Sept. 6, 1932. S. VON BOGDANDY ET AL 1,875,963

METAL VAPOR LAMP

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Fig.1.

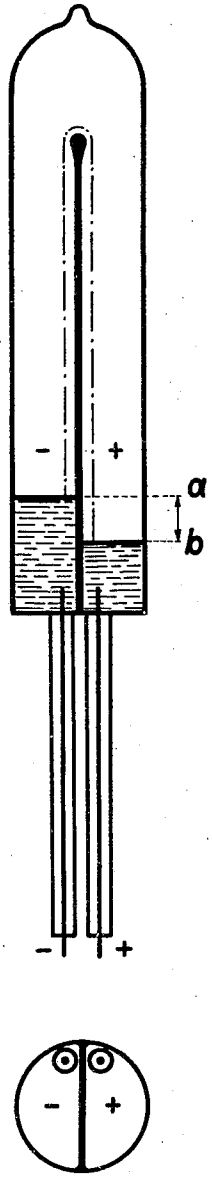


Fig.2.

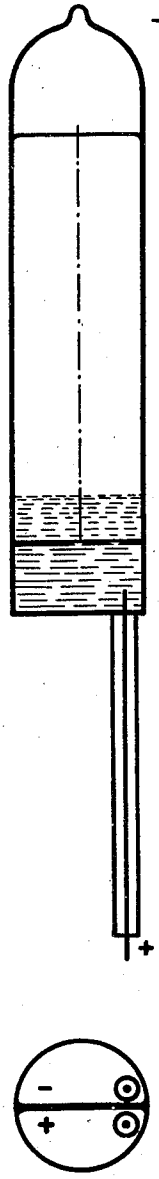


Fig.15

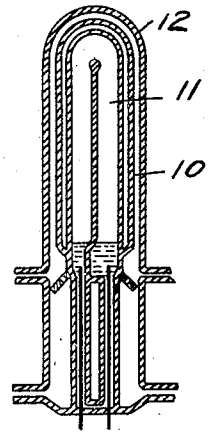
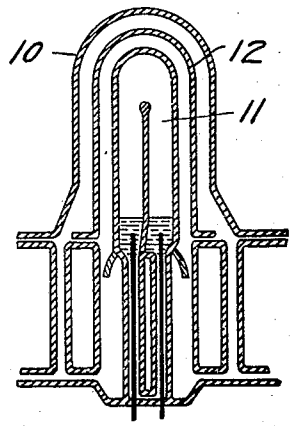


Fig.16



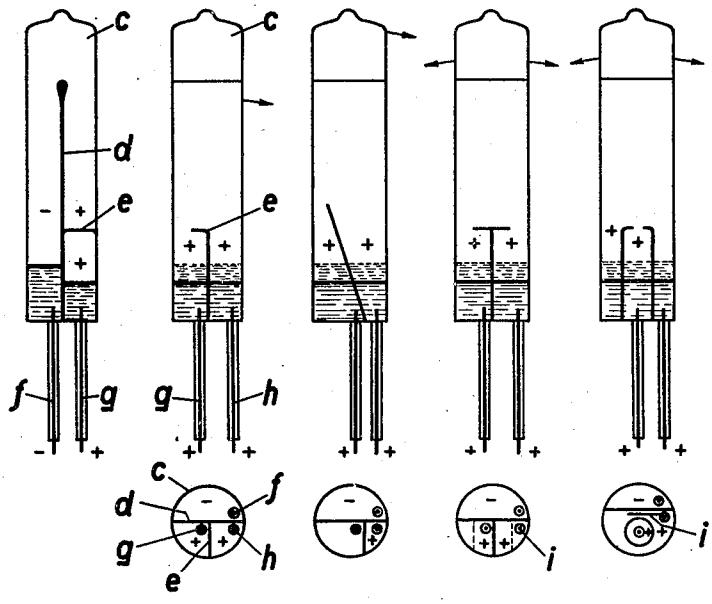
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Fig.3. Fig.4. Fig.6. Fig.7. Fig.8.



