July 20, 1943. J. T. L. BROWN 2,324,556

MANUFACTURE OF SEALED ARTICLES

Filed June 4, 1942

FIG. 1

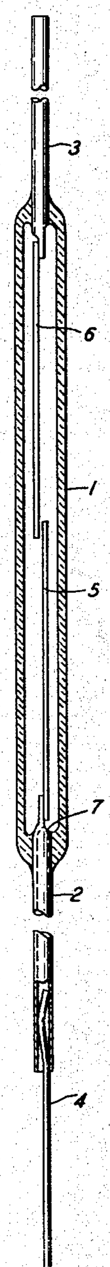
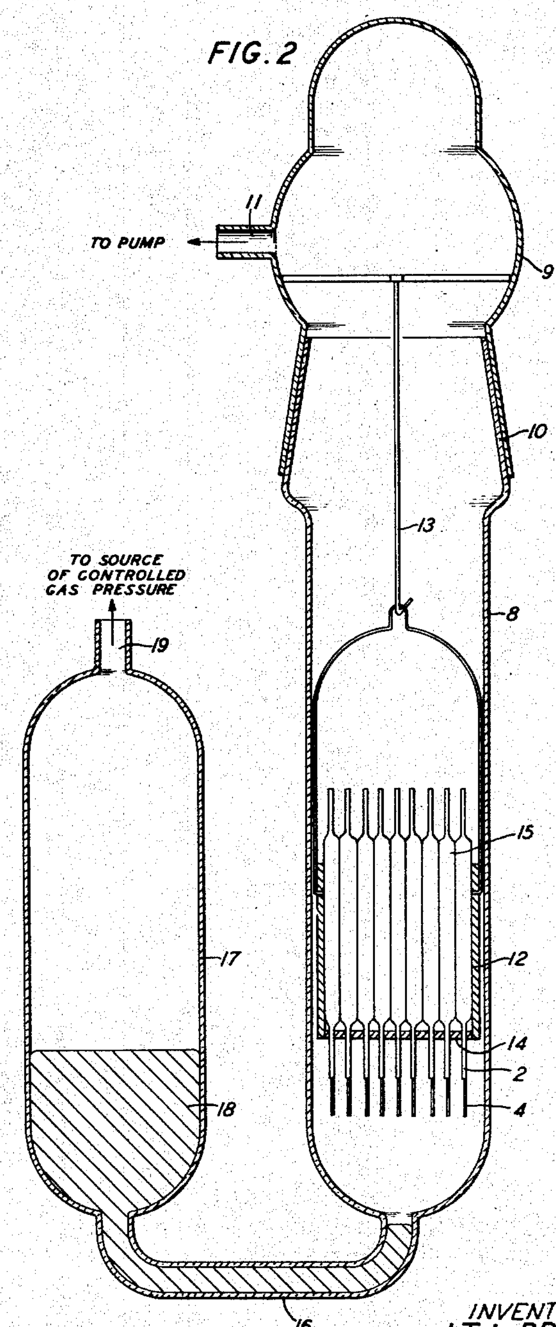


FIG. 2



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MANUFACTURE OF SEALED ARTICLES

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11 Claims. (Cl. 226—20)

The present invention relates to methods and apparatus for the sealing of gas-tight envelopes, particularly those adapted to contain electrical apparatus which it is necessary to maintain in an evacuated or gas-filled atmosphere.

The present invention is particularly adapted to the evacuation, gas filling and sealing of glass-enclosed magnetic reed switches which are provided with one terminal in the form of a metal tube through which the switches are evacuated and filled with gas. Prior to the present invention, switches of this type were evacuated and filled with gas by individually coupling the metal tube ports of each switch to the pumping station and gas source. They were then sealed by squeezing the ends of the tubes flat and welding the flat sections together.

This process was similar to that ordinarily used in the manufacture of vacuum tubes and lamps. This method of individual handling could be carried out at low cost in the manufacture of vacuum tubes and lamps, but this low cost was arrived at to a large extent by providing complicated machinery to perform a sequence of individual operations on identical parts being fed continuously to it. Where it is not desired to produce glass-enclosed apparatus of a standardized design in extremely large quantities, the cost of such individual handling may be excessive.

According to the present invention a method and apparatus are provided whereby such articles may be evacuated, filled with gas and sealed in batches, thus avoiding the necessity for individual handling. This batch method is especially adapted to the manufacture of articles of small cross section, such as the glass-enclosed reed switches referred to above. The structure and operation of the apparatus and method of the present invention can best be explained by reference to the accompanying drawing, in which:

Fig. 1 is a view, partly in section, of the type of glass sealed reed switches adapted to be evacuated, filled with gas and sealed by the method and apparatus of the present invention; and

Fig. 2 is a front sectional elevation of a form of the apparatus of the present invention.

