E. R. WOLCOTT & F. RIEBER.

METHOD AND APPARATUS FOR RECTIFYING ALTERNATING CURRENT.

APPLICATION FILED AUG. 3, 1914.

1,188,597.

Patented June 27, 1916.

Fig. 1.

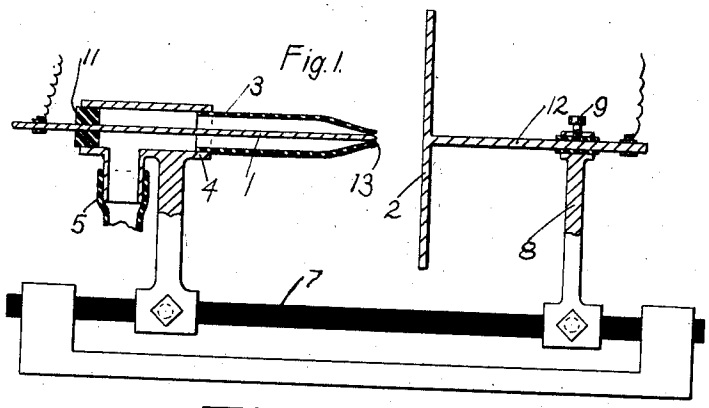


Fig. 2.

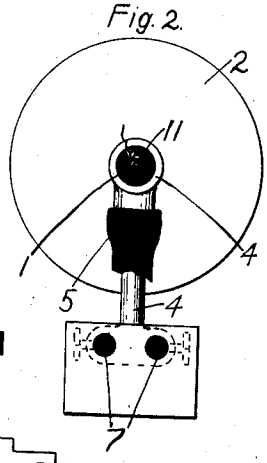


Fig. 3.

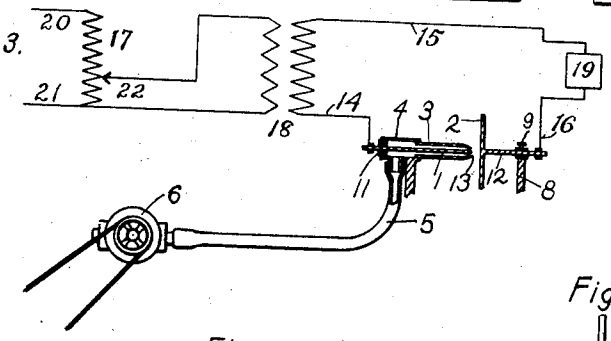


Fig. 4.

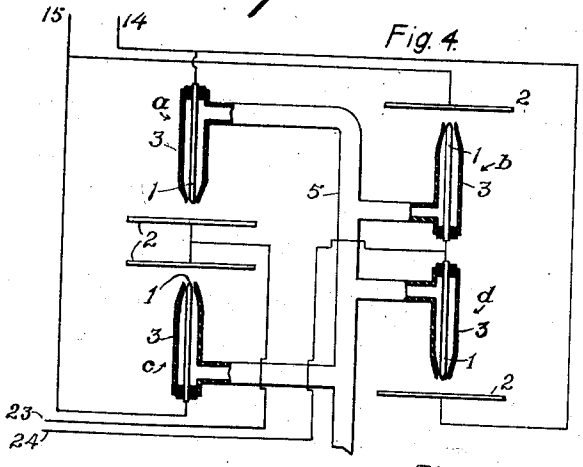
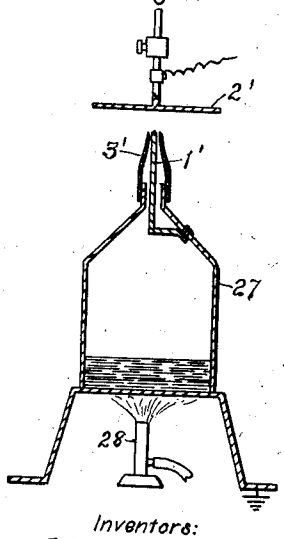
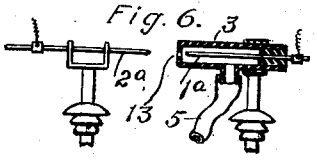


Fig. 5.



