May 4, 1937. D. D. KNOWLES 2,079,354

VACUUM SEAL

Filed April 24, 1935

Fig. 1.

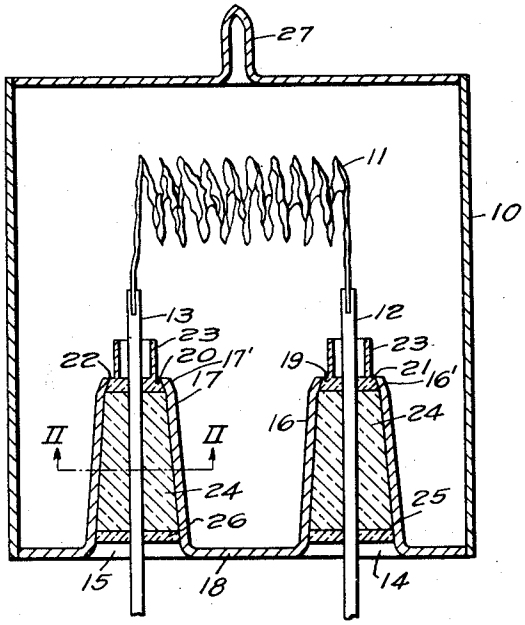


Fig. 2.

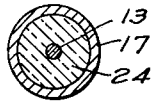


Fig. 4.

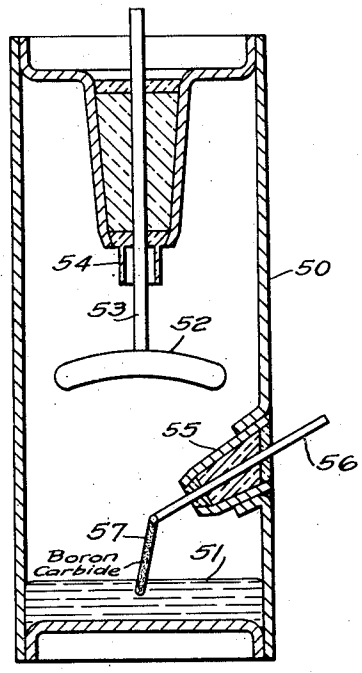


Fig. 3.

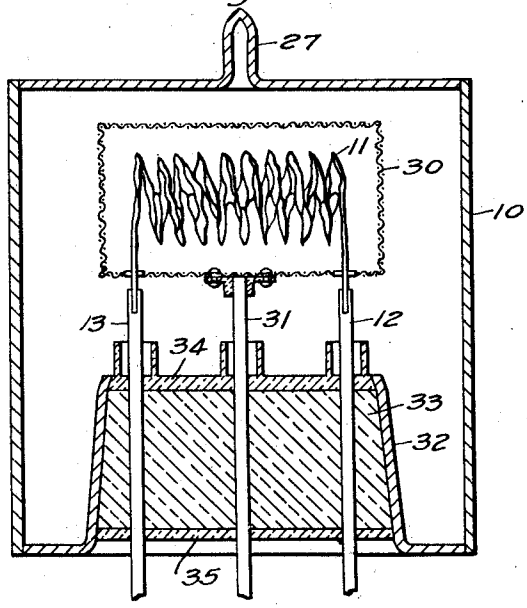
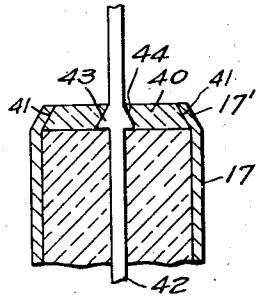


Fig. 5.



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UNITED STATES PATENT OFFICE

2,079,354

VACUUM SEAL

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Application April 24, 1935, Serial No. 17,948

13 Claims. (Cl. 250—27.5)

My invention relates to vacuum seals and especially to seals for electron discharge devices.

An object of my invention is to provide a vacuum-tight seal for electron discharge devices, which will withstand the shock of rather rough handling.

Another object of my invention is to provide an electron discharge device which is adapted to be used in places subject to shock and excessive vibration.

Another object of my invention is to eliminate as much as possible the fragile glass bulb containers of electric discharge devices.

Another object of my invention is to provide a method of constructing an electron discharge device whereby the sealing of the container may be made simultaneously with the heat-treatment of the parts of the device.

