C. P. STEINMETZ.

VAPOR RECTIFIER SYSTEM.

APPLICATION FILED JUNE 21, 1907.

993,899.

Patented May 30, 1911.

2 SHEETS—SHEET 1.

Fig. 1

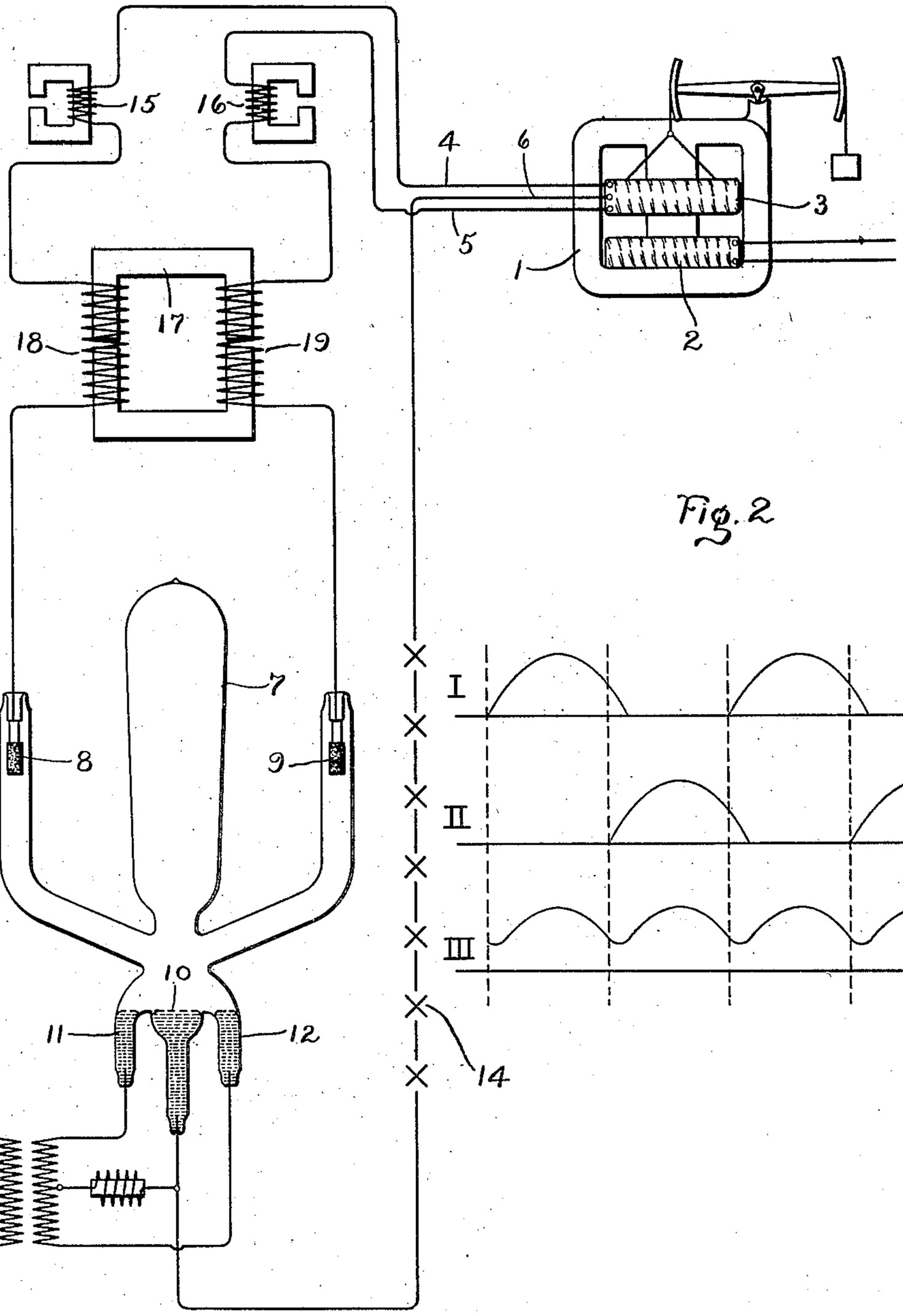

Fig. 2

