July 9, 1935. C. H. BRASELTON 2,007,920

SHORT WAVE LENGTH ELECTRIC LAMP

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Fig. 1.

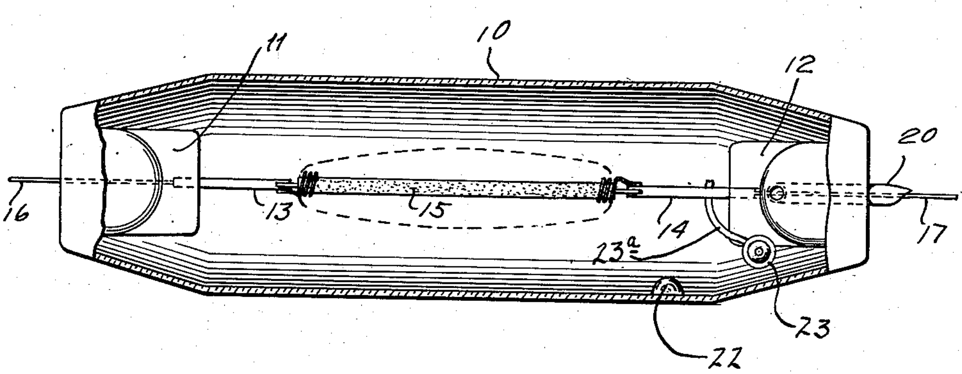


Fig. 5.

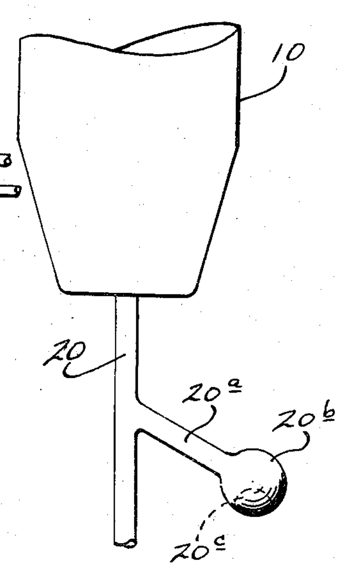


Fig. 2.

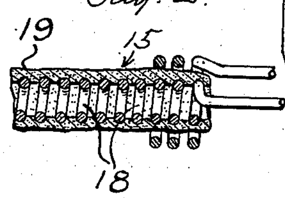


Fig. 3.

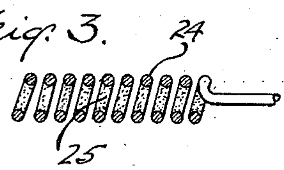
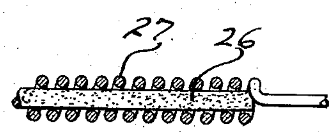


Fig. 4.