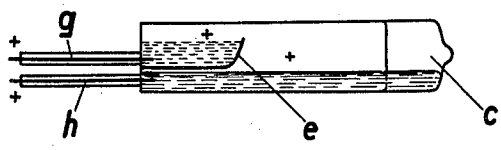
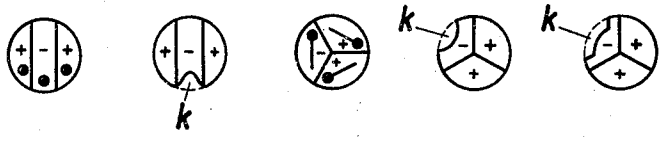


Fig.5.

Fig.9. Fig.10. Fig.11. Fig.12. Fig.13.



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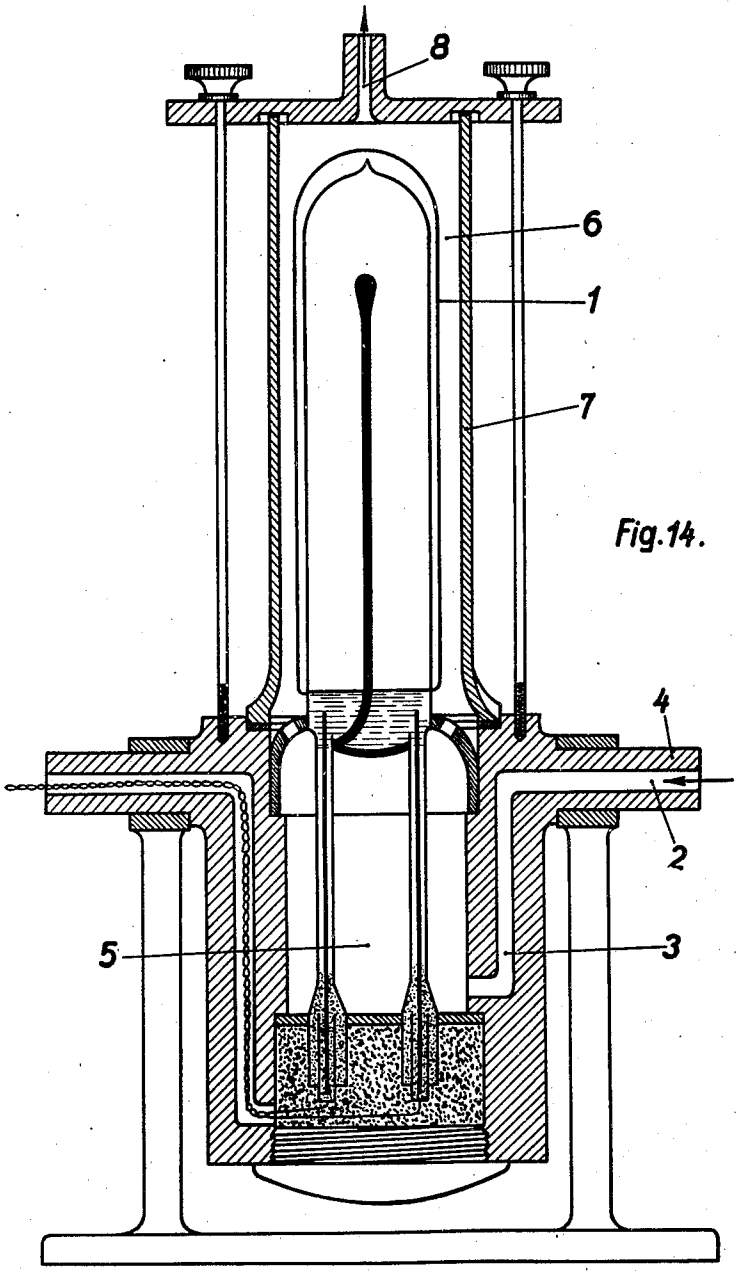


Fig.14.

