P. H. THOMAS.

SINGLE PHASE GAS OR VAPOR ELECTRIC DEVICE.

APPLICATION FILED AUG. 11, 1903.

951,085.

Patented Mar. 1, 1910.

2 SHEETS—SHEET 1.

Fig.1

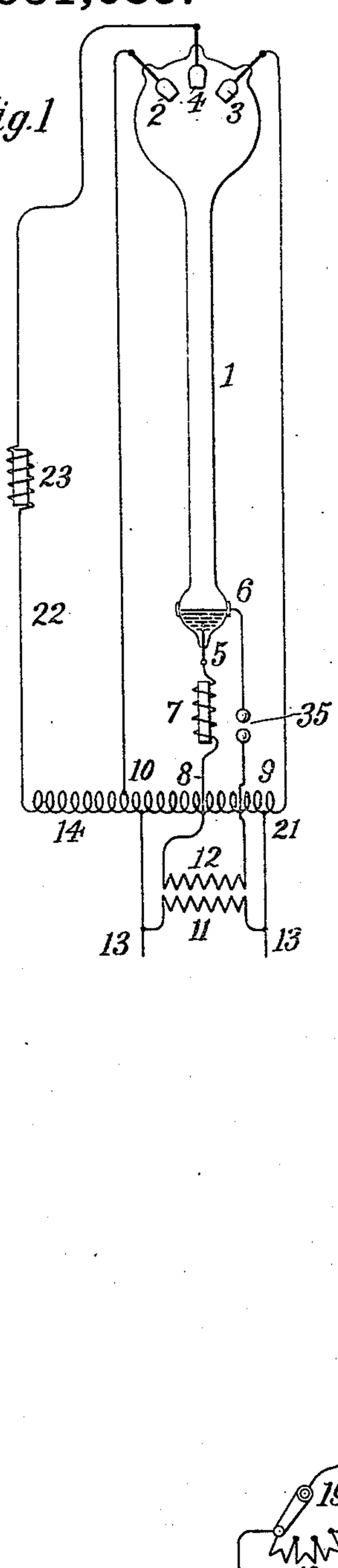


Fig.2

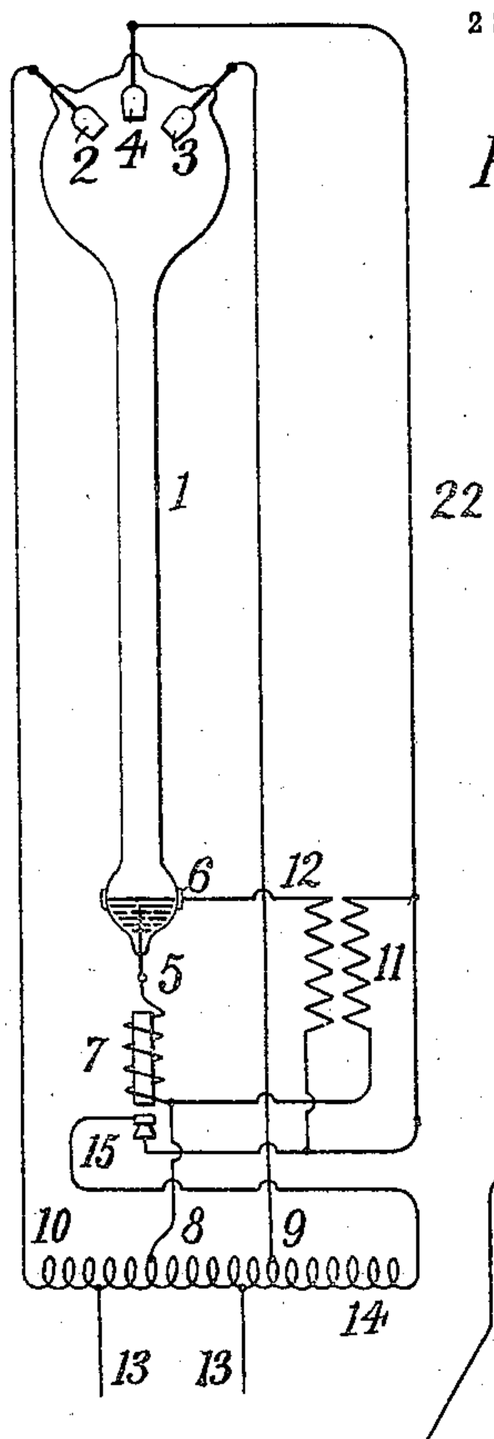


Fig.3

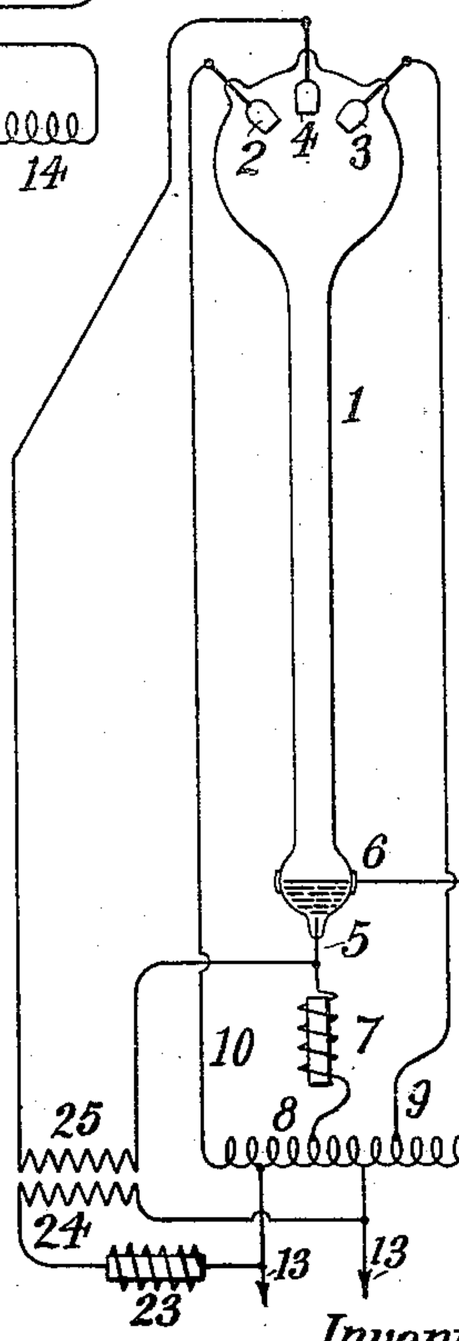
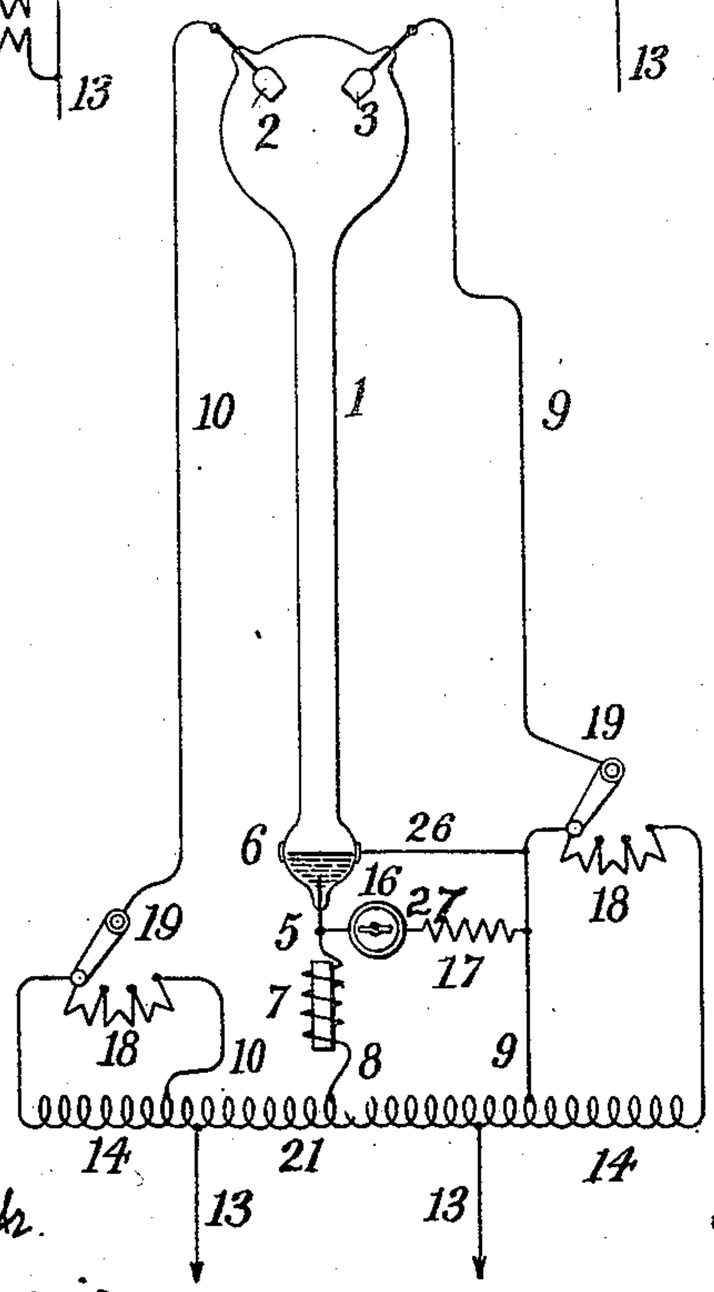


