Nov. 2, 1937. C. SPAETH 2,098,113

LAMP AND METHOD OF OPERATING SAME

Original Filed Feb. 6, 1932 2 Sheets-Sheet 1

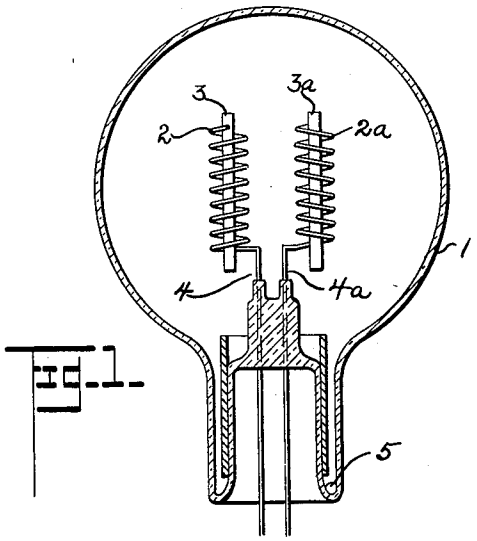


Fig. 1.

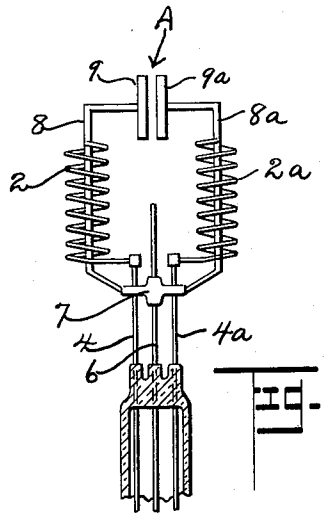


Fig. 2.



Fig. 3.

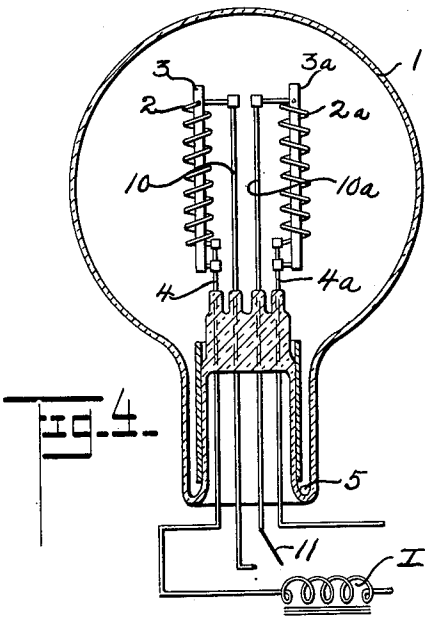


Fig. 4.

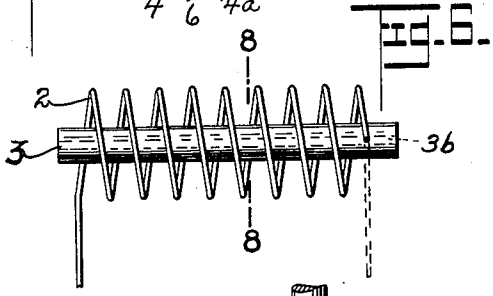


Fig. 6.

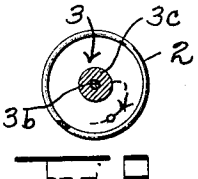


Fig. 8.

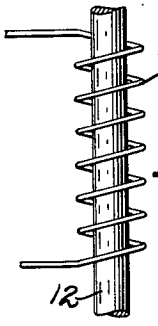


Fig. 7.

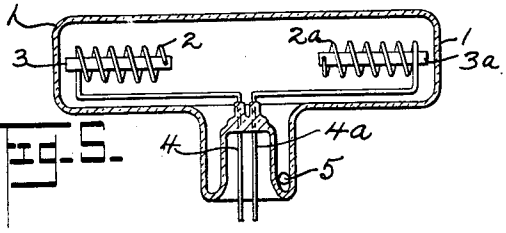


Fig. 5.

