

July 12, 1932.

F. HOTCHNER

1,867,154

METHOD OF FABRICATING VACUUM VESSELS

Filed Dec. 16, 1930

2 Sheets-Sheet 1

Fig. 1

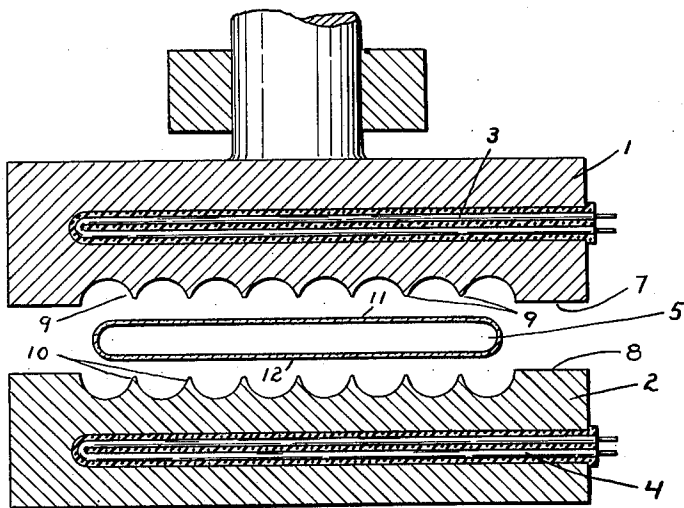


Fig. 2

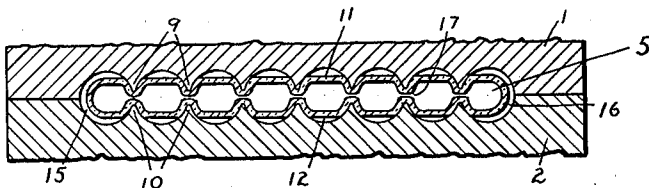


Fig. 3

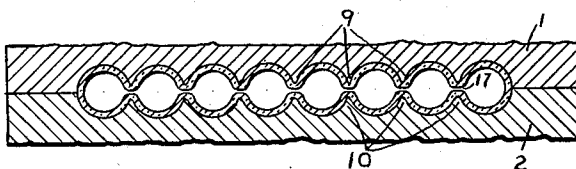
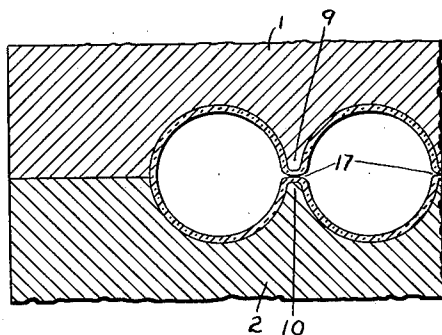


