June 17, 1958 ROGER FRANÇOIS DÉSIRÉ NAVARRE 2,839,700
ALIAS MALHERBE
ELECTRONIC ILLUMINATING LAMPS
Filed Jan. 13, 1956 3 Sheets-Sheet 1

Fig. 2

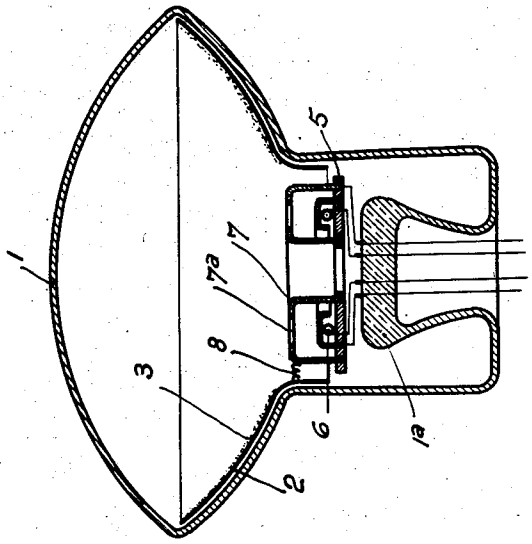
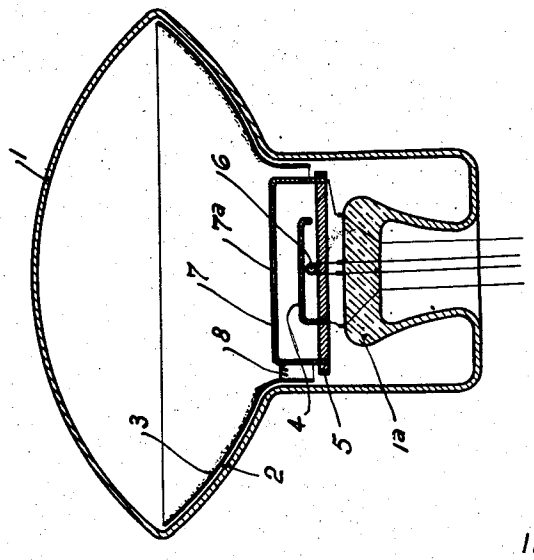


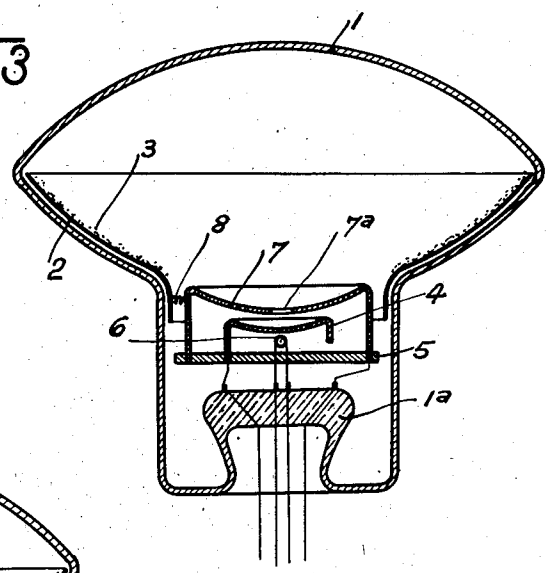
Fig. 1



INVENTOR
ROGER FRANÇOIS DÉSIRÉ NAVARRE ALIAS MALHERBE
By Linton and Linton
ATTORNEYS

June 17, 1958 ROGER FRANÇOIS DÉSIRÉ NAVARRE 2,839,700
ALIAS MALHERBE
ELECTRONIC ILLUMINATING LAMPS
Filed Jan. 13, 1956 3 Sheets-Sheet 2