Fig.4



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2 SHEETS—SHEET 2.

Fig.5

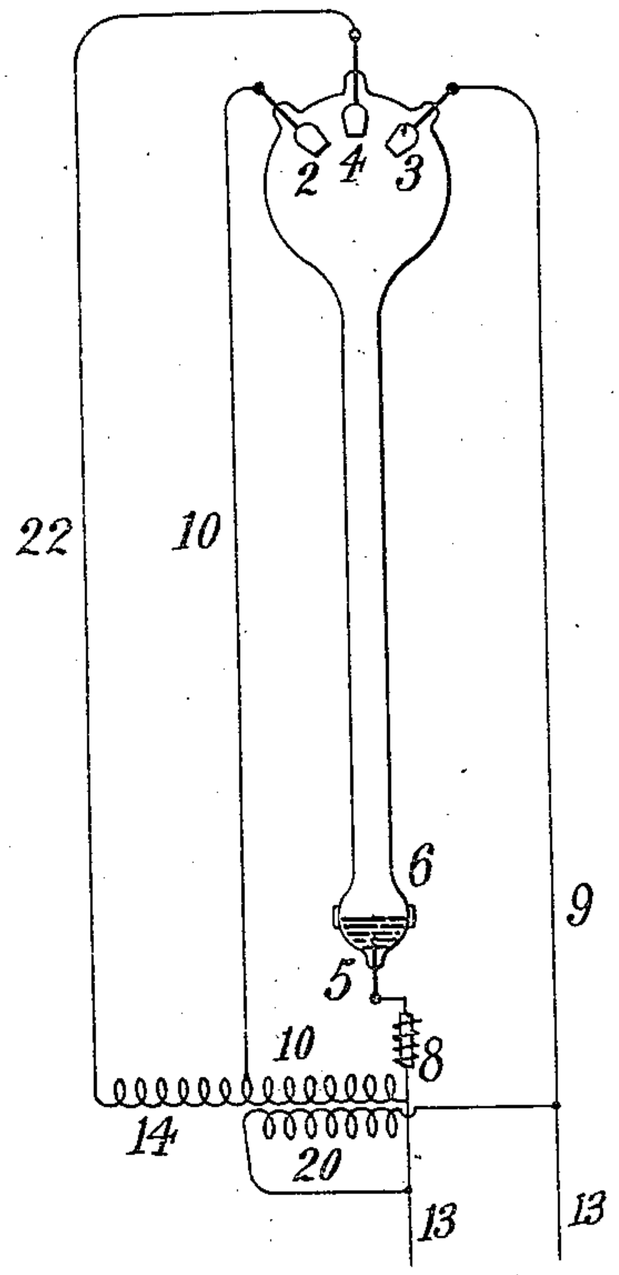
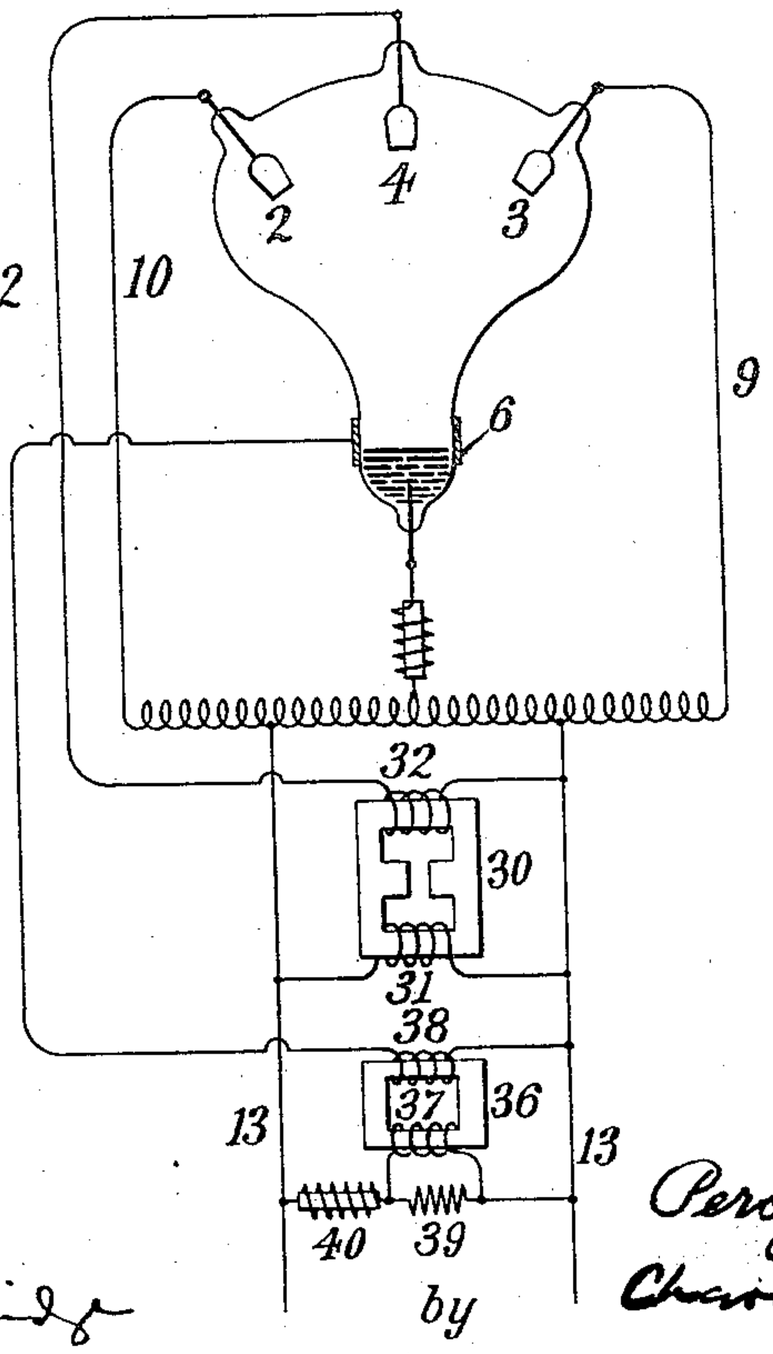


