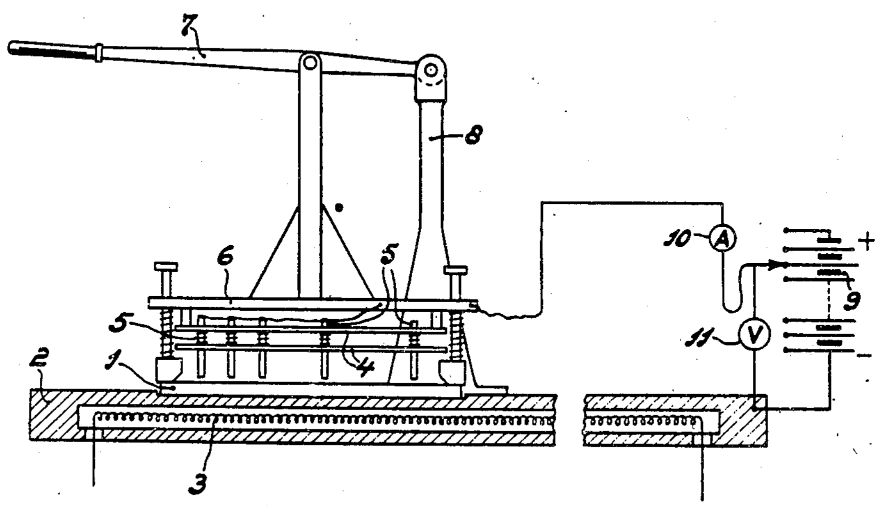
March 8, 1949. N. W. H. ADDINK ET AL 2,464,066

METHOD OF REDUCING THE LEAKAGE CURRENT IN SELENIUM RECTIFIERS

Filed Aug. 29, 1945



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Patented Mar. 8, 1949 2,464,066

UNITED STATES PATENT OFFICE

2,464,066

METHOD OF REDUCING THE LEAKAGE CURRENT IN SELENIUM RECTIFIERS

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Application August 29, 1945, Serial No. 613,326
In the Netherlands May 7, 1941

Section 1, Public Law 690, August 8, 1946
Patent expires May 7, 1961

6 Claims. (Cl. 175—366)

The invention relates to a method of reducing the leakage current in selenium rectifiers.

Since in such rectifiers, due to the emission of the selenium electrode, there also flows a countercurrent, attempts have been made to reduce this current, also referred to as "leakage current," in order to improve thereby the efficiency of the rectifier. This is called the "formation" of the blocking layer.

For reducing the leakage current in a selenium rectifier it is already known to submit the latter after its construction to a treatment wherein a current is sent through the rectifier in the blocking direction. This treatment had for its purpose to burn out the conducting places in the blocking layer which give rise to a heavy counter-current, owing to which at these places the short-circuit or, as the case may be, the current path of low resistance, would be suppressed and a homogeneous blocking layer of satisfactory quality would be produced. The duration of the treatment was always so short that substantially no heating occurred in the rectifier. A treatment of long duration was by no means necessary; the current had only to flow until the "bad" places, which only have small surface areas, were burnt out.

Experiments have shown that such a method is unsatisfactory and that the leakage current retains a value of still inadmissible degree.

The invention has for its object to provide means by which, relatively to the known method, the leakage current is still further reduced or in other words whereby it is possible to apply, with the same leakage current, a higher counter-voltage to the rectifier.

Other objects, features and advantages of this invention will be apparent as the description pro ceeds hereinafter.

The drawing shows a preferred embodiment of the apparatus for practicing the method described hereinafter.

After extensive investigations relatively to the above-mentioned problem it has been found that the improvement in view is obtained by sending a current through the rectifier in the blocking direction while the rectifier has a temperature which exceeds the operating temperature.

Only if the two above-mentioned conditions, viz. passage of current and higher temperature than in normal operation, are fulfilled, the result in view, an appreciable improvement in the leakage current, is obtained. This will hereinafter be set out in detail with reference to measuring results.

If a current is sent through the rectifier, heating of the latter occurs when sufficient intensity and duration are attained. In order to obtain the required temperature, it is in general necessary to send a rather heavy current through the rectifier. In one favourable embodiment of the invention it is therefore proposed to heat the rectifier during the electric treatment from the outside, for example in a furnace. It is evident that by carrying out this method it is possible to take a lower current intensity, that is to say an intensity such as is just high enough to obtain the desired effect in the rectifier.

While the rectifier is being raised to the desired temperature, it may occur that the current flowing through the rectifier gives rise to local increases in temperature which are harmful to the rectifier. In one advantageous embodiment of the invention, use is made during the treatment of means by which the temperature of the rectifier is made uniform all over the surface.

These means may consist, for example, in having the rectifier plate placed during the passage of current on a supporting plate of high thermal capacity, which plate is heated to the temperature which is also the desired temperature during the forming process of the rectifier. If due to the passage of current an excessive amount of heat is locally developed in the rectifier, the heating plate acts at the same time as a means of carrying off the excessive heat and therefore of obtaining a uniform temperature over the whole of the surface of the rectifier. Also other means are possible for achieving this purpose. For example, a current of air may be directed upon the rectifier plate.

