P. H. THOMAS.

MERCURY VAPOR APPARATUS.

APPLICATION FILED SEPT. 12, 1912.

1,163,708.

Patented Dec. 14, 1915.

2 SHEETS—SHEET 1.

Fig. 1

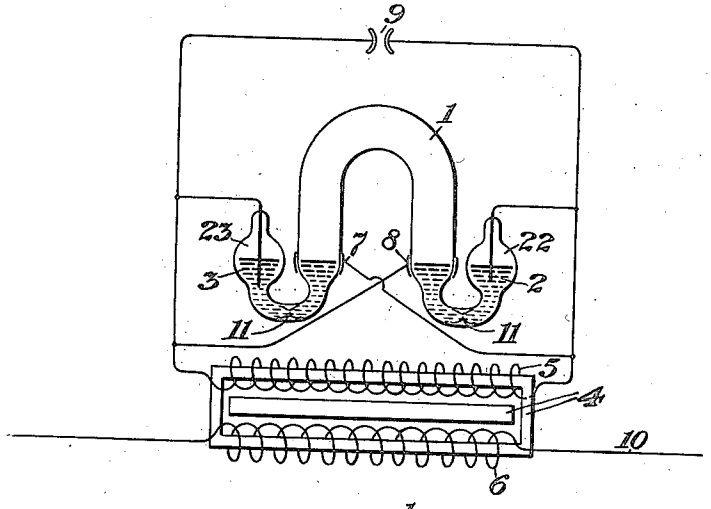
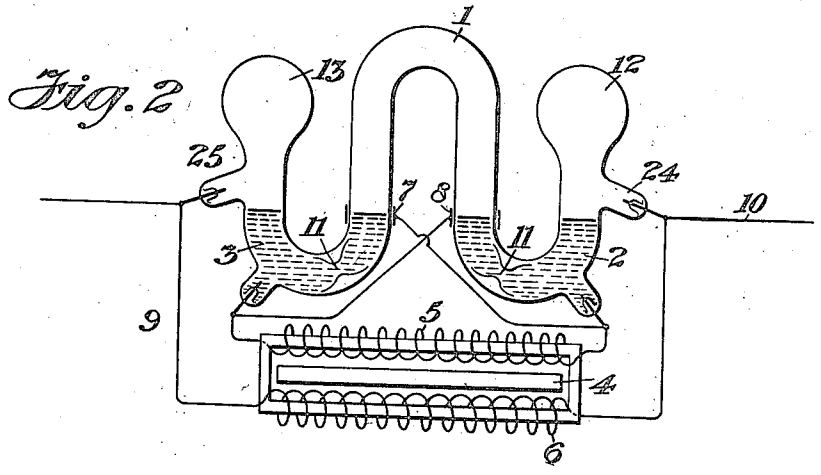


Fig. 2



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2 SHEETS—SHEET 2.

Fig. 3.

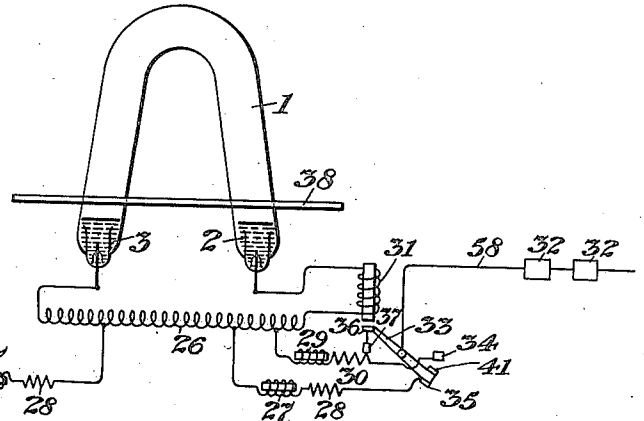


Fig. 4.

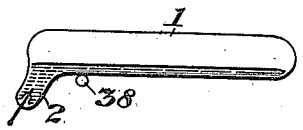


Fig. 5.

