A. W. HULL.

METHOD OF AND MEANS FOR OBTAINING CONSTANT DIRECT CURRENT POTENTIALS.

APPLICATION FILED DEC. 22, 1915.

1,251,377. Patented Dec. 25, 1917.

Fig. 1.

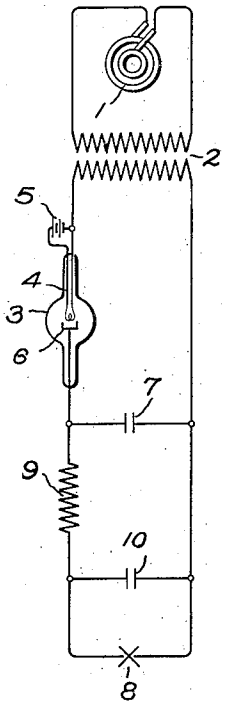


Fig. 2.

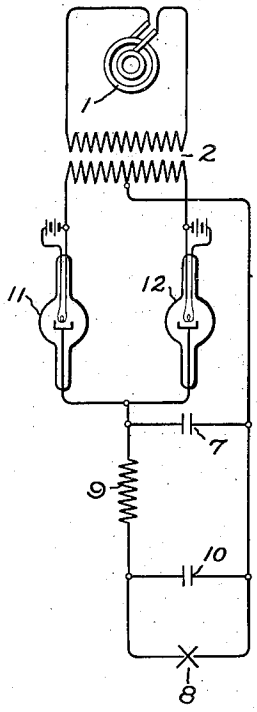
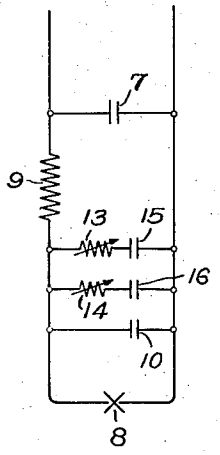


Fig. 3.



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UNITED STATES PATENT OFFICE.

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METHOD OF AND MEANS FOR OBTAINING CONSTANT DIRECT-CURRENT POTENTIALS.

1,251,377. Specification of Letters Patent. Patented Dec. 25, 1917.

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To all whom it may concern:

Be it known that I, ALBERT W. HULL, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Methods of and Means for Obtaining Constant Direct-Current Potentials, of which the following is a specification.

My present invention relates to means for obtaining unidirectional currents or potentials of constant value from variable sources, more particularly from a source of alternating current.

Various means have heretofore been employed for rectifying alternating currents and inductances and condensers have been utilized for reducing the variations in the rectified current. While the current which has been obtained in this way has been of sufficiently constant value for some purposes there are many cases in which the current variations are still great enough to be objectionable.

The object of my invention is to provide means for reducing these variations either in current or potential to such a degree that they will not be noticeable in any organization in which the current may be utilized. A more particular object of my invention is to provide a means for obtaining a high direct current potential of practically constant value.

The features of my invention which I consider novel are pointed out with particularity in the appended claims, the invention itself, however, with further objects and advantages will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 shows one embodiment of my invention and Figs. 2 and 3 show modifications thereof.

As indicated in Fig. 1 the alternating current which is to be rectified is derived from the alternator 1, which supplies the primary of the transformer 2, which is utilized to transform the current from the source 1 to such a degree that a direct current or potential of the desired value may be obtained by rectifying the current in the secondary of the transformer. The secondary circuit includes a rectifier 3 which is preferably of the incandescent cathode or kenotron type comprising a tungsten cathode 4 with battery 5 for heating to incandenscence, and the tungsten anode 6. By this means energy is conveyed unidirectionally to an energy storing device, which preferably consists of a condenser 7, which serves to store up that energy during the small fraction of a cycle during which it is receiving current and to supply the load 8 with energy during the remainder of the cycle. The energy thus stored up is fed to the load 8 through a high impedance 9 which is preferably an inductance but which in some cases may be an ohmic resistance or a device having ohmic resistance characteristics. This impedance together with the condenser 10 serves to smooth out the fluctuations in the voltage supplied by condenser 7. The action of the system herein shown may be described as follows:

The rectified voltage at the terminals of the condenser 7 is an irregular wave which may be analyzed into a constant potential plus a Fourier series of alternating potentials, of which the first component has a frequency equal to that of the source 1. The inductance 9 should have such a value that it will offer a very high impedance to these components as compared with the impedance of the condenser 10. Hence the amplitude which each component will have at the terminals of the condenser 10 and at the load terminals will be very small compared with the amplitude at the terminals of condenser 7, and this variation may be made as small as desired by increasing the values of inductance 9 and condenser 10. This will be true even when no power is being used. If the load 8 happens to be one of fairly low impedance it will assist the condenser 10 in reducing the value of the alternating current components. If on the other hand the load has a high impedance, such for example, as an incandescent cathode X-ray tube which has the characteristic that its current is practically independent of voltage it will have no steadying effect since its impedance is infinite for all frequencies. In this case the inductance 9 would be useless without the condenser 10. While the inductance 9 offers a high impedance to the alternating components of the current it offers a low impedance to the direct current component and hence comparatively large constant direct currents may be obtained.

From the above description it will be clear

that the efficiency of this arrangement depends upon making the impedance of 9 to the alternating components high in comparison with the impedance of condenser 10 and load 8 in parallel.