More specifically stated, it is an object of my invention to provide a metal casing as a substitute for the rather fragile glass bulbs heretofore used, and at the same time, to provide a very strong seal through this metal casing, whereby the seal will stand up under excessive vibration.

Other objects of my invention will become evident from the following detailed description, taken in conjunction with the accompanying drawing, in which:

Figure 1 is a view, partly in cross-section, and partly in elevation, of an electron discharge device constructed according to my invention;

Fig. 2 is a cross-sectional view taken on line II—II of Fig. 1;

Fig. 3 is a view, partly in cross-section and partly in elevation of the electron discharge device of Fig. 1 with modifications.

Fig. 4 is a view partly in cross-section and partly in elevation of the invention applied to the ignition type of discharge device, and

Fig. 5 is an enlarged view partly in cross-section and partly in elevation disclosing the inner parts of the seal on a larger scale.

As disclosed in Figs. 1 and 3, I prefer to make the container portion of my electron discharge device of a metal wall 10 in place of the usual glass bulb construction. These metal walls can be fabricated into any desired shape, but I have taken the rather square cross-section of Figs. 1 and 3 for the sake of simplicity. Fig. 1 is representative of the rectifier type of electron discharge device containing a cathode and in which the metal walls preferably act as the anode. While any suitable type of cathode may be selected, I have illustrated the edgewise-wound helical type of cathode as disclosed in the Patent No. 1,968,608 to E. F. Lowry, issued July 31, 1934, because of its rugged construction and resistance to shocks and excessive vibration. Two sturdy conductor members 12 and 13 are connected to the ends of this cathode structure and extend through openings 14 and 15 in the container walls. In forming the seals about these conductors 12 and 13, I provide tubular extensions 16 and 17 to the base wall 18 of the container. These tubular extensions to the interior of the device are preferably tapered as disclosed on the drawing. I also prefer to taper still more or restrict the end portions 16' and 17' of these tubular extensions. Insulating washers 19 and 20 preferably are fitted snugly at the openings 21 and 22 of these tubular extensions. The washer is also preferably tapered to fit into the restricted end portion 17' of the tubular extensions. These washers are, of course, perforated for the conductor or lead and are of suitable insulating material, such as porcelain. I also prefer to increase the creepage distance from the conductor to the outer edge of the washer by having a ridge or skirt 23 on the side of the washer facing the interior of the device. This ridge surrounds the conductor and may be of any desired heighth, so that sputtered material deposited on the washer will not readily short circuit the conductor and the adjacent metal part of the container wall. The space between the conductors 12 and 13 and the interior of the tubular extensions 16 and 17 is filled with vitreous material 24 which is fused to the tubular extensions and to the conductors, to provide a vacuum-tight seal, I also prefer to have washers 25 and 26 at the outer portion of these tubular extensions to maintain the conductors in alignment during the manufacturing process.

In Fig. 5 I have disclosed an enlarged view of the inner portion of the seal. The tubular extension in this view has cylindrical sides with the tapered or restricted end 17'. The washer 40 has tapered edges 41. The conductor 42 preferably has a bead 43 to fit into a counter-sunk portion 44 about the central hole in the washer 40.

The cathode 11 can be assembled on its conductors and these conductors and cathode assembled on the base plate 18 and sealed thereto and then this unit can be inserted in the container and the metal joints made air-tight. The extension 27 can be used to exhaust the device and also as a means for inserting any of the well-known gases, such as argon, neon, or mercury vapor, if desired.

The vitreous material 24 can be very quickly fused to the tubular extensions of the conductor by providing cylinders, or rather truncated cones in the form of a frustum of a right cone if the extensions 16 and 17 are tapered, perforated at their axis for the conductors 12 and 13. These vitreous cylinders or truncated cones can be slipped over the conductors and inserted into place in the tubular extensions. The application of heat to this vitreous material will readily fuse it to the interior wall of the tubular extensions and also to the conductor or lead-ins 12 and 13.

My invention also contemplates a very rapid construction of the devise by assembling the cathode and lead-in construction in the tubular extensions surrounded by these cylinders or truncated cones of vitreous material and having all other parts of the container vacuum tight, except for the tubulation 27. The parts of the device are then heat-treated to remove all undesired gas from the parts thereof while the pumps are withdrawing the air through the tubulation 27. During this heat-treatment of the parts, the vitreous material at 24 is fused due to this heat at the same time that the other portions of the tube are being treated. This simultaneous utilization of heat for sealing and heat-treatment results in an economy in heat energy not present in the manufacturing processes of the tubes of the prior art.

