Sept. 19, 1950 H. E. CARTIER 2,522,929

RECTIFIER

Filed Nov. 8, 1945

Fig. 1

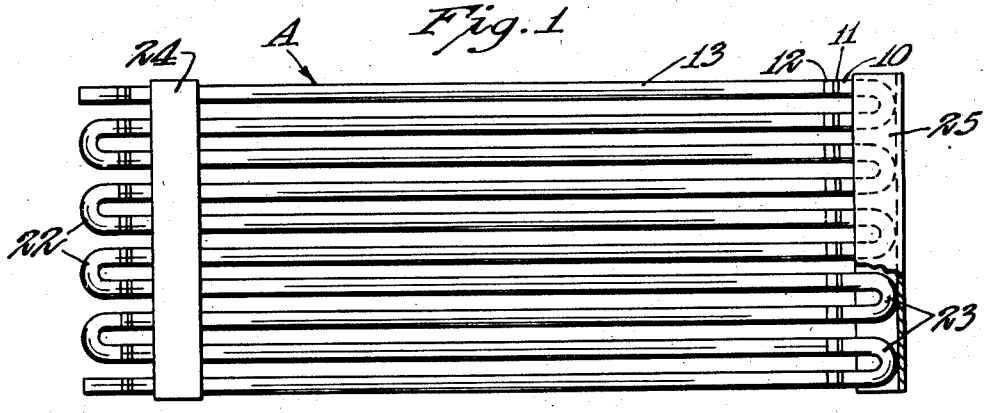


Fig. 6

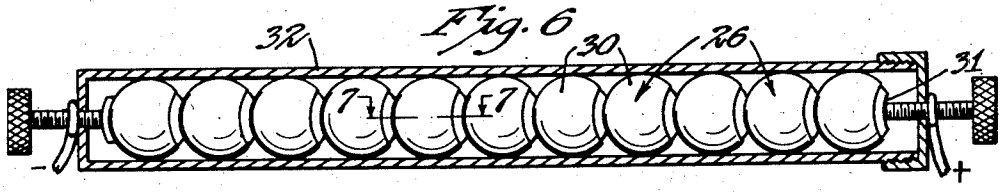


Fig. 3

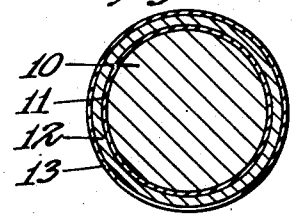


Fig. 7

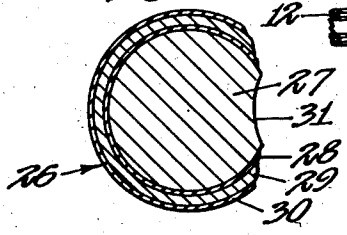


Fig. 8

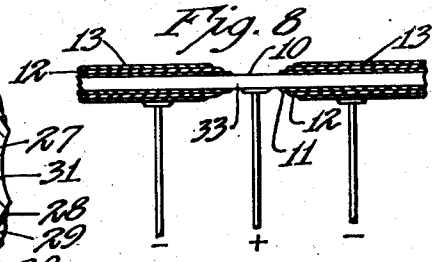


Fig. 4

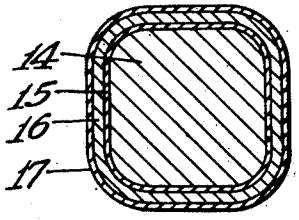


Fig. 2

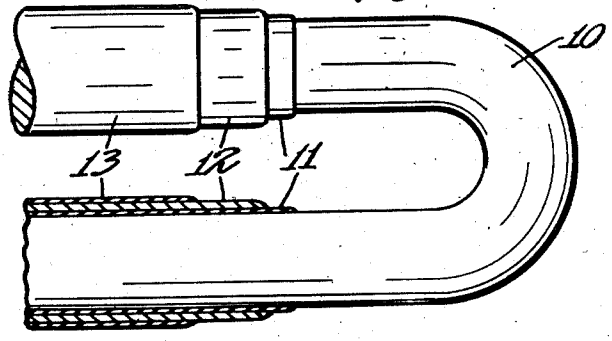
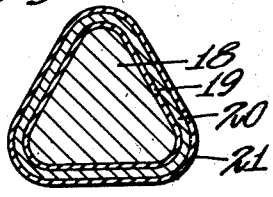


Fig. 5



INVENTOR.
Harold E. Cartier
BY
Williamson & Williamson
ATTORNEYS

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RECTIFIER

Harold E. Cartier, White Bear Lake, Minn.

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3 Claims. (Cl. 175—366)

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This invention relates to rectifiers for changing alternating current into direct current.

One of the objects of the invention is to provide a rectifier of the barrier layer type wherein a greater degree of efficiency can be achieved with a relatively small amount of parent metal.

Another object of the invention is to provide a rectifier including a body of parent metal wherein practically all of the outer surface of said parent metal is provided with a metallic negative coating, and wherein said body of parent metal is so shaped as to prevent the negative metallic coating from flaking off, and wherein nearly all of the parent metal is provided with a continuous active rectifying surface or coating.