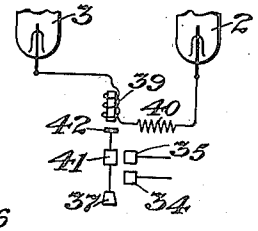


Fig. 6.

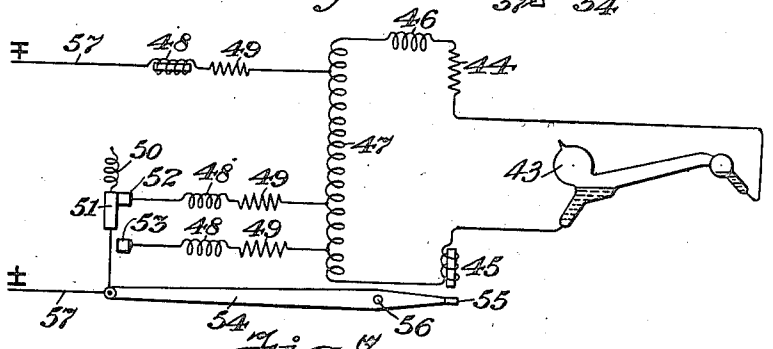
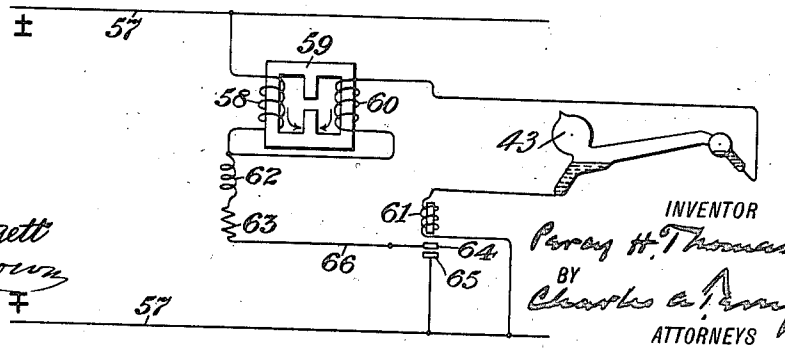


Fig. 7.



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MERCURY-VAPOR APPARATUS.

1,163,708. Specification of Letters Patent. Patented Dec. 14, 1915.

Application filed September 12, 1912. Serial No. 719,924.

To all whom it may concern:

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

My invention relates to the operation of mercury vapor lamps and especially to such lamps when operated at relatively high pressures, from sources supplying alternating current.

My invention further aims to provide means making it possible to operate such a lamp or other apparatus by passing current from the source in opposite directions between the same electrodes. When mercury vapor lamps are operated from alternating mains at relatively low pressures it is usually more convenient to provide an extra anode and pass the current alternately from the two anodes to the same cathode. However, by the method of operation here set forth it is possible to operate from an alternating supply directly with only two electrodes.

The mercury vapor lamp has a very high resistance to starting; but when the temperature of the electrodes, assuming these to be of mercury is raised sufficiently, this starting resistance is much lowered and a lamp that will not run on a certain voltage cold will operate satisfactorily on this voltage when its temperature is sufficiently high. I overcome the difficulty of getting the lamp heated to the point at which it will operate on normal alternating voltage by various methods, such as raising the alternating voltage at the start, shortening the vapor path at the start, or preheating the mercury before attempting to start the flow of current in the vapor; I do not, however, claim to be the first to preheat the mercury of a vapor lamp broadly. The application of these arrangements will be pointed out in more detail in connection with the various figures of the drawings.

It may be well to point out that the normal resistance to current flow in these mercury vapor devices depends as one factor upon the pressure of the vapor which in turn depends upon the temperature of the mercury in the container. The relation between the amount of heat generated in the mercury by the operation and the natural rate of heat dissipation of heat from the mercury is the factor determining the normal temperature of the mercury and the various parts and current strengths may be proportioned in conformity therewith. It is furthermore well known that such apparatus operates most satisfactorily when there is some voltage absorbing device in series therewith or when it is fed by constant currents.