Fig. 3



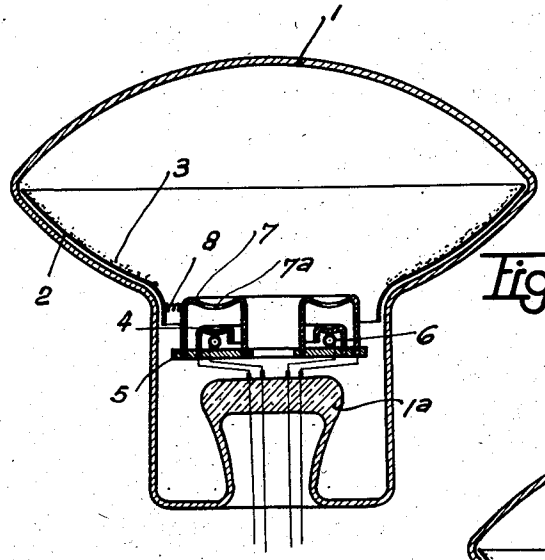
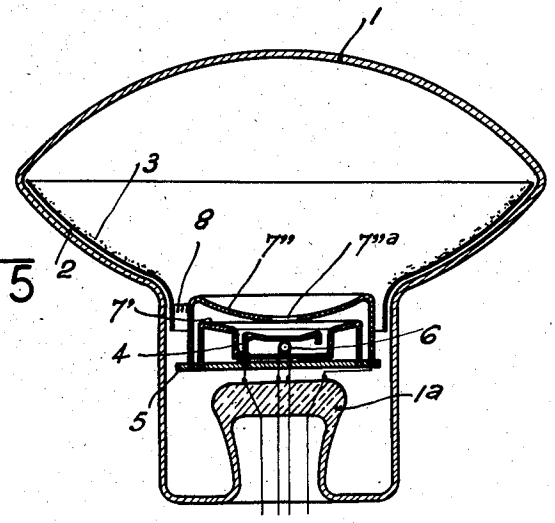