The switch shown in Fig. 1 is made up of a glass envelope 1 having a metal tube 2 sealed in one end and a solid wire lead 3 sealed in the opposite end. The metal tube 2 and the lead 3 are made of a metal having a coefficient of expansion approximating that of glass, such as an alloy of 52 per cent nickel and 48 per cent iron. The metal tube is preferably copper plated to facilitate subsequent sealing with solder. This tube is open at both ends, thus forming a port through which the interior of the envelope communicates with the outside atmosphere. In order to provide a convenient terminal for soldering, a bent piece of tinned copper wire 4 or other suitable metal wire may be inserted in the metal tube leaving a substantial portion of the wire protruding. This wire is subsequently sealed in the metal tube by solder at the time the glass envelope is sealed off. The portion of the tube 2 and the lead 3 within the envelope are flattened and have welded to their flattened portions two reeds 5 and 6 formed of magnetic material. The flattened end of the tube 2 has an opening 7 in its side, furnishing means through which the interior of the envelope communicates with the outside atmosphere as stated above. The construction and operation of this type of switch are more particularly described and claimed in the copending application of W. B. Ellwood, Serial No. 198,629, filed March 29, 1938 which has matured into Patent No. 2,289,830 issued July 14, 1942.

The apparatus shown in Fig. 2 consists of a cylindrical glass evacuation chamber 8 having a removable cover 9 fitted to the body of the evacuation chamber by means of a ground joint 10. A port 11 in the cover furnishes a means whereby the chamber can be evacuated and filled with gas. Within the chamber 8 a cylindrical holder 12 is suspended from the cover 9 by any suitable means 13. The bottom 14 of the cylindrical holder 12 is provided with perforations, which are slightly larger in diameter than the metal tubes 2 of the switches 15. These perforations are uniformly spaced so that, when the tubular metal ports are inserted therethrough, the switches 15 are regularly and snugly positioned within the cylindrical holder. The tubular metal ports protrude freely through the bottom of the holder.

The lower portion of the evacuation chamber is connected by means of a tube 16 to an auxiliary container 17 which contains a supply of molten solder 18. The auxiliary container 17 is connected by means of an outlet 19 to a suitable source of gas pressure. The entire apparatus, with the exception of the holder 12 and the support 13, is preferably made of glass, although obviously any suitable material may be used.

In the operation of the method of the present invention, a plurality of switches, similar to that shown in Fig. 1, are placed within the cylindrical holder 12 so that their hollow metal tube ports are downwardly disposed and protrude from the bottom of the holder through the perforations, the metal tube openings forming substantially a horizontal plane. The cover 9 is then lowered into place on the top of the evacuation chamber together with the support 13 and the holder 12, and a tight seal is established at the ground joint 10. The solder 18 is maintained in a molten state throughout the entire procedure by any suitable source of heat (not shown). During the insertion of the holder into the evacuation chamber 8 and during the subsequent evacuation of this chamber, the solder is maintained within the chamber 17 by a portion of the solder in the tube 16 which has been allowed to solidify so as to close the tube.

After the switches have been inserted in the evacuation chamber, the chamber is evacuated through the outlet 11 to an absolute pressure of about 10^{-3} millimeters of mercury. The portion of the evacuation chamber containing the switches, and the switches therein, are heated to about 100° C. to aid in the elimination of adsorbed gas. The chamber is then flushed with a mixture of hydrogen and helium, re-evacuated and filled with a mixture of hydrogen and helium, the hydrogen pressure being about 130 millimeters of mercury and the helium pressure being about 630 millimeters of mercury. Obviously any other desired inert gas may be employed.

In order to seal the switches after they have been filled with gas, heat is applied to the tube 16 by any suitable means, such as by an open gas flame, in order to melt the solder contained therein. Sufficient pressure is then applied to the solder in the auxiliary chamber 17 by the introduction of gas to force the solder to such a level in the evacuation chamber that the metal tubes of the switches are immersed to a depth of about one-eighth inch.

The heat of the solder causes expansion of the gas within the switches, which results in bubbling of the gas from the bottom of the tubes. After the bubbling has stopped, the helium pressure within the evacuation chamber is increased by about 30 millimeters of mercury and the gas pressure within the auxiliary chamber 17 is increased correspondingly to maintain the proper level of solder in the evacuation chamber. The added pressure forces the solder a considerable distance up inside the metal tubes, where it immediately cools and commences to harden.

The pressure within the chamber 17 is then reduced to withdraw the solder from the evacuation chamber and the solder within the tube 16 is then allowed to solidify by cooling. The cover may then be removed from the evacuation chamber and the finished switches can be taken from the holder. The solder within the chamber 17 may be maintained in a molten state during all operations.

A eutectic solder made up of 63 per cent tin and 37 per cent lead is suitable for this process because of its low melting point and because of the fact that it changes completely from a liquid to a solid within a small temperature range. Another suitable solder, which, however, has a higher melting point, is made up of 96 per cent lead, 2 per cent tin and 2½ per cent silver.

The invention has been described in terms of its specific embodiments, but certain modifications and equivalents will be apparent to those skilled in the art. Such modifications and equivalents are intended to be included within the scope of the present invention which is to be limited only by the fair and reasonable scope of the appended claims.