INVENTOR

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Fig. 12

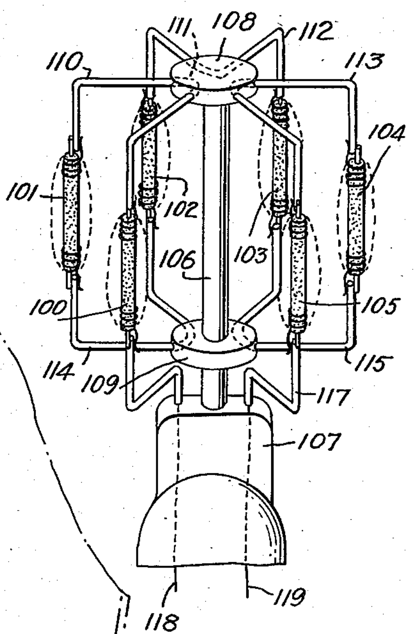

Fig. 6

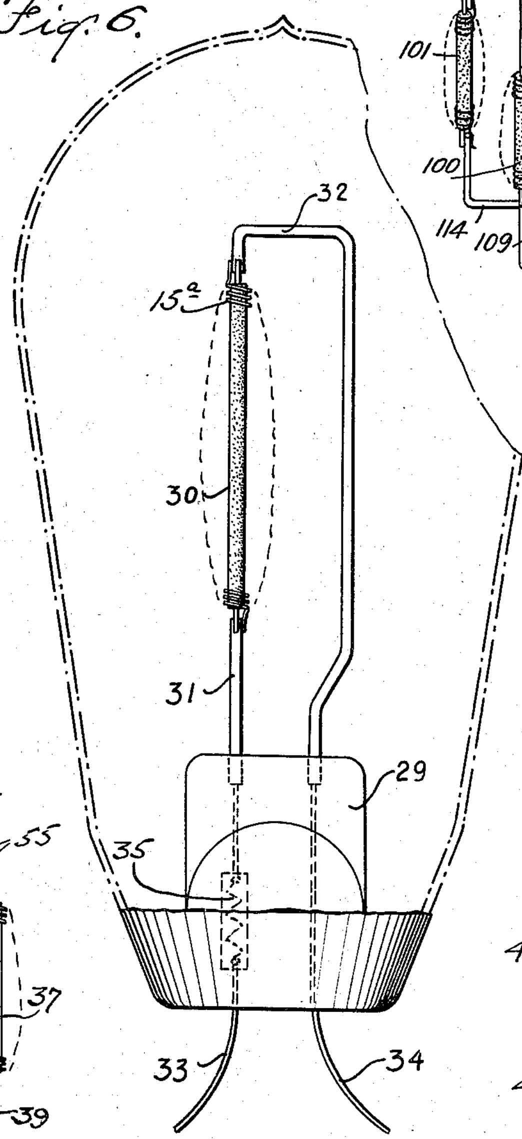

Fig. 7

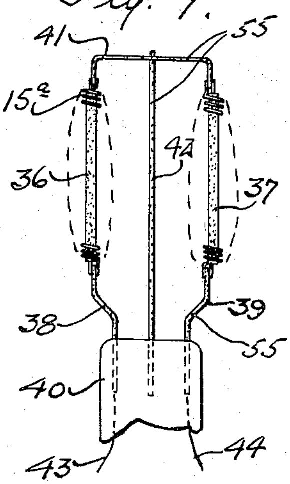

Fig. 8

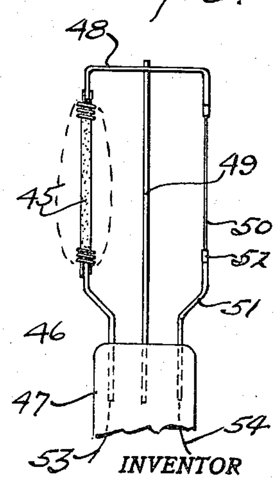

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Fig. 9.

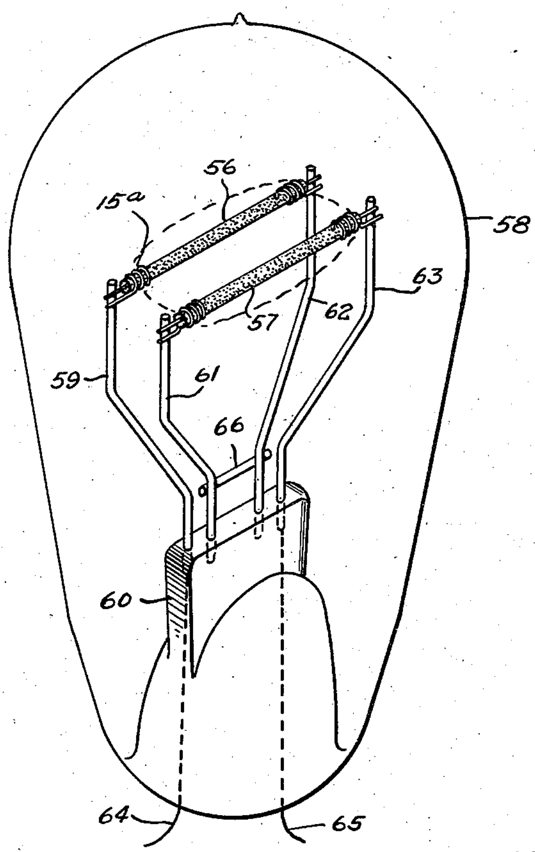


Fig. 10.