Another embodiment consists in the rectifier being placed in a bath containing an insulating liquid whose boiling point corresponds to the temperature which is desired for the formation of the rectifier. This method has the advantage that the temperature of the rectifier during the formation can be fixed with extremely high accuracy.

By taking a high temperature at which the treatment takes place, it is possible to promote the rapidity of the formation. It has been found, however, that afterwards the electrical properties of the rectifier are not always constant. Moreover, for the counter-electrode there is utilized in general an alloy which is already molten at a low temperature, for example, of 130° C. If the forming temperature exceeds this temperature, oxidation of the material may occur and the properties of the rectifier may be harmfully affected. It is therefore desirable to try to find a method which is a comprise between the formation period and the other factors mentioned. In one embodiment this is effected by carrying out the treatment by heat and current several times in succession with intervening periods of rest.

During the periods of rest the forming device may be utilized for other rectifier plates so that these devices are utilized as efficiently as possible. This is still further promoted by submitting the rectifier to a first treatment by heat and current wherein an increase of temperature is produced exclusively by the heat due to the current, said treatment being followed by a treatment by heat and current wherein heat is supplied to the rectifier from the outside, for example, by a heating plate which supports the rectifier. Thus the heating plates are only in use during part of the forming period of the rectifier.

It has furthermore proved to be advantageous to carry out this treatment in such manner that a first thermal treatment takes place above the melting point of the material of the counter-electrode, said treatment being followed by a thermal treatment below the said melting point.

It has been found that in the first treatment the heating above the melting point has a favourable effect on the composition of this layer, especially if the said treatment only takes place during a short time (of the order of 1 minute). In the further treatment it is advisable not to surpass the melting point in order to avoid the previously mentioned disadvantages which would otherwise occur.

Use may be made of direct voltage, of pulsating direct voltage or of alternating voltage in circuit-arrangements suited therefor.

Below is given one practical example in which are mentioned comparative results (which are averages in a large series of measurements) and from which distinctly appears the progress obtained by carrying the present method into effect.

A layer of selenium into which admixtures are introduced in order to increase the conductivity is applied to a disc of iron or aluminum on which is provided an intermediate layer inter alia of carbon to ensure a satisfactory adherence while maintaining a good electrical contact. The whole of it is submitted to a thermal treatment in order to convert the selenium into the conducting modification and to form the blocking layer on the surface of the selenium layer. In order to strengthen the blocking layer a substance producing an alkaline reaction such as piperidene may be applied during the thermal treatment in finely divided condition to the selenium surface. Finally the above-mentioned alloy is sprayed on to the blocking layer.

Upon measurement it is found that rectifiers thus manufactured which have a surface area of 100 sq. cms. allow the passage in the forward direction of a current of 30 amperes when a pulsating voltage having a peak value of 2.2 volts is applied. The countervoltage, i. e. the voltage which has to be applied to cause a current of 100 ma. to flow in the opposite direction, amounts to about 10 volts.

If the rectifiers manufactured according to the above example are submitted for about 1 minute to a treatment by current (forming proccess) during which such a current is led in the opposite direction through the rectifiers that there occurs an increase in temperature to about 125° C., that is above the melting temperature of the alloy, it is found that after cooling the

forward current amounts to 27 amps. but that the countervoltage has increased to 20 volts with a current of 0.1 amp.

In order to reduce the leakage current still further use is made of a following stage of the formation. After the rectifiers have undergone a rest-cure which preferably lasts a few days, the forming process is repeated for about four minutes up to a temperature near 110° C. and which is obtained by placing the rectifier plate on a heated plate, a current of 3 amps. being caused to pass through the rectifier. It then appears that the current in the forward direction is 24 amps. and that with a current of 0.1 amp. the countervoltage has been increased to 20 volts.

The forward current, which has always been measured at a pulsating voltage of 1.5 volts, that is a peak value of about 2.2 volts, consequently appears to be slightly reduced but the gain in countervoltage is such that the slight reduction of the forward current may be considered as immaterial.

In another example we proceed as follows:

Rectifiers having an operative surface area of 12 sq. cms. are measured after the manufacture and prior to the formation. The forward current, measured at an applied direct-current voltage of 2 volts, amounts to 4 amps. The leakage current is 100 ma. at a pulsating voltage of 9 volts. Then the rectifiers are formed in order to increase the countervoltage, during which process the countercurrent passing through the rectifiers gives rise to an increase in the temperature thereof up to 125° C. This operation is only of short duration and lasts from 20 to 30 seconds. It will now be found that at 2 volts the forward current is likewise 4 amps. but that the countervoltage at 100 ma. has increased to 16 volts. Thereupon the rectifiers remain in rest for some time, whereafter the forward current and the countercurrent are measured once more. Now the former appears to be 2.7 amps. at 2 volts and the latter 100 ma. at 17 volts.

