Jan. 27, 1953 J. N. SHIVE 2,626,448

APPARATUS FOR AND METHOD OF TREATING SELENIUM RECTIFIERS

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FIG. 1.

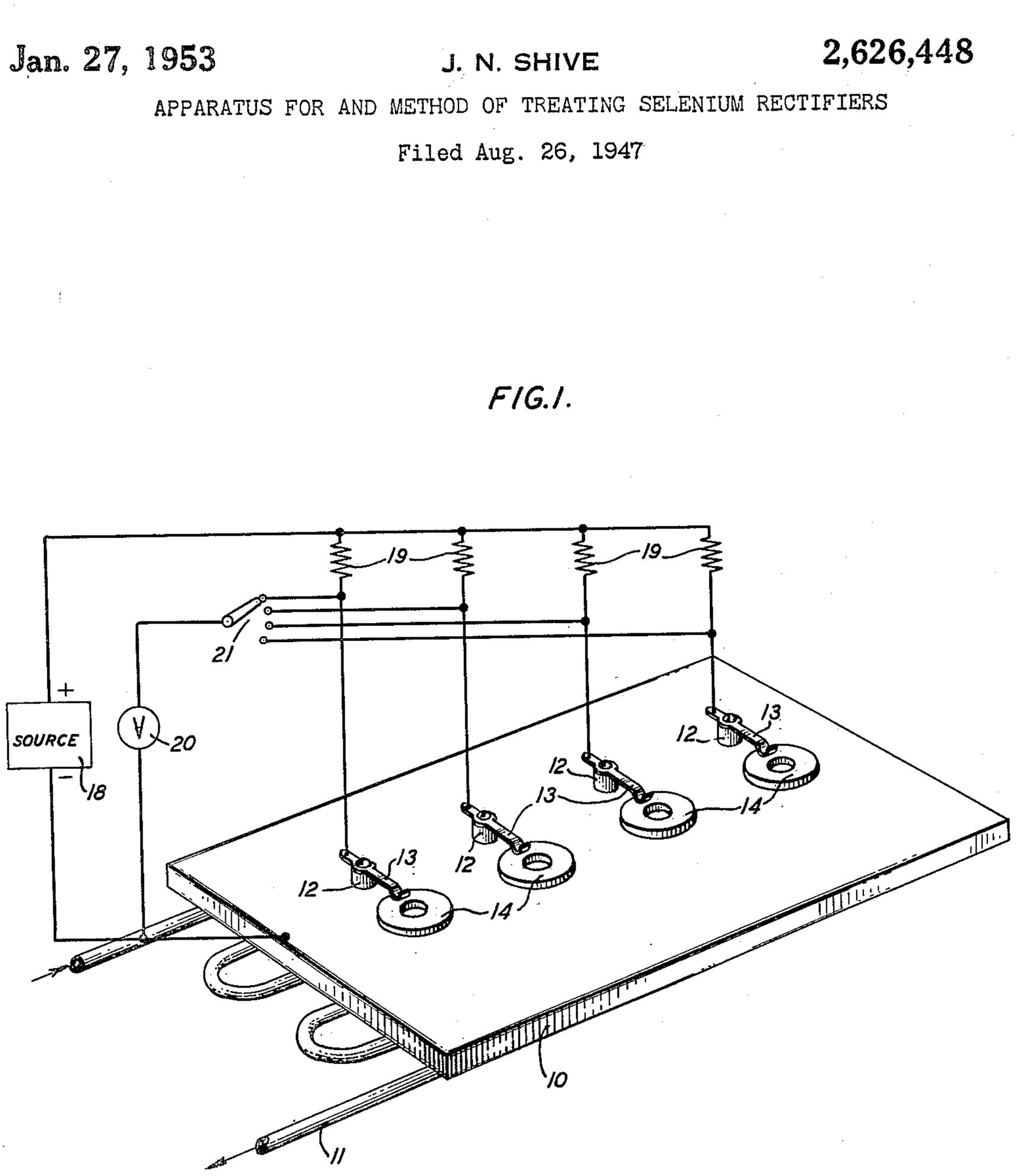
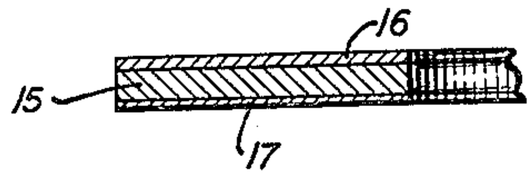


FIG. 2.



INVENTOR
J. N. SHIVE
BY
E. J. Guenther
ATTORNEY

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APPARATUS FOR AND METHOD OF TREATING SELENIUM RECTIFIERS

John N. Shive, North Plainfield, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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9 Claims. (Cl. 29—25.3)

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This invention relates to apparatus for and method of treating selenium rectifiers.