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METAL VAPOR LAMP

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This invention relates to a metal vapor lamp having a longitudinal partition, and more particularly to a mercury arc lamp having a cylindrical luminous tube and fused-in flat longitudinal partition.

It is known in conjunction with such lamps, viz., both in the case of closed as well as open mercury vapor lamps, that the two electrode metals assume with symmetrical cooling conditions temperatures of a different height, whereby a distillation of the metal is occasioned from the hotter to the colder electrode. Attempts have been made to avoid this so-called creeping of the metal, which is prejudicial to the proper operation of the lamp, by causing a compensation of the temperature between the two electrode metals. Thus, for example, in the case of open lamps, it has been proposed to provide a large heat-transmission area between the pole receptacles, so that the compensation might be performed principally by the conduction of heat. In the case of closed lamps a still more complete transmission of the heat has been considered essential, for which reason it has been proposed to place the pole receptacles one within the other, so that the liquid electrode metal of the one receptacle washes that of the other. The large heat-transmission areas in the case of these known lamps naturally necessitate the use of large quantities of metal, which as regards lamps of the open type are moreover unavoidable for establishing the required sealing and the proper degree of pressure. It has been observed that the compensation of the temperature occurring by reason of the direct transmission of heat between the electrodes may be assisted by direct heating on the part of the arc. The extent of participation, however, is not considerable, since the use of large amounts of metal ensures an admirable interchange of heat by direct conduction, and because in the case of the known lamps the distance between the arc burning in the centre of the tube and the cold electrode metal is much too great to make possible an appreciable utilization of the heat of the arc.

In the lamp according to the invention the compensation of the temperature is effected practically by the heat of the arc alone, so that the direct transmission of heat between the electrode metals is, in comparison therewith, quite subsidiary. This extensive utilization of the heat of the arc is accomplished according to the invention by providing in place of the large compensation areas between the liquid electrode metals a large contact area between a part of the arc and the colder electrode metal. In order to increase the thermal effect of the arc to a still greater extent, the arc, according to the invention, is removed from the centre of the tube and situated in close proximity to the partition. This is effected in extremely simple manner by employing a partition made of a relatively thin and highly refractory material allowing radiation to occur through the same, for example quartz glass. In this case, by reason of the two parallelly disposed arc sections, a narrow zone of the partition situated between the same will be heated to such temperature that the two halves of the arc, in opposition to the electro-dynamic rejection, move closely against the said hot zone of the partition and remain there. Such an approaching action of the arc sections has neither been attempted nor has the same been possible in connection with tubes of the hitherto known kind. The effect of this particular measure will be quite obvious. A very intensive heating is attained by the hot gases of the arc and also by their radiation of the pole receptacle with the elevated colder metal, which in the case of D. C. high-pressure lamps with symmetrical cooling conditions constitutes, for example, the cathode. It will be quite apparent that under such conditions the degree of filling of the lamp, viz, the quantity of electrode metal in proportion to the volume of the lamp,—on the anode side, or on the same and also on the cathode side—may be selected to be so small that even in the case of symmetrical lamps the metal vapor of the arc is capable of causing an appreciable difference in the size of the contact areas between the two quantities of electrode metal and the partition. At the same time the contact area between the arc and the colder electrode metal will

be increased to such extent that the compensation of the temperature necessary for the stabilization is performed substantially by the thermal action of the arc.

The invention will now be described more fully with reference to the accompanying drawings, in which

Fig. 1 shows in front view and plan one possible form of embodiment of the metal vapor lamp according to the invention,

Fig. 2 being a side view and plan. The illustrations are diagrammatical for the sake of better comprehension.

Figs. 3, 4 and 5 show in front view, side view and plan, and in tilted horizontal position, a form of the invention adapted for alternating current.

Figs. 6, 7 and 8 each show in side view and plan a modification of the alternating current lamp shown in Figs. 3, 4 and 5.

Figs. 9 and 10 indicate, respectively, a plan and cross-sectional view of an alternating current lamp provided with a longitudinal weir in the cathode chamber.

