity of vapor producing substances introduced into electrical discharge devices. Another object of the invention is the introduction of the metallic substance in the device by an arrangement which is efficient in operation and materially reduces the cost of manufacture.

In accordance with this invention the electric discharge devices are sealed to the usual pumping header of an evacuating system and an injector arrangement is joined to each position on the header intermediate the electric device and the header. The injector device comprises a vertical J-shaped tubular member having an enlarged open end sealed with a porous plug, the long end of the J-shaped tubular member being provided with an inclined tubular section which is sealed to the position on the pumping header. A capillary tubular section is provided between the joint of the inclined section and the long end of the J-shaped tubular member. A supply of mercury or other gas producing medium is located in the J-shaped tubular member and the enlarged open end is filled with a quantity of mercury to seal the porous plug.

After the electrical device has been evacuated in the usual manner the operator inserts a plunger member consisting of an open tubular section having a porous plug sealed in one end into the mercury seal in the enlargement of the J-shaped tubular member. This step breaks the seal in the porous plug of the enlargement and due to the two plugs being in contact air entering the portable tubular section is injected into the J-shaped tubular member to force the mercury supply upwardly through the long length of the J-shaped tubular member until the capillary tube section is filled with mercury. The portable plug is removed from the enlargement of the J-shaped tubular member and the mercury in the capillary tube section

flows through the inclined tubular member by gravity and into the electric device attached to the header.

This arrangement provides an efficient and convenient method of controlling the volume of vapor producing substances introduced into electrical devices and provides an injector system which may be permanently installed in an evacuating system regardless of the number of tubes and devices repeatedly connected to the system. The volume of vapor producing substance is controlled by the length of the capillary tube section. The injector arrangement is provided with a seal for replenishing the supply of vapor producing substance in the chamber.

The invention will be more clearly understood from the following detailed description in connection with the single figure of the drawing showing the assembly of the injector arrangement associated with an electric discharge device connected to a pumping header enclosed in a baking oven, all of the elements being shown in cross-section to clearly disclose the detail construction.

Referring to the drawing, the injector system for electric discharge devices comprises the usual baking oven enclosure consisting of a movable box-like section 10 and a stationary dome-shaped section 11 in which is located the usual pumping header 12. The header is connected, exterior to the casing, to a mechanical pumping mechanism or mercury high vacuum pump, (not shown) to completely evacuate the vessel or device connected to the header. A dependent prong 13 projects from the header to which the device to be evacuated is sealed. For the purpose of this invention the dependent prong is lengthened and the electric discharge device 14 sealed to the lower end as shown in the drawing.

The injector system according to this invention will now be described. Exterior to the oven 10 there is shown a J-shaped tubular member or chamber 15 having its long length extending parallel to the rear wall of the oven 10 and its curved length projecting rearwardly of the oven casing. A hollow chamber or reservoir 16 is joined to the open

end of the curved section of the chamber 15 and extends vertically in parallel relation with the long length of the J-shaped tubular member. A porous plug 17, preferably of lavite or any similar semi-permeable material, either in one piece or finely divided, is sealed into the neck of the chamber 16. An open cup-shaped member 18 is fused to the neck of the chamber 16 containing the plug 17. The cup member 18 contains a quantity of mercury or other sealing medium 19, which prevents the entrance of any gas or air through the porous plug 17. A supply of a vapor producing substance, such as mercury 20, fills the reservoir 16 and the chamber 15 and constitutes the substance which is to be introduced into the electric discharge device 14. A capillary tube section 21 of predetermined length is connected to the upper end of the J-shaped tubular chamber and is joined to an inclined tubular continuation 22 of a larger cross-section than the capillary section. A seal 25 positioned adjacent the upper end of the J-shaped tube 15 provides means for replenishing the supply of vapor producing substance in the chamber or reservoir.

Prior to sealing the injector system to the prong of the header 12 the whole assembly is baked out in vacuum and clean mercury introduced until the mercury in the vessel 16 is at the level of the porous plug 17 and the mercury level in the tube 15 is about an inch below the top. The cup member 18 above the porous plug is filled with mercury until the plug 17 is completely covered. The injector system is sealed to the header prong 13 by fusing the end of the inclined tubular member 22 to the header prong 13 intermediate the end thereof. In this position the inclined tubular member 22 extends through a slot in the rear of the oven wall with the inclined tubular member 22 within the oven and the remainder of the system exterior of the oven in the rear thereof. While the invention discloses a single injector system connected to a device in which it is desired to introduce a definite volume of a vapor producing substance, it is, of course understood, that an injector system is connected to each header prong combined in a single station, the prongs being combined in sets of six or twelve at a single pumping station. The injector remains permanently connected to the header assembly while a large number of devices are pumped at a single station.