Fig. 4

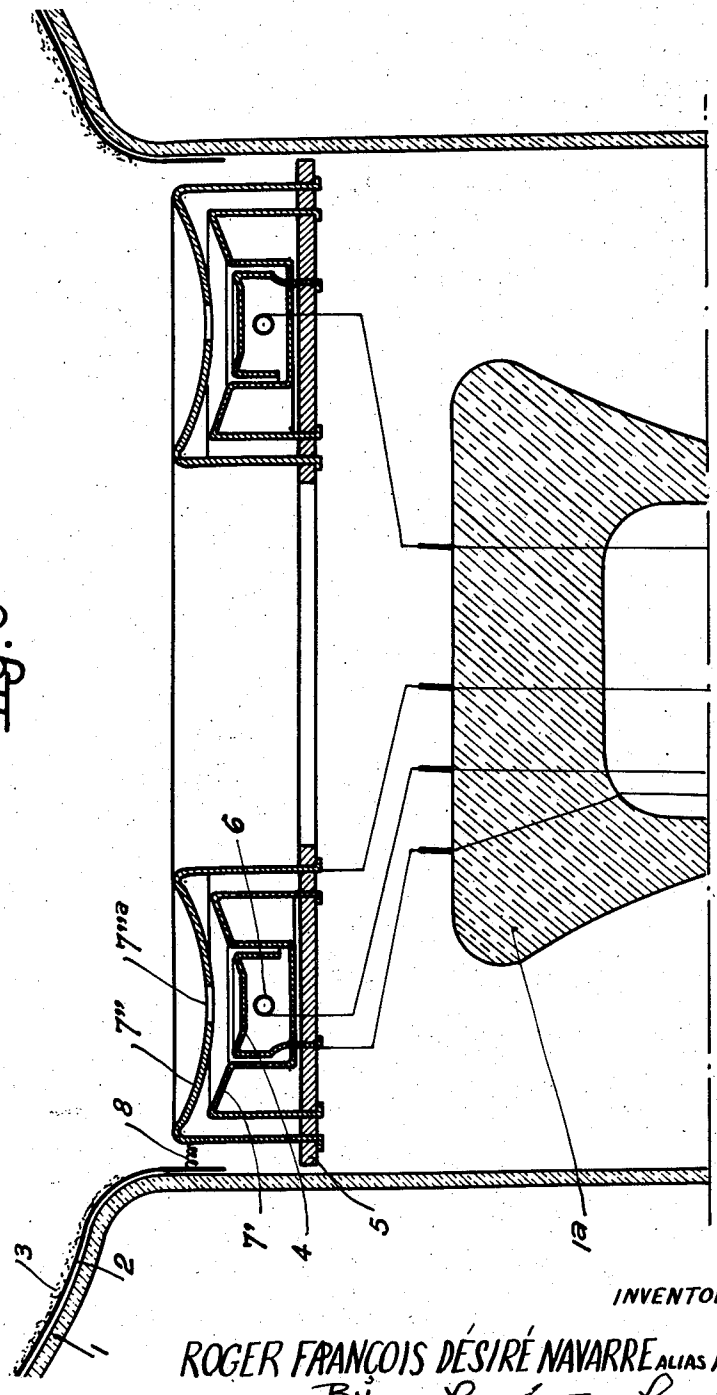
Fig. 5



INVENTOR
ROGER FRANÇOIS DÉSIRÉ NAVARRE ALIAS MALHERBE
By Linton and Linton
ATTORNEYS

June 17, 1958 ROGER FRANÇOIS DÉSIRÉ NAVARRE 2,839,700
ALIAS MALHERBE
ELECTRONIC ILLUMINATING LAMPS
Filed Jan. 13, 1956 3 Sheets-Sheet 3

Fig. 6



INVENTOR
ROGER FRANÇOIS DÉSIRÉ NAVARRE ALIAS MALHERBE
By Linton and Linton
ATTORNEYS

United States Patent Office 2,839,700 Patented June 17, 1958

2,839,700

ELECTRONIC ILLUMINATING LAMPS

Roger François Désiré Navarre, alias Malherbe, Paris, France, assignor to Société dite: Sebel S. A., Tangier, a company of Tangier

Application January 13, 1956, Serial No. 559,028

Claims priority, application France January 15, 1955

11 Claims. (Cl. 313—82)

The present invention relates to electronic illuminating lamps which are self-stabilized and operate under low voltages and employ screens coated with substances which become incandescent under the impact of a beam of electrons.

In the French Patent 1,055,071 dated April 22, 1952, there has been described a fluorescent electronic illuminating lamp which is self-stabilized and operates under low voltages, said lamp including chiefly a transparent evacuated bulb which contains a thermionic cathode and an anode while the kinetic energy acquired by the electrons under the action of the difference in potential applied between the anode and the cathode is transformed into luminous energy through the impact of said electrons onto a fluorescent coated plate target or screen extending across their path.

With a view to neutralizing partly the space charge in the bulb so as to obtain a substantial current without resorting to prohibitive voltages, it has been proposed in the first addition 64,149 to the above mentioned French patent as filed on January 28, 1953, to associate with the cathode an electronic lens including two or more grids maintained at a suitable potential with reference to the cathode, said grids having substantially the same pitch and their elements being aligned in a manner such that they lie in the electronic shadow of one another.

U. S. Patent No. 2,763,814 corresponds generally to the above mentioned French patent and its said first addition.

In the further second addition 65,301 to the same French patent, as filed on January 16, 1954, there has been described various arrangements which allow obtaining with such a system of aligned grids a practically uniform distribution of the electrons over the surface of the anode.

Furthermore, in the French Patent 1,111,658 filed on September 21, 1954, there has been substituted, with a view to preventing the formation of a parasitic space charge after acceleration of the electrons, for the electrostatic lens constituted by aligned grids an electromagnetic lens constituted by a magnetic field the lines of force of which coincide at least partly with the ideal path to be followed by the electrons.

In the different embodiments of these previous patents as referred to hereinabove, the thermionic cathode and the electronic lens associated therewith form an electron gun which ensures an accurate projection of the electrons onto the conductive target provided in the case considered by a cathode-luminescent coating.

