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(54) Light signal apparatus

(57) The invention relates to an apparatus for light signalling to be used particularly, but not exclusively, in the railroad and road fields for a railway signal of a type so-called "permanently luminous" to regulate trains' running, and for semaphore use to regulate the road circulation, the apparatus being of a type comprising a support structure (1) having an aperture for the emission of a signal generated by a relevant light unit, and characterized in that it comprises, inside said structure (1), a mirror (3) developed according to a conical or pyramidal surface, and a plurality of light units (4; 55) disposed on one or more circumferences or portions of circumference, or on one or more perimeters or portions of perimeter, and oriented with respect to the said conical or pyramidal surface so as to project on said mirror (3) light radiations deviated into corresponding reflected rays to make up the luminous signal of the apparatus.

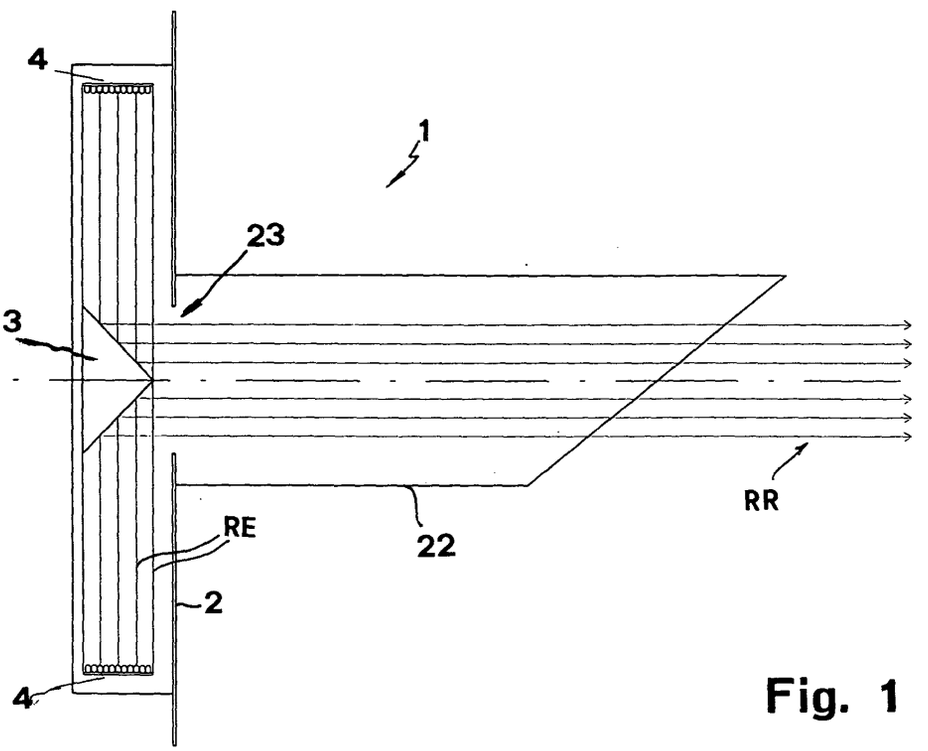

Fig. 1

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Description

[0001] The present invention refers to a light signal apparatus to be used in the railroad and road fields, in particular, but not exclusively, for uses as a railway signal of a type so-called "permanently luminous", that is, for signals of a type utilized for regulating the running of trains, and for semaphore use, that is, for regulating the on-road circulation.

[0002] The railway light signals devices may be subdivided into two main categories: movable screen devices (of electro-mechanical type) and dichroic mirror and optical fibres devices (of static type). In both cases, the light sources consists of lamps which, in the first case are of incandescence type, and in the second are of halogen type. For the semaphores there are generally used incandescent lamps as well.

[0003] The above mentioned light signals devices have many drawbacks, among which the fact that in case of a burnt-out lamp, the relevant useful signal cannot be generated; that overheating, and thus integrity problems may arise due to excess of heat generated by the lamps, in addition to the fact that they may often be affected by the so-called "ghost effect". The latter being a phenomenon of essentially optical nature by which the optical unit - intended to emit the light signal by projecting white or otherwise coloured light - although switched off, is able all the same to project a beam of light following the incidence and subsequent reflection of foreign radiations (for example, coming from artificial sources like railroad or road lamps and lights, signs, natural sources like sun rays) in the signal-projecting direction. Obviously, an event od such nature would dangerously prejudice the recognition and interpretation of the signals by the engine-room's personnel of the trains and by the road users in case of road semaphore signalling.

[0004] The main object of the present invention is to suppress or at least greatly reduce the above said drawbacks.

[0005] This result has been achieved, according to the invention, by adopting the idea of making an apparatus having the characteristics disclosed in the claim 1. Further characteristics being set forth in the dependent claims.

[0006] The present invention makes it possible to greatly increase the reliability and thus the operation safety of this type of signal apparatus; to avoid the onset of the "ghost effect"; to reduce the costs of inspection and maintenance of the signal devices; to lower to a minimum or at least to acceptable levels the detrimental thermal effects related to the supply of electrical power to the light sources.

