No. 620,640. Patented Mar. 7, 1899.

F. M. F. CAZIN.

ELECTRIC INCANDESCENT LAMP.

(Application filed Sept. 11, 1895.)

(No Model.)

Fig. 1.

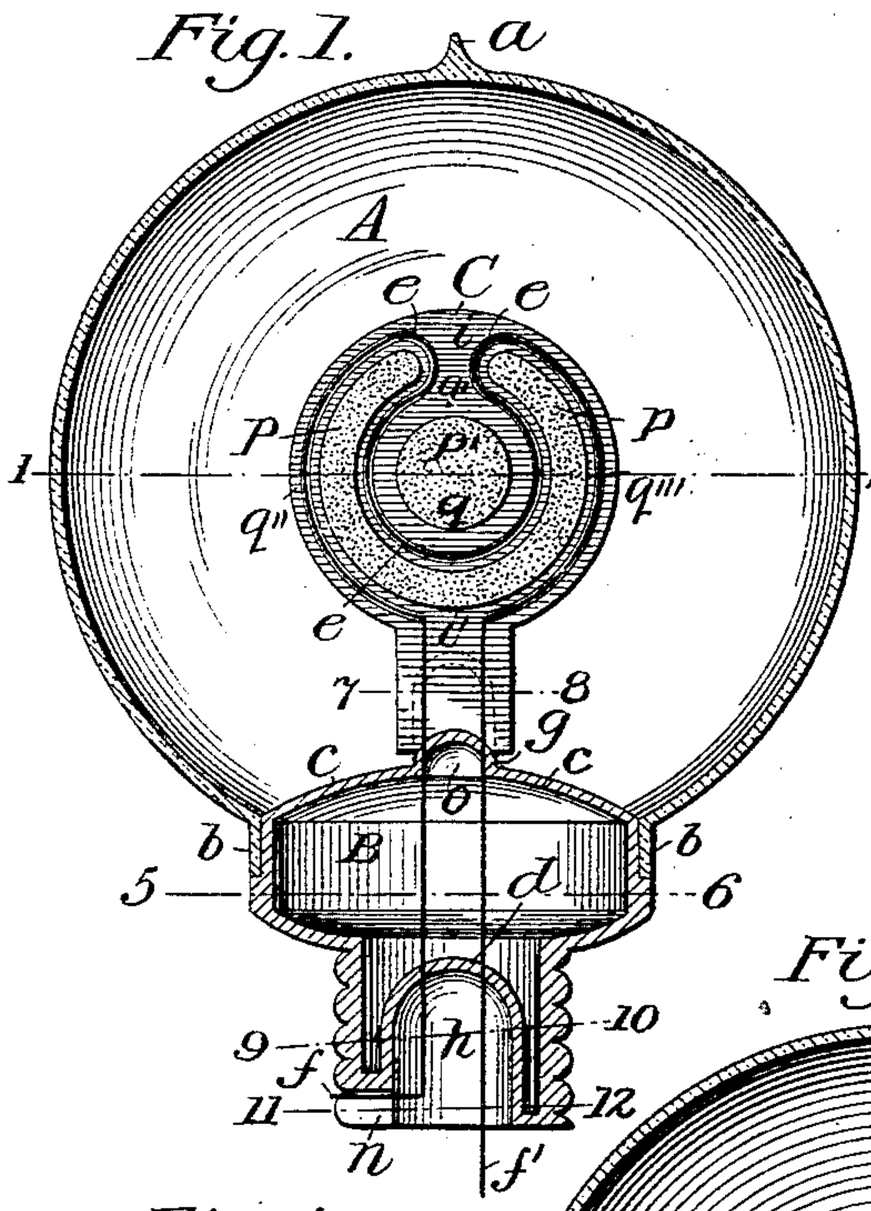

Fig. 2.

