June 21, 1938. H. KERSCHBAUM ET AL 2,121,598

METAL CASE RECTIFIER

Filed June 28, 1935

Fig. 1.

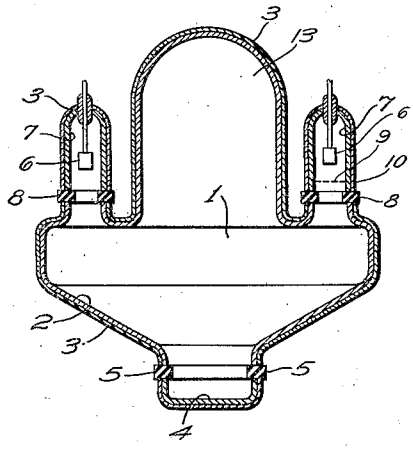


Fig. 2.

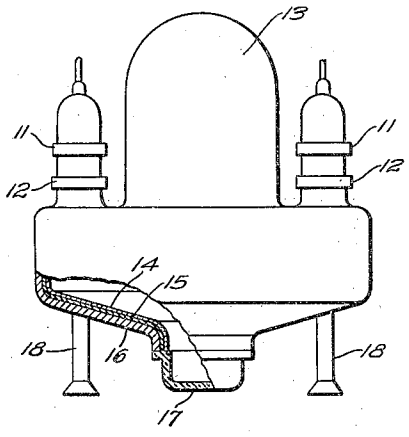


Fig. 3.

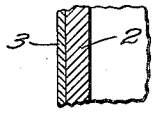


Fig. 4.

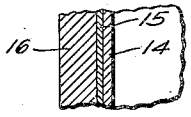


Fig. 5.

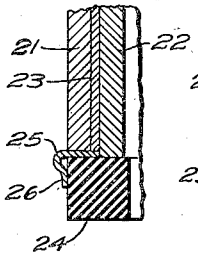


Fig. 6.

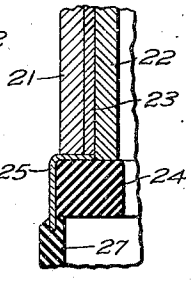


Fig. 7.

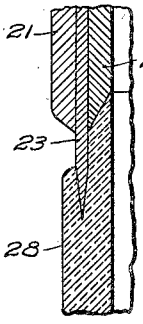
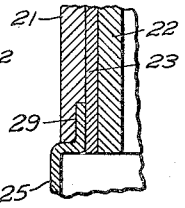


Fig. 8.



WITNESSES:
C. J. Weller.
R. W. Bailey

INVENTORS
Hans Kerschbaum &
Werner Espe
BY
F. W. Lyle
ATTORNEY

Patented June 21, 1938 2,121,598

UNITED STATES PATENT OFFICE

2,121,598

METAL CASE RECTIFIER

Hans Kerschbaum and Werner Espe, Berlin-Siemensstadt, Germany, assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application June 28, 1935, Serial No. 28,862
In Germany June 28, 1934

4 Claims. (Cl. 250—27.5)

This invention relates to metal vapor or gas discharge apparatus and especially to such apparatus with metal walls. It relates particularly to vacuum-tight apparatus with materials which hold or develop chemically active vapor or gases and especially to such apparatus having metallic containers or walls for large mercury rectifiers.

Heretofore, either insulating material, such as glass, or metals, such as iron and steel, have been utilized for current rectifiers. The glass containers have the advantage that they are practically completely gas-tight, and avoid the necessity of a vacuum pump during operation. Such containers, however, have the disadvantage that they are not sufficiently rugged from a mechanical and thermic standpoint. For this reason, they are not suitable for high load installations and the rectifiers of large dimensions. These disadvantages disappear in metal containers, such as those of iron, but these iron containers have the disadvantage that it is difficult to render them gas- and vacuum-tight to a sufficient degree even with a vacuum pump and continuous operation. Furthermore, the casing walls of metal, if very thick, contain gases and foreign bodies which are not removed during treatment, but which may be gradually evolved during operation of the device to diminish the quality of the vacuum and to contaminate the materials within the container. The effect of this gas and contaminating materials is especially dangerous to high capacity discharge apparatus and renders the operating safety and life of the apparatus greatly diminished by their presence.