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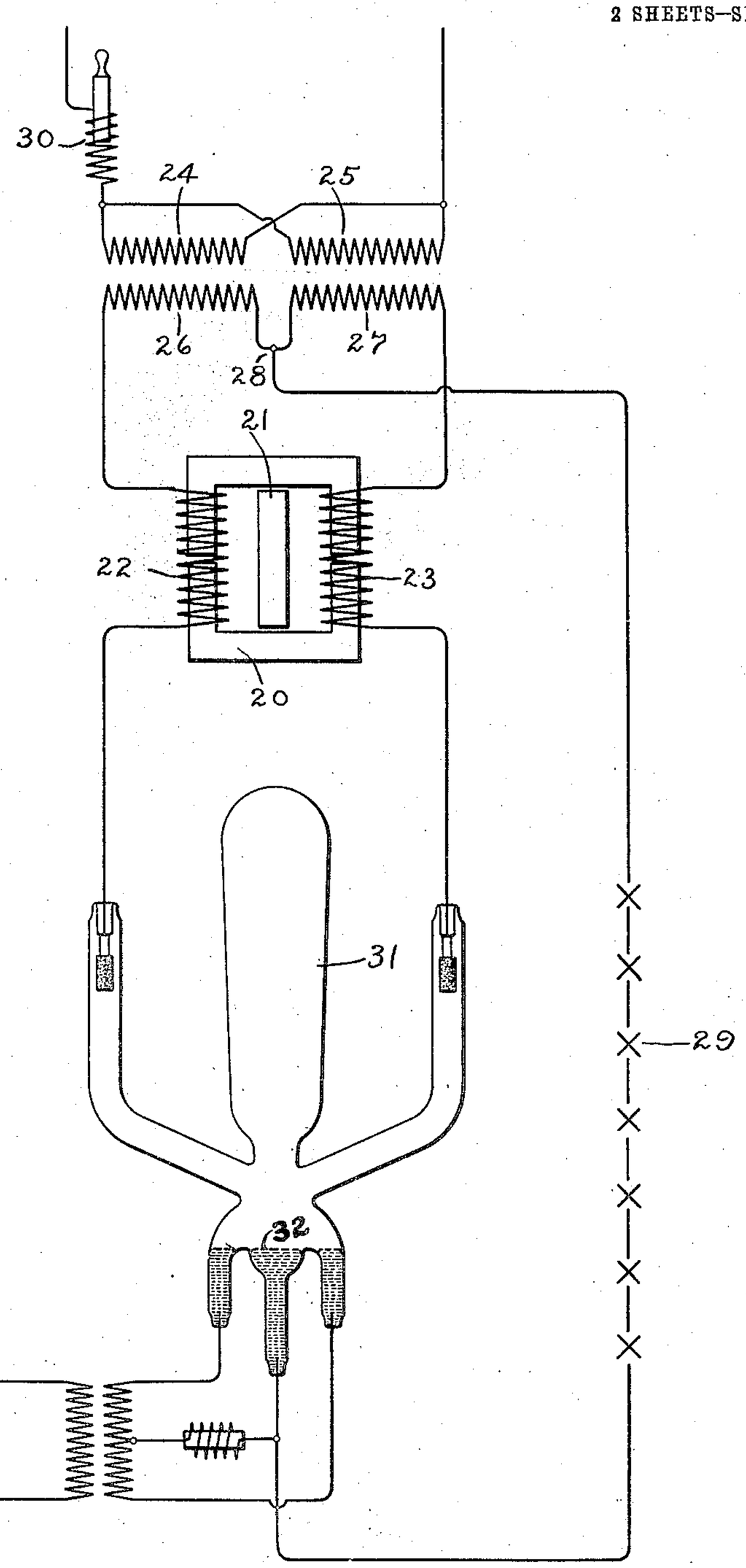
Fig. 3



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UNITED STATES PATENT OFFICE.