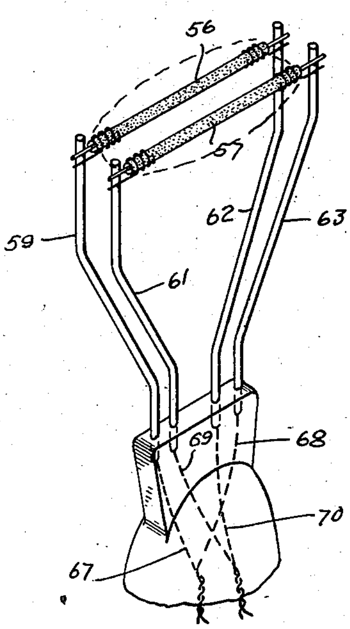
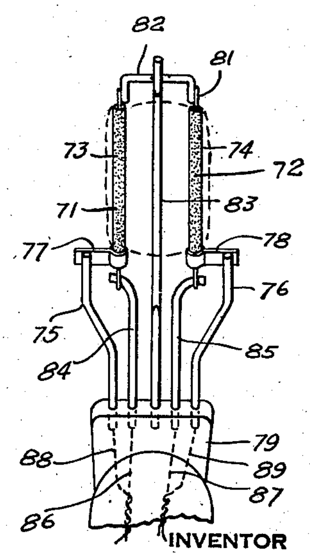


Fig. 11.



INVENTOR

Patented July 9, 1935

2,007,920

UNITED STATES PATENT OFFICE

2,007,920

SHORT WAVE LENGTH ELECTRIC LAMP

Chester H. Braselton, New York, N. Y., assignor to Sirian Lamp Company, Newark, N. J., a corporation of Delaware

Application December 7, 1931, Serial No. 579,587

3 Claims. (Cl. 176—1)

This invention relates to short or low wave length electric lamps such as those producing ultra-violet rays or other low wave length radiations for application to actino-therapy and photochemistry.

Heretofore the practical source of actinic radiations which have been available are sunlight, the arc light, and the mercury vapor lamp. The sunlight is too variable to be considered industrially. Arc lights are also variable in operation and are costly to operate due to the continuous consumption of the electrode material. Mercury vapor lamps besides having a high initial cost require direct current for operation and have a short life due to change of quartz surface. They also require auxiliary equipment.

It is one of the objects of the present invention to provide a low wave length electric light which may be operated on commercial circuits without any auxiliary equipment and with low power consumption and long life.

Another object of the invention is to provide a low wave length light which arises from a uniformly distributed discharge of high intensity and steadiness comparable to a filament.

Other objects of the invention and objects relating to the construction and assembly of the various parts will be apparent as the description of the invention proceeds.

One embodiment of the invention has been illustrated in the accompanying drawings in which:

Fig. 1 is a front elevational view of an electric lamp made in accordance with the invention;

Figs. 2, 3, and 4 are fragmentary longitudinal sectional views of several forms of electron emitting elements which may be used with the device;

Fig. 5 is a fragmentary elevational view of the lamp of Fig. 1 and illustrating an alternative step in the manufacture thereof;

Fig. 6 is a sectional elevation of another embodiment of the invention;

Figs. 7 and 8 are fragmentary sectional views of other modifications of the invention;

Figs. 9 and 10 are perspective views showing modified forms of element structures;

Fig. 11 is a perspective view of another embodiment of the invention; and

Fig. 12 is a perspective view of an element construction showing one manner of mounting a plurality of elements.

In my application Serial No. 459,048, filed June 3, 1930, entitled Electrical discharge device, I have shown and described an electric lamp in which a filamentary wire is coated with an electron emitting material which, when energized in the presence of an ionizable gas at a certain suitable pressure, forms an ionic discharge along the filament which surrounds the filament like a halo. The effect is somewhat dependent on the resistance and length of the wire, the voltage used across the terminals, and the kind of gas used and the pressure thereof. The lamp of the present invention operates on the same principle but makes use of a specific form of ionizable gas to give a definite result.

Thus in Fig. 1 the envelope **10** is preferably made of quartz or other material which will not absorb low wave length radiation to any extent and which may be made tubular being integral with the presses **11** and **12** in a manner well known in the art. A short support rod **13** may be sealed in the press **11** and in like manner a second short support rod **14** may be sealed in the press **12**. An electron emitting element **15** may have connected to its ends support rods **13** and **14**. A pair of leading-in wires **16** and **17** may be connected respectively to the support rods **13** and **14** as indicated in the drawings.