Fig.6



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UNITED STATES PATENT OFFICE.

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SINGLE-PHASE GAS OR VAPOR ELECTRIC DEVICE.

951,085. Specification of Letters Patent. Patented Mar. 1, 1910.

Original application filed June 13, 1903, Serial No. 161,282. Divided and this application filed August 11, 1903. Serial No. 169,091.

To all whom it may concern:

Be it known that I, PERCY H. THOMAS, a citizen of the United States, and resident of Pittsburg, county of Allegheny, State of Pennsylavnia, have invented certain new and useful Improvements in Single-Phase Gas or Vapor Electric Devices, of which the following is a specification.

In gas or vapor electric lamps of the type shown and described in certain United States patents issued to Mr. Peter Cooper Hewitt on the 17th day of September, 1901, and in similar vapor apparatus, whether used for lighting purposes or not, the phenomenon appears at the negative electrode of a reluctance to starting which has now been fully set forth in various patents and publications. Owing to the presence of this phenomenon, means are required for breaking down the initial reluctance at the negative electrode, and such means may be supplied by a current of high potential derived from any source whatsoever and applied either to the terminals of the vapor device or to what is generally called a starting band arranged in proximity to the negative electrode. When apparatus of this character is operated on direct current circuits, it has been customary to apply to the terminals of the apparatus a momentary current of higher potential than that upon which the apparatus is designed to be operated. In employing alternating currents, it is usual to apply a higher potential alternating current derived from the supply circuit to the starting band, which starting band is also preferably present in most types of vapor apparatus. When the high potential current is applied to the starting band, I have found that the relative phase between the high tension current thus applied and the electro-motive-force supplied to the terminals may have an important influence on the starting of the lamp or other apparatus. In practice, I have found that certain lamps will start satisfactorily with no phase difference. On the other hand, other lamps under the same or different conditions of operation, may be more readily started by giving a lead or a lag to the high tension current, and I have found a moderate lead to be very favorable in operating certain sizes of commereial lamps. When the described reluctance to starting has once been broken down, current may continue to flow through the apparatus provided the applied electro-motive-force is sufficiently high and also provided that the direction of flow be maintained uniformly. When, however, currents of varying value or of alternating direction are applied to the apparatus, the electrode reluctance is liable to be re-formed should the current value drop below a certain minimum, and is certain to be re-formed when the direction of flow is reversed. Thus in operating apparatus of this class by means of alternating currents or currents which vary considerably in value, provision has to be made for reinforcing the lower values when the current is of uniform direction and for repeatedly starting the apparatus when the direction of the current changes. It has been proposed to provide means for the purposes indicated by placing a choke coil in series with the apparatus which will store energy while the current is increasing and discharge the stored energy or a portion of it in the original direction of flow when the current falls. With a choke coil of sufficient capacity, the energy stored on the rising current will be sufficient to maintain current through the negative electrode until the supply circuit shall again tend to increase the current flow in the proper direction. In connection with this general arrangement of circuits and apparatus, various organizations have been proposed for preventing the negative alternations from undoing the work of the positives. For example, the amount of energy required from the choke coil is considerably lessened if a path be provided for the negative alternations through the apparatus by means of a second positive electrode. With such an organization, both the positive and negative alternations tend to pass through the lamp in the same direction. Meanwhile, the function of the choke coil in delivering energy enough to supply current for the short period between alternations is constantly called into play.

The organization above indicated comprises, among other features, means for starting gas or vapor apparatus through the application of an initial current of high potential, and also means for storing energy derived from the supply circuit, say in a choke coil, the function of which is to main-

tain the current value above a certain minimum at all times, so that the negative electrode reluctance may not reëstablish itself.

It might be supposed that in operating the vapor apparatus upon a single phase alternating current, the capacity of the choke coil might have to be considerable, but I have found that in order to maintain the operation of the apparatus after it has once been started, the choke coil need not be of excessive size. It is desirable, however, that an extra potential should be supplied to enable the choke coil in the first alternation after starting to absorb a sufficient amount of energy so that it may discharge the energy necessary to maintain the lamp over the first zero point, without falling below the minimum current.

It is the object of the present invention to provide means for supplying this extra initial potential, as will presently appear, it being understood that the additional voltage thus drawn from the source will generally be removed after the starting of the apparatus. This makes it possible to obtain economical conditions during operation, and provides that the extra potential called into use at the starting of the apparatus shall constitute only a momentary demand upon the system.

In order to facilitate the application of the additional voltage, I may employ a third positive electrode or terminal, as a starting electrode electrically independent of the main electrode, although it is not an essential feature of the invention, and a main electrode may be utilized for the purpose if desired.

The supplementary electro-motive-force may be removed in a number of ways, as by including resistance or inductance in the circuit through which the additional electro-motive-force is supplied; by providing a transformer with considerable magnetic leakage between the primary and the secondary, the secondary being used to supply the additional electro-motive-force; or by mechanically opening or deënergizing the circuit through which the extra potential is supplied. The latter method is the one which is generally preferred.

In the accompanying drawings I have illustrated several ways in which the extra potential may be obtained. One of these organizations embodies an addition to the winding of a transformer secondary which is used to obtain rectified alternations within the apparatus. Another organization embodies a separate transformer.

Not only may the supplementary or additional electro-motive-force, or what is called the extra potential, be supplied by the means just described, but the high tension electro-motive-force applied as illustrated in Figure 4 to the normal lamp terminals or the high electro-motive-force applied to the starting band may be obtained from a winding in the same transformer as either of those referred to or from a separate transformer.

When using a mechanical interruption of the circuit supplying the extra potential, I have found it convenient to use a magnetism generated by the current.

As a modification of the above apparatus, it is possible to avoid the use of the supplemental electrode by applying to one or both of the positive electrodes a supplementary electro-motive-force and transferring the positive electrode or electrodes to the normal running point after starting, without the interruption of the circuit.