In the manufacture of selenium rectifiers, for example, rectifiers of the construction disclosed in Patent 2,339,613, granted January 18, 1944 to Joseph A. Becker and John N. Shive, after the unit comprising the selenium body and the electrode or electrodes thereon has been fabricated, it usually is subjected to an electrical process known as forming. This process, the purpose of which is to increase the rectification ratio of the unit and, more specifically, to increase its resistance in the reverse or blocking direction, is effected by passing a current through the unit in the reverse direction until a prescribed resistance or voltage drop in this direction obtains. The time required for forming may vary from unit to unit because of differences in the individual selenium bodies, the electrodes, and other factors. Also, particularly in the processing of units possessing low melting point electrodes, such as of the spray metal contact type, there is danger of destruction of the electrode as a result of the heat generated in the unit. Thus, the electrical forming of selenium rectifier units has entailed heretofore close individual controls so that it has been time consuming and relatively expensive.

One general object of this invention is to expedite the electrical forming of selenium rectifier units.

More specifically, objects of this invention are to enable the simultaneous forming of a plurality of units, to reduce the controls requisite for the proper forming of the units, and to minimize the danger of damaging low melting point electrodes in the processing of units including such electrodes.

In accordance with one feature of this invention, the electrical forming of a selenium unit is regulated by automatic control of the forming current in accordance with the resistance of the unit.

More specifically, in accordance with one feature of this invention, the unit is energized in such manner that the current through it decreases automatically in accordance with increase in the reverse resistance so that the power dissipated in the unit remains substantially constant throughout the forming process.

In one illustrative embodiment of this invention, a plurality of selenium rectifier units are connected in parallel to a common voltage source for supplying the forming current, through individual ballast resistances of prescribed magnitude.

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Initially, each unit has a relatively low reverse or barrier resistance so that the current through it and the associated ballast resistor is high and the voltage drop across the unit is low. As the forming proceeds, the barrier resistance increases, the voltage drop across it increases and the current through the unit decreases. Each of the several units forms at its own rate uninfluenced by the forming rate of any other unit. No individual control is required. Any unit may be removed and replaced by an unformed unit whenever the voltage drop across it reaches a preassigned value.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 shows, partly in diagrammatic form, apparatus illustrative of one embodiment of this invention, and

Fig. 2 is a fragmentary sectional view of one of the units.

Referring now to the drawing, the apparatus therein illustrated comprises a mounting or base plate 10 of a material having good electrical and thermal conductivity, for example, chromium-plated brass, to which a hollow coil 11 for receiving a circulating cooling fluid such as water is secured. Affixed to the plate 10 and insulated electrically therefrom, as by insulating studs 12, are a plurality of metallic spring clips 13, each of which securely holds a respective rectifier unit 14 upon the plate. The units may be annular in form and of the construction disclosed in the patent hereinabove identified, each comprising a body 15 of selenium, a back electrode 16, for example of nickel or iron, and a front electrode 17, for example a thin layer of spray-deposited tin-bismuth-cadmium alloy.

The several units 14 are connected in parallel to a suitable source 18 for supplying a direct current to the units, one terminal of the source being connected to the plate 10 and, thus, to the front electrode of each unit, and the other terminal being connected to the back electrode of each unit via the respective clip 13 and a ballast resistor 19. A suitable voltmeter 20 is arranged for connection across each of the units, as by way of a multiposition switch 21, to measure the voltage drop across each unit.

The electrical parameters of any particular system will be determined, of course, by the characteristics of the units being processed. A principal criterion is that the supply voltage and

ballast resistors be correlated with the resistance of the units so that the power dissipated in each unit remains substantially constant. The power dissipation, of course, should be correlated in turn with the rate of cooling via the base plate **10**. Also the resistors should be of such magnitude that the maximum current through the units is limited to a safe value. A specific case will illustrate the correlation of parameters involved. For units of the construction above described, the front electrode material melts at about 105° C. The cooling provided by the coil **11** is made such that the temperature of the front electrode is kept below this value, for example at about 80° C. For units of this construction having an outer diameter of 1⅜ inches, a face area of one square inch, an initial resistance in the reverse direction of 100 ohms and a desired final reverse resistance of the order of 10,000 ohms at 18 volts, a 50-volt source **18** and 60-ohm ballast resistors **19** have been found satisfactory. The power dissipated in each unit is substantially 10 watts.

The operation of the system will be understood from the following, the values given being for the specific case set forth above. When an unformed unit is inserted between the plate **10** and one of the clips **13**, its reverse or barrier resistance is low and the current through it and the resistor **19** in series therewith is relatively high. Initially the voltage drop across the unit is of the order of 12 to 15 volts. As the unit forms, its barrier or reverse resistance increases, the current through the unit decreases and the voltage drop across it increases. This drop is, of course, a measure of the rectification ratio of the unit and when it reaches a prescribed value, for example 30 volts, as indicated by the voltmeter **20**, the unit is electrically formed. The time required for increase in the voltage drop from of the order of 12 to 15 volts to about 30 volts is of the order of 3 to 4 hours. When the drop thereacross has reached the preassigned value, the unit may be removed and replaced by an unformed one.

