C. M. GREEN.

VAPOR RECTIFIER SYSTEM.

APPLICATION FILED AUG. 11, 1905.

952,109. **Patented Mar. 15, 1910.**

2 SHEETS—SHEET 1.

Fig. 2.

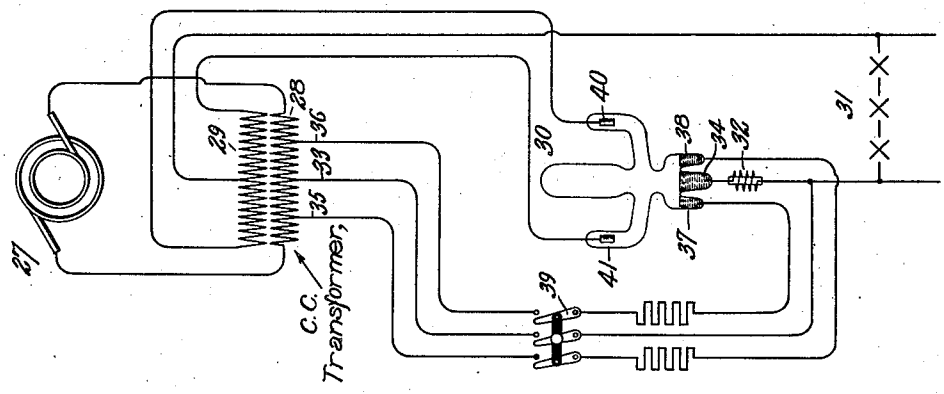
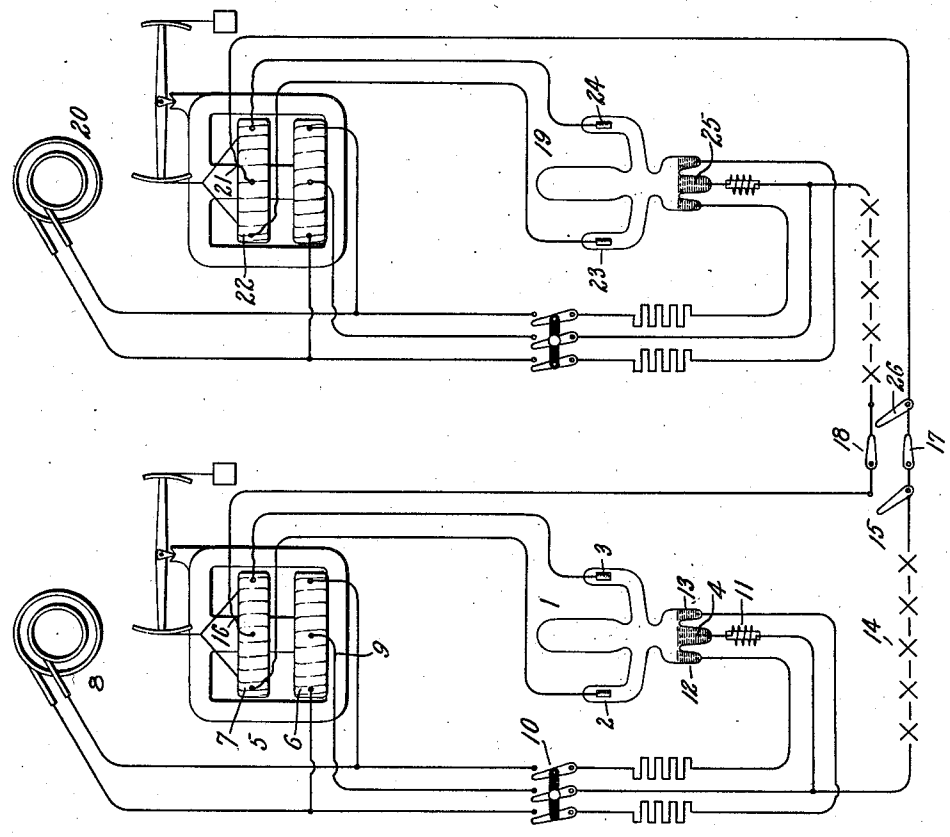


Fig. 1.