One solution to the above-mentioned disadvantages of metal containers is to provide a coat of enamel on the inner surface of the container. This coat does not appear in practice to be of sufficient utility, since this coat is not rugged enough from a chemical, thermic and mechanical standpoint to prevent the development of ruptures even after a comparatively short operation. The materials contained in the metallic casing walls will reach the discharge space through these ruptures in the enamel coating. Furthermore, not only vapor but also alkaline and alkaline earth vapors attack such coatings. In addition, the enamel coating splinters during operation and leads to contamination of the metallic liquid supply, since enamel melts at a comparatively low temperature. The high temperature of the arc during operation will aid in this melting of the enamel coating.

In containers composed of certain metals, additional difficulties are to be taken into consideration. Containers constructed of vacuum-tight metals, such as copper, nickel and the like, are strongly attacked by mercury vapor by reason of the formation of amalgams. Containers of iron, however, are resistant to mercury. Iron containers, however, in addition to the above-mentioned property of giving up foreign bodies during operation, have the disadvantage that they are to a high degree permeable to certain gases. It appears, for example, that hydrogen will permeate comparatively thick iron containers.

It is an object of our invention to construct metallic vapor or gas discharge devices with metallic walls of different materials.

In particular, it is an object of our invention to construct an inner wall part of a metal not affected by vapor or gas, such as iron, or its alloys, while the outer part is constructed of a vacuum-tight material, and in particular of a metal, such as nickel or copper, which is sealable or readily fusible with insulating material, such as glass, porcelain or the like.

More particularly stated, it is an object of our invention to construct the inner wall part of a thin iron coating which absorbs the mechanical forces coated in the discharge apparatus, and provide a copper coating on the outside of the iron coating. Such provision for the casing walls has the advantage that the once carefully degasified iron coating is not contaminated by gas, particularly hydrogen, absorbed from the outside since such an absorption is blocked by the copper coat. The device may also be so constructed that the inner wall consists of a thin iron coat, on the outer surface of which a copper coat is disposed, and in turn has another thick iron housing that absorbs the mechanical forces developed in the discharge apparatus. Such an arrangement has the advantage that a comparatively small amount of iron is to be degasified during the treating process, and is, therefore, comparatively light. The treating out process is facilitated by the high heat conductivity of the copper coating affixed on the thin iron coating.

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

Figure 1 is a front view with the parts mainly in cross-section of a discharge device constructed according to our invention;

Fig. 2 is a front elevation of a device with parts of the container wall broken away to show a modification in cross-section of the device of Fig. 1;

Fig. 3 is an enlarged cross-sectional view of a portion of the wall of the container in Fig. 1;

Fig. 4 is an enlarged cross-section of a portion of the wall of the container in Fig. 2;

Fig. 5 is an enlarged cross-section of a modification of the seal between the conductive and insulating portions of Figs. 1 and 2;

Figs. 6, 7 and 8 are enlarged cross-sectional views of still further modifications of the seal.

In the disclosure of Fig. 1, the rectifier 1 is provided with a vacuum-tight container 2, preferably of iron or its alloys, the outer walls of which are provided with a copper coating 3. The cathode holder 4 is also preferably composed of iron or its alloys having a copper coating 3. The copper coatings 3 are fused or soldered to the cathode insulator 5. The anode 6 on the left-hand side of Fig. 1 is preferably within an iron cap 7, which is electrically separated from the iron container 2 by means of an anode insulator 8. The cap 7 also has a copper coat 3, which, like the copper coat of the main container, is fused or soldered to the anode insulator 8.

In Fig. 2, we have disclosed a modification of the anode tube wherein a grid or auxiliary electrode is desired. A metallic ring 10 is supported between the insulating rings 11 and 12 and is sealed in vacuum-tight arrangement thereto. This metallic ring 10 is provided with a gas or vacuum-tight layer, such as a layer of copper over the base metal which is preferably iron. This ring supports a grid 9 which may be either of the controlled or uncontrolled type as desired according as to whether or not a conductor is connected onto the outer surface of the ring 10. This grid may be of any suitable material such as iron, nickel, cobalt, etc., which is not attacked by mercury vapor.