Witnesses:
S. W. Knight
A. W. Knight.

Fig. 6.



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UNITED STATES PATENT OFFICE.

EDSON RAY WOLCOTT AND FRANK RIEBER, OF LOS ANGELES, CALIFORNIA, ASSIGNORS TO INTERNATIONAL PRECIPITATION COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA.

METHOD AND APPARATUS FOR RECTIFYING ALTERNATING CURRENT.

1,188,597. Specification of Letters Patent. Patented June 27, 1916.

Application filed August 3, 1914. Serial No. 854,693.

To all whom it may concern:

Be it known that we, EDSON RAY WOLCOTT and FRANK RIEBER, citizens of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Method and Apparatus for Rectifying Alternating Current, of which the following is a specification.

The main object of our invention is to provide for rectification of high tension alternating currents by stationary means operating under conditions readily maintained in practice.

In rectifying high tension alternating current, mechanical rectifiers have generally been used. Such rectifiers are expensive to install and to operate, and on account of their moving parts, require continual oversight and care. Moreover, they do not always select the parts of the alternating waves required for maximum efficiency, particularly when the supply and load circuits are subject to sudden fluctuations. Other forms of rectifier have been proposed, based on the selective action of suitable electrodes in a vacuum tube, tending to check discharge in one direction, and to permit discharge in the opposite direction. Such vacuum tube rectifiers are unsuitable for many purposes on account of the difficulty of maintaining them in operative condition, particularly as to the state of exhaustion of the tubes, under the severe requirements of practical use.

An important feature of our invention is that it provides for positive selective action on a discharge produced by an alternating potential difference between electrodes which may be exposed to air or other gas at substantially atmospheric pressure, thereby obviating the expense and difficulty incurred in the use of vacuum tubes.

Another important feature of our invention is that it enables variation of the selective action so as to provide for complete or for partial rectification, as may be desired.

In our invention advantage is taken of certain fundamental differences between the carriers of positive and negative charges in the electric discharge through gases, and the selective action is produced by a blast or current of air or other gas, which is so located and directed as to aid the passage of current in one direction and check passage of current in the opposite direction.

The accompanying drawings illustrate apparatus embodying our invention, and referring thereto: Figure 1 is a side elevation, partly in section, of one form of the rectifying device, adapted for utilizing a blast of air or other gas as a means for controlling the direction of the transmitted current. Fig. 2 is an end elevation of the rectifying device shown in Fig. 1. Fig. 3 is a diagram of the circuit connections, showing also the connection to means for supplying the air blast. Fig. 4 is a diagram of a set of rectifying devices, connected to rectify both halves of an alternating current wave. Fig. 5 is a vertical section of a form of rectifying device in which steam or vapor is generated to serve as a rectifying blast. Fig. 6 is a partly sectional side elevation of another modification.

Referring to Figs. 1 and 2, the rectifying device comprises two electrodes 1 and 2, adapted for connection in a circuit to receive the current to be rectified, and means for applying a current of air or other gas in such manner as to assist the discharge in one direction between said electrodes, and check the discharge in the other direction. The electrode 1 is shown as a rod or conductor having its discharge end pointed or of small area, so as to facilitate discharge therefrom, and the opposite electrode 2 is shown as a plate or conductor of extended surface, adapted to minimize discharge therefrom. The means for supplying the current of air or gas, consists, in the form shown in these figures, of a tube 3, which may be of suitable insulating material, such as glass, said tube communicating with a source of compressed air and surrounding the electrode 1 and being provided with a contracted outlet 13 at its forward end near the discharge end of the said electrode, so as to discharge a jet or blast of air or gas in the general direction of the discharge from said electrode. Said tube 3 may be mounted on a fitting 4, connected by pipe or hose 5 to a pump 6, see Fig. 3, the fitting 4 being mounted by standard 41 on a suitable insulating support 7, which may

also support a standard 8 on which is mounted the plate electrode 2. Said electrode 2 may be carried by a stem 12 adjustably mounted by set screw 9 on standard 8, to provide for variation of the distance of the electrode 2 from the electrode 1, and said electrodes may both be adjustably mounted on the insulating support 7, to permit of further adjustment. The electrode 1 is shown as mounted slidably in a bushing 11 in the fitting 4, so that it may be moved longitudinally in said tube to cause its discharging end to assume any desired position with respect to the end of the tube, so that the electrode may project beyond the tube, or may be flush with the end of the tube, or it may be withdrawn into the tube.