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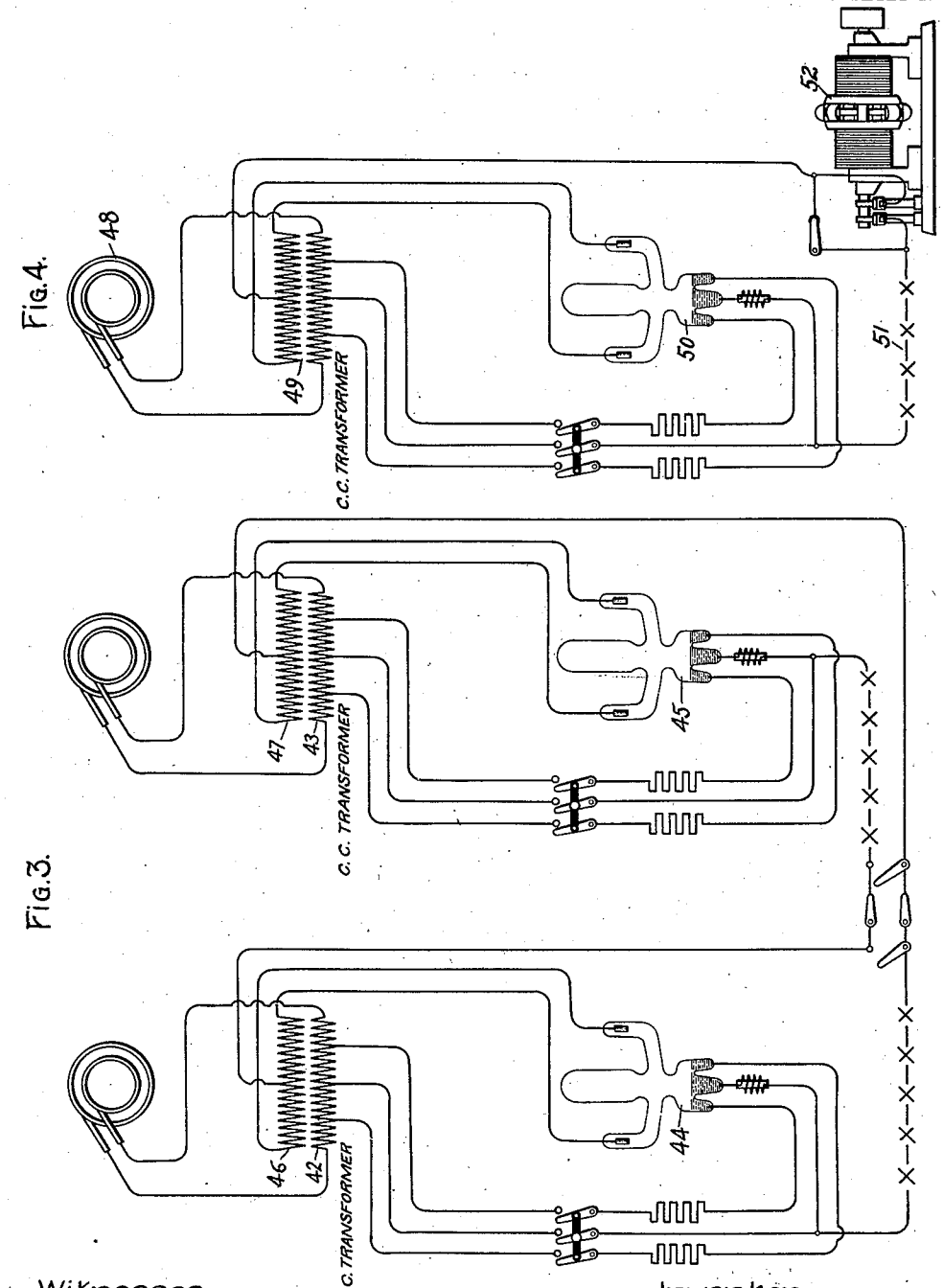

Fig. 4.