Moreover, an apparatus according to the present invention is relatively simple to make and cost-effective in relation to the its performance.

[0007] These and other advantages and characteristics of the invention will be best understood by anyone skilled in the art from a reading of the following description in conjunction with the attached drawings given as a practical exemplification of the invention, but not to be considered in a limitative sense, wherein:

- Fig. 1 is a schematic view in longitudinal section of a possible exemplary embodiment of the present apparatus;
- Fig. 2 is a schematic view similar to the preceding one showing a further possible exemplary embodiment of the present apparatus;
- Fig. 3 is a schematic perspective view of conical mirror and a plurality of light sources disposed along a cylindrical surface to be use for implementing the present invention;
- Fig. 4 shows in schematic perspective view a mirror and a group of light sources with two possible paths of relevant luminous radiations thereof;
- Fig. 5 is an electric schematic diagram relating to a matrix of light sources consisting of in-parallel sectors formed by in-series LEDs.

[0008] In the figures of the accompanying drawings the numeral 1 designates the whole of an apparatus for light signalling according to the present invention. With reference to Fig. 1, the apparatus 1 comprises a containment structure 2, depicted only schematically, which can be modified according to the signal's function.

[0009] With non-limiting reference to the railroad signalling, the structure 2 has a substantially cylindrical shape, with a cylindrical element 22 of lesser diameter extending on its front side in correspondence of a central aperture 23 intended to allow exit of light radiations, so as to define a shield or screen 22.

[0010] Provided inside the structure 2, in a central region and in correspondence of said aperture 23, is a conical mirror 3. In particular, the mirror is of right-cone shape with opening angle of 45°, the opening referring to the angle α between the longitudinal axis of the cone (indicated by Z and passing through the vertex 33 and the centre of the base circle) and a generatrix of the cone; for the sake of clarity, in Fig. 3 the symbol α indicates also the angle defined by an axis X passing through the centre 34 and a segment W; Y indicates an axis orthogonal to the axis X. In Figs. 1 and 2, wherein the mirror 3 is seen in side view, it can be noted that such view defines an isosceles triangle with its right-angle vertex in correspondence of the vertex 33 of the cone making up the mirror.

[0011] The apparatus 1 comprises a plurality of light sources 4 arranged along a cylindrical surface 40 and, in the illustrated example, are made up of LEDs 4. In particular, the cylindrical surface 40 is coaxial to the cone 3. In this way, the luminous radiations RE emitted by the light sources 4 are reflected by the conical mirror 3 reflected into rays RR parallel to the axis Z of the cone. In other words, the axis of cone 3 coincides with the optical axis of the signalling apparatus.

[0012] Advantageously, the light sources 4 are subdi-

vided into sectors connected in parallel to each other, each of said sectors comprising a light source 4 or more light sources connected in series to each other. Shown in Fig. 5 is and electric diagram of a matrix representing the cylindrical surface 40, with m sectors in parallel, each of which consists of n LEDs in series. Provided on each sector is a relevant limiting resistance (R_1, ..., R_m) and n LEDs ($D_{1,1}$ ..., $D_{m,n}$) .

[0013] With reference to Fig. 4, between the LEDs 4 and the conical mirror 3, relevant filtering/orienting means 44 may be disposed. The said filtering means 44 may comprise a pair of converging lenses able to improve the focusing of the luminous beam emitted by the LEDs. In particular, a first lens 45 may be used, disposed closer to a LED, of piano-spheric or plano-aspheric type, with its flat side facing the LED 4, and a second lens 46 of piano-cylindrical type with its flat side facing the conical mirror 3. This configuration, which comprises the filtering/orienting means 44, results particularly useful when the LEDs exhibit emission angles larger than 3-4°.

[0014] Such configuration, besides, offers the further advantage of eliminating the aspheric lens, currently present in the railroad signal devices, as the beam of light projected by the conical mirror is made up of rays substantially parallel to each other which do not require the provision of said lens. This allows reducing the production cost of the light signal device and, at the same time, eliminates the loss of luminous energy (in the order of 8%) deriving by the passage of the light rays through the air/glass interface of said aspheric lens.

[0015] In the examples of Figs. 1, 3 and 4, the LEDs 4 make up directly the cylindrical surface 40 which emits the luminous radiations; in the embodiment illustrated in Fig. 2, on the contrary, the LEDs 4 are connected on output to corresponding light guides of optical fibre 5 (that can be made, for example, from optical glass having a diameter of about 50 μ) able to route the luminous signals up to corresponding emitters 55 disposed along a cylindrical surface facing the mirror 3.

[0016] In all the illustrated examples, the cone 3 has its vertex turned to the direction of emission of the luminous rays, and the reflecting surface is the one external to the cone. It is also possible to construct apparatuses in which the cone 3 is disposed in opposite position, that is, with the vertex 33 located rearwardly and the theoretical centre 34 of the cone's base being turned to the direction of emission of the luminous rays. In these exemplary embodiments (not illustrated), the reflecting surface will be the internal one, the aperture of the conical mirror will be larger, and the arrangement of the light sources (or LEDs) will be such as to form different angles to the axis of the cone.

