

March 24, 1931.

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1,797,587

CURRENT RECTIFYING APPARATUS

Filed March 29, 1927

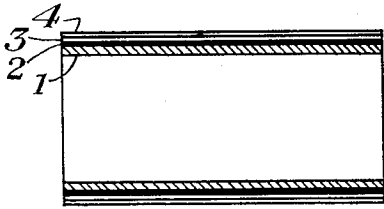


Fig. 1.

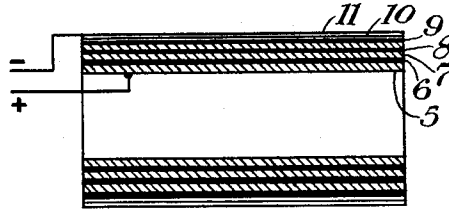


Fig. 2.

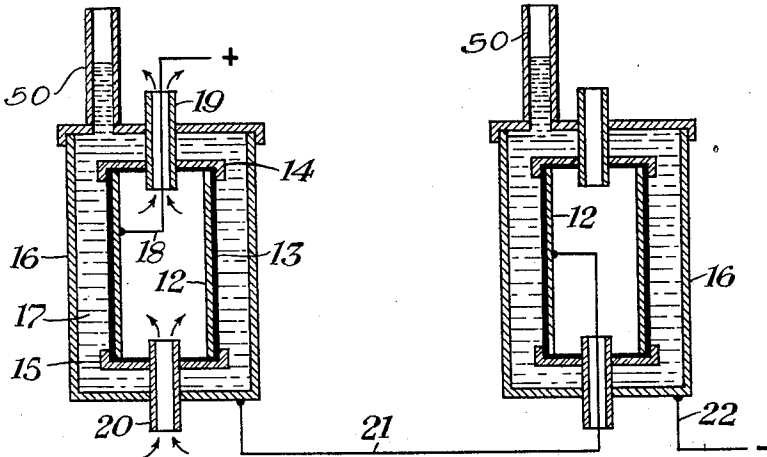


Fig. 3.

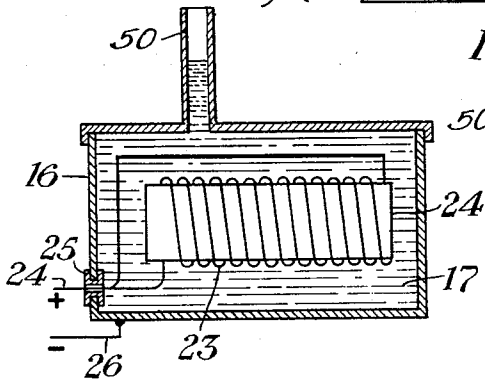


Fig. 4.

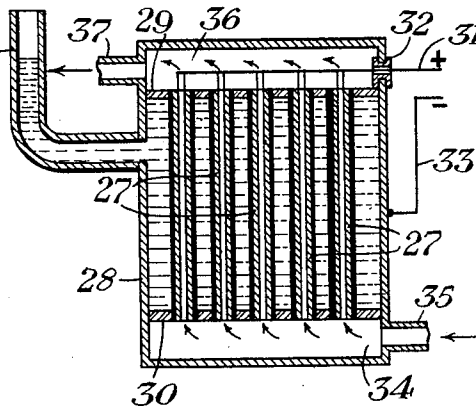


Fig. 5.

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UNITED STATES PATENT OFFICE

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CURRENT RECTIFYING APPARATUS

Application filed March 29, 1927, Serial No. 179,275, and in Great Britain May 10, 1926.

This invention relates to current rectifying apparatus of the type comprising a rectifying element consisting of a body of metal having a layer of a metallic compound formed thereon. A rectifying element of this type in some cases comprises a body of metallic copper having a thin closely adherent layer of cuprous oxide formed on the metal by a heating action and the invention has for its object to provide an improved construction of rectifying element of this general type whereby the capacity and efficiency of the element may be increased.

It is found in practice in apparatus of this description that the current carrying capacity of the element is dependent upon the area of the contact surface of the compound of the metal.

According to the principal feature of the invention the rectifying element is constructed in the form of a hollow member so as not only to increase the contact surface of the compound in contact with the metal but also to provide increased facilities for the dissipation of the heat generated during operation, the external or internal surface or both of the element being available for this purpose.

A further feature of the invention consists in the provision of improved arrangements for ensuring the requisite contact pressure between the metal and the compound so as to improve the rectifying action of the element.

The invention is illustrated by way of example in the accompanying drawings of which Figures 1 to 5 inclusive are sectional views showing somewhat diagrammatically various constructions embodying the invention.