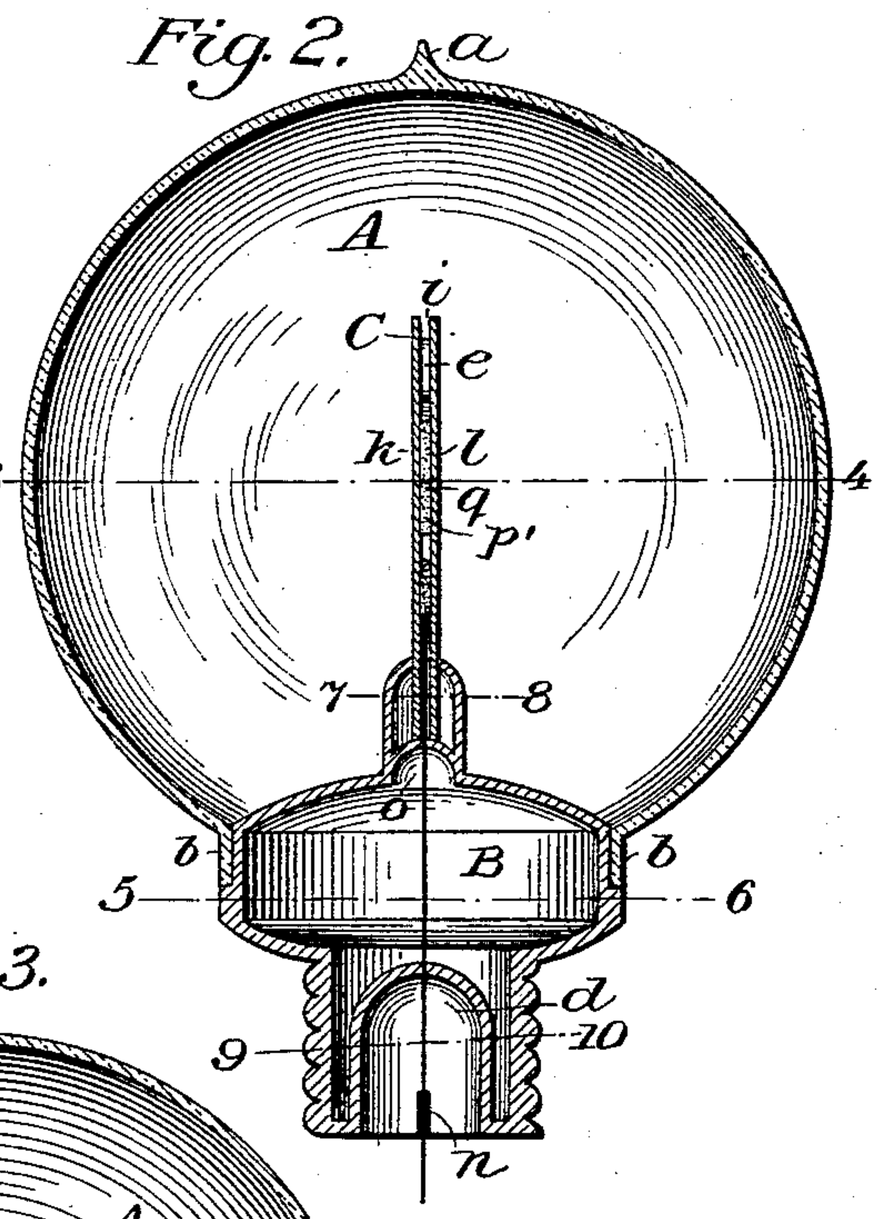

Fig. 3.