Figs. 11, 12 and 13 show modifications of the construction shown in Figs. 9 and 10.

Fig. 14 is a longitudinal section of a modified form of the invention provided with a cooling jacket, and

Figs. 15 and 16 illustrate in longitudinal section still further embodiments of the invention.

Referring now to Figs. 1 and 2, the lamp consists of a cylindrical and preferably perpendicularly disposed tube, for example composed of quartz, which is fused together at the upper end and is furnished at the bottom with a suitable sealing portion, through which are passed the two electrode leads, the latter being composed for example of tungsten. These leads for the purpose of obtaining a proper closure are each passed through a quartz capillary tube fused to the bottom of the lamp. The tube or bulb is divided by means of a partition of quartz extending throughout the whole of its interior with the exception of the upper end into two longitudinal halves, to each of which is assigned an electrode. The partition is fused with the wall of the tube or bulb and the bottom portion on all sides, excepting at the top.

As may be seen from the drawings, the two electrode leads may be fitted with great advantage on the one side in the vicinity of the wall. The lower portion of each of the two halves of the tube or bulb acts as pole receptacle for the electrode metal, which consists for example of mercury. The ignition, as shown in Fig. 2, is effected by performing a tilting action in the direction of the arrow, in such manner that the mercury of the two pole receptacles flows along both sides of the partition and unites at the free end. The lateral disposal of the leads ensures the contact being maintained upon the tilting action, even should the filling of mercury be very small.

After ignition is effected, the lamp is returned to vertical position. After a few minutes a stationary condition will occur, in which, as indicated in Figs. 1 and 2, a difference in level is formed between the anode and the cathode, so that the arc proceeding from the anode (indicated by dots and dashes) traverses the path *a*—*b* in close proximity to the cathode mercury, heating the same.

The stationary condition referred to may, in the case of the invention, be rapidly attained if by suitable axial rotation of the lamp during the tilting action, or by correspondingly shaping the partition, care is taken that a difference in the level occurs by reason of the tilting action alone. As shown by the drawings, the arc, during the abnormal operation of the lamp, burns in the vicinity of the axis of the tube or bulb in close proximity to both sides of the partition. In consequence the wall of the lamp—in comparison with the known lamps, in which the outer wall is so greatly heated that difficulty exists in sufficiently cooling the same—will not be heated, or only to a very negligible extent.

At the turning point of the arc the edge of the partition, which in itself is very thin, may be protected against an inadmissible overheating by thickening the said edge or furnishing the same with a special guard consisting of a metal which does not readily fuse, for example tungsten. The lamp may be employed not only in the perpendicular but also in an inclined position. In place of the mercury it is also possible to employ another metal or one of the known gas fillings.

In order to reduce the amount of electrode metal required to a minimum the cross-section of the cathode chamber near the surface of the cathode metal may be made smaller than the cross-section of the anode chamber near the surface of the anode metal, and/or the capacity of the cathode chamber may be reduced in size by furnishing the same with a tapered form towards the bottom, for example by passing the partition inclinedly at its lower end in a direction towards the cathode chamber.

The lamp does not require any special cooling arrangement, and may be allowed to operate for unlimited time. It is, however, quite possible to furnish the same with a liquid cooling means, for which purpose the cylindrical form of the lamp is particularly adapted. The cooling agent is then preferably passed at first about the two capillary electrode guides to the bottom of the bulb or tube and then through a cooling jacket which surrounds the tube and is composed of any desired material, whereby care must

be taken that any undesirable condensation of the metal vapor on the inner side of the bulb does not occur.

The lamp is adapted for all uses in which it is desired to utilize the physical, chemical or therapeutical action of rays emanating from a metallic arc, for example the irradiation of liquids for the purpose of sterilization or vitamination, whereby the liquid in question may be simultaneously employed as cooling agent; or for ozonization purposes, as source of emission of ultra-violet light, whereby the visible rays may be retained in the known manner by suitable, for example cylindrical, filter glasses or liquid jackets coaxial to the tube or bulb, for generating fluorescent effects, etc.

