P. H. THOMAS.

MEANS FOR STARTING VAPOR CONVERTERS IN SERIES.

APPLICATION FILED MAR. 8, 1907.

984,248.

Patented Feb. 14, 1911.

2 SHEETS—SHEET 1.

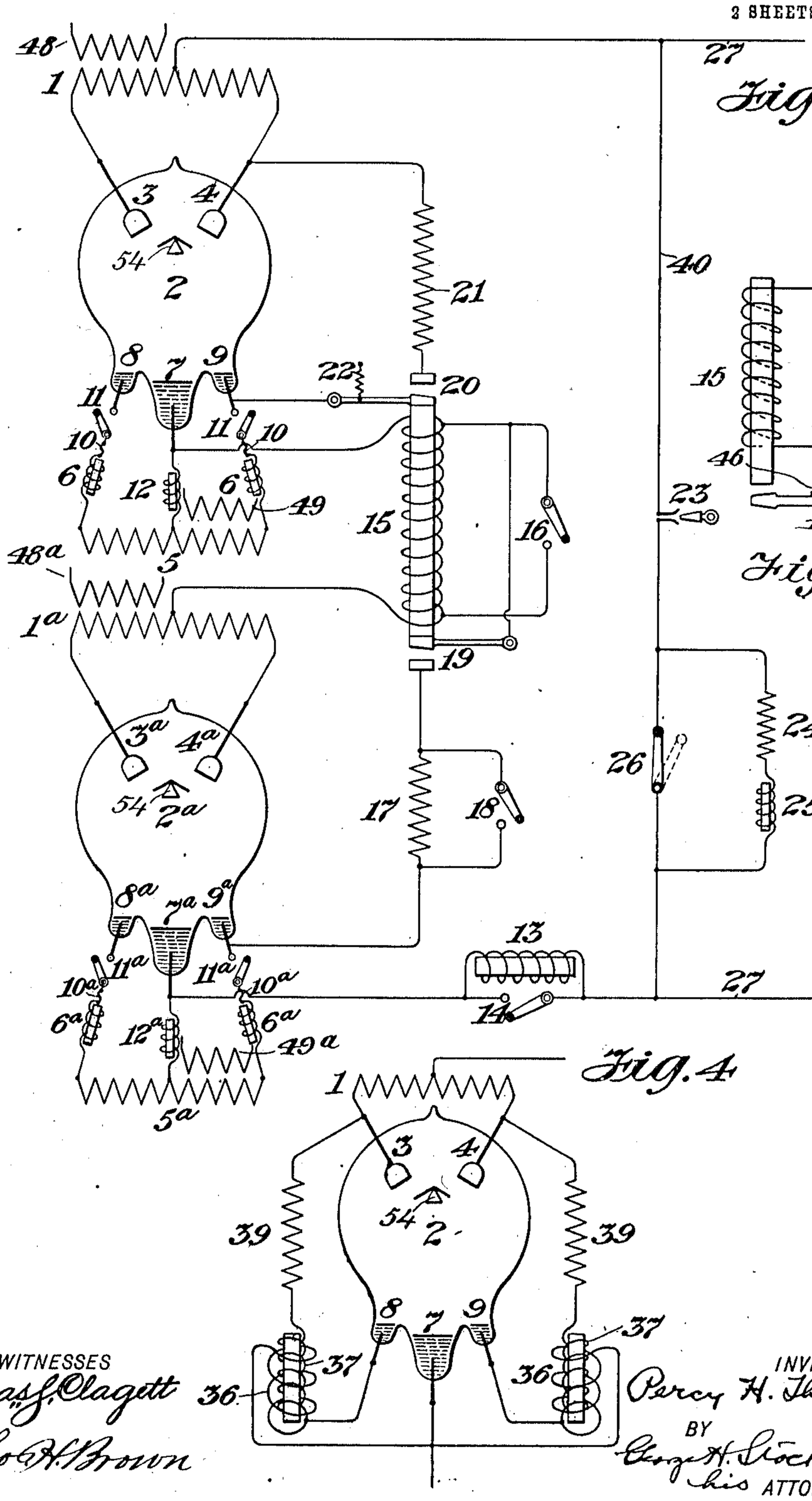

Fig. 1

Fig. 5.