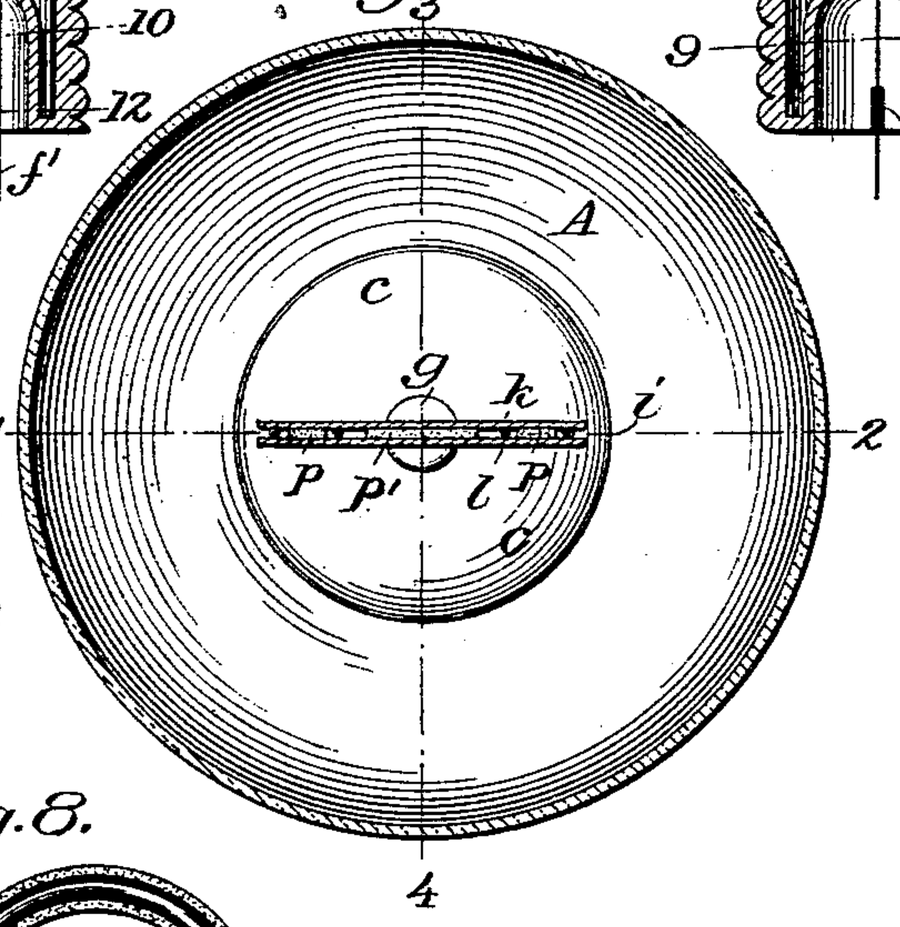

Fig. 4.

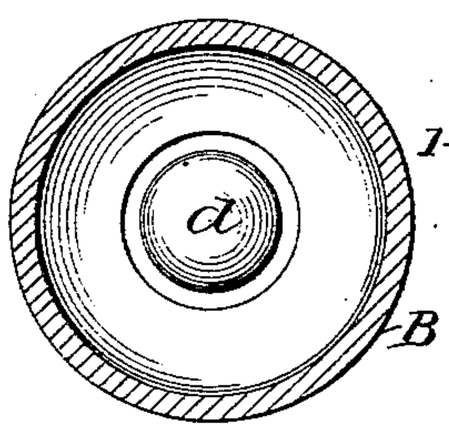

Fig. 5.

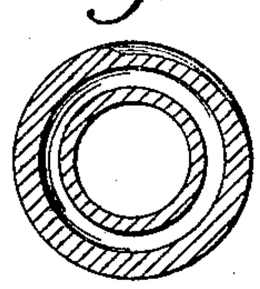

Fig. 6

Fig. 7.

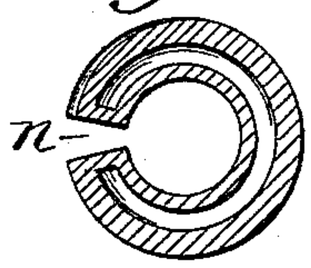

Fig. 8.

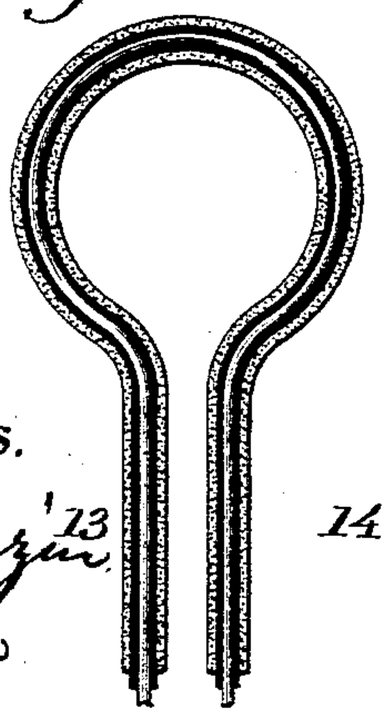

Fig. 9.

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UNITED STATES PATENT OFFICE.

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ELECTRIC INCANDESCENT LAMP.

SPECIFICATION forming part of Letters Patent No. 620,640, dated March 7, 1899.

Application filed September 11, 1895. Serial No. 562,189. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS M. F. CAZIN, a citizen of the United States, residing at Hoboken, Hudson county, State of New Jersey, have invented certain new and useful Improvements in Electric Incandescent Lamps; and I hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

In United States Patent No. 523,460, issued to me on the 24th day of July, 1894, on my application of the 7th of December, 1892, I disclosed an all-solid electric incandescent lamp in which carbonaceous or other semiconductive matter in linear form constitutes the incandescing element and is embedded between two solid bodies, and thereby protected against the deteriorating influence of the atmosphere. In another patent, No. 523,461, issued to me on the same day, I disclosed an electric incandescent lamp of a similar structure, but distinct from the one mentioned by two improved conditions—namely, the selection of some of the inclosing or embedding solid matter "with a view to utilize, aside of incandescence of the film, also dark heat-rays emanating therefrom under electric current" (sixty-sixth line) for heating the so-selected matter and causing the same to also become luminous and the use of an air-space for better protection of the luminous body. In a third patent, No. 566,285, issued to me in August, 1896, I disclosed an electric incandescent vacuum-lamp in which the linear incandescing matter is integrally connected with a solid body which is adapted to become luminous by the heat emanating from the filament under electric current and which incloses the linear incandescing matter entirely or in part only.