Now, it has been found in accordance with the present invention that it is also possible to produce electronic illuminating lamps which are self-stabilized and operate under low voltage conditions while their luminous efficiency is excellent, this being obtained by using such an electron gun for projecting the electrons onto a target including in a manner well-known per se a substance or a mixture of substances, e. g. of the Auer type, adapted

to produce a selective radiation by becoming incandescent at the moment of the impact of the electrons.

The present invention has thus chiefly for its primary object an electronic illuminating lamp including a bulb of transparent material inside which is produced a high vacuum, said bulb enclosing a thermionic cathode associated with an electronic lens of one of the types referred to hereinabove, an anode, a target or screen incorporating one or more substances reacting through incandescence and lying in the path of the electrons, so that the kinetic energy acquired by the electrons under the action of the difference in potential applied between the anode and the cathode may be transformed into luminous energy at the moment of the impact of such electrons onto said target.

The present invention covers also the use of electronic lenses of the well-known diaphragm type instead of or in association with the electronic lenses of the different types referred to hereinabove such as positioned grids and electromagnetic lenses, with a view to partly neutralizing the space charge in the case of electronic illuminating bulbs including either a cathodo-luminescent target or an incandescent target.

In the embodiment of this last feature of the present invention, the shape of the diaphragms is irrelevant and may be flat for instance or at least partly spherical, or else the diaphragms may match the shape of certain equipotential surfaces as required for obtaining the desired result, or again said diaphragms may assume at least partly the shape of a surface of revolution round an axis.

The window provided in the diaphragms may also assume any desired known shape, for instance a rectangular, annular, circular or the like shape.

The shape of the cathode is preferably in conformity in each case with that of the diaphragm.

There have been illustrated by way of example and by no means in a limited sense in the accompanying drawings various embodiments of electronic diaphragm lenses incorporated into fluorescent electronic illuminating lamps. In said drawings:

Figs. 1 to 5 are axial vertical cross-sections of fluorescent electronic illuminating lamps incorporating such electronic diaphragm lenses.

Fig. 1 shows a lamp having a flat circular cathode and a flat circular lens diaphragm;

Fig. 2 shows an annular flat cathode and diaphragm;

Fig. 3 shows a modification in which the cathode and lens diaphragm are spherical segments;

Fig. 4 shows a modification in which the cathode and diaphragm are of toroidal shape and have surfaces which are spherical segments;

Fig. 5 shows a modification having two lens diaphragms, one diaphragm being annular and surrounding the cathode, and the other diaphragm being a spherical segment mounted above the cathode.

Fig. 6 shows in cross-section on a larger scale a portion of a fluorescent electronic illuminating lamp incorporating a preferred embodiment of the electronic diaphragm lens as a modification of the embodiment of Fig. 5 and having a toroidal shape with two diaphragms, the upper diaphragm having spherical segment surfaces.

In the various examples illustrated, the bulb is constituted by an envelope **1** of transparent material such as glass or the like, the shape of which is similar to that of a mushroom while its stem press **1***a* may be provided with a base which is not illustrated wherethrough said bulb may be mounted in the conventional manner of a usual incandescent bulb. The inner wall of the portion of the bulb **1** adjacent the stem press **1***a* is provided with a metal layer or coating **2** forming a conductive target or anode over which is applied a fluorescent layer **3** which becomes luminous under the impact of electrons. The

section portion of the bulb opposite to the stem press in the different embodiments illustrated is clear and does not have any such layer or coating and forms thus a transparent gate which allows the free passage of the luminous rays produced by the fluorescent layer 3 in the direction which is the most favorable for the operation of the bulb.