CHARLES P. STEINMETZ, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

VAPOR RECTIFIER SYSTEM.

993,899. Specification of Letters Patent. Patented May 30, 1911.

Application filed June 21, 1907. Serial No. 380,003.

To all whom it may concern:

Be it known that I, CHARLES P. STEINMETZ, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Vapor Rectifier Systems, of which the following is a specification.

My present invention relates to systems utilizing vapor electric devices, and more particularly to systems wherein alternating-current is rectified by a vapor device and then delivered as unidirectional current to a load circuit.

According to my present invention, the system is provided with reactive means connected in circuit with the anodes of the rectifier whereby the rectifier is maintained continuously operative on a source of alternating-current and whereby the rectified current is rendered less pulsating, and also whereby the system is rendered efficient and reliable and possessed of other desired characteristics, as hereinafter pointed out.

In the accompanying drawing, Figure 1 illustrates a constant current rectifier system embodying my invention; Fig. 2 shows diagrams representing the wave forms of magneto-motive-force in various parts of the system; and Fig. 3 illustrates a modified arrangement of the system.

The system shown in Fig. 1 comprises constant current transformer 1 having a fixed primary winding 2 supplied with energy at constant potential, and also having a floating secondary winding 3 from which energy is supplied to other parts of the system through the terminals 4 and 5 and the central tap 6. The vapor rectifier 7, included in the system, is of ordinary type having anodes 8 and 9 and a mercury cathode 10. The rectifier may be excited by means of auxiliary anodes 11 and 12 receiving energy from an exciting transformer 13 in a manner now well understood in the art. A series consumption circuit 14 is connected between the mercury cathode 10 and the central tap 6 of the transformer secondary 3, and may include lamps or other devices adapted to operate on substantially constant current. Interposed between the mercury rectifier 7 and the transformer leads 4 and 5 are the reactance devices 15, 16 and 17. Reactances 15 and 16 are connected in series with their respective leads 4 and 5, but reactance 17 has a double winding and exerts an influence on both the anode circuits. One leg of reactance 17 is wound with a coil 18 traversed by the pulsating current delivered to anode 8, while the opposite leg is wound with a coil 19 traversed by the pulsations delivered to anode 9. The two coils 18 and 19 are so disposed on the core that they magnetize in the same direction, that is, in a direction to increase the total flux throughout the entire magnetic circuit of the reactance. To prevent saturation of the core, I prefer to make it in two parts separated by air gaps as indicated in the drawing. Owing to the shape of the core, a certain amount of magnetic leakage takes place around each of the windings 18 and 19 and consequently each winding operates on its own pulsating current much as reactances 15 and 16 operate on their respective currents. In addition to this leakage effect, the two coils coöperate to maintain a magnetic flux throughout the entire iron path of reactance 17 and thereby operate to smooth out the current in the load circuit 14. For a better understanding of the action of these reactances, reference may be had to Fig. 2 in which curve I indicates the magneto-motive-force wave of coil 18 when delivering current to anode 8, and curve II, indicates the corresponding wave for coil 19. The portions of the waves overlapping the vertical lines of the figure correspond to the "overlap" produced by the coils. Curve III shows the resultant magneto-motive-force, and therefore magnetic flux in the core of reactance 17. By arranging the two windings of reactance 17 so that the magneto-motive-force waves of the two coils are in the same direction, the effect of very high inductance is produced without high electro-motive-force of self induction, and therefore without impairment of the power factor.