Referring now first to the construction shown in Figure 1 it will be seen that the rectifying element comprises a hollow copper cylinder 1, upon the outer face of which a layer of cuprous oxide 2 is formed by a heating action in manner known in the art. The outer surface of the layer of cuprous oxide 2 is wound successively with layers of lead foil 3 and copper foil or tape 4, these layers being wound under tension in any suitable manner so as to ensure the requisite contact pressure

of the lead foil 3 with the cuprous oxide 2. If necessary, the outer surface of the layer of cuprous oxide 2 may be covered with graphite before the lead foil 3 is wound thereon in order to effect the satisfactory electrical contact with the cuprous oxide. The rectifying element thus formed may be mounted in any suitable manner, preferably with the axis of the copper cylinder vertical so as to ensure circulation of air past the inner and outer surfaces of the cylindrical element for cooling purposes.

Referring now to Figure 2 a modified construction is illustrated adapted for higher voltages, the rectifying element in this case comprising a number of coaxially arranged oxidized layers of copper. As shown in the figure the element consists of a copper cylinder 5 on the outer surface of which a layer of cuprous oxide 6 is formed in the manner above referred to. A cylindrical layer of metallic copper 7 is deposited on the oxide layer 6 by an electrolytic process or in any other suitable manner. On the copper layer 7 a layer 8 of cuprous oxide is formed as above described. On the layer 8 a layer 9 of metallic copper is deposited, the layer 9 having a layer 10 of cuprous oxide formed thereon. The layer 10 is finally surrounded by a wrapping 11 of copper tape and lead foil as described with reference to Figure 1.

Referring now to the construction shown in Figure 3, the rectifying element in this case comprises a hollow copper cylinder 12 on the external surface of which a layer of cuprous oxide is formed as above described. The ends of the cylinder 12 are closed by upper and lower end caps 14, 15 respectively, each having a rim enclosing the ends of the cuprous oxide layer 13. The rectifying element thus constituted is mounted within a cylindrical container 16 constructed of cast or sheet metal containing a body of mercury 17 completely surrounding the rectifying element. The mercury 17 serves to effect an electrical connection between the oxide layer and the container 16, the latter of which constitutes one terminal of the rectifying apparatus, the other terminal being constituted by the copper cylinder 12, to which a conductor

18 leading to the exterior of the apparatus is connected as shown. The caps 14, 15 above referred to are each provided with a ventilating pipe 19, 20 for permitting the flow of a cooling medium through the interior of the rectifying element. This cooling medium may, for instance, be air, which may be arranged to pass into the interior of the rectifying element through the ventilating pipe 20 under the action of a natural draught due to the heating of the rectifying element, the air leaving the interior of the cylinder 12 by upper ventilating pipe 19. Alternatively, the supply of air for cooling purposes may be effected by the action of a fan, blower or exhauster connected to one of the ventilating pipes. A cooling medium other than air, such, for instance, as oil, may, if desired, be arranged to be supplied to the interior of the rectifying element by the provision of any suitable arrangements for this purpose, and the cooling medium may be arranged to be continuously circulated through the interior of the rectifying element, the medium being cooled by passing through a radiator or other suitable device in the well-known manner.

In Figure 3 the rectifying apparatus shown comprises two rectifying elements connected in series with one another, the container 16 of one element being connected by a conductor 21 to the copper cylinder 12 of the other rectifying element, as shown, the conductor 18 and a conductor 22 connected to the container 16 of the second rectifying element constituting the terminals of the apparatus.

It will be apparent that any number of rectifying elements may be connected in series in the manner above described in order to render the apparatus suitable for operation at any desired voltage, and similarly by connecting a number of such elements in multiple a rectifying apparatus of corresponding current capacity may be constructed.

As above stated the mercury 17 in the container 16 serves to effect electrical connection with the layer 13 of cuprous oxide formed on the copper cylinder 12, and in order to increase the efficiency of this connection the mercury 17 may be arranged to be subjected to any desired degree of pressure, as, for instance, by providing the container 16 with an upwardly extending pipe 50 in which a column of mercury or other liquid is maintained for the purpose of providing the necessary head of hydrostatic pressure.

Referring now to the construction shown in Figure 4, the rectifying element in this case comprises a helix 23 of copper wire, a layer of cuprous oxide being formed on the surface of the wire in the manner above described. The helix 23 is mounted as shown, upon a cylindrical support 24 of insulating material, and is immersed in the body of mercury 17 enclosed within a metal container 16. The extremities of the copper helix 23 are

electrically connected to a common conductor 24 passing through an insulating bushing 25 in the wall of the container 16, the conductor 24 forming one terminal of the apparatus while a conductor 26 connected to the metal container 16 forms the other terminal.

The mercury 17 in the container 16 may be arranged as described with reference to the apparatus of Figure 3 to be subjected to any desired degree of pressure in order to increase the efficiency of the electrical connection between the mercury 17 and the layer of cuprous oxide formed upon the copper helix 23.