As confirmed by experiments which have been carried out, the lamp according to the invention may be allowed to burn continuously (several thousand hours) without the electrical operative conditions or the radiation varying to any noticeable extent.

Among the various advantages associated with a lamp constructed in accordance with the invention may be mentioned the following:

The construction is extremely simple and also inexpensive to make, and the amount of electrode metal required so small that the finished lamp may be readily transported without danger of breaking, while on the other hand the evacuation is considerably facilitated by reason of the smallness of the space to be evacuated. The degree of efficiency is extremely favorable in view of the fact that large quantities of metal and consequent loss of heat are avoided. The period of continuous burning may be varied within wide limits greatly exceeding those of the known metal vapor lamps. The lamp burns steadily and reliably both at low pressure as well as high pressure, and is insensitive to fluctuations in the load. Its compact form, in particular the tubular form, enables great intensity of radiation to be obtained in all directions without any disturbing shadows.

The bulb may be of any desired form, although the tubular form is to be preferred. The tubular form in any desired curvature may also be employed. When using a liquid cooling means the cooling jacket of the bulb may be constructed in such manner that the metal vapor condenses at a certain point of the wall of the bulb above the anode, preferably in the vicinity of the summit, and flows back to the anode. In this manner it is also possible to prevent creeping of the metal to the cathode.

If it is desired to construct the lamp for operation with alternating current, care must be taken to avoid the danger of short-circuiting between the anodes, of which there are at least two.

For this purpose the lamp may be constructed in such manner that upon the tilting action merely the metal from the one anode chamber flows along the partition to unite with the cathode metal flowing in the same direction at the end of the partition— under short circuit formation. The remaining anode chambers may be furnished with a dam preventing the mercury from flowing out. In the construction and arrangement of this dam it is important that at least the metal vapor of one of the arcs in the anode chambers is capable of heating the common and colder cathode to such extent that creeping of the metal is avoided. An arrangement in which all anode chambers directly bound the common cathode chamber is very suitable.

On the other hand the metal may be allowed to flow out of the anode chambers if the same is prevented from flowing together by means of suitable weirs at the top of the cathode chamber. These weirs may be in the form of longitudinal ribs fitted internally, or suitably formed elevations in the bulb itself.

In applying the invention to an A. C. lamp the preferably cylindrical bulb or tube is divided into two chambers by means of a longitudinal partition extending practically to the free end, the smaller of these acting as cathode chamber. The larger chamber serves for reception of the anodes and the weirs or dams. The bulb, partition, dams or weirs are preferably made of quartz glass and fused together.

Figs. 3, 4 and 5 show diagrammatically in front view, side view and plan and in tilted horizontal position (whereby the level of the cathode metal is depicted in dotted lines) a possible form of embodiment as applied to an alternate current lamp.

In this case the lamp c contains in addition to the partition d the dam arrangement e. Of the connections f, g and h the former leads to the cathode and g and h to the two anodes.

Figs. 6, 7 and 8 each show in side view and plan a modification of the A. C. lamp. As indicated in Figs. 7 and 8 at i in the plan view, the leads in the case of these lamps, which may be tilted towards both sides, may be passed along the bottom of the pole receptacle in such direction that upon the tilting action contact with the electrode metal is always maintained.

It will be noted that the partition dividing the anode chamber into two sub-chambers in Fig. 6 is inclined so that when the lamp is tilted in the direction of the arrow the metal of the anodes will not run together.

In Fig. 7 the partition in the anode chamber is in the form of a T, so that the tube may be inclined in either direction without causing confluence of the bodies of metal in the anode chambers. A similar result is obtained

with the construction shown in Fig. 8, wherein the partition in the anode chamber is in the form of a tube whose upper end is bent inwardly.