In the structure covered by the above-named three patents the body of solid matter intended and adapted to be made luminous by heat emanating from the semiconductive linear matter under current, although described in the last patent of the three as of "any desired shape," (forty-fourth line,) was shown as preferably a unity with the base part of the lamp, and although it had been shown in the first patent of the three, Figures 1 to 4′, except 2″, as in part independent of the base part no clear and specific distinction was made between the base part and the luminous body of the lamps. Now my present specification contemplates a special solid body distinct from the base part of the lamp and such structure of this special and distinct luminous body in connection with semiconductive current-passing linear material, as is called for by the qualities of the materials to be used in the construction of the said special body.

In common with my lamp as disclosed in my third patent my now further improved lamp has the continuous linear semiconductive material, which resists the electric current sufficiently to be made incandescent and to emanate both light and heat and has a body of solid material, with which it is integrally connected and by which it is inclosed entirely or in part, and which body consists of dielectric or non-conductive materials or material, which will not fuse at the temperature produced in the lamp, and which all or in part are peculiarly adapted to become luminous at the said temperature, and my lamp also has one or more protecting glass bulbs, the specific spaces inclosed by such bulbs being either vacuum or air spaces, according to the special requirement and condition of the luminous body. Therefore the distinctive features in my new lamp consist in the independence of the luminous body as one of the elements in my new lamp, and in the structure of the luminous body, and in the selection of material composing such body, and in the adaptation of the structure of the luminous body to the conditions given by such selection of material.

I disclose in this specification a lamp composed of three distinct and main elements—namely, a base part, providing for pole connections, a preferably air-exhausted glass bulb, and a luminous body. The luminous body, as such, is an integrally-compound body or an integral structure of different materials that are, though of different composition chemically, physically in immediate and permanent contact with one another and of more or less adhesiveness to one another, into which body or structure two essentially different subelements of equal importance

enter. The one is the continuous linear current-passing filament of sufficient resistance to produce light and heat, preferably of carbonaceous material, but so prepared, covered, or coated that it can be made part of the luminous body, as aforesaid, together with the other subelement thereof, without the one exercising on the other any destructive or detrimentary influence, and the other subelement in the luminous body consists of material which performs the function of being heated to luminosity by the heat that is produced in the other subelement and of thus increasing the light effect of the lamp, and the structural arrangement of the two subelements is one in which the filament or filaments form the nucleus and in which the other subelement is arranged on or around such nucleus in any suitable manner, but preferably as stratum or strata. I shall now further specify the material which I select as forming the said second subelement, and also the arrangement thereof in relation to the filament and in relation to one another when divided into intercohesive or structural strata of the same or of different materials, it being understood that the body to which the function of giving off light is assigned is an integral structure, though made up of different materials, with all of its parts in immediate and permanent contact with one another and of more or less interadhesivenes with one another. I preferably select as the substance for the second subelement such material as complies with all the different requirements that are conditional to its function—namely, first, infusibility at the temperature of the filament under current; second, dielectric or non-conducting quality in general and when heated to the said temperature; third, peculiar adaptation to become incandescent at a temperature as stated, and, fourth, stability in composition when heated in contact with other material or mainly with carbonaceous material. It being more practicable to comply with these four requirements in using and combining more than one kind of solid matter in forming the second subelement in the luminous body, I do not intend to limit myself to the use of only one kind or class of material in constructing the luminous body of my lamp, but I combine and arrange different materials, of which each in its place complies with one or more of the stated requirements whenever this appears as serving my purpose better than the use of one kind or class of matter in the making of the second subelement of the luminous body. It is on this account that I show the luminous body of my lamp as made up of different strata, which surround, inclose, or embed the linear filament or filaments. It is evident, therefore, that relative position only and not the shape of either component part or of the whole luminous body is essential aside of the stated four qualities in the parts or in all of the materials that enter the second subelement. Many modifications of shape or form of the luminous body may therefore be made, all of which will answer the same purpose. As main component of the second subelement, I select certain rare-metal oxids, which comply with the three first-mentioned requirements in an almost perfect manner and with the fourth requirement also when the filament is protected by an intermediate suitable stratum. It is to this intermediate stratum that the function is assigned of both chemical and electrical insulation. Although it is not my intention to limit my selection of material to be used in making up this stratum to a few materials that I here may name, I shall illustrate such selection, as well as the leading causes for such selection, by stating further details in regard thereto. In the first place it should be understood that the expression "stratum" is not applied as meaning a sheet of measurable thickness. The dimensions that I am dealing with in making up the luminous body or structure are altogether extremely minute, and its component parts or elements or materials can in consequence not be otherwise than of extremely minute dimensions and cannot be of thicknesses that can by common means be measured, though in still so minute thickness they by their chemical and distinct nature perform the function to them assigned—namely, the function of insulation.