Fig. 4

WITNESSES

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2 SHEETS—SHEET 2.

Fig. 2

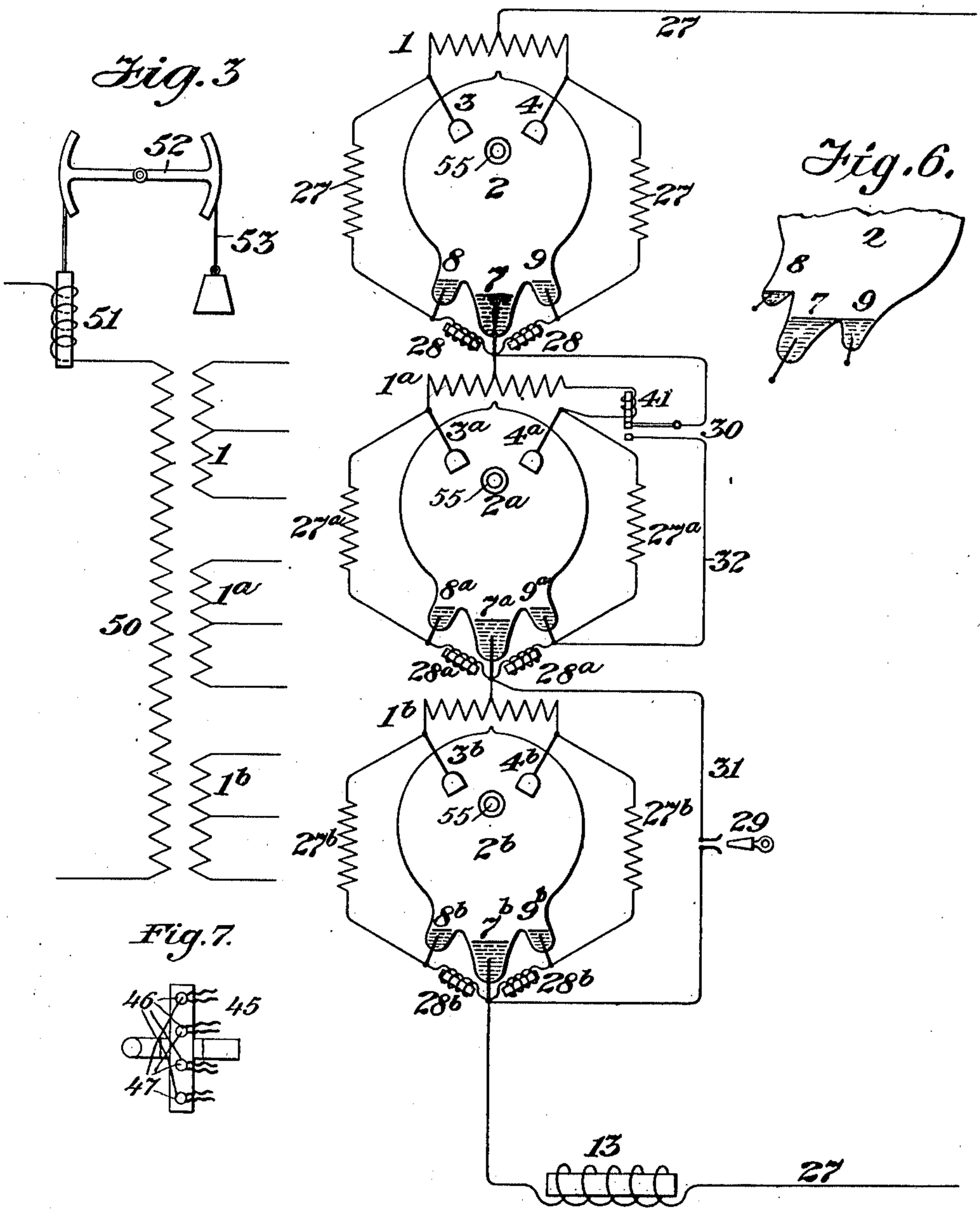

Fig. 3

Fig. 6.

Fig. 7.

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MEANS FOR STARTING VAPOR-CONVERTERS IN SERIES.