In the drawings, Figure 1 represents a mercury vapor lamp adapted to operate on alternating current and provided with means for producing an increased voltage during the starting period. Fig. 2 represents a somewhat similar lamp provided with chambers for regulating the length of the vapor column. Fig. 3 shows another method of varying the voltage during the starting period and a different method of overcoming the initial opposition to the flow of current. Fig. 4 shows a second view of the lamp of Fig. 3, and Fig. 5 a modification of the starting circuits. Figs. 6 and 7 show two arrangements for obtaining additional starting voltage on constant potential circuits.

In Fig. 1, 1 represents the container of the lamp or other apparatus; 2 and 3 electrodes of mercury or other material; 4 represents the core of a transformer having a primary winding 6 and a secondary winding 5; 7 and 8 represent starting bands as used in many commercial mercury vapor lamps; 10 is a constant alternating current supply and 9 is a shunt cut-out for short circuiting the lamp when not in service.

11, 11 are constrictions in the passages containing the mercury which serve to check the oscillations or rushes of mercury which tend sometimes to occur in practice.

This lamp is preferably constructed and exhausted as is usual for mercury vapor lamps, that is by exhausting all gases from the container and the walls of the chamber. However, it will be found advantageous in some cases to facilitate the initial starting by leaving in a certain amount of residual gas between the electrodes. The presence of such gas serves to lessen considerably the

resistance of the device to the initiation of current flow. The container is hermetically sealed and when the gases have been eliminated as already described it is sealed from the pump.

The operation of this system is as follows: When current is applied, or when the short circuiting gap 9 is opened with current in the main circuit, a voltage is impressed on the primary 6 which in turn causes a potential to be impressed upon the secondary 5 and on the lamp terminals 2 and 3 and the starting bands 7 and 8. The effect of these starting bands is well known; they produce small sparks on the inside of the container at the level of the mercury surface which act to overcome the initial opposition at the electrode to the starting of current flow. The voltage of the secondary 5 is so chosen as to be considerably higher than the proper operating voltage of the lamp, when in its stable operating condition. This extra high voltage serves to greatly facilitate the starting of current flow in the first moments of starting when the lamp is not very hot. When, however, the pressure of the mercury vapor has been sufficiently raised by the operations so far described, current flows more freely and assumes its normal value, when the voltage of the secondary 5 drops to normal. As the temperature and pressure of the lamp rise, the mercury in the electrodes 2 and 3 will be forced down until the chambers 22 and 23 are filled with mercury and then no further elongation of the vapor path can occur.

The transformer core 4 can if desired be made without the provision for magnetic leakage, since it is here taken as in a constant current circuit and the voltage will thus automatically be very high when no current is passing in the lamp and will automatically drop to the minimum value that is sufficient to maintain the normal current in the lamp when the mercury has been heated up.

It will be observed that the lamp and circuit are symmetrical and that when the supply potential is in one direction, one starting band is effective and starts the current flow in that direction and that when the supply potential is in the opposite direction, the other starting band then starts the current in the other direction. The current once established continues freely of course for the remainder of the alternation.