The rectifying device above described may be connected in an electric circuit as shown in Fig. 3, wherein 14 and 15 are the leads of a high tension alternating current circuit, lead 14 being connected to electrode 1 and lead 15 being connected to the load or means 19 for utilizing the rectified current, from which a wire 16 leads to the electrode 2. The circuit referred to may be energized by a step-up high tension transformer 18, whose secondary is connected to leads 14 and 15 and whose primary is connected to receive low tension current from an auto-transformer 17, connected to supply circuit 20, 21, and having means 22 for varying the voltage of the current delivered by the auto transformer to the primary of the high tension transformer, so as to correspondingly vary the alternating voltage impressed on the circuit including the electrodes 1 and 2 and the load.

The operation is as follows: When alternating current is supplied to the circuit including leads 14 and 15, load 19, wire 16 and electrodes 1 and 2, at a sufficiently high voltage, discharge takes places across the gap between said electrodes, and in absence of any air blast this discharge produces an arc across said gap, representing an alternating current through the gas between the electrodes. When air under pressure is supplied to the tube 3, the air issues in a continuous blast or current directly around and adjacent to the electrode 1, and when such blast of air is sufficiently strong, the discharge between the electrodes becomes changed in character, and is found to be substantially unidirectional, the current passing in the circuit, including the rectifier and the load, being then a direct current. We have found that satisfactory results are obtained by directing the air blast in the general direction of the discharge from the electrode 1, so that it tends to aid such discharge and to check the discharge from the opposite electrode 2. With an air pressure of about ten pounds per square inch supplied to the nozzle or outlet tube 3, we have found that an alternating current of a tension of about fifty thousand volts, under suitable conditions of load, may be substantially wholly rectified, that is to say, only current in one direction is transmitted. We have also found that, under a given condition of voltage, load etc., and with a given arrangement and construction of electrodes and of the air blast device, the amount of rectification depends on the pressure of the air supplied to the air blast, and that the rectifying effect, under certain conditions, increases with the pressure up to a more or less definite critical pressure, at which the rectification is a maximum. By suitably varying the conditions, for example by using less pressure in the air blast, partial rectification may be effected, so that any desired percentage of the current may be rectified, producing a current having direct and alternating components, such a current being suitable for use in cases where the effects of both direct and alternating currents are desired.

We have found that the best rectifying effect is obtained when the air or gas is blown outwardly around one of the electrodes, in the general direction of the discharge from such electrode, but more or less rectification can also be obtained when the current of air is drawn inwardly past the electrode. With the blast nozzle surrounding the electrode, as above described, the current of gas from the nozzle surrounds the discharge, so that the discharge is wholly included in the blast or current of gas, and with such an arrangement of the blast relatively to the discharge, it is possible to secure the desired rectification or control of the current with low blast pressure. We are aware that it has been proposed to rectify or control alternating current by a blast passing through a conducting nozzle, which constitutes an electrode, but in such case the current or blast of gas does not surround and include the zone of discharge, so that the discharge is or may be, largely outside of the current or blast, or outside of the main body of the blast, and in such case it is necessary to use a relatively high pressure in the blast to secure any considerable rectifying or controlling effect.

The differentiation of the electrodes, by making them of different size and shape, tends to favor discharge of current in one direction, and the air blast is preferably passed in a direction to reinforce the selective action of the electrodes. If desired, however, the electrodes may be substantially alike, the selection being, in that case wholly due to the action of the current of air. Such a construction is shown in Fig. 6, wherein the electrodes 1^a and 2^a are both pointed.

With the above described apparatus the

rectification is such that one half of each wave is selected for transmission and during the other half of the wave there is substantially no discharging or transmitting action.