984,248. Specification of Letters Patent. Patented Feb. 14, 1911.

Application filed March 8, 1907. Serial No. 361,266.

To all whom it may concern:

Be it known that I, PERCY H. THOMAS, a citizen of the United States, and resident of Montclair, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Means for Starting Vapor-Converters in Series, of which the following is a specification.

The present invention relates to methods of starting into operation mercury rectifier bulbs or similar appartaus when operated in series. The invention is more especially useful where for starting purposes a current from a single source is passed through a plurality of rectifiers in series through a circuit including only metallic conductors and afterward thrown into the vapor in the various rectifiers to break down the negative electrode resistance of the main operating negative electrode. This is often accomplished by utilizing in addition to liquid negative electrodes starting electrodes in coöperative relation thereto, so adjusted as to be in contact with the main negatives in the non-operating condition of the apparatus. Current from the starting source may then be passed through a circuit including a number of these coöperating pairs of electrodes and by agitation of the container or otherwise a separation may be produced in one rectifier between the negative and starting electrode which will in a suitable system of circuits cause an initiation of normal operation from the main positive electrodes in this rectifier. Direct current then passes through the remaining part of the original circuit and is in the proper direction to break down the negative electrode resistance of the main negative electrode of each of the other rectifiers when, at any convenient time and in any convenient manner, a separation is produced between its starting electrode and the cooperating negative electrode. In many cases, further, it is customary to utilize separate keeping alive currents which enter each rectifier by one or more supplementary positive electrodes. Such current may be obtained in any suitable manner as by a separate transformer energized from the same source. It will thus be seen that where both the above described starting method and the keeping alive method are to be utilized three additional electrodes are required; two supplementary electrodes and a starting electrode.

It is the object of the present invention to utilize one of the supplementary electrodes as a starting electrode which can be done if the various related circuits are properly designed and connected.

The present invention may be utilized similarly in connection with other methods of keeping alive which require additional electrodes, the essential condition being that the starting and keeping alive circuits shall have a common electrode and the circuits shall be so disposed as not to disturb each other. I further show modifications of the invention including means of controlling the starting circuits and keeping alive currents.

Referring now more particularly to the drawings; Figure 1 shows two converters adapted to be operated in a series and to be started by the method above described and at the same time kept alive by current from a separate transformer, this current being controlled by switches, fuses, and inductances; in connection with these circuits this figure shows automatic means for discontinuing the starting circuits upon the initiation of current in the work circuit. This figure shows also special means for controlling the starting circuit. Fig. 2 shows three bulbs connected in series with a different means of keeping alive and starting circuits together with various methods of dis-continuing the starting circuits. Fig. 3 shows constant current devices for the circuits of Fig. 2. Fig. 4 shows a single bulb whose negative is kept alive by still a different organization of circuits in connection with means adapting this bulb for starting by the method above described. Figs. 5 and 7 show a modification of Fig. 1 and Fig. 6 shows the starting position of the converter box.

In Fig. 1 the transformer primari s 48 and 48^a supply the secondaries 1 and 1^a. The primary windings in this case may be taken as representing different sources of different phase, although a common primary may be used as shown for the secondaries 1, 1^a, 1^b in Fig. 3 these secondaries supply current to the mercury vapor rectifier bulbs 2 and 2^a; 3 and 4, and 3^a and 4^a, are positive electrodes, respectively, of the bulbs 2 and 2^a, 7 and 7^a, are, respectively, their negative electrodes, and 8 and 9, 8^a and 9^a, are, respectively, supplementary electrodes for the bulbs 2 and 2^a. The transformer second-