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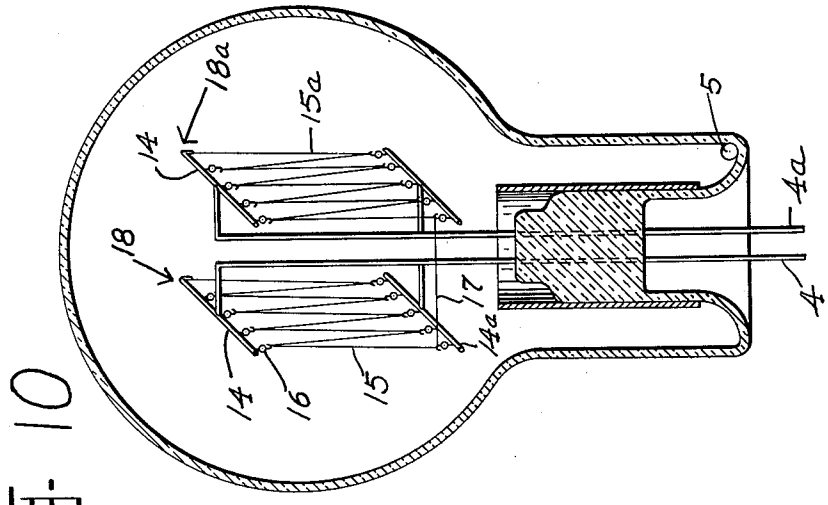


FIG. 10

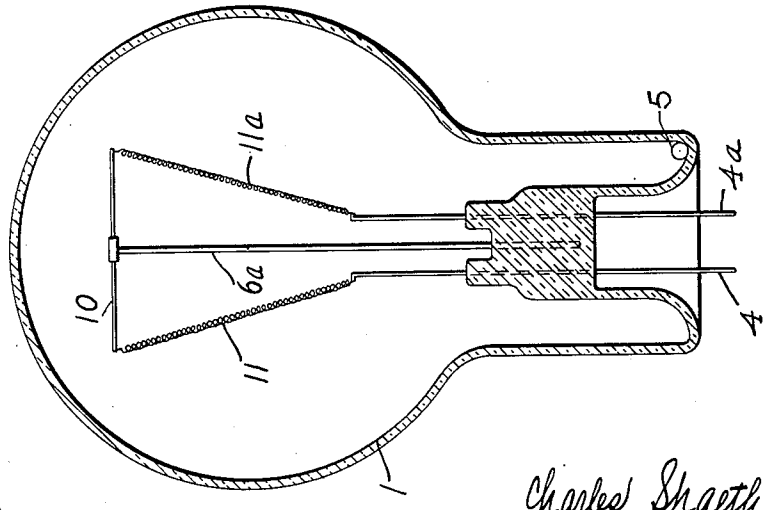


FIG. 9

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Patented Nov. 2, 1937 2,098,113

UNITED STATES PATENT OFFICE

2,098,113

LAMP AND METHOD OF OPERATING SAME

Charles Spaeth, Flushing, N. Y.

Application February 6, 1932, Serial No. 591,305
Renewed February 24, 1936

19 Claims. (Cl. 176—122)

My invention relates to a new and improved electric lamp, and to a new and improved method of operating such a lamp.

One of the objects of my invention is to produce a lamp which shall have high luminous power, and which also produces light having a spectrum which is similar to that of natural sunlight, so that the lamp can be used both for lighting purposes and also for a sunshine lamp.

Another object of my invention is to provide a lamp whose lighting element will deliver a substantial proportion of rays in the violet end of the spectrum, including ultra-violet rays, if the globe or envelope of the lamp is made of suitable light-permeable material.

Another object of my invention is to produce a lamp which can be economically manufactured and operated.

Another object of my invention is to provide a lamp having magnetic means for trapping or controlling the movement of the particles emitted from the electrodes, in order to diminish or substantially prevent the deposit of such particles upon the envelope of the lamp.

Another object of my invention is to produce a lamp of this type which contains a suitable quantity of mercury (preferably a mercury sodium amalgam), so that the vapors of mercury and of sodium are produced in the lamp during its operation, thus securing the proper light emission.

It is also well known to operate lamps with sodium alone, instead of using a sodium alloy, as above suggested.

Other objects of my invention will be set forth in the following description and drawings which illustrate a preferred embodiment thereof, it being understood that the above general statement of the objects of my invention is intended to merely generally explain the same without limiting it in any manner.

Fig. 1 is a diagrammatic vertical section of a device embodying my invention.

Fig. 2 illustrates a modification of the lighting element.

Fig. 3 is a bottom view of Fig. 2, showing the magnetic field.

Fig. 4 shows another modification of the lighting element.

Fig. 5 shows another modification.

