J. L. R. HAYDEN.

HIGH VOLTAGE CURRENT RECTIFICATION.

APPLICATION FILED JUNE 10, 1907.

1,032,900. Patented July 16, 1912.

Fig. 1.

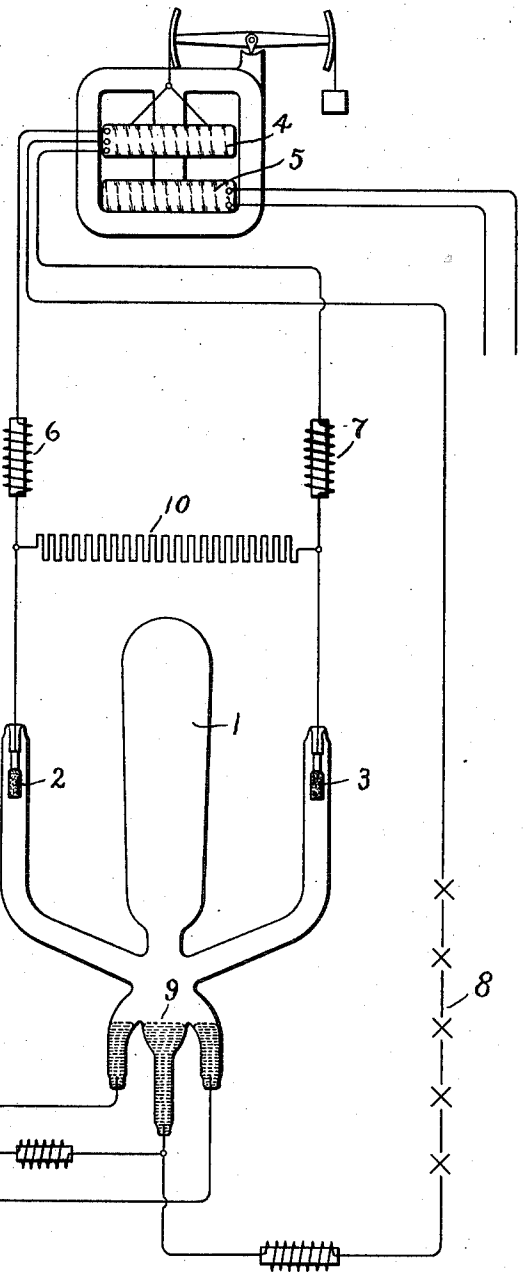
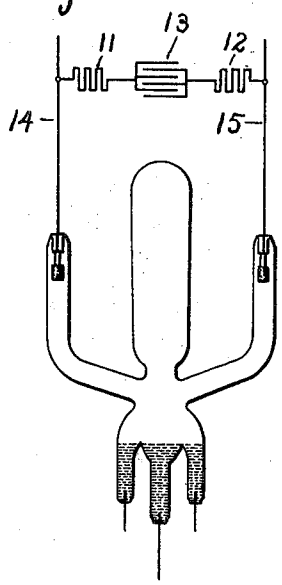


Fig. 2.



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HIGH-VOLTAGE-CURRENT RECTIFICATION.

1,032,900. Specification of Letters Patent. Patented July 16, 1912.

Application filed June 10, 1907. Serial No. 378,157.

To all whom it may concern:

Be it known that I, JOSEPH LE ROY HAYDEN, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in High-Voltage-Current Rectification, of which the following is a specification.

Vapor rectifiers of the mercury vapor type are now being successfully used for converting alternating current into direct current at voltages suitable for series circuits containing fifty to seventy-five or more arc lamps. The strains on such vapor rectifiers is considerably greater than that on rectifiers operating at low potentials, say 110 volts, and many of the phenomena arising in connection therewith are of a complex nature.

I find that some vapor tubes after operating a considerable time, from one hundred to several hundred hours, show a deterioration which grows more and more marked as the tubes age. The symptoms of this deterioration are, that static discharges take place and sparks form about the tube and about the conductors of the system. Frequently the tube goes out during operation. Also the tube sometimes starts with difficulty. By heating the tube, mainly the anode arms, before starting, the tube can still be operated for some time. Finally, however, it refuses to start at all. The above mentioned sparks or discharges are dangerous to the insulation of the system and sometimes puncture the tube.

Although my present invention is not limited to any particular theory I am at present of the belief that the above mentioned phenomena can be explained in the following way:—Mercury oxids are formed during exhaustion of the tube by the action of the arc on the mercury vapor and air left in the tube or leaking into it during exhaustion. These oxids are dissociated by the cathode spot and are only partially re-formed in the arc stream. A part of the oxygen so liberated reaches the graphite anodes and forms CO. The above mentioned chemical reaction progresses very slowly so that the tube may operate for a considerable time without showing any evidence of increase in the gases within the envelop. According to my present belief this gas is gradually absorbed by the anodes when the tube is not in operation; but as soon as the voltage is put on the rectifier at starting, the gas is driven out of the anodes, both electro-statically and by heat, and forms a non-conducting gas cushion in front of the anodes in such a way that the circuit is suddenly interrupted. This causes the static display above mentioned. After the tube has once been started this foreign gas gradually diffuses out of the arc stream into the condensing chamber, and thereafter does not interfere so seriously with the operation of the tube.