In Fig. 2 I have shown an enlarged sectional view of a portion of the element **15**. This element comprises a coil **18** of refractory resistance wire such as tungsten, molybdenum, nichrome and tantalum wound in a concentrated form in a manner well known in the art and having the outer surface of the coil coated with electron emitting material **19**. This electron emitting material may be any of the well known materials such as the oxides of the alkaline earth metal group and may preferably be a mixture of calcium and barium oxides, the calcium oxide having the property of selective radiation and therefore increasing the amount of light produced by the lamp.

If desired the element **15** may be made as indicated in Fig. 3 where a coil **24** of wire is shown with electron emitting material **25** coated upon each individual turn of the coil so that there is a space between adjacent turns while another construction is shown in Fig. 4 where a core **26** of electron emitting material is shown inside of the coil **27**.

Although coiled filaments are shown, the element may be in the form of a single straight wire coated with the electron emitting material, or it may be coated in spots as clearly illustrated in my application above referred to, or a filament with the electron emitting material incorporated in it, such as a thoriated tungsten filament, made by treating tungstic acid and thorium nitrate, may be used, the essential feature being that at least portions of the filament are in contact with the electron emitting material and there is a potential drop from end to end thereof. Also, if desired, the electron emitting material may be coated on electrodes inserted in the ends of the coil and between which the discharge takes place.

In order to take care of the additional current flowing when the element is energized I may prefer to provide additional terminals at each end of the element as the coil 15a which may consist of a few turns of tungsten or other wire capable of standing a high temperature positioned at each end of the element and welded to the support rods as shown in Figs. 1 and 2. The diameter of this wire should be sufficient to carry the additional current but it should not be large enough to cool down the ends of the filament. It may or may not be coated with electron emitting material, as desired.

The envelope may be filled with an inert gas, preferably one producing, when ionized, radiation near the violet end of the spectrum such as argon with some helium and some neon if desired and a metal vapor such as mercury vapor which produces the ultra-violet radiation. Other metal vapors such as caesium and calcium may be found desirable in small quantities to increase the conductivity of the gas.

In constructing such a device the element as shown may be mounted between the presses and the presses sealed or fused to the envelope in a manner well known in the art. The bulb may then be connected by means of a tube 20 to a vacuum pump and an oven placed over it and while the gases and vapors are being withdrawn from the envelope by the vacuum pump it is heated to remove all traces of occluded gases. The element may be also heated to about 600° C. by passing a current through it. When substantially all of the gases have been removed and a high vacuum in the neighborhood of .5 micron is reached the filament current may be increased and the temperature of the filament raised slowly to about 800° C. to drive out the binder used for the electron emitting oxide. When no more gas is found in the bulb the oven may be raised and the current through the element increased to raise the temperature to about 1200° C. or less for a moment, the pump being connected all this time to maintain a high vacuum. The pump and the current may then be shut off and about ½ mm. of an inert gas such as neon may then be admitted into the bulb and the filament current turned on again to activate the electron emitting coating. Spots of localized discharge having a reddish color will then appear and spread until a diffused discharge substantially fills the bulb which generally takes less than ten minutes to insure complete activation. At this period the activating current should not be too high so as to prevent burning out the filament or volatilizing the oxide on the surface thereof. When a discharge from all parts of the filament is apparent the activation is complete and the lamp may be again evacuated until no positive ionization occurs. At this point 5 mm. of helium gas and also 10 mm. of neon may be added to increase the conductivity and to cause the discharge to occur in all directions. Then enough argon gas may be added until all ionic discharge stops except an intense one surrounding the filament and in the same direction as the filament. This discharge will vary with the light intensity as governed by the temperature of the emitting oxide. About 100 mm. of argon have been found to be sufficient to confine the ionic discharges along the length of the filament. The bulb may then be sealed off.

The mercury or other metals for producing the metal vapor may be introduced into the bulb by means of a small container 23 attached to one of the support rods by means of a wire 23a and having a pin hole therein. This container may be filled with a compound of the metal used, as caesium or mercuric chloride and magnesium which when heated liberates caesium or mercury which condenses on the inner sides of the bulb. Where mercury is used it will form a drop as 22, Fig. 1 and it is important to heat this mercury sufficiently to vaporize it in order to properly operate the lamp. I have found that the helium gas which is a good conductor of heat when added to a pressure of 5 mm. is sufficient to quickly vaporize the mercury when the filament is energized.