aries 5 and 5ª supply energy for keeping the negative electrodes alive by the method now well known in the art, namely, by passing current alternately through the electrodes 8 and 9 or 8ª and 9ª, with the varying alternations, such current being returned through the electrode 7 to an intermediate point of the secondaries 5 and 5ª. The primaries 49 and 49ª respectively supply the transformer secondaries 5 and 5ª, and may themselves be supplied from any suitable alternating source. Current controlling devices such, for example, as impedance coils are shown at 6, 6, 6ª, 6ª, for controlling the separate keeping alive current while inductances 12 and 12ª, maintain the operation over the natural zero point of the supply. Fuses, 10, 10 and 10ª, 10ª, are introduced in the leads to the supplementary electrodes for protection against overloads and switches 11, 11 and 11ª, 11ª for opening these circuits. The two bulbs are connected in series through the coil 15 which is connected by one terminal to the negative electrode of the bulb 2, by the other to the middle point of the transformer secondary 1ª. A short-circuiting switch 16 is provided to suppress the action of the coil 15. A resistance 21 connects through a cut-out 20, controlled by a spring 22, the lead of the positive electrode 4 with the supplementary electrode 9, and carries the usual starting current. The resistance 17 in series with the cut-out 19 connects the electrodes 7 of the rectifier 2 with the supplementary electrode 9ª. The switch 18 is provided for short-circuiting the resistance 17 when the latter is not required. The coil 13 is shown connected by one terminal to the negative electrode 7ª, of the converter 2ª and by the other electrode to the work circuit 27. A switch 14 is provided for suppressing the action of the coil 13. The coils 13 and 15 may either or both perform the function of maintaining the flow of current uniform thus bridging the zero points of the wave and rendering the operation of the load devices more uniform. A short-circuiting conductor 40 including a plug switch 23 and switch 26 bridges the load 27. By opening the switch 26 the resistance 24 and inductance 25 are introduced in this circuit. Either the resistance or the inductance may be given a negligible value. The operation of the circuits of this figure is as follows: In the initial non-operating position bulbs 2 and 2ª, which are movably mounted, rest in such a position that the mercury in the electrodes 7 and 9 and 7ª and 9ª make contact. The cut-outs 20 and 19, are closed, since the coil 15, whose magnetism controls these cut-outs, is deënergized. The right hand half of the transformer secondary 1, upon the application of electrical supply, passes an alternating current through the circuit including the resistance 21, the cut-out 20, the electrode 9, the electrode 7, the coil 15, or the switch 16, the cut-out 19, the resistance 17, or the switch 18 according to whether 18 is open or closed, the electrode 9ª, the electrode 7ª, the coil 13 or the switch 14, according as 14 is open or closed, the switch 26, or the resistance and inductances 24 and 25, according as 26 is open or closed, the plug switch 23, the conductor 40, back to the starting point. If the plug switch 23 is open such circuit may be completed through the load 27. If, now, the bulb 2 be moved in such a way as to cause a separation of the mercury between the electrodes 7 and 9, the negative electrode resistance of the electrode 7 will be broken down and the rectifier started into operation when a break occurs at a favorable time within the cycle. Should the first break not be favorable, by repeating the tilting the starting operation would soon be successfully accomplished. Evidently, then the transformer secondary 1 will pass current through the positive electrodes 3 and 4, and deliver over the rest of the original starting circuit direct current from the negative electrode 7 in the usual manner in such rectifiers, the operation being maintained over the zero points of the supply by the coil 15 or the coil 13 or by both coils, or sometimes by the coil 25. Now, upon moving the rectifier 2ª until a separation occurs between the electrodes 9ª and 7ª, the negative electrode resistance of 7ª will be broken down by the direct current just described which evidently must pass in the right direction for accomplishing this operation, and together with the transformer secondary 1ª establish the normal flow of current. Thereupon, the coil 15 energizes the cut-outs 19 and 20 and opens the auxiliary starting connections so that they cannot disturb the operation. If, now, the switches 11, 11 and 11ª, 11ª be closed and the secondaries 5 and 5ª be energized, the separate keeping alive apparatus will give stability to the operation. If the apparatus be suitably designed the switches 11, 11 and 11ª, 11ª, may be left in during the starting of the rectifiers, if so desired. The transformer secondaries 5 and 5ª may either or both be used for overcoming the negative electrode resistance of the electrode 7 or the electrode 7ª. Should by any chance the normal current which passes through the negative electrodes 7 and 7ª become transferred to 8 or 9 or 8ª or 9ª as a negative, the fuses 10 or 10ª will open the circuit provided they be suitably proportioned. In such a case the full operation current passes through the keeping alive transformer which may then be protected by the fuses, such transfer is more likely to take place during the starting conditions.