The high potential at the starting band may be obtained, if desired, through a snap or quick-break switch just as in a direct current lamp. In this case it is sometimes necessary to close and open the switch a number of times in order to insure that the mechanical break should occur at a favorable portion of the wave for producing a high potential impulse.

I have illustrated my invention in the accompanying drawings, in which—

Figs. 1, 2, 3, 4, 5 and 6, are diagrammatic illustrations of my invention as applied to a gas or vapor electric lamp.

In the drawings, 1 is the container of a lamp of the character described above, the same containing, in this instance, a negative electrode, 5, of mercury and positive electrodes, 2 and 3, which may be of iron. In Figs. 1, 2 and 3, I show a supplemental positive electrode, 4, adapted to serve as a starting electrode which may also be of iron. The lamp is provided with a starting band, 6, located in proximity to the negative electrode 5 and variously connected in the different figures of the drawings. The supply circuit for the lamp in Fig. 1 is illustrated by the conductors, 13, 13, between which is arranged the primary, 11, of a transformer whose secondary is shown at 12. One terminal of the secondary is connected to the starting band 6 and the other is connected by a wire, 8, through a choke coil, 7, to the negative electrode 5. The conductors 13 are joined to the windings, 21, of an auto-transformer which has a supplemental winding, 14, as shown. The winding 21 is connected at its opposite terminals by means of wires, 9 and 10, to the positive electrodes 2 and 3, while the winding 14 is joined by a wire, 22, to the supplemental starting electrode 4. At the neutral point between the terminals of the winding 21, the wire 8 is joined to the said winding. The conductors 13, 13 are assumed to be connected with a source of single-phase alternating current, and when the circuit of the said source is closed, throwing potential on the primary

winding, 11, the secondary winding 12 receives a high voltage, which is impressed upon the electrode 5 and the starting band 6 in such a way as to produce a critical strain at the surface of the negative electrode, breaking down its resistance and allowing the positive potential on one of the electrodes 2, 3 or 4 to start the lamp into operation. The operation of the lamp is then as follows: Assuming, for example, that the electrode 2 (neglecting the electrode 4 for the moment) has a positive potential with regard to the negative electrode at the time of the application of the critical strain, current flows from 2 to 5, reaching finally the proper value for the electro-motive-force supplied and at the same time storing energy in the choke coil 7. During the latter part of the first alternation, as the voltage upon the positive electrode 2 falls to zero, the energy previously stored in the choke coil 7 continues the flow of current in the original direction through the coil until the potential upon the electrode 3 becomes positive in its turn, whereupon electrode 3 will itself support the current through the lamp and, as its value rises in the second alternation, will increase the current through the choke coil 7 to the maximum at the time at which it is returning toward zero. As before when the voltage of the electrode 3 becomes too small to support the current through the choke coil 7, this coil supplies energy keeping the current flowing, though at a decreasing intensity, until electrode 2 after having had a negative value during the second alternation again becomes positive in the third alternation, when it is utilized to again support the current through the lamp and the choke coil 7, and so on, as long as the lamp operates. The function of the supplementary winding 14 and the supplementary positive electrode 4 is to supply an additional electro-motive-force during the alternation within which the critical or starting strain is applied. It is evident that during this first alternation, the current must reach its maximum value after starting from zero, whereas, when once the lamp is operating normally, this maximum current must be reached in one alternation, starting, not from zero, but from the minimum value reached during the operation which must at least be the minimum operating current of the lamp. Once the negative electrode resistance of the lamp is broken down sufficiently to allow an operating current to pass, the extra voltage upon the supplementary positive electrode 4 is no longer required and in fact will cause a waste of energy and a disturbance of the operation of the lamp and should be removed from further operation. This disturbance of the operation of the lamp would result from the excess of current tending to flow from the extra potential upon the supplementary electrode 4 provided no restraining devices are used. Such disturbance of the operation may be avoided, however, by the insertion of an inductance device or resistance, 23, which may, as in Fig. 1, conveniently be placed in the circuit of the winding 14. The action of the inductance device or resistance 23 is such as to prevent an excessive flow of current after the apparatus has started into operation, at the same time allowing the full voltage of the source to assist in the overcoming of the negative electrode resistance since unless the current flow actually increases no voltage will be absorbed upon the inductance device or resistance 23. The impedance 23 is so proportioned as to allow only a very small current to flow when the apparatus is in operation. When the apparatus is to be started, however, since no current flows through it, the full potential of the supplementary transformer winding is impressed between the positive starting electrode and the negative main electrode in the apparatus. It is this tension strain backed by the power of the main positives to deliver current which breaks down the electrode resistance. Enough current must, of course, be allowed to flow through this impedance 23 when the apparatus is in operation to establish an initial current in the choke coil 7.