The condensation dome 13 is also preferably composed of an iron cap provided with a copper coating.

According to the modification disclosed in Fig. 2, the casing wall is preferably composed of three layers, namely, an inner thin iron layer 14, a central metal layer of copper 15, and a heavy iron outer wall 16, which absorbs mechanical forces. The cathode holder 17 consists, in this modification, of insulating material, and is fused or soldered vacuum-tight with the intermediate copper layer. The cathode holder may be constructed of glass, porcelain, or other similar material.

If desired, the thick walled outer iron portion of the apparatus may rest upon the legs 18. This modification has the possibility of reducing the vacuum-tight portion of the container walls, namely, the thin iron sheet 14 and the thick copper sheet 15, to a minimum of weight, and a minimum consequently of the material to be heat treated. The iron body 16 constructed of heavier material may, if desired, be used to serve only as a supporting member and need not extend over the whole surface of the wall. This iron body 16 may assume the form of a basket cast of iron or it may be built of individual iron plates, the position and arrangement of which is so adjusted that the vacuum-tight container, which consists of the parts 14 and 15, is safely held without any deformation of the thin walls. Desirable solidity may be obtained if the vacuum container 14, 15 is provided with surfaces which approximate the form of spherical bowls. In case the metallic portion 16 should extend around to the anodes, then a conductor thereto is fused through a vacuum-tight insulator.

In Figs. 3 and 4, the walls of the modifications disclosed in Figs. 1 and 2 are shown in section in an enlarged scale. Fig. 3 shows the inner wall 2 composed of iron, on the outer surface of which a copper layer 3 is supported. According to Fig. 4, the inner wall 14 consists of rather thin iron. The copper layer 15 is preferably still thinner and the supporting iron body 16 is rather thick and rugged.

In Figs. 5 to 8, the sealing portion between the metal walls and the insulator parts are disclosed with various modifications. In the modification disclosed in Fig. 5, the container wall composed of the iron parts 21 and 22 with the copper layer 23 in between butts against the insulator body 24. At the lower edge of the copper sheet 23 a sheet 25 is attached, preferably by welding. The edge 26 of the sheet projects outwardly and is bent around and fused to the insulator body 24. The container wall rests in this modification on the insulator 24, which may be, for example, the cathode insulator 5 of Fig. 1 to which the cathode container is connected in a corresponding manner. The main container may, together with the cathode insulator, rest on the cathode holder.

If it is desirable that the load be removed from the cathode container, the modification shown in Fig. 6 may be utilized. Here the copper sheet 25, which is welded to the copper sheet 23, is projected directly into the wall 27 of the cathode container consisting of insulating materials. The copper sheet 25, in this case, follows the contour of the insulator 24 and is also fused to a considerable depth into the insulator 27. This joint is much stronger than that disclosed in Fig. 5.

In Fig. 7, a connection of the three-part container wall with the glass body 28 is shown. The glass, as can be seen from the drawing, is extended upward to the iron layer 22 on the inner side so that the copper layer 23 does not come into contact with the inner portion of the container. The container sheet 23 is sharpened to a feather edge for fusing to the glass 28 to a considerable depth.

In Fig. 8, another form of connection of the copper sheet 25 with the copper layer 23 is illustrated. A groove 29 is made in the iron coat 21, and the sheet 25 is placed in this groove and welded to the adjacent parallel copper layer 23.

The vacuum-tight layer of material may be put on mechanically or sprayed on, rolled on, or fused on the metal layers which are unaffected by the metallic vapor. These layers may be put on by dipping iron bodies which have been preferably purified in a liquid bath with a coating material. If it is coated by dipping, the material, which is to coat the iron, should be maintained in a high degree of purity. It is recommended that this material be purified electrolytically and that the coating be done in an atmosphere of an inert gas. By this careful process, the oxidation of the metal to be covered, which tends to peel off the covering material, is prevented. The electrolytic purification may, in some cases, take place in the same bath with the electrolytic process; for example, by reversing the poles or changing the character or concentration of the electrolyte.