When the carbon filament is coated very thinly with oxids of the stated nature and is subjected *in vacuo* to an electric current, a very slight reaction takes place, the simultaneous result of which is the formation of carbon oxid and the deposition on the filament reduced both in volume and in conductivity (increased resistance) of a fine metallic skin or stratum, by means of which a compensating increase of conductivity (loss of resistance) is provided. If the operation is continued until the metallic skin is minutely thin as it may be homogeneous, the reaction will cease. With an unreduced coat of oxid left or deposited in a secondary manipulation the luminous body so prepared will consist of the insulated (chemically) filament and the stratum of oxids. If to the first coating of oxids some silicious or aluminous material is added, still another reaction takes place—namely, the formation of silicates or of aluminates, or of both, with the metallic oxids as bases. When in a first operation a metallic skin and an electrically-insulating coat of aluminate or silicate has been formed and in a second operation a coat or stocking of oxids is applied, then the luminous body or structure consists of the chemically and electrically insulated filament and of a stratum of the oxids, as specified.

The drawings which accompany this specification are intended to illustrate the arrangement as well when one class of material is used as when more than one class or kind of material enters in the making up of the second subelement of the luminous body, and

these drawings, showing one form out of many that may be selected for the luminous body, are intended also to illustrate the position into which sundry materials may be brought to one another. Though shape, as such, is of incidental importance only, I so regulate it in my lamp that the volume of matter in the second subelement be not in excess of that which can be kept at incandescence by the heat emanating from the filament or filaments. It is essential to my new lamp that the second subelement in the luminous body of mainly refractory oxids form one stratum or several strata on, over, adjoining, or around the filament or first subelement. The stratum or strata may consist of flat plates or of concentrical tubular strata, and the stratum or strata may be perforated or not and may be the product of pressing plastic material until it becomes rigid and form-retaining, or they may be the product of building up the same by any of the now practiced processes on an original fabric of adequate form and dimensions or on the filament directly by deposition from a non-carbonaceous liquid medium or by partial fusion of powdered oxids in which the filament under current is temporarily embedded. Moreover, when, as stated here above, the second subelement is perforated or consists of a pseudo fabric mainly covering but not coating the filament the further benefit is derived from such partial covering that the luminosity of both the filament and the perforated woven or braided cover or stocking is utilized jointly.

As the form of the second subelement is of incidental importance only, so is the method of manufacturing the same; but the arrangement of the second subelement in integral contact with the first or linear subelement and the character of the combined two as a real self-supporting solid body and the selection of matter as specified (rare-metal oxids, mainly) to produce additional luminosity are essential to my new lamp.

When the entire luminous body as such is plate-like, the plate may fill the entire space that is inclosed by the loop or loops of the filament or filaments or may only adapt itself band-like to the contour of the filaments, leaving free one or more spaces in one or in all of the strata composing the luminous body. The edges of the strata or of the plates may be sharp or rounded off. In cross-section the luminous body may as well be circular, oval, or of any other regular form, as long as the two subelements are in integral contact with one another and of stratified structure the one to the other, as well as the second subelement in itself, when consisting of different parts, and provided that the second subelement hold the first or linear subelement in a channel, recess, or groove and in such contact as will foster the passing of heat from the filaments to the oxids that are intended to become luminous by such heat. Whether the contact as mentioned be immediate or intermediate—in other words, whether there be in the luminous body any intermediate stratum between the filament and the oxids—is a matter of incidental election. This fact may be better understood by my following mention of conditions: When the oxids are in direct contact with a carbonaceous filament, and when the surrounding air is being exhausted in the common way of manufacturing vacuum-lamps, and when with nearly-perfected exhaustion the current is turned on, then, as stated, a slight reaction takes place, by which the oxid in immediate contact is reduced until the filament is coated with a metallic film, when the reaction ceases, the gaseous product having escaped through the porous stratum of oxids. In practice I may avoid this by previously providing the filament with a coat of matter which is not an oxid and which resists to all reaction with either carbon or oxid when in contact under current with either, such coating not being necessarily the metal of the oxids, but any other neutral substance, such as silica or alumina. When I prepare the body of oxids, be it on some woven or braided original fabric or without such, I prefer to admix to the finely-pulverized oxids a small percentage of fluor-spar, not sufficient to materially lower their temperature of fusion and to destroy the textile structure in the product, but sufficient to frit the oxids to better stability than that of the pseudo fabrics of these oxids now known to the art. These changes and improvements have mainly in view that from a stated quantity of power applied, be it mechanical power applied in creating the electric current or be it electric power applied and measured as such, a proportionally and comparatively greater quantity of light and luminosity or a higher light efficiency be produced in my lamp than they are produced in the electric incandescent vacuum-lamps of any description now offered as the product of the art as now known.