Referring now to the construction shown in Figure 5, the rectifying element in this case consists of a number of copper tubes 27 on the outer surface of each of which a layer of cuprous oxide is formed in the manner above described. The tubes 27 are arranged vertically within a container 28, the upper and lower ends of the tubes being mounted in corresponding openings in upper and lower partition plates 29, 30 respectively, dividing the interior of the container 28 into three compartments, the construction thus somewhat resembling that of a steam condenser. The middle compartment enclosed between the partition plates 29, 30 is filled with mercury surrounding the tubes 27 and in contact with the cuprous oxide layers on these tubes. The tubes 27 are electrically connected together by means of a conductor 31 passing through an insulating bushing 32 in the wall of the container 2 above the partition plate 29, the conductor 31 constituting one terminal of the apparatus. The other terminal thereof is constituted by a conductor 33 electrically connected to the metal container 28.

A cooling medium such as air or oil is arranged to be supplied to the lowest compartment 34 of the container 28 through an inlet pipe 35, and passes upwards through the interior of the tubes 27 to the uppermost compartment 36 passing out of this compartment through an outlet pipe 37.

As in the constructions described with reference to Figures 3 and 4 the mercury in contact with the cuprous oxide layers on the tubes 27 may be arranged to be subject to any desired degree of pressure, and it will be understood that this pressure not only enables an effective electrical contact with the layer of cuprous oxide to be made, but also enables the contact pressure exerted between the oxide layer and the metallic copper to be adjusted as desired.

It will thus be seen that the invention enables the contact area between the metallic copper and the cuprous oxide to be greatly increased for the purpose of increasing the current capacity of the rectifying apparatus, while at the same time the heat generated during operation, which is found in practice greatly to effect the efficiency of the rectification, is arranged to be dissipated. Further-

more, the invention enables more effective electrical connection to be obtained with the layer of cuprous oxide, while enabling the necessary contact pressure between this layer and the metal to be obtained and controlled in a convenient and practical manner.

The invention is evidently not limited to the particular constructional arrangements above described for attaining the object specified, and various modifications of these arrangements may evidently be adopted without exceeding the scope of the invention.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In combination, a rectifying element comprising a hollow metal cylinder having a coating of a compound of the metal formed on its outer surface, and means for making uniform electrical contact under pressure with the coating of the cylinder.

2. In combination, a rectifying element comprising a metallic body having a coating of a compound of the metal formed hereon, a container surrounding said element, and a mercury under pressure in said container around said element.

3. In combination, a rectifying element comprising a metallic body having a coating of a compound of the metal formed thereon, a container surrounding said element, mercury under pressure in said container covering said element, and two electric terminals separately connected with said body and said liquid.

4. In combination, a hollow chamber having at least one wall made up of a metal having a layer of a compound of the metal formed on its outer face, a container surrounding said chamber, mercury under pressure in said container around said chamber, and means for conducting a cooling medium through the interior of said chamber.

5. In combination, a container provided with mercury under pressure, a hollow metal cylinder having a layer of a compound of the metal formed on its outer surface and immersed in said liquid, two caps one fitting over each end of the cylinder, two ventilating pipes one passing through each of said caps and a wall of the container, and means for separately making electric connections with said cylinder and said layer.

6. In combination, a rectifying element comprising a hollow metal cylinder having a layer of a compound of the metal formed on its outer surface and a layer of metal foil wound under tension around said cylinder.

7. In combination, a rectifying element comprising a hollow metal cylinder having a layer of a compound of the metal formed on its outer surface, a layer of lead foil wound under tension around said cylinder, and a layer of copper foil wound around said layer of lead foil.

8. In combination, a rectifying element comprising a hollow metal cylinder having a coating of a compound of the metal formed on its outer surface, a layer of graphite covering said coating, a layer of lead foil wound under tension over said layer of graphite, and a layer of conducting metallic material wound under tension around said layer of lead foil.

9. In combination, a rectifying element comprising a plurality of hollow coaxially arranged cylinders of metal each having a layer of a compound of the metal formed thereon and each such layer except the outside layer making electric contact with the surrounding cylinder, and a layer of metal foil wound under tension around the outside layer.

10. In combination, a rectifying element comprising a hollow metal cylinder surrounded by a plurality of alternate layers of metallic compound and metal, means for making electrical connection with the cylinder, and means for making uniform electrical contact under pressure with the outside layer of metallic compound.

11. In combination, a rectifying element comprising a plurality of alternate layers of a metal and a compound of the metal each formed directly on the layer beneath.

12. In combination, a container provided with spaced partitions dividing the container into two outer compartments and a middle compartment, a plurality of metal cylinders each having a layer of a compound of the metal formed on its outer surface and each having its ends mounted respectively in said partitions in such manner that the interior of each cylinder communicates with both said outer compartments, mercury under pressure in said middle compartment, an electric terminal connected with said mercury, and a second terminal connected with each said metal cylinder.

13. In combination, a container provided with spaced partitions dividing the container into two outer compartments and a middle compartment, a metal cylinder having a layer of a compound of the metal formed on its outer surface and having its ends mounted respectively in said partitions in such manner that the interior of the cylinder communicates with both said outer compartments, and mercury under pressure in said middle compartment surrounding said layer.

In witness whereof I have hereunto set my hand.

LESLIE HURST PETER.