If the rectifiers are submitted to a second forming treatment, which lasts about 3 hours and during which the temperature is maintained on the average at 80° C., it is found after termination that the forward current is 2.5 amps. at 2 volts and that the countercurrent has been improved so as to be only 12.5 ma. at a voltage of 18 volts. The indicated values of the voltage are always the peak values of the pulsating voltage or alternating voltage.

Also in this case the improvement of the countervoltage is such that the reduction of the forward current is of minor importance.

The device wherein the rectifier plates are formed will now be described with reference to the accompanying drawing.

A rectifier plate 1 is introduced into a countersunk portion of a block 2 of high thermal capacity which is maintained from the outside, for example by an electric heating element 3, at a constant temperature of about 90°.

A contact member 4 consisting of two parallel metal plates between which are located a plurality of resilient contacts 5 is suspended from a supporting plate 6. The latter is moved by means of a lever 7 which is supported by a column 8.

The resilient contacts 5 are arranged between the plates 4 in such manner that over the whole of the surface of the rectifier plate a uniform distribution of current is obtained. It should be borne in mind that for the formation use is made of a fairly heavy current, viz. of about 3 amps. and over on a rectifying surface area of 140 sq. cms. It is consequently important to distribute the current over a large number of contacts. The contacts 5 are resiliently mounted so that in the case of unevennesses on the rectifier plate notwithstanding a satisfactory contact throughout the whole surface is obtained whilst there occurs the additional advantage that the contact pressure is kept within determined limits so that the risk of the contacts being pressed through the alloy layer and of the blocking layer being damaged is avoided.

In order to ensure that the rectifier plate is pressed flat on the buffer block there is provided a rim 9 which is resiliently hung from the plate 6.

It is obvious that the contact member 4 with the contacts 5 on the one hand and the block 2 on the other hand must be arranged so as to be insulated from one another.

It is customary to provide one or more holes in the rectifier plates for attachment or other purposes. It may occur that a contact 5 comes to lie just opposite such a hole so that upon depressing the block 6 a short-circuit between this block and the buffer block 2 would occur. In order to obviate this drawback use may be made of a mask constituted by a plate of insulating material having the size of a rectifier, which plate has holes which correspond to those contacts 5 which are not located opposite the holes in the rectifier. Different masks are consequently utilized for different types of rectifiers.

The forming current is furnished by a storage battery 12 whose output voltage is regulable, current and voltage being read off on meters 10 and 11. A chronometer completes the equipment of this installation wherein in the present instance one rectifier plate can be treated. In practice, however, an installation is composed of a plurality of the above-described devices so that a plurality of rectifiers can be formed simultaneously.

What we claim is:

1. A process for conditioning a selenium rectifier including a counter-electrode, comprising the steps of heating said rectifier in an insulating liquid bath to raise the temperature thereof to a first temperature above the melting point of said electrode, said bath having a boiling point corresponding to said temperature, submitting said rectifier to a forming current in a reverse current flow direction during said heating for a predetermined period, thereafter rest-curing said rectifier for a selected time, reheating said rectifier to a temperature substantially lower than said first temperature, and maintaining a forming current in a reverse current flow direction during the latter heating also.

2. A method of reducing the leakage current of a selenium rectifier, comprising the steps of heating said rectifier to a higher temperature than its normal operating temperature by immersing said rectifier in a bath containing an insulating liquid whose boiling point corresponds to said heating temperature, and passing an electric forming current through said rectifier in its

blocking direction during the maintenance of said higher temperature.

3. A method of reducing the leakage current of a selenium rectifier, comprising the steps of immersing said rectifier in a bath containing an insulating liquid, heating said bath to a temperature above the normal operating temperature of said rectifier, and passing an electric forming current through said rectifier in its blocking direction during the maintenance of said higher temperature.

4. A process of manufacturing a selenium rectifier, comprising the steps of immersing said rectifier in a bath containing an insulating liquid, heating said bath to a temperature above the normal operating temperature of said rectifier, and passing an electric forming current through said rectifier in its blocking direction of a magnitude which increases the temperature of said rectifier during the maintenance of said higher temperature of said bath.

5. A process of manufacturing a selenium rectifier having a counter-electrode with a given melting point comprising the steps of immersing said rectifier in a bath containing an insulating liquid, heating said bath to a temperature above the melting point of said counter-electrode for a predetermined period of time, passing an electric forming current through said rectifier during the maintenance of said higher temperature, and thereafter heating the bath having the rectifier immersed therein to a temperature below the melting point of said counter-electrode while passing an electric forming current through said rectifier.

6. A process of manufacturing a selenium rectifier having a counter-electrode with a given melting point, comprising the steps of passing a heating current through said rectifier to heat said rectifier to a temperature above the said melting point of said counter-electrode for a predetermined period of time, ageing said rectifier, reheating said rectifier at a lower temperature by immersing said rectifier in a bath containing an insulating liquid maintained at said lower temperature, and passing an electric forming current through said rectifier in its blocking direction during the maintenance of said lower temperature.

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