For rectifying both halves of the alternating current waves, a set of rectifying devices may be arranged as shown in Fig. 4, one rectifier *a*, having its electrode 1 connected to lead 14 and its electrode 2 connected to a wire 23 leading to the load; a second device *b*, having its electrode 1 connected to wire 24 leading from the load, and its other electrode 2 connected to the lead 15; a third device *c*, having its electrode 1 connected to lead 15 and its electrode 2 connected to wire 23, and a fourth device *d*, having its electrode 1 connected to wire 24 and its electrode 2 connected to lead 14; these devices being constructed as described. The air supply pipe 5 is connected to deliver a blast of air at each of the electrodes 1. In the operation of this apparatus one half wave passes through the devices *a* and *b*, and the other half wave passes through the devices *c* and *d*, these pairs of devices being reversely connected, so that the two half waves are rectified as they pass through the load.

While we have found that air is a satisfactory medium for selectively controlling the discharge, any other gas may be used. For example, steam may be used for this purpose, and in that case the rectifier may be constructed as shown in Fig. 5, the steam being led to the pipe 3′ surrounding the rod or pointed electrode 1′, from any suitable steam generator, for example from a boiler 27 directly connected to the tube 3′, and provided with heating means 28. The other electrode 2′ may be formed as a plate supported in any suitable manner opposite the electrode 1.

What we claim is:

1. The method of rectifying an alternating current which consists in maintaining a current of gas and causing the current to produce a discharge within the current of gas and in the direction of said current.

2. The method of rectifying an alternating current which consists in applying the current to opposing electrodes exposed to a gas to produce electric discharge between such electrodes, and applying a current of gas between such electrodes in a direction to aid the discharge in a given direction and check the discharge in the opposite direction, said current of gas surrounding and including the electric discharge.

3. The method of rectifying an alternating current which consists in applying the current at opposing electrodes, exposed to a gaseous medium, in such manner as to produce electric discharge at one of said electrodes, and applying a blast of gas surrounding such electrode in a direction to aid the discharge from such electrode and check discharge in the opposite direction.

4. The method of rectifying an alternating current, which consists in applying the current to opposing electrodes exposed to a gaseous medium, so as to produce discharge predominantly from one of said electrodes, and applying a current of gas inclosing such electrode in a direction to aid the discharge therefrom and to check discharge in the opposite direction.

5. An alternating current rectifier comprising opposing electrodes, and means for applying a current of gas inclosing one of said electrodes in a direction to aid the discharge therefrom and to check discharge in the opposite direction.

6. An alternating current rectifier comprising opposing electrodes constructed to facilitate discharge in a given direction, and means for applying a current of gas throughout the space occupied by the discharge, said current of gas being in a direction to aid such discharge, and to check the discharge in the opposite direction.

7. A rectifier comprising opposing electrodes, and means for supplying a blast of gas around one of said electrodes.

8. A rectifier comprising opposing electrodes, means for producing an electric discharge therebetween, and means for applying a continuous current of gas between such electrodes, and throughout said discharge to selectively influence the discharge.

9. A rectifier comprising a pair of electrodes, a tube surrounding one of said electrodes and having an outlet adjacent to the discharging portion of such electrodes, and provided with means for communication with gas supply means.

10. A current controlling means comprising a pair of electrodes, and means for passing a blast of air around one of said electrodes and toward the other electrode.

11. A current controlling device comprising a pair of electrodes an insulating nozzle surrounding one of said electrodes and means for passing a blast of gas through said nozzle and past and around said electrode and the other electrode.

12. A current controlling means comprising an electrode, a second electrode formed as a rod directed toward the first named electrode, and a nozzle surrounding the second electrode, and having an outlet for directing a current of gas around the second electrode and toward the first electrode and means for supplying gas under pressure to said nozzle.

13. A current modifying device comprising a nozzle, means for causing a current of gas to pass therethrough, an electrode opposite said nozzle and a second electrode extending within said nozzle.

14. The method of rectifying an alternating current which consists in causing such current to produce a discharge between electrodes and directing a current of gas, issuing from a source under less than fifty pounds pressure, in the direction of said discharge and extending over the space occupied by the discharge.

In testimony whereof we have hereunto set our hands, at Los Angeles, California, this 29th day of July 1914.

EDSON RAY WOLCOTT.
FRANK RIEBER.

Witnesses:
ARTHUR P. KNIGHT,
WM. N. DREW.