Fig. 6 is an enlarged detail view of a member of the lighting element which is shown in Fig. 1.

Fig. 7 illustrates another modification of the lighting element member.

Fig. 8 is a section on the line 8—8 of Fig. 6,

Figs. 9 and 10 illustrate different embodiments.

Referring to Fig. 1, the globe or envelope 1 is made of any suitable glass through which the violet and ultra-violet rays can pass. Such glass is well known in the industry and is commonly called "Corex" glass, and "Uriol" glass.

The interior of the globe 1 can contain a suitable inert gas. I prefer to use neon, because its spectrum is complementary to the spectrum emitted by mercury and by sodium. However, I do not wish to limit myself to the use of neon, as I can use any suitable inert gas, such as argon, helium, zenon and krypton. I can also utilize any monatomic gas or vapor.

If neon is used, I prefer to have it within the globe 1 at a pressure of 2–3 mm. of mercury at ordinary room temperature of about 70° F. I do not wish to limit myself to the use of this low pressure range, as this is merely given to illustrate one practical way of utilizing the invention.

The lighting element comprises a pair of coils 2 and 2*a*, which are preferably made from a paramagnetic material, such as an alloy of tungsten with a paramagnetic metal. I prefer to use tungsten because of its high melting point, but I do not wish to limit myself to this metal as I can utilize rhenium, tantalum or molybdenum.

In order to produce a paramagnetic alloy with the high melting metal, either iron or cobalt or nickel, or any suitable material of the paramagnetic group may be alloyed with the high melting metal. Likewise, the alloy may contain thorium or beryllium, as paramagnetic material. Tungsten has some slight paramagnetic properties, and in certain aspects of the invention the same is not to be limited to an alloy of tungsten with iron or nickel or the like. However, I prefer to alloy the tungsten with thorium or the like since the alloy has much greater paramagnetic properties than the pure tungsten.

Reference is made to the previously filed application Serial No. 577,938, and it is sufficient to generally state that a suitable alloy would contain for example 98 percent of tungsten and 2 percent of either iron or cobalt or nickel.

The coils 2 and 2*a* are preferably provided with core members 3 and 3*a*. The ends of the coils 2 and 2*a* can be suitably secured to the cores 3 and 3*a*, as for example by welding.

The lead-in wires 4 and 4*a* may be made of tungsten or nickel or iron, or they may be made of the same material as the coils 2 and 2*a*.

The core of the preferred type is preferably made by providing a wire which is made from iron or nickel or cobalt, with a coating of suitable

thickness. I prefer to form such coating from an oxide or oxides, or from a carbide or carbides, which have a very high electron emission. I may use said coating substances in any desired combination. A coating of this type has a high melting point and a very low vapor pressure. Hence the sputtering of these coated electrodes is extremely small and very little bulb blackening results, so that the envelope 1 remains transparent.

The coatings for said wires can be of the type previously mentioned, such as the oxides and carbides of the rare earth metals and the alkaline earth metals. For example, I can utilize mixtures of the oxides and carbides of metals, such as zirconium, yttrium, aluminum, calcium, barium and strontium. It is also well known that the carbides of tungsten, rhenium, tantalum, molybdenum, and of other metals, produce coatings of this type. Such oxides or carbides can have fine particles of paramagnetic material (iron, cobalt, etc.) intermixed therewith, and the mixture may be ball milled for several hours in order to uniformly intermix the fine paramagnetic particles with the remainder of the coating. A suitable binder, such as paraffin oil, may be used for forming a paste of the oxides and carbides and said fine particles, so that this paste can be molded around the wires by means of high hydraulic pressure, such as about 4–6 tons per square inch. When the moulding has been completed, the cores can be heated in an electric furnace at a temperature of about 1200° C. This produces a sintering effect, so that the cores are made rigid and can be readily handled. Instead of using a mixture of the oxides and carbides of the above mentioned metals, I can use the oxides alone or the carbides alone. The percentage of the paramagnetic particles (iron, cobalt, etc.) may be from 10 to 20 percent of the mass of the entire coating. Of course, I may also use mixtures of the oxides of the rare earth metals and of the alkaline earth metals.

In order to give full practical details, without limiting myself to such details, certain dimensions have been found satisfactory:—

The diameter of the globe 1 is about three inches. The wires 4 and 4*a* may each have a thickness of about .040–.060 inch, and they are about one-eighth of an inch apart.

