Dec. 27, 1938. J. H. PAYNE 2,141,932

PROCESS FOR SEALING RECEPTACLES

Original Filed April 28, 1936

Fig. 1.

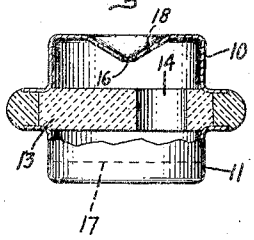


Fig. 2.

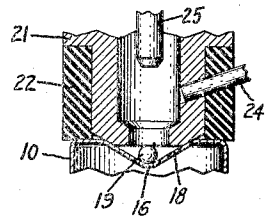


Fig. 3.

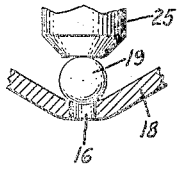


Fig. 4.

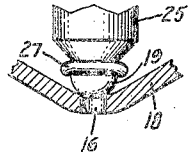


Fig. 5.

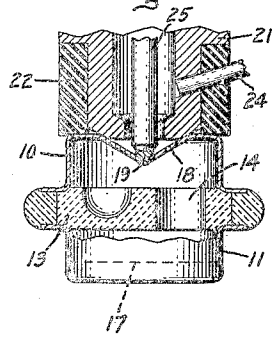
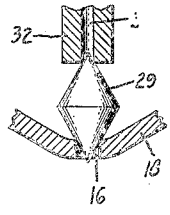


Fig. 6.



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UNITED STATES PATENT OFFICE

2,141,932

PROCESS FOR SEALING RECEPTACLES

John H. Payne, Ballston Spa, N. Y., assignor to General Electric Company, a corporation of New York

Original application April 28, 1936, Serial No. 76,796, now Patent No. 2,101,156, dated December 7, 1937. Divided and this application November 27, 1936, Serial No. 112,884

3 Claims. (Cl. 219—10)

This application is a division of my prior application, Serial No. 76,796, filed April 28, 1936 (now Patent No. 2,101,156, granted Dec. 7, 1937). The invention described and claimed herein relates to the art of sealing hollow metallic receptacles, and more particularly to a process for use in this art.

Although not limited thereto, the invention has been found to have special utility in the manufacture of electric switches of the liquid contact variety such as are described, for example, in my copending application, Serial No. 759,527, filed December 28, 1934 (now Patent No. 2,101,092, granted Dec. 7, 1937). The switches therein disclosed typically comprise a closed vessel consisting of a pair of dished wall members of thin metal separated and insulated from one another by an apertured disk of non-conducting material, a body of mercury being arranged within the vessel to make and break an electrical circuit between the wall members. It is generally found desirable to provide an operating atmosphere of a reducing gas, such as hydrogen, which may be introduced into the vessel through a small aperture which is thereafter sealed off.

In order to assure long life and reliable operation of such switches, it is essential that the enclosing receptacle be sealed in such a way as to remain entirely gas-tight under all conditions of use. Seals of readily fusible materials, such as solder, have been found to be unsatisfactory for this purpose because of the impossibility of causing them to unite integrally with the metal of the switch. Furthermore, the low melting point metals now available are attacked by mercury in such a way as to render them unsuitable for this use.

On the other hand, due to the thinness of the wall material required by considerations of economy to be used in switch manufacture, it has heretofore proved impracticable to produce a satisfactory seal by welding with high melting point materials. At low welding currents the mechanical pressure required to secure proper joining of the parts is so great as to cause bending of the switch receptacle, while at higher currents there is a strong tendency to burn the metal and to produce a leaky seal.

It is an object of the present invention to provide a method of sealing an aperture in a thin metal receptacle by welding a body of difficultly fusible metal into the aperture in such a way as to avoid burning of the metal or bending of the receptacle wall. To this end one mode of application of the invention comprises the steps of positioning a slug of difficultly fusible metal in a receptacle aperture to be sealed so that a relatively extensive contact area exists between the receptacle and the slug, and fusing the slug by welding current entering through a very small area thereof remote from the receptacle.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and the method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompany drawing, in which Fig. 1 is a view in partial section of a liquid contact switch container of a type to which the invention is particularly applicable; Figs. 2, 3, 4 and 5 illustrate successive steps in the practice of the invention, and Fig. 6 is a fragmentary sectional view showing an alternative mode of application of my invention.