The mercury may, if desired, be placed in the bulb in a liquid state by providing a tube 20a extending downwardly from the side of the tubulation tube 20 and having a protuberance or bulb 20b at the lower end thereof in which the mercury 20c may be placed. The tube 20a is long enough so that the bulb 20b is not heated when the oven is placed over the main bulb 10. Then when the bulb is ready to be sealed off the mercury may be heated and the vapor driven up into the bulb 10 through the tubulation tube and then the latter closed off in the usual manner, or the tubulation tube may be closed off below the tube 20a and the mercury poured into the bulb 10 by inverting it, after which the tube 20a may be closed off in the usual manner.

When a lamp such as described above has been sealed off and connected to an electric circuit an intense light will be produced by the ionic discharge along the filament which will be colored in accordance with the gases used. Thus the mercury vapor with the argon will produce an ultra-violet light while modifications of this radiation may be produced if the vapors of calcium, caesium, or other vapors are added.

The discharge is not only intense but practically uniform without any deterioration of the filament or coating and the temperature of the filament is not excessive so that the light of the lamp is greatly increased over anything heretofore known or used.

In Fig. 6 a modified form of the invention is shown. In this case the envelope 28 of glass or other material, transparent to the rays to be produced by the lamp is provided with a single press 29 formed integral therewith in the usual manner and the electron emitting element 30 is supported at its lower end upon a support rod 31 sealed in the press 29 and at its upper end upon a support rod 32 which extends horizontally toward the wall of the envelope and then downwardly where it may be sealed in the press 29. The element may be provided with the small coils 15a as already described in connection with the other figures. A pair of leading-in wires 33 and 34 may be connected respectively to the support rods 31 and 32 to form the means for connecting the device in an electrical circuit. The electron emitting element 30 may be any of the elements already described and the envelope may be filled with gases or vapors as described in connection with the previous figure. Inasmuch as the metal vapors tend to condense on the walls of the bulb and other parts, the tubular construction of Fig. 1 may be preferred as in the construction of Fig. 6 the path between the two support rods 31 and

32 on the press 29 is so short that a film of metal on the press may tend to short circuit the device.

Due to the conductivity of the gas within the envelope there may be a tendency, in case the element burns out, to arc, which so lowers the resistance of the device as to endanger the fuses in the main circuit. I therefore may prefer to incorporate a fuse in the element circuit either within or outside of the envelope so that this fuse will burn out if an arc should start and protect the main fuses in the circuit. In Fig. 6 such a fuse 35 is shown connected as a part of the lead wire 33 at the bottom of the envelope within the stem tube and just below the press 29. Thus positioned the fuse comes within the base of the lamp and is not noticeable.

In Fig. 7 a modified form of the invention is shown wherein two electron emitting elements 36 and 37 are mounted at their lower ends respectively upon two support rods 38 and 39 which are sealed in the press 40. The upper ends of the elements 36 and 37 may be connected to a cross member 41 which may in turn be welded to a central support 42 which extends downwardly and may also be sealed in the press 40. Leading-in wires 43 and 44 may be connected respectively to the support rods 38 and 39 to make the necessary connections outside of the device. The additional coil 15a carrying the excess current when the element is energized are shown at each end of each of the elements 36 and 37.

Due to the fact that a metal filament has less resistance when cold there may be a tendency to produce a surge of current in the circuit when the device is initially connected to a source of energy and in order to prevent this I may desire to place a resistor having a negative temperature coefficient of resistance in series with the element or elements which will then provide a high resistance when the device is cold and as the resistance of the element increases due to the increase in temperature the resistance of the resistor will decrease. In Fig. 8 such a construction is shown wherein the electron emitting element 45 is mounted at its lower end upon a support rod 46 which is sealed in the press 47 while its upper end is connected to a cross member 48 mounted upon a central support 49 which may also be sealed in the press 47. A rod or filament 50 of carbon may have its upper end attached to the other end of the cross member 48 and its lower end connected to a support rod 51 which may be sealed in the press 47, suitable means such as the tabs 52 being provided at each end of the carbon filament 50 making the connections to the support rods. Leading-in wires 53 and 54 may be connected respectively to support rods 46 and 51 and when connected in a circuit and a current initially turned on the carbon filament 50 has a high enough resistance to prevent a surge through the element 45 and as the element 45 and the carbon filament 50 heat up the resistance of the first increases while the resistance of the second decreases thereby permitting a gradual increase of current without the tendency to surge.