The resistance 17 serves the purpose of controlling the starting current which flows after the initiation of operation from the

electrodes 3 and 4. In some cases this resistance may be dispensed with. Similarly, the resistance 24 and the inductance 25 can be made to control the total starting current and may serve to protect the work circuit 27. In certain cases the resistance 17 performs important functions. When a plurality of bulbs are operated in series supplying direct current to a work circuit from an alternating current source, including some device for maintaining current constant, there is a tendency for an excessive starting current under certain conditions, for example, after the starting of the first bulb, which evidently short circuits the original starting resistance and withdraws its current controlling power. A constant current alternating supply is shown in Figs. 2 and 3. With such an arrangement, adapted to the operation of a plurality of bulbs, the devices depended upon for producing constant current are adjusted to give a certain current with all bulbs operating. If now a single bulb be started alone, the constant current devices will produce therein a current greater than the normal current by a factor equal to the total number of bulbs. Thus, during the starting operation if only one starting resistance be used and this in connection with the first bulb to be started there may be a considerable excess current flow through the starting circuits before the establishment of normal operation in the other bulbs. Thus in Fig. 1, resistance 17 is adapted to control starting currents even after the resistance 21 has been cut out by the starting of the bulb 2. The same principle may be applied to three or more bulbs, the temporary starting connection on each bulb including a starting resistance. The resistance 24 may serve the same general purpose as the resistance 17 in certain cases.

It may sometimes be convenient to have the controlling switches 11, 11 and 11^a, 11^a, open during the initial starting conditions and to have the same automatic apparatus which discontinues the starting connections close these switches and thus apply the supporting power of the keeping alive circuits after the starting period is completed since deleterious action in the keeping alive currents is more likely to happen at this time. This arrangement is shown in Figs. 5 and 7 where coil 15 of Fig. 1, at the same time that it operates the cut-out 19, closes the cooperating pairs of contacts 46 and 47, which take the place of the switches 11 and 11^a, being connected, respectively, to the electrodes 8, 9, and 8^a, and 9^a, and the fuses 10, 10, 10^a, 10^a, through the lead wires 45.

In Fig. 2, the transformer secondaries 1, 1^a and 1^b, which may be energized from any suitable primary, normally pass current through the positive electrodes 3 and 4, 3^a and 4^a, 3^b and 4^b, and the coil 13 to the work circuit 27 as described in connection with Fig. 1, while the coils 28, 28, 28^a, 28^a, 28^b, 28^b serve to store energy from the supply and discharge the same through the negative electrodes 7, 7^a, and 7^b, for the purpose of steadying the operation of the rectifiers 2, 2^a, and 2^b. The resistances 27, 27^a, 27^b, 27, 27^a, 27^b, serve to control the energy supplied from the transformer secondaries to the coils just mentioned, while the electrodes 8 and 9, 8^a and 9^a, 8^b and 9^b provide a short path for the discharge of these coils during the periods of low supply voltage. Since these coils must discharge at the time when the supply is low they bridge the periods when there is a tendency for the apparatus to cease operating and steady the system. In the starting of this system, which is carried out according to the method described in connection with Fig. 1, current is passed from the right hand half of the transformer secondary 1 through the resistance 27, the electrodes 9 and 7, the cut-out 30 and the conductor 32, the electrodes 9^a and 7^a, the conductors 31 and the plug switch 29, the electrode 9^b and 7^b, the coil 13 through the load back to the transformer secondary 1. In the starting condition the rectifiers must be in such a position that the mercury between the pairs of electrodes 7, 9, 7^a, 9^a, 7^b, 9^b are in contact. The starting position of the rectifiers is shown in Fig. 6, in which as a result of the tilted position of the container, the electrodes 7 and 9 are joined by the mercury therein. In starting, the containers may be put into the starting position by hand, all but one being held there while the starting of the other is accomplished, and then being allowed to return to the operating position. In this case, the restoring force might well be gravity. As before, the repeated movement of the rectifier 2, causing separation between the electrodes 7 and 9 will ultimately start a direct current through the electrode 7 in the manner already described. The other rectifiers may then be started upon direct current. By introducing the coil 41 in the lead to one of the positive electrodes, as 4^a, of the bulb 2^a, the cut-out 30 may be opened upon the initiation of normal current flow through the bulb 2^a; thus, deenergizing the starting means for this bulb. Similarly, with any bulb, as, for instance, 2^b.