More specifically it is an object of the invention to provide a rectifier wherein the outer surface of the parent metal is free of abrupt changes in contour and is provided with a rectifying layer of metal which will not flake off under current stresses because of the fact that the body of parent metal has no abrupt contour changes, sharp corners, etc.

The above and other objects and advantages of the invention will more fully appear from the following description made in connection with the accompanying drawings, wherein like reference characters refer to the same parts throughout the views, and, in which:

Figure 1 is a plan view of a rectifier grid element made in accordance with the invention;

Figure 2 is an enlarged fragmentary and partial sectional view of an end portion of the grid element shown in Figure 1;

Figure 3 is an enlarged transverse sectional view through one of the round wires making up the grid elements of Figures 1 and 2;

Figure 4 is an enlarged transverse sectional view through a wire rectifier element having four flat sides and rounded corners;

Figure 5 is an enlarged transverse sectional view through a rectifier element which is triangular in cross section and has rounded corners;

Figure 6 is a view partially in section of a rectifier assembly utilizing generally spherical rectifier units;

Figure 7 is an enlarged sectional view taken approximately on the line 7—7 of Figure 6; and

Figure 8 is a plan view of a half-wave bridge meter rectifier embodying the principles of the invention.

In Figure 1 there is shown a grid A made up of a continuous piece of wire having a plurality of multiple reverse bends. The main body of the grid element A comprises a wire 10, best shown in

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Figures 2 and 3, which is the parent metal of the rectifier. In the illustrated embodiment of the invention and for the purposes of description the wire body of parent metal 10 can be considered to be copper, although other suitable metals can be used. The usual barrier layer 11 is shown immediately adjacent the parent metal body 10. Outside of the barrier layer 11 is a layer 12 of cuprous oxide and over the layer of cuprous oxide is a layer of plating 13 of nickel which forms the negative side of the rectifier element.

In a rectifier of this type the plated surface completely surrounds the central wire of parent metal 10 so that practically all of the outer surface of the element acts as a rectifier.

The outer surface of the round copper wire 10 or of any body of parent metal which does not have abrupt changes in contour can be processed to provide a rectifier unit, some examples of which are shown in the drawing and will be found described below.

Figure 4 is a transverse sectional view through an elongated bar or wire of parent metal 14 and, if desired, it can be made up in a grid-like form such as the grid A of Figure 1. The rectifier element of Figure 4 is provided with a barrier layer 15, a cuprous oxide layer 16 and a negative plating, such as a coat of nickel 17, in the same manner as the cylindrical wire rectifier element shown in Figures 1, 2 and 3.

Figure 5 shows a parent metal elongated mass or wire 18 having a barrier layer 19, a cuprous oxide layer 20 and an outer negative metallic plating 21.

If the rectifier elements shown in Figures 3, 4 and 5 are arranged in the form of a grid such as the grid A of Figure 1 it is a simple matter to connect the grid elements in banks of any desired number, depending upon the current desired. When a grid is made up in any desired shape, Figure 1 being an example, it is etched in concentrated nitric acid and then emersed in a boiling distilled water and afterward dried. The grids are then placed in a furnace at a temperature of 1020° to 1030° C. for a period of approximately five to ten minutes. This produces a layer of copper oxides, and the grids are then placed in a heat treating furnace at a temperature of approximately 500° to 530° C. for approximately one-half hour. They are then withdrawn from the furnace and immediately quenched in water at approximately 70° C. After the quenching step the active areas of the grids are reduced at a temperature of approximately 40° C. in a strong alkali solution of formaldehyde. The

formaldehyde reduces the black oxide layer on the parent metal until forward electrical resistance is at a minimum. The active areas of the grid elements are then plated with nickel.

After the plating operation of the grid, the bends therein are placed in a concentrated solution of sodium cyanide to remove the oxide and expose the copper or other parent metal up to a point beyond the termination of the outer nickel plate. The exposed copper or other parent metal is then tinned in a solder of low melting point. A negative contact bar **24** is soldered to the horizontal bar portions A, as shown in Figure 1, said contact bar being in electrical contact with the outer layer **13** of nickel plating. A positive contact bar **25** which, as shown in Figure 1, may be U-shaped to receive the right hand ends or bends of the grid, is soldered to such bends, and is in contact with the exposed parent metal **10**. A plurality of grid elements such as the element A can then be connected in any suitable manner depending upon the desired capacity of the rectifier.