The nature of my invention may best be understood by considering its application to a particular use such as sealing a liquid contact switch receptacle of the type illustrated in Fig. 1. The receptacle there shown comprises a pair of dished thin metal wall members 10 and 11 positioned on opposite sides of an insulating barrier 13 which has a contact-permitting opening 14 therein. The wall members may suitably consist of a chrome-iron alloy while the insulating barrier may be constituted of a refractory ceramic, for example, a mixture of magnesium oxide and clay. These parts are hermetically joined by a fillet or ring of plastic material such as glass which is in continuous contact with the adjoining edges of the various elements.

In the manufacture of such switches it is convenient first to complete the switch assembly except for the provision in one of the wall members of a small aperture 16. This is used in the final stages of manufacture to introduce into the otherwise closed receptacle a quantity of mercury (designated by the dotted line 17), which is needed for contact making operations and to permit the establishment of a desired gas pressure inside the switch during the sealing process. In accordance with the present invention the aperture 16 is located at the bottom of a depression formed by an inwardly bent portion 18 of the receptacle wall. As will be pointed out more fully in the following this configuration is extremely useful in positioning the closure elements employed in the sealing operation.

In order finally to seal the switch receptacle

and to render it entirely gas-tight, a procedure whose first step is indicated in Fig. 2 is employed. As shown in Fig. 2 a closure element 19 of spherical contour is positioned in the depression formed in the wall member 10, so that it coincides with the aperture 16. For the purposes of the present invention it is preferred to form the closure element of a difficulty fusible metal having a melting point on the order of that of the switch material and capable of being integrally welded to the same. Metals which are particularly suitable for this use include steel, chrome-iron alloys and nickel, all of which are substantially resistant to mercury corrosion. Where steel balls of the type commercially available for ball bearings are to be employed, it is advantageous to soften them somewhat by decarbonizing them in hydrogen or in a similar reducing atmosphere.

With the switch parts in the position indicated the spherical closure element is necessarily caused to come to rest at the proper place as a result of the inwardly directed slope of the depressed wall portion 18. Consequently, automatic feeding of these elements is entirely practical. It will be understood, of course, that each element should be of slightly larger diameter than the aperture 16 in order to prevent its falling to the switch container.

In order to weld the closure element into place a welding assembly of the type illustrated may be employed. This assembly may, for example, form a part of the sealing machine described in my aforementioned prior application, Serial No. 76,796. As shown, a stationary hollow electrode 21 is placed in contact with the outer surface of the wall member 10, being shaped if desired to correspond with the slope of the depressed wall portion 18. In order to render the joint between the electrode and the wall member substantially gas-tight a gasket 22 is provided which seats firmly against the surface of the wall member. As a result of this gas-tight connection a desired condition of gas pressure or vacuum may be established within the receptacle before it is sealed, such pressure being communicated through the hollow electrode 21. In the manufacture of switches of the type under consideration the sealing operation will preferably take place when the switch receptacle and the interior of the electrode are subjected to hydrogen at a pressure of the order of from 1 to 2 atmospheres. In order to permit closure elements to be fed into place after the desired gas pressure is created, a hollow tube 24 is provided which passes laterally through the electrode 21 and the gasket 22.

Cooperating with the stationary electrode 21 there is provided a movable electrode 25 arranged concentrically within the former. Referring to Fig. 3 it will be seen that the lower surface of this electrode is flattened and is adapted to contact the closure element 19. It is also contemplated that during the welding operation the contact pressure between these two elements shall be very slight, being provided, for example, by the weight of the movable electrode only or by the weight of the electrode assisted by a weak compression spring. Under these conditions the initial area of contact between the electrode and the closure member will be extremely small, closely approximating a point contact. On the other hand, since the diameter of the sphere 19 is but slightly greater than that of the aperture 16 a relatively extensive contact area for the passage of welding current exists between the sphere and the receptacle wall. For this reason, when an impulse of high amperage welding current is passed serially through the electrode 25, the closure element 19, and the receptacle wall portion 18 (whence it returns to the cooperating welding electrode 21), intense heating of the closure member is produced at its upper portion with a minimum of heating at the portion in contact with the receptacle wall. As a result local fusion occurs at the top of the sphere causing the same to develop a mushroom portion 27 which flows outwardly over the cooler lower portion. This latter remains in a relatively unfused condition but is sufficiently hot to be forced down into the aperture 16, becoming integrally united with the walls of the same during the last instant that the welding current is permitted to flow. So little welding pressure is required by this process that bending of the thin metal of the receptacle wall is effectively avoided.