Fig. 3 represents the supply circuit for the transformer secondaries 1, 1^a and 1^b of Fig. 2, the secondaries 1, 1^a and 1^b of Fig. 3 represent the similarly numbered arrangements of Fig. 2, the primary of these three secondaries is shown at 50. At 51 is shown a variable choke coil which when controlled by current in 50 and the counter weight 53 through the variable radial lever arm 52 serves to maintain constant current from the supply, this general system is applicable to

the operation of series arc lamps and is generally well known in that art.

In Fig. 4, is shown a somewhat different arrangement of the keeping alive and starting circuits of the bulb 2 which may be utilized without changing the general method of operation. In this figure an additional winding 37 is placed upon the original winding 36 the latter coil being located as the coil 28 in Fig. 2. This winding 37 is connected in series with the resistance 39, and serves to store energy in the core of the winding 36 from current passing from the supply to the electrode 9 which energy can be discharged through the coil 36 and the electrode 9 to the electrode 7 as already described. By this means, the current taken through the resistance 39 can be much less than by the arrangement of Fig. 2, since by properly proportioning the coils 36 and 37 the current in 37 may be made less than that in 36 which has a minimum effective value in virtue of the qualities of the negative electrode 7. Otherwise, the apparatus of Fig. 4 operates as described in connection with Fig. 2. The means whereby the containers are made movable are indicated in several figures by the knife edges 54, 54, or the trunnions 55 and 55.

It is not intended that this invention shall be limited to the specific organization of circuits shown in connection with the figures, but is applicable to any modifications thereof involving the central idea of a common use of electrodes for starting series operated bulbs with the alternating and direct current and for separate keeping alive purposes.

I claim as my invention:

1. In a system of electrical distribution, the combination of a plurality of rectifier bulbs operated in series, each bulb having two main anodes, two supplemental anodes and a cathode, and supply and load circuits and connections therefor, with separate means for each rectifier for passing current continuously between the supplemental anodes and the cathode, together with starting connections external to the bulb between the source which is connected with the main anodes and the supplemental anodes.

2. In a system of electrical distribution, the combination of a plurality of serially operated rectifiers, each provided with two main anodes, two supplemental anodes and a cathode, said cathode being adapted to cooperate with one of said supplemental anodes, a direct current work circuit, an alternating current supply circuit and connections therefor, with separate keeping alive circuits for the several rectifiers between the supplemental anodes and the cathode together with means for starting each bulb by the coöperation of a supplemental anode and a cathode including starting connections between the main source and said supplemental anode.

3. A serially operated alternating current rectifier, having two main anodes, two supplemental anodes and a cathode and a suitable source, work circuit and connections therefor in combination with a separate source of energy connected with the supplemental anodes and the cathode for keeping alive the rectifier and a starting circuit connected between the supply and at least one of the supplemental anodes, together with switches for controlling the separate keeping alive circuits during starting.

4. A serially operated alternating current rectifier, having two main anodes, two supplemental anodes and a cathode and a suitable source, work circuit and connections therefor, in combination with a separate source of energy connected with the supplemental anodes and the cathode for keeping alive the rectifier and a starting circuit connected between the supply and at least one of the supplemental anodes, together with switches for controlling the separate keeping alive circuits during starting and automatic means for cutting out said starting circuit.

5. In a system of electrical distribution in which a plurality of vapor rectifiers are utilized in series for supplying direct current from an alternating current supply and in which the operation is steadied by separate keeping alive circuits controlled and protected by fuses and switches, and connected to supplemental anodes within the rectifier and in which at least one such anode is adapted to coöperate with the cathode, the method of starting, which consists in breaking down the negative electrode resistance of the rectifier through the use of direct current obtained from a rectifier operating in series thereof through the coöperation of the supplemental anode and the cathode, transferring the flow to the main anodes and subsequently applying a steadying force through the supplemental electrode.

Signed at New York in the county of New York and State of New York this 7th day of March A. D. 1907.

PERCY H. THOMAS.

Witnesses:
WM. H. CAPEL,
THOS. H. BROWN.