Feb. 6, 1940. E. SIEBERT ET AL 2,189,617

METHOD AND DEVICE FOR COOLING METALLIC DRY RECTIFIER ELEMENTS

Filed July 16, 1938

Fig. 1.

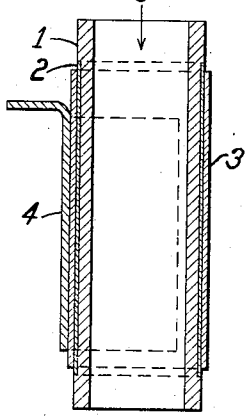


Fig. 2.

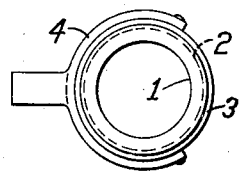


Fig. 3.

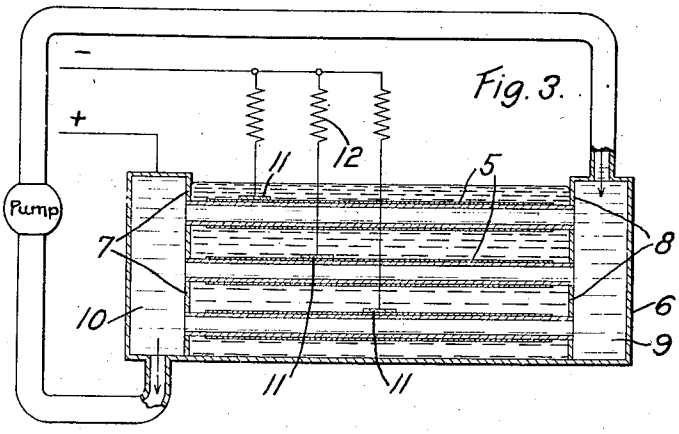
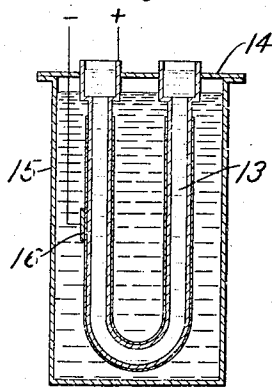


Fig. 4.



WITNESSES:

Wm. B. Sellers.

R. W. Bailey

INVENTORS

Ernst Siebert and

Wilhelm Kafka.

BY

F. W. Lyle

ATTORNEY

Patented Feb. 6, 1940 2,189,617

UNITED STATES PATENT OFFICE

2,189,617

METHOD AND DEVICE FOR COOLING METALLIC DRY RECTIFIER ELEMENTS

Ernst Siebert and Wilhelm Kafka, Berlin-Siemensstadt, Germany, assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 16, 1938, Serial No. 219,532
In Germany November 3, 1937

4 Claims. (Cl. 175—366)

The invention relates to contact rectifiers and especially contact rectifiers requiring a cooling medium applied thereto.

The object of the invention is a method and device for cooling metallic dry rectifier elements with an effective layer deposited on one side of the base metal. The new method makes possible a very effective cooling of such dry rectifier elements, since it avails a combination of the advantages of water cooling with a complete protection of the effective layer against all atmospheric influences. This is, in accordance with the invention, attained by drawing away from the side of the base metal carrying the effective layer, by means of a humidity removing means, for example, oil, the harmful influences of the atmosphere, while a cooling means acts on the other side of the base metal. A suitable device for carrying out this method in accordance with a further aspect of the invention may, for example, consist in constructing the dry rectifier element of tubular form and depositing the effective layer with which the humidity removing means is in contact, preferably on the outer side of the tube. Preferably also one or more of such tube-shaped dry rectifier elements are arranged in an oil filled container in such manner that cooling means, for example water or air, may be conducted through the inner portions of the tube.

Further details of the invention will be seen from the following description of an exemplary embodiment with reference to the drawing in which Figs. 1 and 2 show a tube-shaped rectifier element, according to the invention, in longitudinal section and plan, while Figs. 3 and 4 illustrate metal containers in which one or more rectifier elements are incorporated in accordance with the invention.