The axes of the coils 2 and 2*a* may be spaced from 1–1½ inches. In view of this spacing, and considering the pressures previously mentioned, the discharge between said coils 2 and 2*a* is a glow discharge, as distinguished from an arc discharge.

The coils 2 and 2*a* may be made from wire having a thickness of 5–25 mils (.005–.025 inch).

The wires used for making the cores 3 and 3*a* may have a thickness of 10–30 mils. The external diameter or thickness of the core 3 and of the core 3*a* is about 60–80 mils. This lamp is designed to take a full line voltage of 110 volts, for example.

Into the lamp I place a suitable mass 5 of mercury, or of mercury-sodium amalgum or alloy. The mercury may have a volume of ½ cc. or 1 cc. If I use a mercury sodium alloy, said ingredients are present in the alloy in about equal proportions, although such proportions can be varied.

The lamp can be connected to the power line by means of a suitable inductance or resistance in order to limit the initial current, or to limit the current at any time.

When the lamp is first connected to the electric power line (which may be either direct or alternating), a discharge takes place between the coils 2 and 2*a*, and the cores 3 and 3*a*. At the beginning of the discharge, the current may be from 1–2 amperes, although this may vary depending upon the individual design of the lamp. As the internal temperature of the lamp rises, its resistance diminishes, so that the lamp is designed to normally take a maximum current of from 5–6 amps.

When this full current is taken, the wires 4 and 4*a* have a sufficiently intense electromagnetic field between them and around them, so that the magnetic particles which are sputtered from the coils 2 and 2*a* and from the cores 3 and 3*a* travel in a ring-path, as diagrammatically shown in Fig. 8. This greatly diminishes the deposit of these particles upon the interior of the globe 1, so that this is reduced to a minimum. These particles are deposited on the wires 4 and 4*a* or adjacent thereto, at the base of the lamp. Likewise, the internal temperature of the lamp is sufficient to vaporize the mercury or mercury alloy, so that the suitable spectrum combination is secured.

In the embodiment shown in Fig. 2, a supporting wire 6 is utilized, and a glass bead 7 is supported on the wire 6. The wires 8 and 8*a* of the arc A are supported upon the bead 7. The coils 2 and 2*a* are connected to the wires 8 and 8*a*.

When the lamp is switched on, a discharge initially takes place between the coils 2 and 2*a* and the cores 8 and 8*a* because of their small diameter, so that a corona discharge can be produced. The heat of this discharge vaporizes the mercury or the like so as to gradually lower the resistance of the gap A. The discharge is therefore gradually transferred from the coils to the gap A, so that when the lamp is in full operation, practically all of the discharge takes place through the gap A.

The lead-in wires 4 and 4*a* have the composition previously specified. Likewise, the coils 2 and 2*a* have the composition previously specified.

The core wires 8 and 8*a* and their electrodes 9 and 9*a* are preferably of the paramagnetic alloy previously specified. Likewise, the electrodes 9 and 9*a* may be constructed like the cores 3 and 3*a*.

Fig. 3 shows how the particles which are emitted from the electrodes or from the coils travel in a ring-shaped path, following the electromagnetic field surrounding the conductors.

Referring to Fig. 4, this shows two additional tungsten lead-in wires which may be connected or disconnected by means of a switch 11. Fig. 4 also shows the inductance I which is utilized with an alternating current.

In starting the lamp, the switch 11 is closed. When the switch 11 is closed, the current has a complete wire circuit through the lamp, so that the coils 2 and 2*a* can be heated to incandescence, and thus heat the cores 3 and 3*a* and cause them to emit, so as to bring the cores 3 and 3*a* up to the emission temperature. When this has been done, the switch 11 can be opened.

Fig. 5 shows a globe 1 of tubular shape. It also shows the coils mounted endwise. In this case the gap or positive column between the coils can be as long as two feet for use with a 110 volt line voltage (alternating current). Of course, in order to have a gap of this length, the tube must have a sufficient cross section, in order to lower the resistance sufficiently. In starting this lamp a glow discharge will take place near the lead-in wires which are very closely spaced, as soon as the circuit is closed. This discharge will

move towards the end of the tube and to the electrodes 2 and 2a, 3 and 3a, until there is sufficient ionization to start the positive column between the electrodes. Otherwise, the details previously mentioned apply to other embodiments.