In Fig. 5 I have illustrated the electrode and switch assembly as it appears at the instant the welding operation is complete. At this time the aperture 16 is hermetically closed by the fused member 19 which now comprises a portion projecting into the aperture and an upper enlargement which overlaps the edges of the aperture and is integrally united with the outer surface of the receptacle.

The foregoing mode of procedure has been found to result in a surprisingly small number of imperfect seals due to the fact that the metal of the closure element has a high melting point and by the welding process is integrally united with the metal surrounding the aperture. The closure is inherently gas-tight and, since the sealing material preferably comprises a metal which is not attacked by mercury, gradual corrosion of the seal no longer constitutes a limitation on the life of the switch.

While I have described my invention as being preferably applied in connection with a spherical closure member, it is not necessarily limited thereto. In Fig. 6 I have illustrated an alternative application in which the closure element 29 is of essentially rhombic cross-section having one apex sealed in the seal-off aperture 16 and the other in a relatively small opening 31 provided for that purpose in the lower face of a welding electrode 32. It will be understood that due to the slight contact existing between the electrode 32 and the slug 29 the initial fusion will be substantially localized at the upper part of the slug thus causing the desired mushrooming effect described in connection with Fig. 4.

In the appended claims I aim to cover this and all other modifications which fall within the true spirit and scope of the foregoing disclosure.

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

1. The process of sealing an aperture in an exposed surface of a thin metal body under circumstances which prevent applying a reinforcing support to the opposite surface of the body, which process comprises positioning in said aperture a generally spherical member constituted of a metal adapted to be welded integrally to the body, the member being of such dimensions as to be incapable of passing through the aperture and being in direct contact with the body, bringing a welding electrode into substantially point contact with the member at a region thereof remote from the body, passing an electric current serially through the electrode, the member and the body sufficient to initiate fusion of the

member at its point of contact with the electrode, and continuing such current without the application of appreciable electrode pressure to cause progressive flow of metal from the region of electrode contact into welding relation with the exposed surface of the body around the aperture and to produce partial penetration of the member into the aperture, thereby completely to close the same.

2. The process of hermetically sealing an aperture in a receptacle constituted of such thin metal as to be readily deformable, which process comprises positioning in the aperture and in direct contact with the metal of the receptacle a generally spherical member consisting of a metal which is adapted to weld integrally to the metal of the receptacle, the member being of such dimensions as to be incapable of passing through the aperture, bringing a welding electrode into light pressure contact with the member at a region thereof remote from the receptacle, passing an electric current serially through the electrode, the member and the receptacle to initiate fusion of the member at the region of its contact with the electrode, and continuing such current without the application of substantial electrode pressure to cause progressive flow of metal from said region into welding relation with the outer surface of the receptacle around the aperture thereby to effect complete closure of the aperture.

3. The process of sealing an aperture in a thin metal receptacle which comprises providing a depression in one face of said receptacle, forming a circular aperture at the bottom of the depression, positioning in said aperture a spherical metal member of such dimensions as to seat readily therein in contact with the metal of the receptacle, bringing an electrode surface into light pressure point contact with the member at a spot remote from the aperture, passing an electric current serially through the electrode, the member and the wall of the receptacle sufficient to initiate fusion of the member at its point of contact with the electrode and continuing such current without the application of appreciable electrode pressure to cause progressive flow of metal from the region of electrode contact into welding relation with the outer surface of the receptacle around the aperture and to produce partial penetration of the member into the aperture.

JOHN H. PAYNE.