Since the injector system is practically wholly outside the oven there is little danger of breakage of any of the glasswork during pumping, in raising or lowering the oven, connecting the electrode leading-in wires of the device to the test circuit and during the interval of sealing the device to the header. The injector system may be conveniently clamped rigidly in position to reduce acci-

idental breakage. Furthermore, the vapor producing substance in the injector system is not exposed to air after the injector is sealed to the header assembly. The vapor pressure in the header assembly is very small even during the baking process as there is no vapor producing substance inside the oven and the small capillary section of the injector arrangement reduces the rate of effusion to a very low value. Due to the absence of any chemical reaction there are no foreign gases produced in the system and there is no leakage of vapor from the source within the device during the baking-out process.

The method of introducing the vapor producing substance into the device 14 under evacuation consists of the preliminary step of exhausting the device 14 to the proper degree of vacuum, heating the glass part during evacuation to remove occluded gases and activating the filament of the device 14. At the proper stage when it is desired to introduce a definite volume of vapor producing substance, such as mercury 20, into the device 14, a removable pressure injecting device is inserted in the cup 18. This device consists of a length of hollow tubing 23 and a porous plug 24, preferably of lavite, sealed in one end thereof and adapted to be manually inserted in the cup 18 by the operator to inject air or inert gas into the reservoir to force the mercury column in the reservoir to rise to the level of the capillary tube section 21. This is accomplished by the porous plug 24 engaging the porous plug 17 which is stationary in the neck of the reservoir. The mercury seal 19 is broken by the plug 24 and the open tube 23 allows air to slowly leak through the engaging porous plugs 24 and 17 into the reservoir. The air entering the reservoir forces the mercury column to rise in the tubular member 15 until the desired amount of mercury flows into the capillary section 21, from which it flows by gravity into the inclined tube 22, through the header prong 13 and into the device 14. The control of the definite volume of mercury injected into the device 14 is determined by the length and diameter of the capillary tube section 21 which is made of the proper length to contain the desired volume. As a specific example, if it is desired to introduce about .01 cc. of mercury into the device 14 a length of about 1.5 cm. of 1 mm. capillary tubing is used.

When atmospheric air is used as the pressure medium for forcing the mercury through the injector system the removable plug 24 in the injecting device is held in contact with the stationary porous plug 17 until the mercury just starts to flow through the short capillary section 21, then the injecting device is removed from the cup 18 and the stationary porous plug 17 is self-sealed by the body of mercury 19 in the cup 18. The lag in the

injector system allows the mercury to flow until the capillary tube section 21 is full and only the volume of mercury in the capillary tube section flows by gravity into the device 14, the rest of the column sealing itself off by surface tension. The electric discharge device 14 is then sealed off the header assembly.

When the header assembly is open to air prior to sealing on another set of devices, the mercury column drops automatically in the tubular member 15 and the small volume of air trapped in the reservoir 16 bubbles out through the porous plug 17 and the mercury in the cup 18, and escapes, and the station returned to its original state. The injector system remains permanently connected to the evacuating station until practically the whole volume of mercury in the reservoir is used and since the seal 25 at the upper end of the J-shaped tubular member permits the supply of mercury to be replenished it will be seen that the injector system provides an efficient assembly for controlling the volume of vapor producing substance introduced into electric discharge devices.

The capillary tube section of the injector system allows the pumping station pressure to be kept low and also determines the volume of mercury which it is desired to introduce into each device connected to the pumping system. The capillary tube section may be of various lengths for individual requirements so that the volume of this tubing is approximately that of the substance which it is desired to admit into the electric discharge device, thus forming an arrangement for admitting repeatedly a predetermined amount of substance into the device. Furthermore, the position of capillary section at the point near the top of the path of mercury flow allows the head of mercury impelling the mercury into the capillary tube section to continue flowing after the air leakage has stopped.

The arrangement of an inclined tubular section or passageway leading from the capillary tube section to the pumping header provides a gravity flow for the mercury which is contained in the constriction of the capillary section and since this passageway is of large diameter there is very little resistance to the mercury flowing from the capillary tube section. The movable and stationary porous plugs in the injector system form a convenient and positive arrangement for injecting air as a slow leak into the injector system to raise the level of the column of mercury in the long section of the reservoir. It is, of course understood, that while air permits a slow leak to force the mercury through the system, higher pressure than atmospheric pressure may be used with such an arrangement. Furthermore, inert gases or other force producing media may be sup-

plied to the removable injecting device to raise the level of mercury in the system.

While the invention has been disclosed in a particular manner and shown in the drawing as a specific assembly, it is, of course understood, that various modifications may be made in the structure for accomplishing the results of this invention and such modifications are intended to be within the scope of the appended claims.