It may be desirable in view of the electrical conductivity of the gases used to insulate all of the exposed parts other than the electron emitting element (or carbon filament of Fig. 8) from the gas. This may be done by coating the support rods with an insulating compound such as that described for coating heating filaments in my application entitled Mounting of elements in radiation devices, Serial No. 578,940, filed December 4, 1931. This insulation material may be any insulation material having a high insulation factor and being capable of adhering to the metal rods and of being degasified, such as a mixture of finely divided aluminum oxide and a small quantity of aluminum chloride dissolved in water to make a paste. When this material is heated in an oxidizing atmosphere the aluminum chloride reacts with oxygen to form aluminum oxide liberating chlorine. The aluminum oxide thus chemically formed is so finely divided as to form an intergrain cement between the particles of the main body of aluminum oxide thus forming when the reaction is completed an entire body of insulating material containing no inactive matter and which adheres very closely to a wire or other metal parts upon which the insulation material is applied. Such material is shown at 55 applied to the exposed parts of Fig. 7 and it is to be understood that these coated parts should be degasified previously to assemblying the device as it is difficult to raise the temperature thereof sufficiently to degasify them during the evacuation of the envelope.

Other means of insulating the parts might be used such as surrounding the support rods with tubes of glass, quartz, isolantite, lavite, and the like, which may be fused to the press to make a gas tight connection.

In Fig. 9 a construction is shown in which a pair of spaced apart electron emitting elements 56 and 57 are supported in substantially parallel relation in the envelope 58. One end of the element 56 is mounted upon a support rod 59 which extends downwardly and is sealed in the press 60 while the corresponding end of the element 57 is mounted upon a support rod 61 also sealed in the press 60. The opposite end of the element 56 is mounted upon a support rod 62 which extends downwardly and is sealed in the press 60 and the corresponding end of the element 57 is mounted upon a support rod 63 which is also sealed in the press 60. The additional coil 15a may also be used at the ends of the element as indicated and as already described in connection with the other figures. The leading-in wires 64 and 65 may be connected respectively to support rods 59 and 63 and a short connector 66 may be connected between the rods 61 and 62. When the wires 64 and 65 are connected across a circuit current will flow through the elements 56 and 57 in the same direction although these elements are in series with each other and all points on the element 56 therefore will have the same potential difference from corresponding points on the element 57 and there will be a tendency for a discharge to appear between the two elements as well as the halo of discharge longitudinally of each element.

While these elements in Fig. 9 are shown connected in series the same effect may be obtained by connecting the elements in parallel as indicated in Fig. 10. Here the parts are just the same as shown in Fig. 9 with the exception of the leading-in wires. Leading-in wires 67 and 68 connected respectively to the support rods 59 and 63 and corresponding to the leading-in wires 64 and 65 of Fig. 9 may be connected together to one side of the circuit while two more leading-in wires 69 and 70 may be connected respectively to the support rods 61 and 62 and may also be connected together and to the other side of the circuit. This will place the two elements 56 and 57 in parallel with the current flowing in opposite directions through the elements and thus they are given a uniform potential drop between the elements throughout the length thereof.

In Fig. 11 a still further modification of the invention is shown in which a pair of unipotential cathodes 71 and 72, made of suitable sheet metal and coated with electron emitting material 73 and 74 respectively, may be mounted upon two support rods 75 and 76 respectively by means of bands 77 and 78. The support rods 75 and 76 may be sealed in the press 79. Each of the cathodes is provided with a heater element which extends through the center thereof and is insulated therefrom. Thus the cathode 71 is provided with a heater element 80 while the cathode 72 is provided with a heater element 81 these elements being connected at their upper ends to a cross member 82 supported upon an offset central support member 83 which extends downwardly and is sealed in the press 79. The lower ends of the heating elements are mounted respectively upon rods 84 and 85 which may also be sealed in the press 79. Leading-in wires 86 and 87 may be connected respectively to the support rods 84 and 85 and complete the energizing circuit for the heater element. The leading-in wires 88 and 89, connected respectively to the support rods 75 and 76 for the cathodes, may be connected respectively to the leading-in wires 86 and 87 causing the cathodes to be connected to the high potential sides of the circuit. When the cathodes are raised to electron emitting temperature the discharge will take place between them and will be substantially uniform due to the fact that the potential of each cathode is uniform throughout the length thereof.