The form of the invention shown in Figs. 9 and 10 is composed of a cylindrical tube in which are located two parallel longitudinal partitions extending from the bottom of the tube to nearly the top thereof, so that three chambers are formed which communicate only at the upper end of the tube. The lower part of these chambers is filled with mercury and thus provides the three pole receptacles into which the three electrodes project from below, the electrodes being located in proximity at one side of the tube as indicated in Fig. 9. Both of the outer electrodes may, for example, be connected to the terminals of the secondary winding of a transformer, while the middle electrode is connected to the middle of such winding. Since the mercury vapor lamp, as is known, operates as a rectifier, the outer electrodes, with much connection, act alternately as anode, while the central electrode operates continuously as the cathode. The cathode and anode chambers are separated from each other by flat longitudinal partitions which may either be parallel to each other or converge toward each other. In the latter case, the lamp is tilted in the direction of convergence.

In the embodiments illustrated in Figs. 11 to 13 three partitions are shown which are arranged in star fashion and divide the tube into three chambers. In order to insure continuous electrical contact between the electrodes and the mercury inside such chambers, when the lamp is tilted, the electrode wires are extended along the bottom of such chambers as shown in Fig. 11.

The lamps designed for use with alternating current and shown in Figs. 3 to 13 can be ignited simply by tilting the same, no special provisions being necessary for preventing short-circuiting of the anodes. In certain cases, however, such provision may be desirable.

In the case of the embodiments according to Figs. 9–13 short-circuiting between the anodes upon the tilting action is prevented by means of special weirs *k*, which may be constructed for example in the form of elevations in the bulb or ribs or the like specially fitted in the cathode chamber, preferably at the upper end thereof. Upon the tilting action short-circuiting then occurs between the cathode and each anode. The anode with which the ignition occurs depends upon the direction and strength of the particular voltage.

The partitions between the anode chambers do not in these embodiments require to be quite as long as the cathode walls; the alternate current arc then traverses for the greater part always the same path, and breaks off towards the particular anode shortly above the low anode partition.

To facilitate the passage of the discharge from the ignition anode to the metal behind the dam arrangement, the wall of the latter may be furnished in the known manner with apertures or perforations, which are so small that the liquid metal, due to its large surface stress, is unable to pass out.

The same type of lamp may also be used for direct current, for which purpose the anodes, for example, are connected together exteriorly and connected in common to the positive terminals of the direct current source.

If the lamp is furnished with a liquid cooling means, or if the same for other reasons, possibly in the sterilization of a liquid by the rays emanating from the lamp is brought into contact with a liquid, the arrangement may be such that the action (reduction of the difference in temperature between the electrode metals) of the metal vapor forming the arc is assisted by the cooling action of the liquid, the new effect obtained as set forth above being still further amplified.

This, as shown diagrammatically in longitudinal section in the embodiment according to Fig. 14, may be accomplished by furnishing the lamp in a manner known per se with a heat-insulating jacket, for example a layer of quartz 1 which, however, not only surrounds the bulb itself as in the known case but also extends within the vicinity of the electrode metal.

The cooling liquid, or the liquid subjected to irradiation for the purpose of sterilization or the like, which liquid in the embodiment according to Fig. 14 is conducted through the boring 2, 3 of the hollow journal 4 of the lamp holder, through the receptacle 5 and through the space intermediate of the lamp and the casing 7, and is discharged through the socket 7, is then capable of cooling the parts of the electrode metal which are not covered by the jacket 1, while the electrode metal which is covered by the jacket remains uncooled and is accordingly heated to a greater extent than the electrode, say anode, metal cooled by the liquid. The compensation of the temperature performed in this manner may be made to vary in its effectiveness in accordance with the extent to which the electrode metal is subjected to or safeguarded against the cooling action of the liquid by the jacket 1, i. e., in accordance with the extent to which the jacket 1 covers the part of the lamp filled with the electrode metal, or—with a given area covered by the jacket—the degree of filling of the lamp.