It will be appreciated that the forming system is automatic in operation. Each unit forms at its own rate uninfluenced by the forming rates of the other units. The operation is continuous each unit being replaceable, when formed, by an unformed one. Inspection of the system by an operator is minimized, all that is required being measurement from time to time of the voltage drop across each unit. Further, by virtue of the self-adjustment of the current through any unit as its barrier resistance increases, the power dissipated in the unit remains substantially constant whereby protection against damage of the front electrode by thermal effects is provided. Maintenance of a safe temperature at the front electrodes is further assured by cooling of the plate **10** through the agency of the cooling coil **11**.

It will be understood that although the invention has been shown and described in connection with the simultaneous electrical forming of four units, it may be used in the treatment of a different number of units. For example, in the manufacture of selenium rectifiers, simultaneous forming of 60 units on a single panel with a single power supply has been accomplished advantageously and conveniently.

It will be understood further that the specific embodiment of the invention shown and described is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. Apparatus for electrically forming a plurality of selenium rectifier units simultaneously, comprising a voltage source, means for connecting the units in parallel to said source in such polarity relation as to pass current through each unit in the reverse direction, and individual impedance means for said units connected in circuit with said source, each impedance means being of such magnitude as to maintain the power dissipated in the respective unit substantially constant throughout the forming process.

2. Apparatus for electrically forming a plurality of selenium rectifier units simultaneously, comprising a voltage source, terminal means for connecting the units to said source in parallel and in such polarity relation as to pass current through each unit in the reverse direction, and a plurality of ballast resistors, one for each unit, connected to be in series with a respective unit and said source, each resistor being of such magnitude as to maintain the power dissipated in the respective unit substantially constant throughout the forming process.

3. Apparatus for electrically forming a plurality of selenium rectifier units simultaneously, comprising terminal means for contacting one electrode of all of the units, a plurality of terminals, one for each unit, for contacting the other terminal of the respective unit, a voltage source having one pole connected to said terminal means and its other pole connected to said terminals, the polarity of connections being such that current is passed through each unit in the blocking direction thereof, and individual resistor means connected between each of said terminals and said other pole, each resistor means being of such magnitude as to maintain the power dissipated in the respective unit substantially constant throughout the forming process.

4. Apparatus for simultaneously electrically forming a plurality of selenium rectifier units each of which includes a selenium body and a front electrode having a relatively low melting point, the apparatus comprising a conductive plate for engaging the front electrode of all of the units, means for cooling said plate to maintain the temperature of the front electrodes below the melting point thereof, a plurality of terminals for establishing connection individually to the other electrodes of the units, a voltage source connected to said plate and said terminals for passing current through each unit in the blocking direction thereof, and individual ballast resistors for the units, each resistor being of such magnitude as to maintain the power dissipated in the respective unit substantially constant throughout the forming process.

5. Apparatus for simultaneously electrically forming a plurality of selenium rectifier discs each of which has an end surface of substantially one square inch and a reverse resistance, in the unformed state, of the order of 100 ohms, the apparatus comprising a direct current source and means for connecting the discs to said source in parallel and in such polarity relation as to pass current through each disc in the blocking direction thereof, the voltage of said source being substantially 50 volts, and means including individual ballast resistors for the units arranged for series connection therewith and each having a resistance of substantially 60 ohms.

6. Apparatus for simultaneously electrically forming a plurality of selenium rectifier discs each of which has an end surface of substan-

tially one square inch and a reverse resistance, in the unformed state, of the order of 100 ohms, and a front electrode having a melting point of the order of 105° C., the apparatus comprising a metallic plate for engaging the front electrodes of all the discs, terminal members for making individual electrical connection to the other electrode of each disc, a source having a voltage of substantially 50 volts, the negative pole of said source being connected to said plate and the positive pole being connected to said terminal members, a plurality of approximately 60-ohm ballast resistors each connected between said positive pole and a respective one of said terminal members, and cooling means thermally coupled to said plate for maintaining the temperature thereof at or below 80° C. during the forming process.

7. The method of simultaneously forming a plurality of selenium rectifier units electrically which comprises passing current through said units in parallel from a common source, in the reverse direction of each unit and through individual ballast resistors in series with each unit and of magnitude such as to maintain the power dissipated in each unit substantially constant throughout the forming process, and cooling the units concurrently with the passage of current therethrough.

8. The method of simultaneously electrically forming a plurality of selenium rectifier discs each of which has an end surface of the order of one square inch, a reverse resistance in the unformed state of the order of 100 ohms and a deposited front electrode of a tin-bismuth-

cadmium alloy having a melting point of substantially 105° C., the method comprising passing current through said units in parallel and in the reverse direction of each unit to produce a substantially constant power dissipation of 10 watts in each unit, and cooling said units concurrently with the passage of current therethrough to maintain the temperature of the front electrode of each unit at or below 80° C.

9. The method of forming a selenium rectifier having a front electrode which comprises maintaining the rectifier below that temperature which is detrimental to the front electrode, applying continuously to the rectifier a voltage in the reverse direction through a ballast resistance, the ballast resistance being of such magnitude as to maintain the power dissipated in the rectifier substantially constant throughout the forming process, and interrupting said voltage when it has increased to a predetermined value.

JOHN N. SHIVE.

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