Finally and incidentally my improvements contemplate a materially better and more economical making of the independent base part.

In the adjoined drawings, forming a part of this specification, Fig. I represents a central vertical section of my improved lamp when the luminous body is made in the shape of a plate for the purpose of showing the arrangement of subelements and parts in their position relative to one another. Fig. II represents a similar section taken at right angles to that shown in Fig. I. Fig. III is a section along the line 1 2 in Fig. I and along the line 3 4 in Fig. II, looking toward the base part of the lamp. Fig. IV is a section along the line 5 6 as marked in Figs. I and II, looking toward the pole-connecting end of the base part. Fig. V is a section of the last-mentioned base part along the line 9 10 as marked in Figs. I and II. Fig. VI is a section on the line 7 8 as marked in Figs. I and

II. Fig. VII is a section along the line 11 12 as marked in Figs. I and II. Fig. VIII represents the luminous body in my improved lamp with a filament of curvatures as now commonly used and with successive layers of material adapted to such filament and curvatures. Fig. IX represents sections of the luminous body and in special at the points marked 13 and 14 in Fig. VIII.

The lamp, as shown in the drawings, comprises three elements or main parts—namely, A, an inclosing preferably air-exhausted glass bulb, B a base part providing for pole-connecting terminals, and C a solid body, intended to become luminous as such, inclosed in the part A and supported as an independent and third part on the part B.

The part A is shown globular in shape, but, the same as in the two other parts B and C, the shape is incidental only and not of essential importance as long as such shape complies with the conditions of the function assigned to the part, which function of the part A is the same in my lamp that it is in the older lamps now known to the art. The only additional requirement in the shape of the preferably air-evacuated glass bulb of my new lamp consists in this: that the opening and neck *b b* be made large enough to admit the body C for the purpose of not exposing the body C when being inserted into the bulb A to rupture. The neck may form the only seal, provided the joint between the globe A and the glass base B be hermetical, as herein-above stated.

n marks an archway by means of which the inleading wire *f* may, after having been sealed in the navel *d* by means of the fused glass *h*, pass to the outside of the base part B at a distance from the point where the other inleading wire *f'* passes to such outside. The two wires are thus made ready to singly and insulatedly make their separate connections with two different contact-rings or with two different contacts in a socket.

The luminous body C is shown in the drawings in the shape of a stratified plate. In Fig. I the linear filament (marked *e e e e*) is shown as double-looped, with its two ends joining the inleading wires *f* and *f'*. Although Fig. II shows the body C as composed of three strata, the central section (shown in Fig. I) is intended to represent only the middle stratum, in which the filament of less thickness than the middle stratum is completely embedded. This middle stratum is marked in Fig. I, as well as in Fig. II, with the circular central part *p'* cut out to indicate that the embedding second subelement in the composition of the luminous body C is intended to preferably follow the contour of the filament. The middle stratum, which in both Figs. I and II is marked *i*, shows another space *p*, also inclosed by a line which follows the contour of the filament on the opposite side in further illustration of the condition to the building up of the body C of both following the contour of the filament and of stratification in all directions, it being immaterial whether both spaces *p* and *p'* be cut out or be filled with any of the matters entering into the composition of the second subelement in the body C, as long as the characteristic feature of arranging such matter in one or more strata around the linear filament and of following its contour is maintained.

The letters *q*, *q'*, *q''*, and *q'''* indicate a mechanical means—such as rivets, clamps, &c.—by which the three plate-like strata *i* and *l* are joined; but I in no wise intend thereby to indicate that I may not use any other method—such as fritting, fusing, cementing, and water-glass pasting—suitable for joining parts or strata in the body C.