In Fig. 2 I have shown an arrangement which operates in the same manner as that shown in Fig. 1 with the exception that two rectifiers 11 and 12 are used in a well known manner in order to rectify both half waves of alternating current and thus feed energy into the condenser 7 during each half cycle instead of during every other half cycle.

In Fig. 3 I have shown another modification in which the impedance in parallel with the load is still further reduced by providing tuned circuits consisting of variable inductances 13 and 14 and condensers 15 and 16 in parallel with the load. One of these circuits is tuned to the frequency of the source which supplies the fluctuating current to condenser 7. The second circuit is tuned to the first harmonic of that frequency and, if desired, additional circuits may be provided tuned to higher harmonics. By this means the shunt impedance to the alternating components may be made very small in comparison with the impedance 9 and hence the fluctuations in the potentials supplied to the load may be made very small.

It will of course be understood that the variation in the rectified current will depend upon the capacity of the condensers 7 and 10, the value of inductance 9 and the frequency of the alternating current source and that by varying the proportions of these different factors substantially any degree of constancy in the rectified current may be secured. I have found in actual practice that with the arrangement shown in Fig. 2 with a 2000 cycle source of energy and with the condensers 7 and 10 having a capacity of about 1/1000 of a microfarad each, and the inductance 9 having a value of about 200 henries, it is possible to obtain five kilowatts of energy in the load circuit at any potential between 10,000 and 100,000 volts with a voltage fluctuation of less than 1%. The arrangement shown in Fig. 3 is especially suitable for use with lower frequencies than 2000 cycles as it is difficult to reduce the shunt impedance of the circuit sufficiently low for these lower frequencies by capacity alone without unduly increasing the size of the condenser 10.

While I have described the application of my invention to the obtaining of direct current of constant value from a source of alternating current it will be apparent that it will also be of utility in obtaining constant potential direct currents from other variable sources. For example, the condenser 7 which, in the embodiments which I have illustrated, constitutes a variable source of current, might be replaced by any other variable source with similar results. It will also be apparent that many modifications in the precise arrangement of the various devices used and in the specific form of the same may be made without departing from the scope of my invention as set forth in the appended claims.

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

1. The method of obtaining a constant potential direct current from an alternating current which consists in rectifying the alternating current, storing up the energy in a capacity and delivering it continuously from the capacity to a utilization circuit having an impedance in shunt to a load through a series impedance which is high in comparison with the shunt impedance of the circuit.

2. The method of obtaining a constant potential direct current from an alternating current which consists in rectifying the alternating current, storing up the energy in a capacity and delivering it continuously to a utilization circuit having an impedance in shunt to a load through a series inductance which offers a high impedance to the alternating components of the current in comparison with the shunt impedance of the circuit.

3. The method of obtaining a constant potential direct current from an alternating current which consists in rectifying the alternating current, storing up the energy in a capacity, delivering it continuously to the utilization circuit through a high series impedance, and providing an impedance in shunt to the load which is low in comparison to the series impedance.

4. The method of obtaining a constant potential direct current from a variable voltage source which consists in continuously delivering current from said source to a utilization circuit having an impedance in shunt to a load through a series impedance which is high in comparison with the shunt impedance of the circuit.

5. The method of obtaining a constant potential direct current from a variable voltage source which consists in continuously delivering current from said source to a utilization circuit having an impedance in shunt to a load through a series inductance which offers a high impedance to the variable components of the current in comparison with the shunt impedance of the circuit.

6. The method of obtaining a constant potential direct current from a variable voltage source which consists in continuously delivering current from said source to a load circuit through a high series impedance and providing an impedance in shunt to the load which is low in comparison to the series impedance.

7. Means for obtaining a constant poten-

tial direct current comprising a source of alternating current, means for rectifying the alternating current from said source, an energy storing device for storing up the energy of the rectified current, and means for continuously supplying the stored up energy from said device to a load at a substantially constant rate comprising an inductance in series with said load and a condenser in shunt thereto, the impedance of said inductance being high in comparison to that of the condenser.

8. Means for supplying a load with a constant potential direct current comprising a source of alternating current, means for rectifying the current from said source, a condenser for storing up the energy of the rectified current, a device permanently connected in series with the load which offers a high impedance to the alternating component of the current flowing therethrough but a low impedance to the direct current component of said current and a device permanently connected in shunt to the load which offers a high impedance to the direct current component and a low impedance to the alternating current component.

9. Means for producing a constant high potential direct current comprising a source of alternating current of high potential, an incandescent cathode rectifier for rectifying the alternating current from said source, a condenser for storing up the energy of the rectified current, means for supplying the stored up energy to a load at a substantially constant rate comprising an inductance permanently connected in series with said load and a condenser permanently connected in shunt thereto, the impedance of said inductance being high in comparison to that of the condenser.

10. Means for supplying a load with a constant potential direct current from a variable voltage source comprising a device connected permanently in series with the load which offers a high impedance to the alternating component of the current flowing therethrough but a low impedance to the direct current component of said current, and a device connected permanently in shunt to the load which offers a high impedance to the direct current component and a low impedance to the alternating current component.

11. Means for supplying a load with a constant potential direct current from a variable voltage source comprising the combination of an inductance permanently connected in series with the load and a condenser permanently connected in shunt thereto, the impedance of said inductance being high in comparison with that of the condenser.

In witness whereof, I have hereunto set my hand this 21st day of December, 1915.

ALBERT W. HULL.