In Fig. 2 is shown a somewhat similar set of circuits except that in this figure two additional electrodes 24 and 25 are provided in the lamp and when the pressure has risen in the vapor path the mercury electrodes will be pushed back until they reach these additional electrodes and connect the main circuit directly to the electrodes. In this case while a portion of the current will continue to flow through the secondary 5, the main portion will pass through these additional electrodes, 24 and 25. In the lamp of this figure the chambers 12 and 13 are provided to give a certain flexibility to the operation of the lamp for as the pressure in the vapor path rises, the mercury will recede from the center portion and rise in the outside portions and if a suitable amount of air be placed in the chambers 12 and 13 they will resist more and more vigorously until a very great increase in pressure in the central portion will be required to cause even a small increase in the compression in the chambers. This is often a desirable adjustment, as it tends to prevent one lamp from taking too much voltage when run in a series since a very long vapor path might be produced were there no gas in the chambers 12 and 13. However, under other conditions the reverse condition may be more desirable. Except in the points already mentioned this system is the same as that of Fig. 1. In either figure the container may be made of any one of many substances, such as ordinary flint glass, German glass, Jena glass, Bohemian glass, quartz or any hard glass containing a large proportion of silica, especially where high temperatures are expected. It is of course necessary to use suitable leading in wires for each particular container, for example, platinum for flint glass with the usual hermetical seal. A mercury sealed ground joint may, if desired, be employed where quartz is used.

In Figs. 3 and 4 is shown an inverted U shaped container adapted to be moved to facilitate the starting of the apparatus. In Fig. 3 this device is shown in the operating position and in Fig. 4 in starting position. In the latter figure the mercury is used as an electrode material for both electrodes as shown, there being a sufficient amount in the container for bridging between the electrodes 2 and 3. The rod marked 38 serves as a shaft or axis about which the lamp is rotated in the starting operation.

The starting of lamps of the mercury vapor type for low pressure or high pressure operation is well understood. One advantage which is of importance in the present case is the fact that, when the electrodes are relatively cold, the current path in the vapor is relatively short, thus in effect providing excessive voltage to the short arc, especially if the tilting motion be made sluggish and some measurable time interval be given for heating the electrodes before the full vapor path is introduced into the circuit. The circuit 58 in Fig. 3 is a constant current circuit, the inductances 27 and 29 and the resistances 28 and 30 being regulating and current transmitting means. I secure in a system as here shown, an added potential between the lamp terminals upon the lamp

in the main circuit by means of the transformer 26 as will be understood from the drawing. In initial position, the revolving arm 33 and the armature 36 attached thereto, is carried downward by the weight 37 until the contact 41 bears on the contact block 34. The path of the main current in the circuit 58 is then through the two central portions of the transformer winding and the inductance 29 and the resistance 30, giving relatively high voltage. When, however, the device has been started, the current flowing therethrough will energize the coil 31 and raise the armature 36, the contact point 41 will then connect with the contact block 35 and current will flow to only the central portion of the transformer 26 thus reducing the lamp voltage.

32—32 are devices similar to that just described located in the main circuit 58.

Fig. 5 shows an alternative method of operating the contact point 41 of Fig. 3. At the start—before the initial current flow—the energizing coil 39 attracts the armature 42 for there is a relatively high potential on the device whose electrodes are shown at 2 and 3. The resistance 40 serves to control the current through the coil 39 in shunt to the device. Before the weight 37 can move the contact point 41 from the contact block 35 to the contact block 34, below, the voltage in the lamp must be greatly reduced as when the relatively low operating voltage is impressed thereon. The transformer ratio is then lowered as before. In Fig. 5 the potential on the lamp operates the shift mechanism while in Fig. 3 this mechanism is operated by the current through the device.

Fig. 6 shows a system in which a mercury vapor lamp, more particularly a high pressure vapor lamp is operated from a constant potential source. The voltage is applied to the lamp through a transformer 47 here shown as a raising auto-transformer; it might equally well of course be made a lowering transformer. Voltage is fed from the circuit 57 to the transformer 47 through the contact block 52 in the starting position, and through a high potential for starting, but into the block 53 during running conditions. This change of connection is accomplished by means of the contact point 51 which is jointly controlled by the spring 50 and the coil 45, the latter coil being included in the lamp circuit, and operating upon the armature 55 at one end of the lever 54, the latter turning on the pivot 56.

Inductance devices 48—48—48 and 46 as well as resistances 49—49—49 and 44 serve a regulating function. These devices may be given any desired relative proportion, one to the other. The operation of this system is clear and is intended to cover the adaption of the prior apparatus for constant potential mains. The device 43 may have its reluctance to the current flow overcome by any of the methods shown in this application or known in the art, for example, by tilting or by starting bands.