The tube-shaped rectifier element illustrated in Figs. 1 and 2 consists of a copper tube 1 having a part or major portion of the curved outer side provided with a cuprous oxide layer 2, produced in known manner by heating under the supply of air, while on the inner side, the base metal is free. On the cuprous oxide layer 2, there is a metal coating 3 deposited, for example, by spraying, which consists, for example, of zinc. The current conduction of the dry rectifier element constructed in this manner takes place by means of a shell or clasp 4 disposed around the tube and lying rigidly on the metal coating, while the copper body of the tube 1, which is the base metal, serves to conduct away the current.

For the purpose of conducting away the Joule heat arising in operation, a streaming cooling means, for example, cooling air, is conducted through the inner portion of the tube in the direction of the arrow, while the outer side of the tube-shaped dry rectifier element is preferably protected by oil or another humidity removing means, for example, by an air space closed against the outside and being gas-tight against all harmful influences of the outer atmosphere. A particularly preferable embodiment of a device serving for carrying out the method, according to the invention, is shown in Fig. 3, which discloses a rectifier arrangement, suitable for connecting to a three-phase network in star connection. In this arrangement, a single rectifier element is disclosed for each phase for the sake of clearness of drawing although more could be supplied. The tube-shaped rectifier elements 5 are arranged in a metal container 6 which is provided with two intermediate bottoms 7 and 8 and the center portion of which is filled with oil. The oil contacts the effective outer sides of the tube-shaped rectifier elements 5, while preferably cooling water plays on their metallic inner sides. The water streams through in the manner shown in the drawing to collection spaces 9 and 10 in open communication with the inner portions of the tubes in the direction of the arrow. The current conduction to the rectifier elements is effected by shells 11 located on each of the outer sides of the tube. Of the three shells 11, each one is connected to another phase of the secondary winding 12 of a transformer, the neutral point of which, at the same time, forms one of the direct current poles of the rectifier arrangement. The other direct current pole is in the walls of the metal container 6, the intermediate bottoms 7 and 8 of which are metallically, conductively connected with the base metal 1 of the tube-shaped rectifier elements 5. These connections may be produced by soldering or screwing; the tube ends may also be rolled into the intermediate bottoms. So that, in the construction of these connections, the effective layer of the rectifier elements should not suffer, they should be so deposited on the base metal 1 that the tube ends are free from the effective layer in the manner illustrated in Fig. 2. It may be preferable to carry out one or two of the intermediate bottoms 7 and 8 flexibly, or fasten them flexibly in the container, and to take into consideration the heat expansion of the tube shaped rectifier elements and to prevent a too strong mechanical stress of the connection positions with the intermediate bottoms.

In the embodiment illustrated in Fig. 4, one or more U-shaped bent rectifier tubes 13 are in-

serted in the cover 14 of a metal container 15 which is filled with oil, while cooling water is conducted through the rectifier tubes. For supplying the alternating current, tube shells 16 serve here also. The direct current is derived from the base metal of the rectifier tubes 13.

If the tube shaped rectifier elements are to be used in series circuit or in Graetz bridge circuit, then the individual rectifier tubes are preferably connected with each other and with the container walls by oil-proof rubber hose or by tube elements of insulating material in which the rectifier tubes are screwed in water-tight. The electrical series connection of two tube parts then takes place at best through the insulating tube elements by means of a metallic buckle which contacts the outer metal layer of one of the tube shaped rectifier elements and the tube end free of effective layers in the other. Instead of this, the rectifier tube parts and the insulating tube shaped intermediate pieces may also be connected by means of a suitable cement. To construct the intermediate elements, a composition material of various types may be used.

In one of the cuprous oxide rectifiers constructed and arranged in the above given manner, a considerable cooling effect is attained, since copper is a very good heat conductor with the method according to the invention. With this cooling effect, we succeed in conducting away the Joule heat developed in the blocking layer, i. e., between the copper and the cuprous oxide with a very small temperature drop at the cooling means conducted through the inner portions of the tube. Since the danger of break-down and the magnitude of the back current of the cuprous oxide rectifiers rise with the temperature of the blocking layer, the above-described cooling method, especially since it avails a high drop in the blocking layer temperature, offers the possibility of utilizing the rectifier elements, as regards potential, particularly well. For example, the potential on the direct current side may be raised from the heretofore common value of 6 volts to 8–10 volts without much consideration. Since the losses in the current passing direction are not influenced by this potential increase, we succeed in this manner in decreasing the watt loss of the rectifier by approximately ⅓ and correspondingly increasing the efficiency.