Instead of using one long electron emitting element or two elements in series as shown in the figures already described it may be desirable when the device is used on the ordinary lighting circuit of 110 volts to split up the electron emitting elements into a number of separate units so as to reduce the voltage per unit to a value as low as between 10 and 40 volts. One way of doing this is illustrated in Fig. 12 in which a plurality of short elements 100, 101, 102, 103, 104, and 105 are mounted in series, the elements being positioned as far apart from each other as possible so that the discharge along one unit cannot interfere with the discharge along any other.

To this end a glass rod 106 may be formed integral with a press 107 and may have an enlargement or disc 108 at its upper end and a disc 109 at its lower end adjacent the press 107. A support rod 110 may be bent in the form of a V with its vertex 111 sealed in the glass disc 108 and its free ends extending outwardly and being bent downwardly to support the upper ends of the elements 100 and 101. A second V-shaped support rod 112 may have its vertex sealed in the disc 108 similarly to the rod 110 and may support at its free ends the elements 102 and 103. Similarly a V-shaped support rod 115 may be sealed in the disc 108 and may support the upper ends of the elements 104 and 105 in the manner shown. In like manner a pair of V-shaped support rods 114 and 115 may be sealed in the lower disc 109 so as to come respectively underneath points between the upper support rods 110 and 112, and 112 and 113, and these rods may support the lower ends of the elements 101 and 102, and 103 and 104 respectively. A support rod 116 sealed in the press 107 may be bent outwardly and may be attached to the lower end of the element 100 while another support rod 117 sealed in the press 107 may be bent outwardly to support the lower end of the element 105.

Leading-in wires 118 and 119 may be attached to the rods 116 and 117 respectively for making the outside connections to the device. Thus connected as clearly illustrated in Fig. 12 and when the lead wires 118 and 119 are connected across the circuit the current will flow in through the lead wire 118, through the support rod 116, up through the first element 100, through the support rod 110, down through the element 101, through the support rod 114, up through the element 102, through the support rod 112, down through the element 103, through the support rod 115, up through the element 104, through the support rod 113, down through the element 105, and out through the support rod 117 and lead in wire 119.

By using six elements as shown the voltage drop across each element will be eighteen or nineteen volts.

It is to be noted that any of the constructions shown may be combined with any of the others as for instance the fuse and carbon filament ballast may be used with the constructions shown in Figs. 9, 10, 11, and 12 as well as Figs. 1 to 6 inclusive and the insulating materials may be applied to the support rods of any of the figures as described in connection with Fig. 7.

While certain specific pressures have been referred to with respect to the gas in the envelope the pressure may be varied depending on the desired size of the discharge. A lower pressure tends to permit the discharge to extend further away from the filament and a higher pressure tends to confine it closer to the filament. It is preferred however that the gases used be chemically pure or at least do not have an excess of one per cent of impurities.

Many modifications of the invention may be resorted to without departing from the spirit thereof, and I do not therefore desire to limit myself to what has been shown and described in this application except as such limitations are included in the appended claims.

What I claim is:

1. An electric lamp for producing short low wave length radiation comprising an envelope, a filamentary conductor within said envelope, a coating of electron emitting material upon the surface of a portion of said conductor, and an ionizable gas surrounding said conductor and containing approximately 5 mm. of helium, 10 mm. of neon, 100 mm. of argon, and a quantity of mercury vapor.

2. An electric lamp for producing low wave length radiation comprising an envelope, and electron emitting element having an electron emissivity not less than that of calcium oxide within said envelope, an ionizable gas containing mercury vapor surrounding said element, and a carbon resistor in series with said element and having a negative temperature coefficient of resistance, said element constituting the sole source of the radiation.

3. An electric lamp for producing low wave length radiation comprising an envelope, an electron emitting element having an electron emissivity not less than that of calcium oxide within said envelope, means to support said element, an ionizable gas containing mercury vapor surrounding said element, means to insulate said supporting means from said gas, and a carbon resistor having a negative temperature coefficient of resistance in series with said element, said element constituting the sole source of the radiation.

CHESTER H. BRASELTON.