In Fig. 7, I show another system of circuits adapted for any of the mercury vapor devices so far described. When current is thrown on the constant potential mains 57, the transformer primary 58 is energized through the inductance device 62, the resistance 63, the conductor 66 and the cut-out contacts 64—65. This energizes the transformer 59, which in turn produces the voltage in the secondary line 60, which may be given any desired ratio to the primary 58. When the lamp starts the coil 61 is energized by the flow of current which opens the cut-out 64—65, thus interrupting the current in conductor 66. The current is then forced through the device 43 by way of the primary 58 and the secondary 60 of the transformer, whose core 59 is provided with a shunt leakage path having an open magnetic circuit. These two coils operating together, produce in effect an inductance device in series with the circuit which operates as steadying means. Where desired, a very high potential can thus be impressed upon the device 54 during the starting period only, without maintaining such high potential during operation.

While I have described my invention with regard to these specific diagrams and figures illustrated, I do not wish to limit myself to the particular embodiments of my invention but consider any system utilizing the novel features of this disclosure to come within my invention. Any of the lamp structures shown may, if desired, be made of quartz or any of the other material described for the device of Figs. 1 and 2, for these devices may be used over a wide range of pressure. Of course, in each case the pressure of the vapor, the dimensions of the tube, the voltage impressed and radiating power of the apparatus must be properly correlated to secure the results described. Many of the lamps shown may be operated to advantage upon direct current, but in this application I have illustrated more particularly alternating current sources. Material other than mercury may be used in these tubes and when run at a high temperature any material, even material solid at the temperature appropriate to low pressure lamps can be used as the electrode material. I may mention tin, which has a very low vapor pressure; zinc and copper as materials that may become liquid at reasonable temperatures, each giving its one characteristic color; also lead; lithium and cadmium.

I claim as my invention:

1. In a system of electrical distribution, the combination of a mercury vapor apparatus comprising a hermetically sealed con-

tainer and mercury therein, said container being exhausted to a high degree of purity, a constant current alternating supply and a transformer included in said supply circuit and feeding said vapor device, and means for varying the ratio of said transformer in response to the starting of current flow through the lamp.

2. In a system of electrical distribution, the combination of a mercury vapor apparatus comprising a hermetically sealed container and mercury therein, said container being exhausted to a high degree of purity, a constant current alternating supply and a transformer included in said supply circuit and feeding said vapor device, and means for varying the ratio of said transformer in response to the changing potential of the device following the initiation of current flow in the apparatus in volume.

3. In a system of electrical distribution including a mercury vapor apparatus adapted to be started from an initially cold condition in which the establishing of current flow meets a relatively high resistance and adapted to operate normally in high temperature condition in which the resistance to current flow is relatively small, the method of starting operation, which consists in applying to the cold apparatus a temporary excessive voltage, connecting the electrodes and separating them, at first relatively short distances and as the device approaches its normal temperature, removing the excess potential and extending the vapor path to normal.

4. The combination with a vapor device having upon alternating current a very high starting and a relatively low operating resistance, said device including a hermetically sealed container and an electrode exhausted to a high degree of purity, means for applying a relatively high potential to the device at the starting through a transformer supplying said excess voltage and automatic means for varying the ratio of the transformer as the device approaches its normal operating condition.

5. In a system of electrical distribution, the combination of a mercury vapor device comprising a hermetically sealed container and mercury therein, said container being exhausted to a high degree of purity, a constant current alternating supply circuit; a transformer included in said supply circuit and feeding said vapor device, and means for varying the ratio of the primary and secondary voltages of said transformer in response to the starting of current flow through the vapor device.

Signed at New York, in the county of New York and State of New York, this 9th day of September, A. D. 1912.

PERCY H. THOMAS.

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