Or as an additional embodiment the lamp, furnished with a heat-insulating jacket protecting at least the bulb or tube against any undesirable cooling, may be constructed to form an excellent source for ultra-violet light, as illustrated diagrammatically in longitu-

dinal section in Figs. 15 and 16, which show two possible examples.

The bulb or tube 11 of the cylindrical lamp surrounded by the heat-insulating jacket 10 is furnished in certain special relation with a filter tube 12, which is adapted in form to the shape of the bulb or tube, and which wholly or practically wholly retains the visible rays and allows the passage of merely ultra-violet rays. For the purpose of cooling the filter tube, which is sensitive to high temperatures, the same, as shown in Figs. 15 and 16, may be washed by a flowing liquid either on the inner side (Fig. 15) or on its exterior (Fig. 16).

Due to the intrinsic brilliancy resulting from the method of guiding the arc and the ultra-violet radiation of great intensity and extent on all sides with the exception of the bottom the lamp thus arranged is particularly adapted for creating fluorescent effects in cases in which the application of ultra-violet irradiation could hitherto not be considered, for example in the case of shop windows, the irradiation of advertising matter, etc. The cooling liquid, as may be considered desirable in certain cases, may be employed with certain additions thereto for producing the filtering action.

It will be understood that no restriction is made to the exact forms of embodiment shown, but that various other embodiments may be employed without departing from the spirit of the invention.

What we claim as new and desire to secure by Letters Patent is:

1. A metal vapor lamp comprising a closed bulb or tube, a longitudinal partition extending from the lower end practically to the opposite end of the said bulb or tube, the said partition being flat and protected at its free end with a highly refractory metal, anode and cathode chambers, electrode fillings in the said chambers, and points of attachment for the electrode leads.

2. A metal vapor lamp comprising a closed bulb or tube, a longitudinal partition extending from the lower end practically to the opposite end of the said bulb or tube, anode and cathode chambers, electrode fillings in the said chambers, a vacuum insulating jacket over the said bulb or tube and extending beyond the level of the said electrode fillings, and points of attachment for the electrode leads.

3. A metal vapor lamp comprising a closed bulb or tube, a plurality of longitudinal partitions dividing said tube into a cathode and a plurality of anode chambers, said cathode and anode chambers having electrode fillings, points of attachment for the electrode leads, and means for preventing confluence of the metal of the anodes.

4. A metal vapor lamp comprising a closed bulb or tube, a longitudinal partition extending from the lower end practically to the opposite end of the said bulb or tube a cathode chamber, a plurality of anode chambers within said bulb or tube arranged symmetrically to the said cathode chamber and having contact with one another, electrode fillings in the said anode and cathode chambers, and points of attachment for the electrode leads, the liquid metal being situated at one end of the tube only and forming the sole poles of the lamp.

5. A metal vapor lamp comprising a closed bulb or tube, a longitudinal partition extending from the lower end practically to the opposite end of the said bulb or tube, a cathode chamber, a plurality of anode chambers arranged symmetrically to the said cathode chamber, electrode fillings in the said anode and cathode chambers, a weir in the upper part of the said cathode chamber preventing the anode metal from flowing together, and points of attachment for the electrode leads.

6. In a mercury vapor tube, a partition which separates said tube into at least two chambers, said partition being connected to the bottom and a side wall of the tube, and a liquid electrode in each of said chambers for the starting and continuous operation of the tube, said electrodes being situated on one end of the tube only and constituting the sole electrodes of the tube.

7. In a mercury vapor tube, a partition which separates said tube into at least two chambers, said partition being connected to the bottom and a side wall of the tube, a liquid electrode in each of said chambers for the starting and continuous operation of the tube, and electrode leads in said chambers, said liquid metal electrodes and said electrode leads being situated on one end of the tube only.

8. In a mercury vapor lamp, a main partition which separates said tube into two chambers, said partition being connected to the bottom and the side walls of the tube, another partition in one of said chambers, and liquid electrodes for the starting and continuous operation of the tube, said electrodes being situated in said chambers at one end of the tube only and constituting the sole electrodes of the tube.

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