The qualities of the different materials that I make use of and their arrangement in the luminous body C have been described hereinabove. As an example of suitable oxid for the purpose, as mentioned, I name those of the so-called "rare" metal or "zirconium" class; but I do not limit myself to the use of any one particular refractory metal oxid or to any particular mixture thereof, and I elect such and such mixture thereof as are best adapted to the sundry practical requirements of a good luminous-body electric incandescent lamp. I reserve the same latitude in the selection as well as in the preparation of any other material that I may cause to enter in the composition or construction of the second subelement of the luminous body. For the purpose of insulating the filament either electrically or chemically from the refractory oxids I provide, as heretofore stated, for a special preparing, covering, or coating of such filament, to the double effect that conductivity of oxids may not render that of the filament excessive and that the carbon of the filament may not react excessively or at all on the oxids under the influence of heat or of electric current.

One of the requirements of a good lamp being that it will maintain the body C in good shape while being transported, I provide for such maintenance in sundry ways. One of the methods used by me for imparting sufficient self-supporting strength to the luminous body C consists in using such supporting plates or frames as are marked by *k* and *l* in Figs. II and III. Another such method consists in providing for increased cohesiveness in the oxids, whether they form sheets or pseudo fabrics or plates or frames, which provision is made by cementing or fritting these parts, as mentioned and indicated by *i* and *i'* in Figs. I, II, and III, the fritting being done by means of admixing powdered fluor-spar to the oxids previous to exposing them to heat or current. A third such method yet consists in making the volume of the oxids or of the second subelement as heavy or large as is consistent with its function and in special of greater thickness than the mere coating or film of paint or of deposition.

I have plainly and clearly stated in the preceding specification that which I consider as the essential in my new improved lamp and that which I consider as incidental only in adapting the essential elements in my lamp for performing their function, and I have in equal clearness stated in what the arrangement of these elements in relation to one another consists, and I desire it to be understood that on account of showing any special form or modification in my drawings for that which is not essential—such as one filament and not more than one, a double loop of filament and not one or sundry loops, a plate shape of the body C and not a cylindrical shape exclusively, the fastening of the body C to the projection of the base B by inserting the body C into the groove on the projection and not the use of frames or brackets or horns for the same purpose, a globular glass bulb A and not a pear-shaped or other form, an all-glass base and not one of the base parts now in use—I do not in any way waive my privilege to make use of other forms or modifications in the matter of parts or of their arrangement.

I further desire to state that with the body C otherwise constituted, as hereinabove specified, I also propose to eventually expose the linear filament with a part of its surface to the evacuated space, while the other longitudinal part of the circular surface is integrally embedded in the second subelement of the luminous body—viz., in the oxids—in such manner as heretofore disclosed and specified in my Patent No. 566,285, and with the filament completely embedded in solid matter, as disclosed and specified in my Patent No. 523,461, I propose to dispense at times, as there also shown, with the air evacuation from the glass bulb A, using instead an air-filled bulb.

Having described my invention, I claim—

1. A three-part electric incandescent vacuum-lamp, consisting of a suitable base, an air-exhausted glass bulb, and a body or structure of solid matter, which latter part constitutes a cohesive entirety and as such consists of two main constituents, namely of a continuous, linear semiconductive, current-passing filament, which resists to a passing electric current to the effect of giving off light and heat, and which filament is electrically and chemically insulated from the other constituent, by a protecting stratum, and a stratum of matter, which by the heat given off by the filament, becomes luminous, as and for the purpose set forth.

2. A three-part electrical incandescent vacuum-lamp, consisting of a suitable pole-connecting base, an air-exhausted glass bulb, and a body or structure of solid matter, which latter part constitutes a cohesive entirety and consists of two main constituents, forming an integral structure, which constituents are, a continuous linear semiconductive, current-passing filament, which under current gives off light and heat, and which filament is electrically and chemically insulated from the other constituent by a protective stratum, and a stratum of matter, which by the heat, given off by the filament under current is made luminous and exceeds in main volume that of the filament, as and for the purpose set forth.

3. A three-part electrical vacuum-lamp, consisting of a suitable pole-connecting base, an air-exhausted glass bulb, and a body or structure of solid matter, which latter part consists of two more or less adhesive parts, which are in permanent contact with one another, these parts or constituents being: a linear continuous semiconductive, current-passing filament, which is electrically and chemically neutral or insulated as against the other constituent, and solid matter, that is peculiarly adapted to become luminons by heat and exceeds in main volume that of the filament, as and for the purpose set forth.

4. In an electric vacuum-lamp, the combination with a suitable base, or main pole-connecting support, and with an air-exhausted glass bulb, that surmounts the said base, of a solid body or structure, erected on the said base, inside of said glass bulb, which body or structure consists of two main constituents, that are in cohesive and permanent contact with one another, namely of: a continuous linear filament or filaments, electrically and chemically insulated from the other constituent, and matter, which is peculiarly adapted to become luminous by the heat, that is given off by the filament, as and for the purpose set forth.