In the example illustrated in Fig. 1, the bulb is provided with a cathode 4 which is indirectly heated and is constituted by a flat member of nickel or the like suitable material covered by an emissive substance; said cathode being of a circular shape for instance is arranged coaxially with the bulb and is secured to an insulating support 5 constituted for instance by a mica washer. The heating of the cathode is produced through a coiled filament 6 of tungsten coated with alumina or the like insulating material and located underneath the flat cathode. The diaphragm forming an electronic lens is constituted in the embodiment illustrated by a flat element 7 the shape of which is circular and corresponds with that of the cathode, said element 7 extending over the latter in parallelism therewith and being secured to the same insulating support 5. Said diaphragm is provided centrally with a preferably circular opening 7*a* the diameter of which is of a magnitude approximating that of the distance separating the diaphragm from the cathode 4. Between the metal anode 2 and the diaphragm 7 is inserted a metal spring 8 which provides for an electrical contact between said two parts and consequently subjects the diaphragm to the same potential as the anode.

In the example illustrated in Fig. 2 in which the same reference numbers designate the same parts as in Fig. 1, the cathode 4 is constituted by a flat ring or annulus located coaxially with the bulb 1 while the diaphragm 7 is also in the shape of a flat ring coaxial with the cathode and provided with an annular opening 7*a* the radius of which is of the same magnitude as the distance separating the diaphragm from the cathode.

In Fig. 3, the cathode 4 and the diaphragm 7 are given the shapes of spherical caps or segments arranged coaxially with the bulb 1 and the concave side of which is directed towards the outer end of the latter. At 7*a* is shown an opening formed centrally of said diaphragm 7.

Fig. 4 shows an embodiment similar to that of Fig. 3 and wherein the cathode 4 and the diaphragm 7 are both in the shape of an annular surface of revolution the generating element of which is constituted by an arc of a circle.

Fig. 5 illustrates a modification wherein the cathode 4 is constituted by an element in the shape of a circular cap provided with a flat base and a widely flaring frustoconical top. The diaphragm includes in this case two elements, to wit a first annular element 7′ arranged around the cathode 4 and connected electrically with the latter and maintained consequently at the same potential as said cathode and a second element 7″ in the shape of a spherical cap or segment located above the cathode and the first diaphragm element 7′ and maintained by the connecting metal spring 8 to the same potential as the anode 2. The second diaphragm element 7″ is provided centrally with an opening 7″*a*. This arrangement provided for defining equipotential surfaces which further the production of a linear beam of electrons as well known in the art of electronic optics.

Fig. 6 illustrates on a larger scale an embodiment similar to that of Fig. 5 wherein the cathode 4 and the diaphragm elements 7′ and 7″ are brought respectively to the potential of the cathode and to the potential of the anode as in Fig. 5 and have vertical cross-sections similar to those illustrated in Fig. 5, but are formed as rings or toroids arranged in annular superposed formation symmetrically around the axis of the bulb instead of intersecting the axis of the bulb.

In Fig. 6 the axis of the generating elements forming

diaphragms 7 and 7′ is spaced from the axis of the bulb, while in Fig. 5 it coincides therewith.

Obviously and as already mentioned hereinabove, arrangements similar to those described hereinabove may, without going beyond the scope of the invention defined in the accompanying claims, be incorporated into the structure of electronic illuminating bulbs provided with an incandescent target instead of a cathodal-luminescent target.

On the other hand, and in all cases, the electronic diaphragm lenses illustrated and described may also without unduly going beyond the scope of the invention thus defined be associated with lenses of different types as described in the above mentioned French Patent 1,055,071 and its additions and in the above mentioned French Patent 1,111,658 of September 21, 1954.

What I claim is:

1. An electronic illuminating lamp comprising a transparent evacuated bulb, a substantially flat annular thermionic cathode and an anode within said bulb, means to produce a beam of electrons between the cathode and the anode, a coating layer carried on the interior of said bulb in the path of the beam of electrons and comprising at least one substance capable of transforming the kinetic energy of the electrons impinging on to said coating layer into luminous energy, an electronic lens comprising an annular diaphragm disposed substantially parallel to said cathode and coaxially to the latter, the annular surface of said diaphragm being provided with an annular opening whose radial width is substantially equal to the distance separating said diaphragm from said cathode, and means to maintain said diaphragm at the potential of said anode.