Whatever may be the cause of the peculiar deterioration of the tube and consequent disturbances in the electrical system, I find that the trouble can be overcome and the static discharge can be completely prevented by the means hereinafter described.

Two embodiments of my invention are illustrated in the drawing accompanying this specification and forming a part thereof.

Figure 1 illustrates a complete rectifier system, and Fig. 2 shows a modified form of discharge path.

Fig. 1 illustrates a mercury rectifier 1 of well known type, connected by its anodes 2 and 3 to current supplying winding consisting, in this case, of a movable secondary 4 of a constant current transformer. The primary 5 of the transformer is connected to a source of constant potential alternating current. Suitable reactances 6 and 7 are connected between the rectifier anodes and the transformer secondary 4. A load circuit 8 is connected between the mercury cathode 9 of the rectifier and a central tap on the movable transformer secondary 4. This load may consist of arc lamps or other translating devices, and may be adapted for operation on a potential of several thousand volts. The part of the system above described is necessary for converting the energy of the constant potential alternating current into direct current of constant value for use in the load circuit 8; and the operation of the several elements of such a system will be readily understood by persons skilled in the art.

According to my present invention, the rectifier tube is shunted by a path having high impedance for the line voltage. Such a path may consist of a non-inductive resistance 10 having a value sufficient to prevent appreciable loss of energy by virtue of the constant potential impressed thereon by transformer secondary 4. The exact value of the resistance is dependent somewhat on the voltage of the system, but one-

half megohm per 1000 volts is a very suitable value. The current shunted by such a resistance is only about .002 amperes and that, on a system of this kind, is negligible. If, now, a film of foreign gas forms around one of the anodes and interrupts the high voltage circuit, the system can discharge through the non-inductive resistance 10 without danger to the tube or to the insulation of the system. The static discharges are of extremely high voltage and very high frequency, but of small quantity; they therefore discharge safely over the very high non-inductive resistance even though that resistance be of relatively small current carrying capacity.

The modification shown in Fig. 2 includes a shunt path consisting of resistances 11 and 12 connected in series with a condenser 13 and forming a discharge path between the anode leads 14 and 15. This current carrying shunt or path is selective in its action and offers a ready path to high frequency currents and a somewhat difficult path to energy of normal line frequency. As the static effects in the tube are of high frequency, they will pass through a condenser of low apparent resistance even though the capacity of the condenser is so small as to consume very little current at normal frequency. It is advantageous, however, to limit the flow of current through the condenser 13 in order that the condenser may not produce oscillations and disruptive discharges by coaction with the self induction of the circuit; this can be effected by use of the resistances 11 and 12. These resistances need not be large and can easily be made of such a value as to give a free discharge to the static electricity while preventing the condenser from producing oscillations.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The combination of a vapor electric device having a plurality of anodes, means for supplying electrical energy at high potential to said anodes, and a shunt of high impedance for current of normal frequency connecting said anodes to afford a discharge path for static charges developed during the normal operation of said device.

2. The combination of a vapor electric device having a cathode, a plurality of anodes, a source of energy connected across said anodes, and a discharge shunt of low inductance and high resistance connected across said anodes.

3. The combination of a vapor rectifier having anodes, a high voltage load circuit receiving current from said device, a source of energy connected to said anodes, and a shunt for static discharge directly connecting said anodes, said shunt having a high impedance for current of normal frequency.

4. The combination of a constant current transformer, a vapor rectifier having anodes connected therewith, a series load circuit connected between said rectifier and said transformer, and a non-inductive shunt connected between the anodes of said rectifier to equalize static charges on said anodes said shunt having high impedance for current of normal frequency and potential.

5. The combination with a vapor electric device having a plurality of anodes and a cathode, of a static discharge shunt connecting said anodes and including a capacity reactance.

6. The combination of a vapor electric device, having a plurality of electrodes of the same polarity, means for supplying current to said device, and a non-inductive discharge shunt connected between said electrodes, for dissipating static charges accompanying the operation of the device.

7. The combination of a vapor electric device having a plurality of anodes and a cathode. of a discharge shunt connected between the said anodes and including a condenser and a resistance.

8. The combination with a vapor electric device having a cathode and a plurality of anodes, means for supplying current to said anodes, and a shunt of low inductance for the discharge of static accumulations connected between said anodes, said shunt offering high impedance to current of normal frequency and voltage.

9. The combination of a transformer winding, a load circuit, a vapor device having anodes connected to said winding and a cathode connected to said load circuit, a connection from said load circuit to said winding, and means for relieving excessive potential stress connected between said anodes.

10. The combination of a vapor device having a plurality of electrodes of the same polarity, a current supplying winding connected to both electrodes and a current carrying shunt between said electrodes adapted to discharge static charges thereon.

11. The combination of a vapor device having a plurality of anodes and a cathode, means for supplying current to said anodes, and a current carrying shunt for relieving static strains developed during the normal operation of the device.

In witness whereof, I have hereunto set my hand this 8th day of June, 1907.

JOSEPH L. R. HAYDEN.

Witnesses:

BENJAMIN B. HULL,

MARGARET E. WOOLLEY.