Fig. 4



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Fig. 5

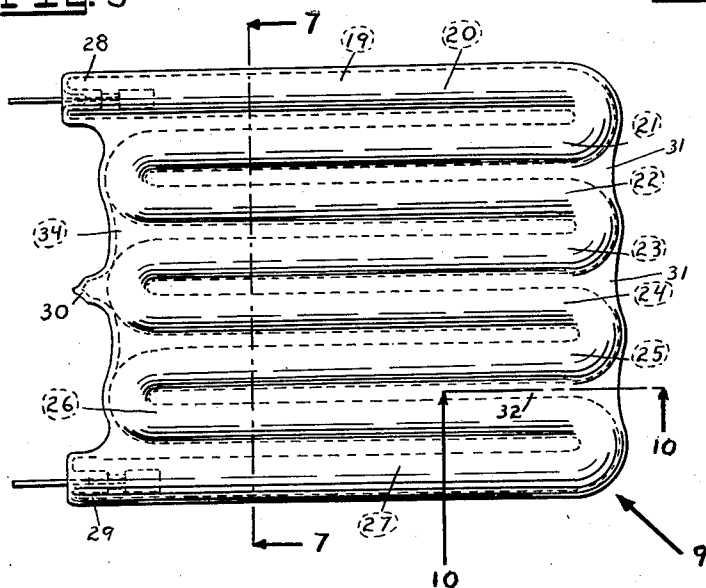


Fig. 6 Fig. 7

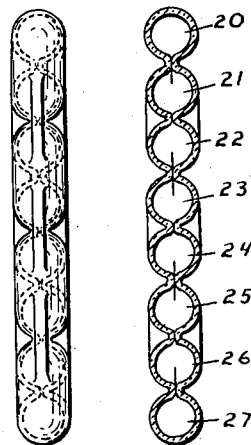


Fig. 8

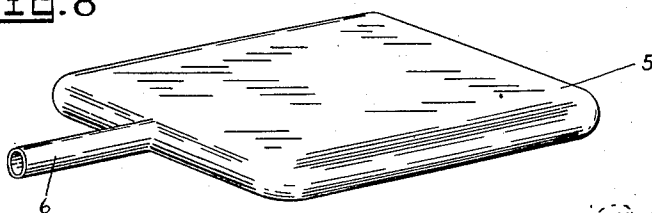


Fig. 10

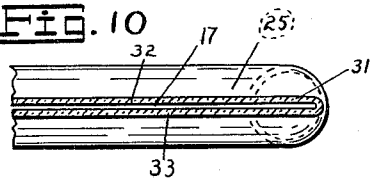


Fig. 11

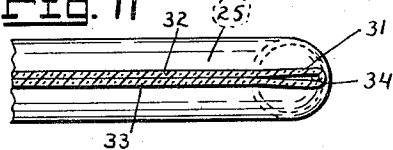
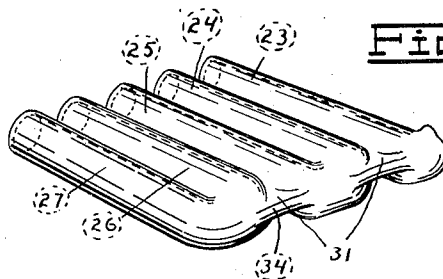


Fig. 9



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METHOD OF FABRICATING VACUUM VESSELS

Application filed December 16, 1930. Serial No. 502,662.

This invention relates to a method of fabricating vacuum vessels having a generally flattened form and of relatively thin material, such as the various types of vessels described in my co-pending application for Letters Patent Serial No. 509,253, filed Jan. 16, 1931. In general, said application describes vessels suitable for ionization conductor lights having relatively thin walls and generally flattened forms, there being tortuous passages for the discharge provided through the vessels by means of inward protuberances from the opposite walls thereof. This invention is not limited to vessels of any particular type but may be used in many ways in the art; for instance, heat insulating units may be fabricated by the method herein set forth.

By the term "generally flattened" I have reference to articles having forms of considerable extent compared with the thickness as contrasted to the vessels of the prior art which were in the form of solids of revolution. By the term "relatively thin" I have reference to a wall of such thickness which if made flat and of any considerable extent would be crushed in by the pressure of the atmosphere. As an illustration, the glass of an incandescent lamp, if made in a flat sheet, would be crushed in by the pressure of the atmosphere but when blown into the continuously arched wall of the usual bulb, it resists the pressure of the atmosphere because the pressure on the bulb is translated into compression within the walls and is balanced in all directions. It will be observed upon inspecting an incandescent lamp in which the usual form of a solid of revolution is deviated from for decorative purposes that the glass is made considerably thicker to resist shear.

The term "vacuum vessel" here refers to an envelope within which the fluid pressure is less than that of the atmosphere, or in special cases, to vessels in which the pressure on the outside is greater than that on the inside.

The material contemplated in this invention for the fabricating of the devices is any vitreous material such as glass, quartz or

similar material that may be worked by heating and pressing or blowing.

The objects of the invention are as follows:

To provide a method of fabricating a vacuum vessel of thin material having walls provided with inward protuberances to balance the pressure of the atmosphere between the sides thereof from a partially completed blank having a form approaching the completed form of the vessel and deviating from a solid of revolution;

To provide a method of fabricating a vacuum vessel of thin material having walls provided with inward protuberances to support opposite sides against the pressure of the atmosphere;

To provide a method of fabricating vessels of vitreous material into forms deviating considerably from that of solids of revolution;

To provide a method of working vitreous material in a die to produce hollow ware of forms deviating considerably from that of solids of revolution and to produce each object exact to form and uniform in quality.

To provide a method of fabricating a vacuum vessel having a tortuous passage there-through formed by the meeting of portions of the opposite walls thereof;

To provide a method of fabricating a vacuum vessel of a generally flattened form having portions of the opposite walls pressed very closely together without adhering.

Fig. 1 is a section through a die suitable for carrying out this process, showing a partially completed article therein ready to be pressed.