Because of the fact that the vitreous material is preferably limited to a sturdy cylindrical or truncated cone mass, a higher temperature of heat can be applied to the electron discharge device in the process of manufacture and this heat may be at a temperature of 700° C. to 900° C. or above, in place of a much lower limit with glass container electron discharge devices. The glass container electron discharge devices of the prior art are in danger of caving in if heated above 500° C. The higher temperatures possible with my construction provide a more complete outgasing and deoxidization of the parts of the tube.

While the materials used in the construction of this device may be selected from any one of a suitable group, yet I prefer to use a composition of nickel, cobalt and iron, such as described in the copending application of Howard Scott, Serial No. 736,000, filed July 19, 1934. This alloy preferably contains from 24% to 34% nickel, 5% to 25% cobalt, less than 1% manganese and the remainder iron. My preference for this alloy which is vended under the trade names Kovar or Fernico, is because of its low coefficient of expansion throughout the range of annealing the parts of the container. I also prefer to use this alloy because it permits the use of borosilicate glass for the vitreous material 24. These borosilicate glasses have expansivities between 3.0 and 6.5×10^{-6} centimeters per centimeter per degree centigrade and the various suitable grades are also described in the aforementioned application. The alloy mentioned is easily fabricated and yet is not attacked by mercury vapor if such an interior atmosphere is desired.

I also contemplate using a vitreous material having a very high softening point such as above 800° C., which material, for example, may be porcelain or quartz for the vitreous material 24. If porcelain or quartz are used, then the retaining washers 19 and 20 may not be necessary. It will be noted, however, that the construction of the rest of the device permits the application of more than 800° C. softening temperature and thus permits utilization of porcelain or quartz for sealing material.

In Fig. 3 is illustrated an electron discharge device having an additional electrode therein. This electrode is, of course, generally the screen 30 surrounding the cathode structure. While this screen may have its lead-in 31 pass through a tubular extension seal similar to that disclosed in Fig. 1, yet I also contemplate having these electrode leads pass through the same tubular extension 32 and sealed by a common vitreous mass 33 as illustrated in Fig. 3. Enlarged washers 34 and 35 may be used on the sides of this vitreous seal similar to the purpose of the washers 19, 20, 25 and 26 in Fig. 1. These washers, of course, have a suitable number of perforations therethrough according to the number of lead-in wires. It is apparent that any number of electrodes may be passed through this enlarged seal or these electrodes may be passed through the container wall in a similar manner to that of either Fig. 1 or Fig. 3 at other portions of the container wall.

In Fig. 4 I have illustrated a still further application of my invention. The container 50 is preferably all metal as previously explained except for the insulating materials about the seals and conductors. The casing contains mercury 51 and the cathode connection can be made to any suitable portion of the casing. An anode 52 has its connection 53 passing through a seal similar to that described in Fig. 1. On the side of the casing is a tubular extension 54 pointing towards the bottom of the container. A conductor 56 is sealed through this extension in a manner similar to that of Figs. 1 and 5. Connected to the inner end of the conductor 56 is a member 57 of semi-conducting material such as boron carbide or carborundum to form a make-alive such as described in the copending application of Slepian and Ludwig, Serial No. 626,866. Fig. 4 is an improvement on the disclosure of this copending application.

The vitreous material in the seals is under such conditions of mechanical stress under all shocks as tend to help it to resist them and is, therefore, very strong. There is no angle at which a shock will readily introduce stresses within this seal. All parts of the complete assembly are thoroughly annealed by the use of higher temperatures and the stresses removed therein. In the case of hot cathode tubes, the standard oxide coating will be largely activated during the heat treatment or baking process.

It will be apparent that the particular types of washers and also the seals disclosed have particular advantages in themselves and, accordingly, there is no intention of limiting their application to the specific devices disclosed on the drawing, which are illustrated only as the preferred type. Various other modifications of the specific embodiments of my invention are also possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art.

I claim as my invention:

1. The method of constructing an electron discharge device which comprises forming a metal casing as the anode thereof with the cathode inside and having the cathode leads extending through openings in the casing, surrounding the cathode leads with vitreous material substantially closing said openings and simultaneously heat-treating the parts of said device and sealing said openings.