What is claimed is:

1. In the manufacture of electrical devices enclosed in gas-filled sealed glass tubes which are adapted to be sealed off by closing tubular metal ports sealed therein, the steps which comprise suspending a plurality of said glass-enclosed devices, while yet unsealed, in an enclosed chamber in such manner that their open metal tube ports are downwardly disposed and have their openings arranged in substantially a horizontal plane, evacuating said chamber, filling said chamber with the desired gas under the desired pressure, introducing a molten solder into the lower portion of said chamber until the level of the solder is slightly above the open ends of said metal tube ports, increasing the gas pressure within the chamber to force the solder part way up in said metal tubes, wherein it solidifies, and withdrawing said solder from the chamber.

2. In the manufacture of electrical devices enclosed in gas-filled sealed glass tubes which are adapted to be sealed off by closing metal tube ports sealed therein, the steps which comprise suspending at least one of said glass enclosed devices, while yet unsealed, in an enclosed chamber in such manner that its metal tube port is downwardly disposed, altering the atmosphere within said chamber to correspond with that desired within the glass enclosed device and sealing said metal tube ports by introducing molten solder into the lower portion of said chamber until the level of the solder is slightly above the open end of said metal tube ports.

3. In the manufacture of glass envelopes which are adapted to be sealed off by closing protruding tubular ports, the steps which comprise suspending at least one of said envelopes, while yet unsealed, in an enclosed chamber in such manner that its tubular port is downwardly disposed, altering the atmosphere within said chamber to correspond with that desired within said envelope and sealing off said tubular port by introducing a solidifiable liquid sealing material into the lower portion of said chamber until the liquid level is slightly above the open end of said tubular port.

4. In the treatment of glass envelopes having hollow metal tubes sealed in the walls of said envelopes, the steps comprising placing at least one of said envelopes, having its metal tube unsealed, within a chamber, altering the atmosphere within said chamber to correspond with that desired within the envelope and establishing contact between the open end of said metal tube and a pool of molten solder within said chamber whereby the envelope is sealed.

5. In the manufacture of enclosed gas-tight envelopes, the steps comprising placing within a chamber at least one of said envelopes having an unsealed opening, altering the atmosphere within said chamber to correspond with that desired within the envelope and sealing said opening by introducing a liquid solidifiable sealing material into the lower portion of said chamber until the liquid level is above the area of said envelope surrounding said opening.

6. In the manufacture of enclosed gas-tight envelopes, the steps comprising placing within a chamber a plurality of said envelopes having unsealed openings, said envelopes being so arranged that their openings are downwardly disposed, altering the atmosphere within said chamber to correspond with that desired within said envelopes and establishing contact between the areas of said envelopes surrounding said open-

ings and a pool of molten sealing material within said chamber, whereby the openings in said envelopes are sealed.

7. In the manufacture of enclosed gas-tight envelopes, the steps comprising placing within a chamber at least one of said envelopes having an unsealed opening, altering the atmosphere within said chamber to correspond with that desired within said envelope and establishing contact between the area of said envelope surrounding said opening and a pool of liquid solidifiable sealing material within said chamber whereby the opening in said envelope is sealed.

8. A device for altering the atmosphere within and sealing glass vessels which are adapted to be sealed off by closing protruding tubular ports, which device comprises an enclosed sealing chamber, means within said sealing chamber adapted to support a plurality of said glass vessels with their tubular ports in a downwardly disposed direction and with their tubular ports defining substantially a horizontal plane, means for withdrawing and introducing gas into said sealing chamber, a second chamber adapted to contain a molten sealing material, a duct connecting the lower portions of both said chambers and means for causing the flow of said sealing material from said sealing material containing chamber through said duct into said sealing chamber.

9. A device for altering the atmosphere within and sealing glass vessels having sealable protruding tubular ports, which device comprises an enclosed glass chamber having a cover fitted to an opening in said glass chamber by means of a gas-tight ground glass joint, said opening being sufficiently large to permit the insertion of a holder for said glass vessels, a holder for said glass vessels within said chamber adapted to support said glass vessels with their tubular ports in a downwardly disposed direction, means for withdrawing and introducing gas into the space defined by said glass chamber and cover, and means for introducing liquid sealing material into the lower portion of said chamber.

10. A device for altering the atmosphere within and sealing gas-tight vessels having sealable protruding tubular ports, which device comprises an enclosed chamber, means for introducing and withdrawing gas from said chamber, supporting means within said chamber adapted to support a plurality of said vessels with their tubular ports disposed in a downward direction and with the openings of said tubular ports disposed substantially in a horizontal plane and means whereby molten material may be introduced into the lower portion of said chamber until its surface within the chamber is sufficiently high to contact said sealable ports.

11. A device for altering the atmosphere within and sealing gas-tight vessels having sealable ports which comprises an enclosed chamber adapted to be evacuated, supporting means within said chamber for supporting at least one of said vessels and means for establishing contact within said chamber between the surface of a pool of molten sealing material and the sealable port of at least one of said vessels so supported.

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