Fig. 2 is a section through the die showing the work portions of the two die parts with the work therein partially completed.

Fig. 3 is a section through the die showing the work fully completed before being removed.

Fig. 4 is an enlarged section through a portion of the work and the die drawn to a larger scale in order to give a better idea of the important dimensions of the work, although it is to be understood here that the glass is shown much thicker than actually

used in practice, for purposes of illustration.

Fig. 5 is a plan view of a device made according to this invention which, in this particular instance, is a positive column ionization conductor lamp.

Fig. 6 is an end elevation of the same.

Fig. 7 is a cross section through the line 7-7 of Fig. 5.

Fig. 8 is a perspective view of a partially completed device ready for insertion in the die.

Fig. 9 is a perspective view in the direction of the arrow 9 in Fig. 5 showing a portion of the lamp in order to illustrate the way the return bends of the legs of the grid are fabricated.

Fig. 10 is a section through the line 10-10 in Fig. 5 to illustrate the condition of the walls of the lamp after fabricating and before evacuating.

Fig. 11 is the same section illustrating the condition of the walls of the lamp after evacuating.

It is to be understood that in these last two views that the walls of the lamp are shown much thicker than they are made in practice, for purposes of illustration.

In producing articles according to this invention, two extremes in treatment of the material are to be considered in designing the dies, preparing the blanks and passing the material through the process.

In all of the prior art methods of producing articles of vitreous material that I know of, the material is heated to a temperature considerably above that temperature at which it is workable and cools rapidly as it passes through the moulding process. In the manufacture of bottles, for instance, the glass passes directly from the melting tank into relatively cold dies and cools rapidly during at least one stage of the moulding process while in the die. In some cases the glass is reheated in order to permit time to give it form but it enters the dies fluid or practically in a fluid condition and leaves sufficiently solidified to at least hold its own form. It is a characteristic of plastic bodies to tend to take a spherical form and hence in all such processes the work must pass through the dies with extreme rapidity, and there is much inaccuracy and considerable loss. There is also a great deal of limitation to this kind of work and in general it may be said that articles become more and more difficult to produce as they deviate from simple solids of revolution.

The production of articles of the nature of the device illustrated in Fig. 5, by methods of the prior art, is most impracticable as will be seen by a consideration of the physical conditions inherent in such processes. The usual method of moulding glass, as has been stated above, is to heat the glass to a rather high temperature, that is, at least sufficient

to allow for the drop in temperature in passing through the mould, the mould being at a relatively low temperature. The contraction of the glass is therefore very rapid in the mould and the shape of the recesses must be such that the glass can pull away from the recesses without straining the article. Hence such a vacuum vessel as may be readily produced by the present process, would be torn to pieces in contracting by the raised portions of the die face. The reason why this method is so universally used undoubtedly is that early methods of forming glass articles have been manual methods of heating in a flame and then blowing to the desired form. This has been carried over to the machine processes of the present day, the glass first being heated to a temperature at which it tends to form a globule and then being blown outwardly into the mould. This method also introduces considerable difficulty from preventing the glass from sticking to the metal of the mould as the mould must be kept fairly cool because as soon as the temperature of the mould approaches that of the glass at such high temperatures as spoken of, the glass and the mould tend to fuse together very quickly.

The present process contemplates that the glass be placed in the mould at a temperature at which it tends to retain its form whatever it may be but still may be pressed at a relatively slow rate into the desired shape. The temperature at which this may be done is well below that temperature at which danger of the glass and the metal sticking together is very great. Therefore, the problems in designing a mould for this process are different and simpler than those met in designing the moulds for the methods of the prior art, the most important condition being to maintain a uniform temperature at the working face of the die and to protect the article from cold drafts of air or contact with cold metal in moving into and out of the die.

It is possible to practice the process herein disclosed in the production of the flat vessels illustrated by techniques of the prior art so far as temperature regulation is concerned, but I prefer to pass the work thru the process without a considerable variation in the temperature thereof and by maintaining the temperature at a point around that temperature at which the glass becomes just sufficiently plastic to be workable by air pressure but will not tend to become spherical. In this manner much more accurate work may be done and a uniform product produced. It is also possible thus to make the finished article from a preformed blank having the general form of the finished article but prepared by less difficult operations.