In the embodiment shown in Fig. 7, the wire 12 has a thickness of about 4–60 mils, and it is made of a paramagnetic alloy of the type previously mentioned. Since Fig. 7 is only a fragmentary view, it may be noted that the wire 12 may be formed into a helical coil, as shown in the complete embodiments disclosed for example in Fig. 1 and in Fig. 9.

The coil 14b is made of the tungsten alloy previously mentioned, having a coating of the oxides previously mentioned. The coil 14b can be considered as taking the place of the coil 2. The coil 14b consists of a wire core having a thickness of from 0.5–10 mils. As previously stated, after the wire 14 has been coiled upon the wire 12, said wire 12 may be formed into a helical coil. This provides a combination helix whose outside diameter may be from 3 mils to 15 mils although this outside diameter may be increased, depending upon the size of the lamp and the incidental wattage consumption.

The wire core of the coil 14b may be made from the paramagnetic tungsten alloy previously mentioned, and the oxide or carbide coating of said coil 14b may be similar to the oxide or carbide coating of the cores 3 and 3a.

The embodiment shown in Fig. 7 has superior emission. The helically coiled wire 12 serves both as a support and also to lower the magnetic reluctance, and it also serves to intensify the magnetic field which is induced by the coil 14.

It will be noted that the discharge between the coils 2 and 2a is not a so-called arc discharge. The discharge is a true glow discharge, in that each coil is surrounded by a luminous zone, and there is an intermediate dark area between said luminous zones. This glow discharge is produced because there is a proper proportion between the pressure of the gaseous filling of the lamp, and the spacing of the discharge members. If the gaseous atmosphere of the lamp is at a certain pressure, the glow discharge will be transformed into the undesirable arc discharge, if the discharge members are too close to each other. As previously stated, I do not wish to be limited to any particular pressure of said gaseous atmosphere. In a lamp which produces an arc discharge, the luminescence is limited to the area which surrounds the ends of the discharge members, so that a concentrated and intensely bright light is produced. If a true glow discharge is utilized, the luminescence is much more extended. A lamp which produces a glow discharge has a much longer life, than a lamp which produces an arc discharge.

In the embodiment shown in Fig. 2, a true arc is formed between the electrodes 9 and 9a, when the mercury or the like is sufficiently vaporized by the heat.

When the lamp is heated, the neon gas emits a red light, the mercury emits a blue and bluish-green light and the sodium emits a yellow light. Hence, the combined spectrum delivered by the lamp is practically complete, so that a white light is delivered by the lamp. Hence, the lamp possesses desirable and high illuminating power, in addition to producing a large amount of violet and ultra-violet rays. The mercury vapor emits the violet and ultra-violet rays.

In the embodiment shown in Fig. 9, the envelope 1 is provided with lead-in wires 4 and 4a, and said envelope is also provided with a supporting wire 6a which supports a wire 10. Said wire 10 may be made of any suitable metal which has a high melting point, such as tantalum, tungsten, molybdenum, etc. Said wire 10 may have any shape. It is not necessary that the wire 10 should be made of a paramagnetic alloy, although this may be done if desired. The current passes through the coils 11 and 11a which are similar to the coil 14b. As previously noted, the wire 12 shown in Fig. 7, may be formed into a helical coil, after the wire 14 has been coiled helically upon said wire 12. That is, said coils 11 and 11a are made of paramagnetic material having a high melting point, and having a coating of high electron emission power, said coating including finely divided paramagnetic particles. When this lamp is put into circuit, the current passes through the complete circuit provided in the interior of the lamp until the coils 11 and 11a are sufficiently heated, so that they emit electrons. When the coils 11 and 11a have been sufficiently heated, they act as discharge members and the current (or a portion of the current) then passes through the lamp as a discharge current between the discharge members 11 and 11a. If it is desired to have a glow discharge within the lamp shown in Fig. 9, this can be accomplished by having a proper proportion between the spacing between the coils 11 and 11a, or between those ends of said coils which are closest to each other, in proportion to the pressure of the gaseous atmosphere. As previously specified, the coils 11 and 11a, or the parts thereof which act as discharge members, must be spaced apart sufficiently, in accordance with the pressure of the gaseous atmosphere, in order to retain the flow discharge.