It will be readily understood that the alternating-current reactances 15 and 16 may be dispensed with by properly designing transformer 1 so that the secondary has a high internal inductance; or if so desired, the transformer may furnish part of the inductance and reactances 15 and 16 may be made small and just sufficient to supply the remainder. It is also possible to dispense entirely with reactances 15 and 16 and to rely on reactance 17 for producing the desired overlapping in the current pulsations

delivered to the several anodes of the rectifier, for, as previously pointed out, the separate coils 18 and 19 set up a leakage flux about themselves, of the same character as the flux in coils 15 and 16, and this flux gives each coil, a reactive characteristic, and it follows, that by designing this reactance to increase the leakage flux between the coils it is possible to greatly vary the influence of the reactance on the energy supplied the rectifier. One mode of varying the design of reactance 17 to produce the above mentioned effect, is shown in Fig. 3, in which reactance 20 is provided with a third leg 21 acting as a magnetic shunt for the windings 22 and 23. The system shown in Fig. 3 differs in some other respects from that illustrated in Fig. 1, more particularly in the source from which energy is supplied. In Fig. 3 the source consists of a transformer having primary coils 24 and 25 and secondary coils 26 and 27. The secondaries are connected together to form a neutral point 28 to which current is returned from the series consumption circuit 29. A reactance 30 in series with both primaries of the transformer, furnishes a means for regulating the energy supplied and serves, within reasonable limits, to automatically control the current transmitted by the mercury rectifier 31 to the series consumption circuit 29. From the preceding, it will be understood that by virtue of the automatic regulation afforded by reactance 30, the series consumption circuit 29 is supplied with current of substantially constant amperage, and furthermore, it will be understood that the load current is free from violent pulsations because of the smoothing action of reactance 20 connected to the anode side of the vapor device. This latter regulating action is quite independent of any reactance in the load circuit, and even though the path from the rectifier cathode 32 to the transformer neutral 28 may be inductionless, a relatively smooth current wave is obtained therein.

By connecting the mercury cathode directly to the load circuit through a non-inductive path, the cathode is not subject to the static strains which might occur if that path were of high reactance.

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

1. The combination of a consumption circuit, a vapor rectifier supplying current thereto, a source of energy for said rectifier, a magnetizable core, and means connected between said source and said rectifier to maintain a high magneto-motive-force throughout said core.

2. The combination with a rectifier having a plurality of anodes, of a source of current therefor and reactive means between said source and said anodes wound to magnetize in the same direction for current to either anode.

3. The combination of a consumption circuit, a vapor rectifier connected therewith, a source of current for said rectifier, and reactive means for smoothing the current pulsations in said load circuit, said reactive means being on the anode side of said rectifier and being continuously energized.

4. The combination with a load circuit, of a vapor rectifier connected therewith, anodes for said rectifier, a magnetizable core, and windings on said core connected to deliver energy from said core to either of said anodes to suppress current pulsations in said load circuit.

5. The combination of a load circuit, a vapor rectifier connected therewith, and a current smoothing reactance for the load current connected on the anode side of the rectifier and having separate coils for each anode circuit, said coils being wound to magnetize in the same direction.

6. The combination of a transformer, a vapor rectifier having anodes receiving energy therefrom, a reactive winding in circuit with each anode, and a magnetizable core energized cumulatively by a plurality of said windings.

7. The combination of a source of current, a vapor rectifier having anodes connected therewith, a reactive coil in circuit with each anode, and a magnetizable core common to said coils and thereby magnetized cumulatively while permitting magnetic leakage about each of said coils.

8. The combination with a rectifier having a plurality of anodes, a source of current therefor, and reactive means connected between said source and said anodes, and acted upon cumulatively by all the anode currents.

9. The combination of a source of current, a vapor rectifier having anodes receiving energy therefrom, a magnetizable core, a winding on a part of said core and in circuit with one of said anodes, and a second winding connected with another anode and mounted on a different part of said magnetizable core, said coils magnetizing said core in the same direction.

In witness whereof, I have hereunto set my hand this 19th day of June, 1907.

CHARLES P. STEINMETZ.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.