A blank such as shown in Figure 8 may be made by several known methods in the art without much difficulty and may be positioned in the dies as shown in Figure 1 and

finished by the operations which are described below without any unusual or complicated procedure as long as the temperatures of the work, the die and the surrounding medium are all so regulated that the glass is neither chilled nor rendered unduly plastic during the process.

The two parts of the die are indicated by numerals 1 and 2 and the blank by 5. The electric heating elements 3 and 4 should be so regulated that the work faces of the die during the operation remain at substantially the selected temperature of the work. Provision should be made to protect the work from cold drafts of air and preferably heated gas should pass over the work while it is going thru this process. The blank is provided with a tubular stem 6 by means of which it may be handled and thru which air pressure may be applied at the proper time. As this blank would tend to become spherical if air pressure is applied before it is in the die, it should be heated to a temperature not much above that which it is just beginning to become plastic. It is then positioned in the die as shown in Fig. 1. The die is closed as shown in Fig. 2 and air pressure is applied blowing the walls of the blank out to fit the recesses of the die, as shown in Fig. 3. The condition shown in Fig. 2 may or may not be reached by the closing of the die before the application of air pressure, depending on the various conditions of the particular case. In general it may be said that the die should be closed or practically closed before air pressure is applied and that both operations should proceed relatively slowly to allow the glass to flow into position and take a uniform set.

The working faces 7 and 8 of the die are patterned in accordance with the form of the finished article there being protuberances 9, 9, etc. and 10, 10, etc., disposed to press together portions of the opposite walls 11 and 12 of the blank. In the particular case illustrated they are made as ridges to produce an ionization conductor lamp such as shown in Figs. 5 to 11. In other cases they may be merely bosses disposed to balance the atmospheric pressure between opposite sides of the vessel without providing passages therein. While in general it is preferred that the contacting portions of opposite sides be pressed towards each other to meet at the center plane of the device, either side may be pressed towards the other which may be flat or they may meet at any other desired plane.

In order to prevent the vessel from cracking, it is usually necessary to prevent the pressed-in portions of the walls from sticking together. In order to do this I so proportion the die that a very small space remains between the meeting portions of opposite walls as indicated by 17. This space should be so small that upon drawing a vacu-

um in the vessel, the walls will be pressed together and the protuberances will meet without a great deal of stress being set up in the glass. Glass is to a very slight degree elastic and this characteristic is here taken advantage of. The space 17 is shown disproportionately large in Figs. 2 and 3, a more correct idea may be gained from Fig. 4. It is to be understood that the thickness of the walls of the device is shown disproportionately large in all of the views for the purpose of illustration. For a lamp of the type illustrated, the glass might be of about the thickness of the glass in an incandescent lamp.

It is preferred that the blank 5 be made slightly smaller overall than the size of the finished article in order that the ends may be blown out into the die as indicated at 15 and 16 to avoid the possibility of folds at these places.

The lamp shown in Fig. 5 is in the completed form, being provided with the electrode terminals 28 and 29 which are sealed on after the vessel has been formed in the die. The passage 19 is evacuated thru the tube 6 and the device completed by charging with an ionization conductor such as a rare gas and tipping-off as indicated at 30. The passage 19 in which the radiation is generated by means of the passage of current is in the form of a grid having the sections 20, 21, 22, 23, 24, 25, 26 and 27. The illustration in Fig. 9 shows in perspective the form of the return-bend portions of the passage and the detail of the webs 31, 31, etc.

In Figs. 10 and 11 is illustrated in an exaggerated way the closing of the spaces 17 by the drawing of the vacuum. In Fig. 10 the space 17 remaining between the pressed in portions 32 and 33 is shown and in Fig. 11 this space has been closed by the movement of the walls under the pressure of the atmosphere, a small space remaining open, however, at 34 near the edge of the vessel. As described in my co-pending application above mentioned the existence of the latter space is compensated for by the increased leakage path at such places between adjacent portions of the passage.

The invention is not limited to the production of the particular types of devices described or to the particular steps set forth, but in a general way is applicable in the art of fabricating devices of vitreous material in many ways and hence is to be limited only by the prior art and the appended claims.

What I claim is:

1. The method of fabricating a vessel of vitreous material having a generally flattened form which consists in heating a blank having a form approaching that of the desired finished article to a temperature at which it will flow under pressure but will not otherwise change its shape to an ap-

preciable degree while passing through the steps of this process, positioning the same in a mould and applying fluid pressure within said article to blow the walls thereof into the recesses of said mould.