If a selenium is used as an effective layer also, it is preferable to deposit the selenium layer on an iron tube and to provide it with a sprayed metal coating after the heat treatment. However, instead of this, aluminum tubes may also be utilized by oxidizing or nickeling them on the outer sides and then depositing the selenium layer. In iron selenium rectifiers, the actual blocking layer is separated from the iron tube forming the base metal by an intermediate selenium layer. Since selenium has a comparatively small heat conductivity, it is preferable also to cool the outer side of the tube shaped selenium rectifier element. This may take place either by providing tubes through which cooling means streams in the means surrounding the rectifier tubes externally in the oil or air, however, even without such cooling tubes, a good cooling of the outer side of the tube shaped selenium rectifier elements may be attained by covering the outer side of it only in regions with the effective layer, while at the remaining parts, the outer side of the base metal is bare, so that just as the base metal of the tube inner portion, it may serve for heat conducting.

Dry rectifier elements constructed and cooled in the above described manner are suitable with particular advantage for feeding galvanic paths and other electro-chemical current consumers, accordingly, in the case in which large current strengths and lower potentials are involved, and in which, at the same time, the air is commonly humid and contains acid vapors and impurities, while only cooling water is available.

Since the described dry rectifier elements withstand a comparatively high loading, they may be constructed not only with particularly good efficiency, but also with dimensions decreasing spatially; in many cases, the space requirements of these dry rectifier elements drops down to ⅕ of that heretofore required. A further important advantage resides in the fact that a very intensive cooling without rotational parts, or parts mechanically moved in any other way, such as ventilators or pumps, is attained. Further, since their effective layers are closed gas-tight against the outer atmosphere, the rectifiers may be arranged in electro-chemical operations without any additional protection immediately adjacent to the rectifier loads.

If the feeding of welding devices or other current consumers is involved which require rectifiers of large capacity which may be moved from place to place, it is advantageous to cool the tube shaped rectifier elements not by streaming cooling water, but by means of cooling air. Also, in this case, a liquid, for example, water or oil, may be used as cooling means which is itself cooled in a special air-cooled device.

As compared to the air cooling, the oil cooling has the advantage that when it is used, harmful influences which arise from any impurities of the cooling air, such as dust, humidity or acid vapors, are avoided. On the other hand, the relatively small cooling effect attained with oil cooling must be taken into consideration, since for the dry rectifier elements—particularly when such as involved in which the effective layers manifest a negative temperature coefficient—only comparatively low operating temperatures are permissible and this requires a very small thermic circulation of the cooling means. Artificial oil circulation, however, will require special pump devices which render the plant complicated and costly.

The invention is also applicable to contact rectifiers and similar devices involving materials other than or in addition to those mentioned. In fact many modifications can be made in the number, arrangement, combination and form of the elements disclosed. Accordingly no limitations are intended to be placed upon the following claims except as necessitated by the prior art.

We claim as our invention:

1. A contact rectifier comprising a tubular metallic element, a layer on one surface of said tubular metallic element forming a rectifying contact, means for making electric contact to the surface of said layer and means applying an electrically-insulating cooling medium to both the outside and the inside of said metallic tubular element.

2. A contact rectifier comprising a hollow copper tube, a copper oxide layer on the outer curved surface of said copper tube, means for making electrical contact to the periphery of said layer, an electrically-insulating liquid contacting the first said means, and means circulating a cooling medium through said tube.

3. A rectifying system for connection to a polyphase circuit comprising a plurality of hollow tubular elements having contact rectifiers on their

outer surfaces and means circulating a cooling medium through the hollow portion of said elements, and an electrically non-conducting liquid in contact with the outer surfaces of said hollow tubular element.

4. A contact rectifier comprising a copper tube having an oxidized layer on at least a portion of the surface thereof, means for making electrical contact to the outer surface of said layer, means for supporting said tube in an oil bath, and means for circulating a cooling fluid through the interior of said tube.

ERNST SIEBERT.
WILHELM KAFKA.