Fig. 3.

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UNITED STATES PATENT OFFICE.

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VAPOR-RECTIFIER SYSTEM.

952,109. Specification of Letters Patent. Patented Mar. 15, 1910.

Application filed August 11, 1905. Serial No. 273,805.

To all whom it may concern:

Be it known that I, CHARLES M. GREEN, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Vapor-Rectifier Systems, of which the following is a specification.

In the commercial distribution of electrical energy it is often found desirable to shift the distributing circuits from one source of power to another without interrupting the service and it is sometimes found necessary to introduce additional units into the operating system to meet the varying conditions of load on the consumption circuits. Such a flexibility in the system is especially desirable when the load consists of a plurality of translating devices operating in series, for the total resistance of a series circuit varies through a wide range as translating devices are introduced or cut out of the circuit.

My present invention discloses means for operating a distribution circuit on energy derived from a mercury rectifier and also discloses means for introducing a second source of power into the consumption circuit to carry part or all of the load as occasion may require.

My present invention also contemplates an improved system of excitation for mercury rectifiers which is applicable not only to rectifiers used in the system hereinafter described, but also to rectifiers and mercury apparatus of various other types, as will be readily understood by a person skilled in the art.

Referring to the drawing forming part of this specification, Figure 1 shows a plurality of mercury vapor rectifiers operated from separate and independent sources and provided with means whereby they may be thrown in series, to meet the varying conditions of load which commonly arise in series systems of distribution; Fig. 2 shows a compensator connection for the auxiliary or exciting anodes whereby a moderate and constant voltage is supplied to these anodes independent of the fluctuations in voltage on the main anodes of the rectifier. Fig. 3 illustrates the series system using the rectifier unit illustrated in Fig. 2; Fig. 4 is a similar system with one of the rectifier units replaced by a Brush series arc machine.

The mercury rectifier 1 consists of an evacuated chamber of glass or other suitable material, provided with a plurality of carbon anodes 2 and 3 and a mercury cathode 4. Energy is supplied to the tube from a constant current transformer 5 comprising a stationary primary coil 6 and a floating secondary coil 7. The terminals of the latter are connected respectively to the anodes 2 and 3. The primary 6 is excited by current from an alternator 8 driven in any suitable manner and is provided with a central tap 9 connected through a switch 10 and a reactance 11 to the mercury cathode 4. Adjacent to this mercury cathode are two mercury anodes 12 and 13 which operate to produce an initial flow of current through the evacuated chamber, and if desired to maintain the tube continuously conductive for current waves of the proper polarity. These auxiliary anodes 12 and 13 are connected through the switch 10 to the alternator 8.

To start the apparatus the rectifier 2 may be tilted so that mercury from one of the auxiliary anodes forms a momentary contact with the mercury cathode 4, thus short-circuiting half of the primary winding 6 and starting a flow of current through the mercury. When this circuit is interrupted by the separation of the mercury electrodes an incipient arc is formed which ionizes the tube or otherwise renders it conductive for current so that a second arc will be established between the other starting electrodes and the mercury cathode thereby making the ionization of the tube continuous. To secure this kindling of one arc by another it is necessary that the coil 6 should have considerable inherent reactance so that the current impulses flowing from the auxiliary anodes 12 and 13 may overlap somewhat in phase, thereby giving a small time interval during which there exists a current flow between one auxiliary anode and the cathode and an effective electro-motive-force between the other anode and the cathode capable of establishing an arc therebetween before the preceding arc ceases. The reactance 11 serves to smooth out irregularities in the current flowing from cathode 4 and prevents momentary disturbances in the line circuit from interrupting the arcs from the anodes and thus rendering the tube non-conductive. After the rectifier has been started in the manner above described the pressure impressed on the anodes 2 and 3 by the float-

ing secondary 7 causes current to flow unidirectionally through the rectifier tube to the cathode 4, and thence through reactance 11 to a suitable consumption circuit 14.