In the embodiment shown in Fig. 10, the discharge members are arranged in the form of grids. Each grid comprises supporting wires 14 and 14a, which are generally similar to the wire 10 shown in Fig. 9. The grids 15 and 15a are connected to the supporting members 14 and 14a by means of insulating members 16 which may be made of synthetic quartz or other material having a suitable high melting point. The grids 15 and 15a are made of paramagnetic material having a coating of the type previously described. Said grids may be formed of wire having any shape. Said grids are connected to each other by means of a wire 17. It will be noted that the grids 15 and 15a are respectively connected to the members 14, at the points 18 and 18a. Likewise, the lead-in wires 4 and 4a are respectively connected to the members 14 and 14a. The lamp shown in Fig. 10 operates essentially like the lamp shown in Fig. 9.

The use of wires arranged in the form of grids, in the manner shown in Fig. 10, produces high emission, so that the luminous effect is substantially the same as though the discharge members consisted of flat plates having the areas of the grids.

I have shown a preferred embodiment of my invention, but it is clear that numerous changes and omissions can be made without departing from its spirit.

I claim:—

1. An electric lamp having lead-in wires and separated discharge members connected to said lead-in wires, the distance between said discharge members being greater than the distance between

said lead-in wires, said discharge members including paramagnetic material.

2. An electric lamp comprising a pair of separated discharge members, said discharge members respectively consisting of coils of paramagnetic conducting material having electrodes located therein, said electrodes comprising cores of paramagnetic material, said cores having coatings of high electron emission power intermixed with fine paramagnetic particles, and lead-in wires connected to said coils.

3. An electric lamp comprising a pair of separated discharge members, said discharge members respectively consisting of coils of paramagnetic conducting material having electrodes located therein, said electrodes comprising cores of paramagnetic material, said cores having coatings of high electron emission power intermixed with fine paramagnetic particles, and lead-in wires connected to said coils, the distance between said discharge members being greater than the distance between said lead-in wires.

4. An electric lamp comprising separated discharge members and lead-in wires, said lead-in wires being connected to said discharge members by coils made of paramagnetic material, said discharge members including paramagnetic material, said coils being sufficiently closely spaced so as to emit electrons and permit the passage of current when the lamp is put into circuit while said lamp is cold.

5. An electric lamp comprising separated electrodes having coatings of high electron emission power mixed with paramagnetic material, lead-in wires connected to said electrodes by means of coils, said coils being made of paramagnetic material, the distance between said coils exceeding the distance between said lead-in wires, said coils being sufficiently closely spaced to produce an electron discharge and the passage of current through the lamp, when the lamp has its circuit closed while the lamp is in the cold condition.

6. An electric lamp comprising separated discharge members made of paramagnetic material, lead-in wires connected to said discharge members, the distance between said dscharge members exceeding the distance between said lead-in wires, conducting means passing through said lamp and connected to said discharge members, and a switch external to said lamp and adapted to connect said conducting means.

7. An electric lamp comprising an envelope having separate discharge members located therein, said discharge members being connected to lead-in wires which pass through said envelope, at least one of said discharge members including paramagnetic material which is emitted during the operation of the lamp, said lead-in wires carrying sufficient current during the normal operation of the lamp to attract said emitted paramagnetic material.

8. An electric lamp comprising an envelope having separate discharge members located therein, said discharge members being connected to lead-in wires which pass through said envelope, at least one of said discharge members including paramagnetic material which is emitted during the operation of the lamp, said lead-in wires carrying sufficient current during the normal operation of the lamp to attract said emitted paramagnetic material, said lead-in wires being closely associated so that all of said emitted paramagnetic material is deposited at the same portion of the lamp.

9. An electric lamp comprising an envelope having separate discharge members located therein, said discharge members being connected to lead-in wires which pass through said envelope, at least one of said discharge members including paramagnetic material which is emitted during the operation of the lamp, said lead-in wires carrying sufficient current during the normal operation of the lamp to attract said emitted paramagnetic material, said lead-in wires being made of paramagnetic material.

10. An electric lamp comprising an envelope having separated discharge members located therein, said discharge members being connected to lead-in wires which pass through said envelope, at least one of said discharge members including paramagnetic material which is emitted during the operation of the lamp, said lead-in wires carrying sufficient current during the normal operation of the lamp to attract said emitted paramagnetic material, said lead-in wires being closely associated so that all of said emitted paramagnetic material is deposited at the same portion of the lamp, said lead-in wires being made of paramagnetic material.

11. An electric lamp having an envelope and separated discharge members located within said envelope, at least one of said discharge members including paramagnetic material which is emitted during the operation of the lamp, the circuit of said discharge members including electromagnetic means which are adapted to attract said emitted paramagnetic material, in order to localize the deposit of the emitted paramagnetic material.