Figures 6 and 7 illustrate another form of the invention. In Figure 6 there is shown a plurality of generally spherical bodies **26** which are treated and coated or plated in the same manner as the rectifier elements of Figures 3, 4 and 5. As best illustrated in Figure 7, the spherical bodies **26** include cores **27** of parent metal, barrier layers **28**, cuprous oxide layers **29**, and outer layers of nickel plating **30**. It will be seen in Figure 7 that a portion of the parent metal **27** is cut away to provide a concave socket **31** wherein the parent metal is exposed. A plurality of generally spherical rectifier elements are placed in a tubular casing **32** formed from a dielectric meter and the elements **26** are so arranged that the outer negative metallic plating **30** on one of the elements **26** is in contact with the parent metal **31**, with a next adjacent element **26**, and the outer negative platings **30** of adjacent elements **26** are out of contact with each other. The arrangement shown in Figure 6 provides a series grouping of spherical elements and they embody the same general feature of the rectifier element shown in Figures 3, 4 and 5 in that the outer metallic negative coating is, by reason of the shape of the parent metal **31**, free of abrupt changes in contour. It is to be understood that any number of units such as shown in Figure 6 may be connected together to provide the desired rectifier capacity.

Figure 8 discloses a bridge meter to illustrate another application of the invention. The parent metal core is shown at **33**, and the various layers such as described in the previously disclosed embodiments are also present in this form of unit.

In describing the rectifier elements as being free of abrupt changes in contour I mean that any change in surface configuration shall be free of relatively sharp corners as in the case of comparatively thin plates or strips. I have found through experimentation that where surface contour changes are made on relatively gentle curves as distinguished from sharp curves or sharp angles it is possible to apply a negative outer plating about the entire surface or substantially all of the entire surface and about such gentle changes in contour, and the rectifier unit will operate efficiently and not break down. The oxide and negative outer layer will remain on the core of parent metal and practically all of the surface of the rectifier element provides rectification.

With my invention it is possible to achieve a much higher ratio of active surface for a given weight of parent metal than is possible in a thin plate type rectifier. For this reason the rectifier structures will be relatively smaller in mass and for use will be less expensive in proportion to the amount of direct current drawn from them.

In connection with the elongated or wire type of rectifier element described above it should be noted that it is more easily cooled than a flat thin plate because it has a larger surface for a given mass. By reason of the fact that electrical rectifiers are limited to a greater extent by a minimum temperature rise factor, the greater cooling surface of a structure embodying my invention will greatly reduce the size and cost of the unit.

Through experimentation and for some reason not thoroughly understood by me, a much higher ratio of forward current to backward current can be obtained in rectifier elements constructed in accordance with the invention. Since the backward current goes directly into heat, the low backward current in an element such as disclosed results in considerable efficiency.

I have found that for a reason which is also not well understood that the rectifier disclosed herein improves with age instead of falling off in efficiency as is the case with a thin plate type rectifier, and the rectifying units will operate relatively farther from peak capacity. This naturally will increase the effective operative life of the unit.

In a grid type rectifier such as illustrated in Figure 1 and wherein the plated outer surface completely surrounds the parent metal there is sufficient mechanical strength to permit soldering directly to the rectifier elements with a low melting point solder. This construction produces a metallic bond directly with the plated surface, and has the advantage of eliminating the difficulties of mechanical contacts such as are commonly used in the above mentioned thin plate rectifiers.

There is another distinction between what might be termed my wire type rectifier unit and the flat thin plate type. Assuming that rectification is due to a stressed condition set up between the oxide and the copper as the unit is quenched from a high temperature, it is possible to explain the differences in behavior of plates and wires and also the relatively large masses such as the generally spherical elements **26**. If the stress is higher than the minimum creep strength of copper then the metal will move to relieve the stresses at some definite rate. This assumption is strengthened by the fact that the aging curves of the ordinary thin rectifier plates are very similar to the creep curves of copper. In a plate the stresses can be relieved in two coordinated directions but in the wire these stresses are relieved in only one direction. For that reason it is believed that in a plate rectifier the stresses can be relieved to a lower value than in the wire type or roughly spherical type disclosed. Based on the theory that a definite quantity of stress which will produce optimum rectification, the plate type of rectifier will not reach such optimum and will begin to relieve its stresses at some point below that required for best results. However, in the rectifier disclosed herein the element would be initially stressed to some point above the optimum and the relief allowed in one direction of stress would allow it to approach the desired optimum condition. Following this line of reasoning the generally spherical shape will make a more stable

rectifier than the elongated wire type which in turn is much more stable than the flat thin plate type.

It will, of course, be understood that while I have referred to a rectifier of the copper oxide type, my invention is intended to apply to all alternating current rectifiers of the barrier layer class, and that various changes may be made in the form, details, arrangements and proportions of the units without departing from the scope of my invention.

What I claim is:

1. In an alternating current rectifier of the barrier layer type, an elongated solid wire-like core of parent metal having relatively sharp bends at spaced points therealong to produce a compact structure having a considerable length of wire therein, and said core being substantially completely covered by the barrier layer and an outer metallic coating except at the bends in said core.

2. The structure in claim 1 and the ends of said wire being free of said barrier layer and outer metallic coating.

3. In an alternating current rectifier of the barrier layer type, an elongated wire-like solid core of parent metal, the outer surface of said core having a barrier layer thereon and an outer metallic coating, and said core being free of said barrier layer and said outer metallic coating at a point between the ends of the core to provide an electrical contact point and to produce a half wave rectifier.

HAROLD E. CARTIER.

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