I have illustrated the consumption circuit as embodying a plurality of arc lamps connected in series, but it should be understood that this circuit may include a motor or in fact any apparatus adapted to operate on constant current. A switch 15 is connected to one side of this consumption circuit in such a manner that when closed it affords a path from the consumption circuit to the central tap 16 of the floating secondary coil 7, so that the load 14 may be operated by rectifier 1 entirely independent of the other rectifier shown in the figures. If desired the switches 17 and 18 may be closed to introduce the rectifier 19 in series with rectifier 1. This second rectifier 19 is in all respects similar to the rectifier previously described, but is operated by energy derived from an entirely separate and independent source, such as a second alternator 20, which if desired may be of more or less different frequency and different voltage from the alternator 8.

When the rectifiers are operating in series as shown in the figure the current which passes through rectifier 1 traverses the load 14 to a neutral tap 21 of the floating secondary coil 22, and from the terminals of this coil it passes to anodes 23 and 24 and then to cathode 25 and back to the central tap 16 of coil 7, thus completing the circuit to rectifier 1.

By suitably arranging the switches 15, 17, 18 and 26 the two rectifier sets may be operated independently or in series so that in case of an overload on one the other may be added to properly distribute the load. I find that in making such changes in the loading of the circuit it is not necessary to have the two sources of power 8 and 20 in synchronism or in phase, and that all ordinary adjustments of load such as are commonly practiced with Brush series arc machines may be performed with the apparatus just described.

Fig. 2 shows a special connection by which a constant potential may be impressed on the auxiliary anodes to maintain the rectifier constantly conductive irrespective of current fluctuations in the constant current coil of the tube transformer. An alternator 27 is connected to the stationary primary 28 of a constant current transformer having a secondary 29 connected to the rectifier 30 in the usual way through a load 31 and reactance 32. The primary 28 is provided with a central tap 33 connected through the reactance 32 to the mercury cathode 34, and is also provided with two taps 35 and 36 located on either side of the central tap and serving to step-down the voltage to a value lower than that of the entire primary winding 28:—The ratio of transformation is substantially the ratio of the total number of turns to the number of turns included between taps 35 and 36. This step-down connection is commonly known as a compensator connection. The taps 35 and 36 are respectively connected to the auxiliary anodes 37 and 38. The taps 35 and 36 are so disposed on the coil 28 that a moderate voltage is impressed on the auxiliary anodes 37 and 38 thus obviating the danger of a destructive short circuit at the lower end of the tube. I have shown a three-pole switch 39 in the exciter leads and I contemplate opening this switch after the rectifier has been started as I find that when the constant current transformer coil 29 is properly designed it has sufficient reactive effect on the current supplied to the anodes 40 and 41 to bridge over the point of zero current so that the rectifier will maintain itself in a continuously conductive condition without the use of the auxiliary anodes 37 and 38. It is sometimes desirable, however, when the rectifier is running on light load, or when it is subjected to serious fluctuations in the load resistance to leave the switch 39 closed so that the auxiliary anodes are in continuous operation.

Fig. 3 shows the same general system as Fig. 1 except that the rectifier units are of the specific type illustrated in detail in Fig. 2. The stationary primaries 42 and 43 of the constant current transformers are provided with taps for supplying current to the auxiliary anodes of the rectifiers 44 and 45. The movable secondaries 46 and 47 are connected with their corresponding anodes and operate as explained in connection with Fig. 2.

If desired a Brush series arc machine of proper current capacity may be substituted for the rectifier 19 of Fig. 1, or for the rectifier 45 of Fig. 3 and may be used as a booster to relieve the overload on the other rectifier. Such a system is illustrated in Fig. 4. The alternator 48 supplies energy to the constant current transformer 49 and that transformer supplies substantially constant current through rectifier 50 to the consumption circuit 51. The Brush generator 52 is illustrated diagrammatically and is provided with the usual regulating devices and means for cutting it in circuit to operate as a booster.