What is claimed is:

1. An injector device for electric discharge devices, comprising an elongated reservoir containing a vapor producing substance, an inclined tubular passageway connected to said reservoir, a capillary tube portion intermediate said reservoir and inclined passageway, a sealed porous plug in the open end of said reservoir, and means for temporarily engaging said porous plug to inject a force producing medium into said reservoir to raise the substance therein to the level of said capillary tube portion.

2. An injector device for introducing a vapor producing substance into electric discharge devices, comprising a vertical reservoir containing a supply of the substance, means at one end for controlling the volume of said substance introduced into said device, self-regulating means at the opposite end for sealing said reservoir, and removable means entering said self-regulating means for injecting a pressure medium to said reservoir.

3. An injector device for introducing a vapor producing substance into electric discharge devices, comprising a vertical reservoir containing a supply of the substance, a capillary tube section on one end thereof for controlling the volume of said substance introduced into said device, a fluid sealed pervious element located at the opposite end for sealing said reservoir, and a separable pressure injecting element adapted to be placed in contact with said pervious element to introduce a pressure into said reservoir to elevate the supply of said substance to said capillary section.

4. An injector device for introducing a vapor producing substance into electric discharge devices, comprising a vertical reservoir containing a supply of the substance, a capillary tube section on one end of said reservoir for controlling the volume of said substance introduced into said device, a fluid sealed porous plug rigidly held in the open end of said reservoir, and a portable injecting element adapted to be inserted in the open end of said reservoir.

5. An injector device for introducing a vapor producing substance into electric discharge devices, comprising a reservoir containing a supply of the substance, a capillary tube section on one end of said reservoir for controlling the volume of said substance introduced into said device, fluid sealed porous

material held in the open end of said reservoir, and a portable injecting element having porous material contained in one end thereof and adapted to break the fluid seal and contact with said porous material in the end of said reservoir.

6. An injector device for introducing a vapor producing substance into electric discharge devices, comprising a vertical reservoir containing a supply of the substance, a capillary tube section at an angle with respect to said reservoir for controlling the volume of said substance introduced into said device, self-regulating means at the opposite end of said reservoir for sealing a cup-shaped opening therein, portable means entering said cup-shaped opening and engaging said self-regulating means for injecting a pressure medium into said reservoir, and an inclined passageway leading from said capillary tube section to said electric discharge device.

7. An injector device for introducing mercury into electric discharge devices, comprising a vertical J-shaped reservoir containing a supply of mercury, an angularly arranged tubular member connected to the long length of said reservoir, said member containing a constricted portion of predetermined length adjacent said reservoir, sealed porous material in the open end of said reservoir, and a manually operated removable member adapted to be inserted into said open end to engage said porous material.

8. An injector device for introducing a definite volume of mercury into electric discharge devices, comprising a vertical J-shaped reservoir containing a supply of mercury, an inclined tubular member connected to the long length of said reservoir, said member containing a capillary section of predetermined length and diameter, a self-sealing stationary porous plug in the open end of said reservoir, and a separable tubular member having a porous termination for temporarily engaging said stationary porous plug in the open end of said reservoir to raise the mercury therein to the level of said capillary section.

9. In combination, an evacuating header

sealed to an electric discharge device, a heating oven surrounding said header and device, a mercury injector system exterior to said oven, and an inclined tubular passageway having a capillary section therein connecting said injector system to said header through said oven.

10. In combination, an evacuating header sealed to an electric discharge device, a heating oven surrounding said header and device, a mercury injector system exterior to said oven, an inclined tubular member connecting said injector system to said header through said oven, and a separable air injecting device for inserting into one end of said mercury injector system to cause a definite volume of said mercury to flow through said inclined member into said device.

11. In the manufacture of vapor devices including a chamber containing a vapor producing substance and having a constricted portion, a vessel adapted to be supplied with said substance, and an exhaust system, the method of controlling the volume of substance introduced into said vessel which comprises connecting said chamber to said vessel and exhaust system, temporarily introducing a pressure force into said chamber to raise the level of said substance to said constricted portion, and allowing the volume of said substance in said constricted portion to flow by gravity into said vessel.

12. In the manufacture of mercury vapor discharge devices including a reservoir containing a supply of mercury and having a predetermined length of capillary tubing, a discharge device adapted to be supplied with said mercury, and an exhaust system, the method of controlling the volume of mercury introduced into said discharge device which comprises connecting said device to said exhaust system, connecting said reservoir between said exhaust system and said device, and allowing a controllable leakage of air to enter said reservoir to force said mercury into said capillary tubing.

In witness whereof, I hereunto subscribe my name this 5th day of September, 1930.

DONALD S. BOND.