12. An electric lamp having an envelope, said envelope having a gaseous atmosphere, separate lead-in wires projecting through said envelope, said wires being adapted to be connected to the opposite terminals of a source of electric current, discharge members connected to said lead-in wires, said discharge members including paramagnetic material and additional material of high electron-emission power, said discharge members being sufficiently close to each other to produce an electron discharge in said atmosphere, the pressure of said atmosphere being sufficiently low to cause said discharge to be a glow-discharge, said discharge members being connected within said envelope so as to form a complete wire circuit within said envelope.

13. An electric lamp having an envelope, said envelope having a gaseous atmosphere, separate lead-in wires projecting through said envelope, said wires being adapted to be connected to the opposite terminals of a source of electric current, said lead-in wires being connected to discharge members by coils made of paramagnetic material, said discharge members including paramagnetic material and additional material of high electron-emission power, said discharge members being sufficiently close to each other to produce an electron discharge in said atmosphere, the pressure of said atmosphere being sufficiently low to cause said discharge to be a glow discharge, said discharge members being connected within said envelope so as to form a complete wire circuit within said envelope.

14. An electric lamp having an envelope, said envelope having a gaseous atmosphere, separate lead-in wires projecting through said envelope, said wires being adapted to be connected to the opposite terminals of a source of electric current, discharge members connected to said lead-in wires, said discharge members being made of an alloy which has a high melting point, said al-

loy including a paramagnetic ingredient which has a different melting point than said alloy, said discharge members also including additional material of high electron-emission power intermixed with a paramagnetic metal whose melting point is different from the melting point of the alloy, the pressure being sufficiently low to cause said discharge to be a glow discharge.

15. An electric lamp having an envelope, said envelope having a gaseous atmosphere, separate lead-in wires projecting through said envelope, said wires being adapted to be connected to the opposite terminals of a source of electric current, discharge members connected to said lead-in wires, said discharge members being made of an alloy which has a high melting point, said alloy including a paramagnetic ingredient which has a different melting point than said alloy, said discharge members also including additional material of high electron-emission power intermixed with a paramagnetic metal whose melting point is different from the melting point of the alloy, the pressure being sufficiently low to cause said discharge to be a glow discharge.

16. An electric lamp having an envelope, said envelope having a gaseous atmosphere, separate lead-in wires projecting through said envelope, said wires being adapted to be connected to the opposite terminals of a source of electric current, discharge members connected to said lead-in wires, said discharge members being made of an alloy which has a high melting point, said alloy including a paramagnetic ingredient which has a different melting point than said alloy, said discharge members also including additional material of high electron-emission power intermixed with a paramagnetic metal whose melting point is different from the melting point of the alloy, both said before-mentioned metals being paramagnetic, the pressure being sufficiently low to cause said discharge to be a glow discharge.

17. An electric lamp having an envelope, said envelope having a gaseous atmosphere, separated discharge members located within said envelope, at least one of said discharge members comprising a coil of conducting material, and an electrode located within said coil, said electrode having a coating which includes paramagnetic material and which has high electron-emission power, said coil being made of paramagnetic material, said coil being sufficiently close to the other discharge member so as to enable the current to permanently discharge between said discharge members during the operation of the lamp, said pressure being sufficiently low to cause said discharge to be a glow discharge.

18. An electric lamp having an envelope, said envelope having a gaseous atmosphere, separate lead-in wires projecting through said envelope, said wires being adapted to be connected to the opposite terminals of a source of electric current, a metal member connecting said lead-in wires, the ends of said metal member being sufficiently close to each other to produce an electronic discharge between them so that said ends act as discharge members while current is flowing through said metal member, said discharge members including paramagnetic material and additional material of high electron-emission power, the said ends being sufficiently spaced apart in proportion to the pressure of said atmosphere, in order to cause the discharge to be a glow discharge.

19. An electric lamp having an envelope containing a gaseous atmosphere, separate lead-in wires projecting within the envelope and adapted to be connected to the opposite terminals of a source of electric energy, discharge members connected to said lead-in wires, said discharge members being made of an alloy which has a melting point and which includes a paramagnetic ingredient having a different melting point from said alloy, said discharge members also including additional material of high electron-emission power, intermixed with a paramagnetic metal whose melting point is different from the melting point of the alloy.

CHARLES SPAETH.