2. The method of forming a vacuum-tight seal

in a container which comprises forming a tapered tubular opening into said container, placing vitreous material about a conductor into said tapered tubular opening and applying heat to said vitreous material to seal said opening.

3. A seal for an electron discharge device having a metal container comprising a tubular extension of said container terminating in an opening, an insulating washer across said opening, a conductor extending through said tubular extension and said washer and vitreous material sealing said conductor and tubular extension in vacuum-tight arrangement.

4. A seal for an electron discharge device having a metal container comprising a tubular extension of said container, a plurality of insulating washers in said tubular extension, a conductor extending through said washers and a vitreous material sealing the portion of the tubular extension between the washers vacuum tight.

5. A seal for an electron discharge device having a container with a metallic wall comprising a tapered tubular extension of said container, a plurality of insulating washers in said tapered tubular extension, a conductor extending through said washers and a vitreous material sealing the portion of the tapered tubular extension between the washers vacuum tight.

6. A vacuum-tight seal for an electron discharge device comprising a metal portion of the container having a tubular extension, a conductor extending through said tubular extension and a vitreous material having a softening point above 800° fused to said conductor and said tubular extension.

7. In combination with a metallic container, a metallic tubular projection from the wall thereof, an electrical conductor passing through said tubular projection and separated from the walls thereof by glass fused vacuum-tight to said projection and said conductor, the surface of said projection to which said fusion is made being of an alloy of nickel, cobalt and iron.

8. In combination with a metallic container, a metallic tubular projection from the wall thereof, an electrical conductor passing through said tubular projection and separated from the walls thereof by glass fused vacuum-tight to said projection and said conductor, the surface of said projection and said conductor to which said fusion is made being of an alloy of nickel, cobalt and iron.

9. In combination with a metallic container, a metallic tubular projection from the wall thereof, an electrical conductor passing through said tubular projection and separated from the walls thereof by glass fused vacuum-tight to said projection and said conductor, the surface of said conductor to which said fusion is made being of an alloy of nickel, cobalt and iron.

10. As an article of manufacture, an electrical conductor having at least its surface layer of an alloy of nickel, cobalt and iron, an annular sleeve having at least its surface layer of an alloy of nickel, cobalt and iron surrounding it and insulated from it by glass filling the space between said conductor and said sleeve throughout an axial length at least equal to the inner radius of said sleeve, said glass being fused vacuum-tight to said conductor and to said sleeve.

11. The method of constructing an electrical discharge device which includes the steps of forming a metallic envelope, producing a metallic tubular projection from the walls thereof, positioning a metallic conductor surrounded by a glass sleeve within said tubular projection, said glass sleeve being so dimensioned as to make contact with both said conductor and said projection throughout an entire circumference of each, heating all the elements so far enumerated with such a temperature distribution that said glass forms a fused contact with both said conductor and said tubular projection, and reducing the pressure within said container to a value lower than that of the atmosphere surrounding it.

12. The method of constructing an electrical discharge device which includes the steps of forming a metallic envelope, producing a metallic tubular projection from the walls thereof, positioning a metallic conductor surrounded by a glass sleeve within said tubular projection, said glass sleeve being so dimensioned as to make contact with both said conductor and said projection throughout an entire circumference of each, heating all the elements so far enumerated with such a temperature distribution that said glass forms a fused contact with both said conductor and said tubular projection, confining said glass within said projection, and reducing the pressure within said container to a value lower than that of the atmosphere surrounding it.

13. A seal for an electron discharge device having a metal container comprising a metallic tubular extension of said container terminating in an opening, an insulating washer across said opening, a conductor extending through said tubular extension and said washer and vitreous material sealing said conductor and tubular extension in vacuum-tight arrangement, said washer being provided with a ridge surrounding said conductor to increase the creepage distance between said conductor and said tubular extension.

DEWEY D. KNOWLES.

DISCLAIMER

2,079,354.—*Dewey D. Knowles*, Wilkinsburg, Pa. VACUUM SEAL. Patent dated May 4, 1937. Disclaimer filed March 9, 1939, by the assignee, *Westinghouse Electric & Manufacturing Company*.

Hereby enters this disclaimer to claims 2, 7, 8, 9, and 10 in said specification.

[*Official Gazette April 4, 1939.*]