The wall portions consisting of different materials may be combined under the application of pressure. As previously mentioned, either one of the metals to be combined may be sprayed on the other metals or combined therewith by a rolling process, and both metals are combined in a single operation. The wall parts composed of vacuum-tight material, such as copper, are par-

ticularly qualified for the reception of fused portions such as lead-in electrodes, etc. The wall portions consisting of the vacuum material may be either sealed or fused to the portion of the container consisting of insulating material or with the cathode-anode insulators or may be fused or sealed with the cathode holder, which is composed of insulating material.

Local cooling can, of course, be applied to the outer casing in any desired manner. The material for the metallic walls may be of various suitable substances besides those mentioned. The alloys of iron that are not attacked by mercury vapor can, of course, be used and other substances, such as chrome-nickel alloys, may be used.

It is also according to our invention to use other materials besides the two or more superimposed metals previously described. A container of iron may be used and its outer layer subjected to a special smoothing process, and a packing material applied to the pores of the iron container. The iron, for example, may be saturated with lead. In this process, the iron body is heated to a red glow so that its pores are opened and in this condition is exposed to liquid or vaporized lead. When the iron body cools, it compresses the absorbed lead articles between its pores and presses the excess outward. By subsequent hammering or other pressure means, the outer surface becomes substantially completely gas or vapor tight. Casing walls of this type may be utilized in situations in which the large weight of the container is of no importance. In cases in which it is desirable to reduce the weight to a minimum, the other modifications previously described are preferred.

The new arrangement of the walls of the discharge apparatus offers the possibility of change from the container apparatus utilized heretofore, and also the possibility of adapting the apparatus in each case to the requirement of the practice as regards to the form of the container. Of particular significance is the new arrangement of the container walls for control rectifiers, since the control members may be set in any portion of the container wall with ease. If desired, windows may be welded or soldered in the casing or vacuum-tight solderable material layer by using a glass disc for the supervision and observation of the inner portion of the rectifier during construction and operation. It is understood that electrode connections can be sealed through the insulation wherever desired.

The new container walls are not limited to mercury vapor apparatus, but also may be utilized for other vapor apparatus, particularly apparatus operating with gallium. It is also suitable for vacuum containers, vacuum tubes, cooling installations of all kinds and the like. It is particularly advantageous to utilize for the intermediate layer an iron-nickel alloy, for example, 50% iron, 50% nickel, which has the advantages of being gas-tight and also having a high mechanical strength. In place of the materials mentioned other materials may be utilized. In addition to nickel, copper and iron, also tungsten, molybdenum, chromium, etc., may be utilized in either a pure metallic condition, or else in alloys in combination with the other materials.

Although certain specific embodiments of the invention have been shown and described, many other modifications thereof are possible. The invention, therefore, is not to be restricted except insofar as is necessitated by the prior art.

We claim as our invention:

1. An electrical discharge device having an electrode therein and having a metallic vapor therein, said device having a portion of its walls composed of metal, said metal portion of the walls having a thin sheet of material of the iron group having an inner surface not affected by the metallic vapor, a thin intermediate layer of non-porous material, and an outer thick layer of strengthening material for the intermediate and inner layers.

2. An electrical discharge device comprising a container having an electrode and metallic vapor therein, the container walls being part insulation and part conducting, the conducting part of the walls comprising a thin sheet of metal that will withstand the metallic vapor, an intermediate thin non-porous metal and a thick metal outside layer and a metal sealed to said insulation wall part and extended to the intermediate non-porous layer and also sealed thereto.

3. An electron discharge device comprising a container having metallic parts forming a cathode container, a condensation chamber and anode arms, insulating parts between said container, chamber and arms, said metallic parts having a thin inner coating resistant to metallic vapor, an intermediate thin non-porous coat, an outer thick metal coat, said intermediate non-porous coat fused into said insulating parts.

4. An electric discharge casing having a major portion thereof comprising a thick outer portion of the iron group, an intermediate thin portion of the copper group and a thin inner portion of the iron group, and electrode supporting portions on said casing, insulation for said electrode supporting portions, said insulation being sealed to said intermediate thin portion of the copper group.

HANS KERSCHBAUM.
WERNER ESPE.