Referring to Fig. 2, the transformer primary 11 is connected between one terminal of the coil 14 and the conductor 8. In the circuit of the primary is included the movable element of a switch, 15, which constitutes an armature for the choke coil 7. The organization illustrated in Fig. 2 is in other respects similar to that shown in Fig. 1, except that the switch 15 is utilized for removing the source of extra-potential from the system as soon as the operation begins. It is clear that when the supply circuit is closed and current is caused to traverse the primary 11, the secondary 12 will be energized, as before, and the choke coil will also receive current. In response to the described action, the movable element of the switch 15 will be withdrawn from contact with the stationary element thereof and the winding 14 and the primary 11 will be cut out.

In Fig. 3 the extra potential applied to the lamp is supplied by a transformer 24, 25, the latter being the secondary and having its respective terminals connected to the supplemental electrode 4 and to the electrode 5. The other connections are shown clearly upon the drawing. In this arrangement of circuits I may include the inductance or resistance 23 in the circuit of the primary 24, its functions being the same as already described in connection with Fig. 1.

Referring to Fig. 4, it will be noted that

the supplemental electrode 4 is here omitted, and that the conductors 9 and 10 are joined to the windings of the auto-transformer 21 through resistances 18, 18, provided with movable arms, 19, 19. In this figure the starting band is connected by a wire 26 with the conductor 9, while a shunt circuit 27 containing a quick break switch 16 and a resistance 17 (which may be in the form of an inductance device or reactance coil) is connected between the lead of the electrode 5 and the conductor 9. In this figure the switch arm 19 at the left is represented at starting position, while the corresponding arm at the right is represented as having been moved from the starting position to the opposite extreme position. An extra winding 14 is here added at both ends of the winding 21, and each is connected through one or the other of the adjustable resistances to a separate positive electrode in the lamp. With the switches in the starting position, the supply circuit 13, 13 is closed and the snap or quick-break switch 16 is operated. By the action of the switch 16 and the choke coil 7, a high potential impulse is created at the starting band and this is reinforced by the energy developed in the windings 14, 14. The lamp having been once started into operation in this way, the switches 19 are moved from the starting position to the operating position (the latter being illustrated, as already explained, by the switch at the right hand side of Fig. 4) and the operation continues with the windings, 14, 14 disused.

In the figures already described, there are impressed between the neutral point and the two main positives, respectively, two alternating electro-motive-forces exactly opposite in period. These are obtained by connecting the neutral point of the supply circuit to the negative electrode and utilizing the supply mains as the two positives. In Fig. 5 the same result is attained in a slightly different manner which allows the full line voltage to be impressed between the neutral point and one positive. In this figure, as before, we have two exactly opposite electro-motive-forces impressed between the negative electrode and the two main positive electrodes of the lamp. One of these is the supply electro-motive-force itself, the other is a similar electro-motive-force obtained by means of a transformer which allows its direction to be reversed. It is evidently possible to utilize another winding, as 14, upon the same core as the transformer 20 for supplying the supplementary voltage for starting the lamp.

The arrangement illustrated in Fig. 6 is broadly similar to that shown in Fig. 1, the main difference being that as a substitute for the inductance or resistance 23, I make use of a transformer 30, having considerable magnetic leakage between the primary and secondary windings 31 and 32. As soon as the lamp is started in the manner already described in connection with Fig. 1, the transformer 30 will come into play to check the flow of current through the conductor 22, thus practically deënergizing that part of the circuit. In this figure I also show means for creating a phase difference between the current applied to the starting band 6 and that applied to the supplementary starting electrode 4. In practice, I find it advantageous to give to the current applied to the starting band a slight lead or lag, depending upon the circuit conditions. This can be accomplished as in Fig. 1, by means of a spark-gap such as is shown at 35 or by such means as are illustrated in Fig. 6, where the primary 37 of a transformer, 36, is coupled up between the supply wires 13, 13 while the secondary, 38, is connected between one of the conductors 13 and the starting band 6. In shunt to the primary I may arrange a resistance, 39, and in series therewith an inductance device, 40, the same being so proportioned as to give the necessary lead or lag to the secondary current. The arrangement shown is so devised as to give a lag to the secondary current, whereas by reversing the position of the resistance 39 and the inductance 40, a lead would be given to the current. The form of vapor device illustrated in this figure is that of a converter, being different in this respect from the device illustrated in the other figures, insomuch as all of the electrodes including the starting electrode 4, are closely adjacent to the negative vapor-emitting electrode, so that the intervening vapor column is very short.