2. The method of fabricating a vessel of vitreous material having a generally flattened form which consists in first heating a partially completed vessel having a form deviating materially from that of a solid of revolution to a temperature at which it may be pressed into a desired shape but at which it does not tend to a troublesome degree to become spherical, placing the same in a mould and applying fluid pressure within said article to blow the walls thereof into the recesses of said mould.

3. The method of fabricating a vessel of vitreous material having a generally flattened form which consists in first providing a partially completed vessel having a form deviating materially from that of a solid of revolution and heating the same to a temperature at which the material may be pressed but at which it does not tend to become spherical, placing the same in a die, closing said die to press portions of the walls of said vessel inwardly and applying fluid pressure within said vessel to press the remaining portions of the walls thereof outwardly into the recesses of said die.

4. The method of fabricating a vessel of vitreous material which consists in blowing said vessel into a die formed to press together portions of the opposite walls thereof without said opposing portions actually touching.

5. The method of fabricating a vessel of vitreous material having portions of the opposite walls formed to come in contact and bear against each other when said vessel is evacuated which consists in blowing said vessel into a die having portions thereof disposed to press portions of the opposite walls of said vessel together without touching but so closely that upon the application of fluid pressure to the outside of the completed vessel said opposing wall portions will come in contact with each other.

6. The method of fabricating a vacuum vessel which consists in providing a die maintained substantially at the temperature at which the material of said vessel becomes plastic but not fluid, providing a hollow vessel of said material at a temperature at which it is plastic but not fluid, said vessel being of generally flattened form, placing said vessel in said die, closing said die upon said vessel while maintaining the temperature of said vessel and said die substantially at said given temperature, opposing portions of the walls of said vessel being thus pressed together without touching by suitable portions of said die, applying fluid pressure within said vessel to blow the walls of the

same into the recesses of said die, and finally removing said vessel from said die without permitting the said vessel to cool sufficient to bind in said die.

7. The method of fabricating a vacuum vessel which consists in providing a hollow vessel of generally flattened form, placing the same in a die having portions disposed to press portions of the opposing walls of said vessel together without touching, closing said die on said vessel, and applying fluid pressure within said vessel to blow the walls thereof into the recesses of said die.

8. The method of forming a vacuum vessel which consists of providing a partially completed vessel having a generally flattened form, pressing portions of opposing walls thereof together without touching, allowing said vessel to cool, and subsequently applying suction to the inside of said vessel whereby the opposing walls are pressed together by the atmosphere and said pressed-in portions of the walls thereof come in contact.

9. The method of fabricating a vacuum vessel which consists in providing a partially completed vessel of generally flattened form at a temperature sufficient to render the material thereof just plastic, pressing portions of the opposing walls thereof together without causing the same to touch, cooling said vessel and applying vacuum thereto to cause said opposing portions to touch.

10. The method of fabricating a vacuum vessel of vitreous material having a generally flattened form which consists in heating said vessel and pressing portions of the opposing walls thereof together.

11. The method of fabricating a vacuum vessel of vitreous material having a generally flattened form which consists in pressing opposing portions of the walls of said vessel together while maintaining said vessel at a temperature approximating that temperature at which said walls are rendered plastic without allowing said opposing portions to actually contact, allowing said vessel to cool without allowing said opposing portions to contact, and subsequently drawing a vacuum within said vessel whereby said opposing portions come in contact.

12. The method of fabricating a vacuum vessel of vitreous material having portions of opposite walls formed to come in contact with each other when said vessel is finally evacuated; which method consists in positioning a partially completed vessel having a form approximating that of the desired completed vessel in a die having portions thereof disposed to press together portions of the opposite walls of said vessel without causing said portions to actually touch each other but so closely that upon the application of fluid pressure to the outside of the finally completed vessel said opposing portions of

said walls will come in contact with each other.

13. The method of fabricating a vacuum vessel of vitreous material having a generally flattened form which consists in first providing a partially completed vessel having a form approaching that of the desired completed vessel and heating the same to a temperature at which the material may be pressed but at which it does not tend to a troublesome degree to become spherical, placing the same in a die, closing said die to press portions of the walls of said vessel inwardly and applying fluid pressure within said vessel to press the remaining portions of the walls thereof outwardly into the recesses of said die.

Signed at Los Angeles this 11th day of December, 1930.

FRED HOTCHNER.