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

1. The combination of independent sources of energy, a consumption circuit, a vapor rectifier having its cathode connected with said circuit for supplying current from one of said sources, means for maintaining said current substantially constant, and means for simultaneously supplying additional en-

ergy to said consumption circuit from another of said independent sources.

2. The combination of independent sources of energy, a consumption circuit, a vapor rectifier for supplying current to said circuit from one of said sources, a movable coil transformer for maintaining said current substantially constant, and means for simultaneously supplying energy to said consumption circuit from another of said sources by way of a point on said transformer.

3. The combination of a consumption circuit requiring substantially constant current, a plurality of separate and independent sources of energy, a vapor electric apparatus for each source having anodes connected therewith each rectifier having a single cathode connected to said consumption circuit.

4. The combination of a consumption circuit, a plurality of separate and independent alternating current sources, mercury rectifiers having anodes supplied with energy from said sources, and means for connecting said rectifiers in series to supply current to said consumption circuit.

5. The combination of a plurality of separate and independent alternating current sources, vapor rectifiers supplied with energy from said sources, a consumption circuit, means for connecting said rectifiers in series on said consumption circuit, and means for maintaining substantially constant current in said consumption circuit.

6. The combination of a plurality of separate and independent alternating current sources, movable coil transformers connected thereto, vapor rectifiers having anodes receiving current from said transformers, a consumption circuit, means for connecting said rectifiers in series on said consumption circuit, and means for maintaining substantially constant current in said consumption circuit.

7. The combination of a plurality of separate and independent current sources operating at different frequencies, a vapor rectifier receiving energy from one of said sources, a consumption circuit supplied by current from said rectifier, and means for simultaneously supplying energy from another of said sources to said consumption circuit.

8. The combination of a plurality of alternating current sources operating at different frequencies, a consumption circuit, and vapor rectifiers for simultaneously supplying energy to said consumption circuit from said sources.

9. The combination of a plurality of alternating current sources operating at different frequencies, a consumption circuit, and vapor rectifiers connected in series for supplying energy from said sources to said consumption circuit.

10. The combination of a plurality of alternating current sources operable at different frequencies, a consumption circuit having a plurality of sections, vapor rectifiers connected between said sections for supplying energy from said sources to said consumption circuit, and means for maintaining substantially constant the current carried by said consumption circuit.

11. The combination of a vapor rectifier having a cathode and a plurality of anodes, a source of alternating current, a constant current transformer receiving energy from said source and delivering current to said rectifier, connections between one winding of said transformer and one pair of said rectifier anodes, and connections between taps on another winding of said transformer and another pair of said rectifier anodes.

12. The combination of independent sources of energy, a consumption circuit, a vapor rectifier for supplying current thereto from one of said sources, means for maintaining said current substantially constant, and means for boosting the voltage of said consumption circuit with energy derived from another of said sources operating at different voltage and different frequency.

13. The combination of a vapor rectifier having a cathode and a plurality of anodes, a transformer, a source of alternating current supplying energy through said transformer to said rectifier, a compensator connection on one winding of said transformer for supplying energy to at least one of said anodes, a consumption circuit receiving energy from said rectifier, and boosting means connected in said consumption circuit.

14. The combination of a vapor rectifier having a cathode and a plurality of anodes, a source of alternating current, a transformer receiving energy from said source and delivering current to at least one of said anodes, taps from a winding of said transformer connected to two of said anodes, a consumption circuit connected to said cathode, and a source of direct current in series with said consumption circuit and supplying energy thereto.

In witness whereof, I have hereunto set my hand this second day of August, 1905.

CHARLES M. GREEN.

Witnesses:
JOHN A. McMANUS, Jr.,
JAMES R. VIETZ.