It is known that the critical strain may be applied to the apparatus through other instrumentalities than the starting band, and if desired any means equivalent to the starting band may be substituted therefor.

In another application filed by me June 13, 1903, Serial Number 161,282, of which this application is a division claims are made upon the method described herein.

In a divisional application, Serial Number 540,738, filed Jan. 29, 1910, claims are made upon certain features of the invention described herein.

I claim as my invention:—

1. In a system of electrical distribution, a gas or vapor electric apparatus, means for creating within the same a critical strain, means for storing electrical energy in the system, means for discharging a portion of the said energy through the apparatus, and means for creating a momentary initial excess of potential above the normal in the apparatus.

2. In a system of electrical distribution,

a gas or vapor electric apparatus, means for creating within the same a critical strain, means for storing electrical energy in the system, means for discharging a portion of the said energy through the apparatus, means for creating a momentary initial excess of potential above the normal in the apparatus, and means for withdrawing the source of increased potential.

3. In a system of electrical distribution, a gas or vapor electric apparatus provided with a starting band, two or more positive electrodes, and a negative electrode, a source of single phase alternating current connected with the said apparatus, a choke coil interposed at a suitable point in the system, a starting device capable of creating a critical strain within the apparatus, and means for applying to the apparatus a momentary initial excess of potential.

4. In a system of electrical distribution, a gas or vapor electric apparatus provided with a starting band, two or more positive electrodes and a negative electrode, a source of single phase alternating current connected with the said apparatus, a choke coil interposed at a suitable point in the system, a starting device capable of creating a critical strain within the apparatus, and means for applying to the apparatus a momentary initial excess of potential, the current produced by the extra-potential being adapted to pass through the choke coil.

5. In a system of electrical distribution, a gas or vapor electric apparatus, provided with a starting band, two or more positive electrodes and a common negative electrode, in combination with a source of single phase alternating current connected with said apparatus, a choke coil interposed at a suitable point in the system, and means for including a spark-gap for impressing upon the starting band a critical strain within the apparatus, and means for applying to the apparatus a momentary initial excess of potential.

6. In a system of electrical distribution, a gas or vapor electric apparatus, provided with a starting band, two or more positive electrodes, and a common negative electrode, in combination with a source of single phase alternating current connected with said apparatus, a choke coil interposed at a suitable point in the system, and means for including a spark-gap for impressing upon the starting band a critical strain within the apparatus, and means for applying to the apparatus a momentary initial excess of potential, the current produced by the extra potential being adapted to pass through the choke coil.

7. In a system of electrical distribution, the combination with a mercury vapor apparatus comprising a completely exhausted container, a vaporizable cathode and suitable anodes therein, and an alternating source, of means for supplying suitable alternating current to said device, such means including a transformer and an impedance between said transformer and said supply, together with means for maintaining the cathode in operative condition.

8. In a system of electrical distribution, the combination with a mercury vapor apparatus comprising a completely exhausted container, a vaporizable cathode and a plurality of anodes therein, and an alternating supply, of connections from the cathode to an intermediate point of said supply, connections from terminals of the supply to the anodes and adjustable voltage absorbing means in said last named connections.

9. In a vapor conductor, the combination of an exhausted envelop, a vapor-emitting main electrode, a plurality of non-vaporizable electrodes, and means for starting current flow between the vaporizable electrode and each of said non-vaporizable electrodes, said means consisting of a single starting electrode located in operative relation to said vapor-emitting electrode.

10. In a system of electrical distribution, the combination with a mercury vapor apparatus comprising a completely exhausted container, a vaporizable cathode and at least one anode therein, and an alternating supply, of a connection from a terminal of the supply to an anode, said connection including an impedance together with means for returning rectified current from the cathode to the supply.

Signed at New York, in the county of New York, and State of New York, this 29th day of July A. D. 1903.

PERCY H. THOMAS.

Witnesses:

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GEORGE H. STOCKBRIDGE.