5. In an electric vacuum-lamp, the combination with a suitable current-connecting support or base, and with an air-exhausted glass bulb, that surmounts the base, of a third main part, which is a body or structure, inside of the said glass bulb, and surmounts the said support or base and consists of two constituents or parts, that are in permanent and cohesive contact with one another, namely, a continuous linear semiconductive filament, which under current gives off light and heat and is electrically and chemically insulated from the other constituent, and rare metal oxids of the class, that is peculiarly adapted to become incandescent when heated, as and for the purpose set forth.

6. In an electric vacuum-lamp, in combination with a suitable contact-providing main support or base, and with an air-exhausted glass bulb, that is directly or indirectly sealed into the said base, surmounting the same, a main third part, which is made up of two main constituents, which, joined by mechanical means or by fusing, cementing or pasting, form one integral structure or body, the said constituents of which body being: a continuous linear filament, producing light and heat under current, and electrically and chemically insulated from the other constituent, by an intermediate stratum of neutral material, and rare metal oxids, of the class peculiarly adapted to become luminous, when heated,

which form a stratum and embed a part or the whole of the filament or filaments on their entire length, and which in quantity and in other incidental qualities are selected to so become luminous by the heat given off by the filament under current, adding their luminosity to that of the filament, as and for the purpose set forth.

7. In an electric vacuum-lamp, having suitable contact-providing base parts and an air-exhausted glass bulb, a separate solid body of stratified matter, inside of the said glass bulb, and supported on the said base parts, which body or integral structure is held together by suitable means and embeds the continuous linear filament or filaments of the lamp in a channel or groove on their entire main length, in a stratum or strata of matter, which insulates the filaments electrically and chemically from an outer stratum of rare metal oxids of the zirconium class, as and for the purpose set forth.

8. In an electric incandescent vacuum-lamp, having suitable contact-providing and supporting-base parts, and an air-exhausted glass bulb, hermetically connected with these base parts, a solid body inside of the said glass bulb and supported by means of inleading wires, or by other supports in connection therewith, of which solid body a linear filament or filaments constitute one part, and of which body concentrical strata of different materials constitute another or major part, and which strata are so selected, that the material in the stratum next to the filament, insulates the filament electrically and chemically from the outer strata, and that the material in the outer stratum or strata is made incandescent by the heat emanating from the filament under current, as and for the purpose set forth.

9. An electric incandescent lamp, that is made up of three main parts, namely of a contact-providing supporting part or parts, a glass bulb, inclosing an air-space and the third main part, which is in itself a separate body, supported on the base part, as a body or structure, of which a continuous linear filament or filaments of semiconductive matter, that give off light and heat under current, are an embedded nucleus, which is completely incased by concentrical strata, the inner one of which insulates the filaments electrically and chemically from the outer stratum or strata, and the outer stratum of which consists of rare metal oxids, peculiarly adapted to incandesce by the heat given off by the filaments under current, and which are mixed and prepared or selected and prepared to properly perform the function of increasing the light effect of applied energy, as and for the purpose set forth.

10. In an electric incandescent vacuum-lamp an all-glass base part, which is bottle-shaped, having neck, body and navel, the projecting neck providing a support to the luminous part or parts of the lamp and a hermetical seal, around the inleading wires, and providing jointly with the body part, a hermetical seal to the glass bulb of the lamp, and the navel providing a cavity as the means of further hermetical sealing of inleading wires, which navel is surrounded by a threaded surface, which fits into suitable sockets, as and for the purpose set forth.

11. In an electric incandescent vacuum-lamp, an all-glass base part, which is bottle-shaped, having neck, body and navel, the projecting neck providing a support to the luminous part or parts of the lamp and a hermetical seal around the inleading wires, and providing, jointly with the body part, a hermetical seal to the vacuum glass bulb of the lamp, and the navel providing a cavity, as the means of further hermetical sealing of the inleading wires, which navel is surrounded by a threaded surface, that fits into suitable sockets, a lateral archway, leading from said cavity to said surface, as and for the purpose set forth.

12. In an electric incandescent vacuum-lamp an all-glass base part, being in the shape of a press-blown bottle, with an open neck, when made, and with a navel and with a threaded end to fit a metal cap, and a rim at the upper end for fusing thereto a glass bulb, the neck and the navel being the means of perfecting a double seal around the inleading wires.

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Witnesses:
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