2. An electronic illuminating lamp according to claim 1, wherein said diaphragm has the form of a flat ring.

3. An electronic illuminating lamp according to claim 1, wherein said diaphragm has the form of an annular surface of revolution whose generatrix is constituted by a circular arc.

4. An electronic illuminating lamp according to claim 1, wherein said diaphragm comprises two annular elements mounted superposed coaxially to each other and each having the form of equipotential surfaces, adapted to define a desired beam of electrons, means being provided to maintain said elements respectively at the potential of the anode and at the potential of the cathode.

5. An electronic illuminating lamp according to claim 1, comprising additionally an electronic lens comprising two grids interposed between the cathode and the anode, the first grid which is the closest to the cathode being maintained at a potential which is at the most equal to the potential of the cathode and the second grid being maintained at a potential which is positive with reference to the cathode, the two grids having substantially the same pitch and the elements of the second positive grid being arranged in the electronic shadow of the elements of the first grid.

6. An electronic illuminating lamp according to claim 1, comprising additionally an electronic lens comprising two grids interposed between the cathode and the anode, the first grid which is the closest to the cathode being maintained at a potential which is at the most equal to that of the cathode and the second grid being maintained at a potential which is positive with reference to the cathode, the two grids having substantially the same pitch and the elements of the second positive grid being arranged in the electronic shadow of the elements of the first grid, and the cathode and the two grids having a form such that the geometrical locus of the points situated at the critical distance is very near the anode and corresponds substantially to the form of the latter.

7. An electronic illuminating lamp according to claim 1, comprising additionally an electronic lens constituted by a magnetic field whose lines of force coincide at least

partially with the ideal desired trajectories for the electrons.

8. An electronic illuminating lamp according to claim 1, said cathode and said diaphragm having the form of spherical segments mounted coaxially with said bulb, and having substantially mutually parallel concave surfaces directed toward the end of said bulb remote from its mounting stem press, said diaphragm being centrally apertured.

9. An electronic illuminating lamp according to claim 1, said cathode being frusto-conical, said electronic lens comprising a first annular element which surrounds said cathode and is electrically connected thereto, and further comprising a second curvilinear element which is centrally apertured and is mounted above said cathode and said first annular element and is electrically connected to said anode.

10. An electronic illuminating lamp according to claim 1, said cathode being frusto-conical, said electronic lens comprising a first annular element which surrounds said cathode and is electrically connected thereto, and further comprising a second curvilinear element which is centrally apertured and is mounted above said cathode and said first annular element and is electrically connected to said anode, said cathode and said lens elements being mounted coaxially of said bulb.

11. An electronic illuminating lamp comprising a transparent evacuated bulb, a therminonic cathode and an anode within said bulb, means to produce a beam of electrons between the cathode and the anode, a coating layer carried on the interior of said bulb in the path of the beam of electrons and comprising at least one substance capable of producing luminous energy under the impact of the electrons impinging thereon, said cathode being annular, a first annular electronic lens piece mounted surrounding said cathode and electrically connected thereto, a second annular electronic lens piece provided with an annular opening extending around its surface, and mounted above said cathode and said first annular piece and being electrically connected to said anode, said cathode and said lens pieces being surfaces of revolution formed by rotating a cathodic frustoconical generating element surrounded by a first lens generating element and also rotating a second curvilinear lens generating element superposed above said cathode and first lens element about an axis which is the axis of said bulb, the axis of said cathodic element and said lens elements which are so rotated being spaced from the axis of said bulb.

References Cited in the file of this patent

UNITED STATES PATENTS

2,056,545	Varian	Oct. 6, 1936
2,177,705	Friederich	Oct. 31, 1939
2,221,644	Lucian	Nov. 12, 1940
2,222,668	Knoll	Nov. 26, 1940
2,264,858	Record	Dec. 2, 1941
2,763,814	Navarre	Sept. 18, 1956