[0017] In other embodiments, also not illustrated, instead of the conical mirror, use can be made of a right-pyramid mirror whose base is defined by a regular polygon of any number of sides. Also in this case, the considerations apply made in relation to the reflection of the rays emitted from the light sources, that is, the correspondence between the perpendicularity of the direction of the ray emitted by the light source, with respect to the axis of the pyramid, and the angle that the corresponding side surface of the pyramid (on which the ray is reflected) makes with the same axis. In practice, the mirror may be shaped according to a conical or pyramidal surface, these surfaces including also those relating to conical and pyramidal frustums.

[0018] The apparatus 1 may use a very high number of LEDs, also of different types, that is, LEDs able to emit light of more colours (for example, green, yellow and red, that can be obtained also with the provision of filters disposed along the path of the luminous radiation emitted by white-light LEDs), thereby offering optimal performance, in terms of light intensity and availability of the system, and providing a signal characterized by a very high reliability.

[0019] As for the reliability of a signal apparatus according to the invention, comprising a matrix of LEDs arranged in parallel sectors, each sector including one or more LEDs in series, experimental tests have shown that this arrangement allows a significant increase of the reliability and availability of each of the three optical groups (equal to each other) that form the ligth signal apparatus. The particular embodiment and technology being used actually bring about a very long average life; by way of non-limiting example, such length can be expected of over 20 years.

[0020] It should be apparent that the maintenance of the signal systems result therefore cost-effective and the organization of the service activity more efficient.

[0021] By using a matrix of LEDs or equivalent light sources as above described, it is avoided to make use of optical components like mirrors, prisms, colour filters or others, which may alter the optical path and/or the colour of the light rays produced by external sources and coming back to the observer ("ghost effect").

[0022] In relation to the latter aspect, reference being made in particular to the illustrated examples in Figs. 1 and 2, the so-called screen (indicated with 22) of railroad signals extends over at least 225 mm, approximately, starting from the front surface of the signal's optical unit (in the centre of which the vertex 33 of the conical mirror 3 is disposed) according to a cylindrical shape with 191 mm diameter. By using a conical mirror 3 of a height of 70 mm, base diameter of 140 mm and aperture of 45°, the screen 22 defines a region of protection towards the luminous radiation which is assimilable to a cylinder 225 mm high and 191 mm in diameter. This implies that, to allow the luminous radiation to enter the signal's optical unit, the same radiations must be inclined, with respect to the optical axis of the signal, by an angle less than about 42°. In other words, in order to pass through the mouth of the cylinder defined by the screen 22, the luminous radiations must be inclined to the axis by less than 42° approximately; besides, in order to act upon half of the mirror's surface, the angle should be less than 22°. By taking into account that a light ray, in order to

come back to the observer, should encounter the mirror (which is inclined by 45° with respect to the optical axis) at an angle to the normal, in the point of incidence, higher than 23° (and thus an angle larger than 68° (45°+23°) with respect to the optical axis)), it will be evident that the "ghost effect" results therefore suppressed.

[0023] In an alternative embodiment of the invention, the present apparatus can provide a direct illumination, that is, without the interposition of the mirror 3; in such case, the electric diagram will be similar to that illustrated in Fig. 5, with a matrix of LEDs having m sectors in parallel, each sector being formed by n LEDs in series. Possibly provided on each sector is a relevant limiting resistance (R_1, ..., R_m) and n LEDs ($D_{1,1}$ ... , $D_{m,n}$) . Also in this alternative embodiment, provision may be made for lenses, for example of concave or convex type.

[0024] In relation to the use of the apparatus in the road semaphore field, the considerations are similar to those pointed out for the railroad signal devices, as far as the reliability characteristics and ghost effect are concerned, with a difference in the dimensions of the signal device and screen. Moreover, by using LEDs of coloured light, it is possible to eliminate coloured filters and front coloured caps, by replacing the latter with transparent caps being unaffected in any way by the said ghost effect.

Claims

1. Apparatus for light signalling to be used particularly, but not exclusively, in the railway and road fields for a railway signal of a type so-called "permanently luminous" to regulate the trains' running, and for semaphore use to regulate the road circulation, the apparatus being of a type comprising a support structure having an aperture for the emission of a signal generated by a relevant light unit, apparatus **characterized in that** it comprises, inside said structure (1), a mirror (3) developed according to a conical or pyramidal surface, and a plurality of light units (4; 55) disposed on one or more circumferences or portions of circumference, or on one or more perimeters or portions of perimeter and oriented with respect to the axis of said conical or pyramidal surface so as to project on said mirror (3) light radiations deviated into corresponding reflected rays to make up the luminous signal of the apparatus.

2. Apparatus according to claim 1, **characterized in that** each of said luminous units is made up of a matrix of light sources (4) comprising a preset number of luminous groups or sectors connected in parallel to each other: each luminous sector comprising one or more light sources connected in series to each other.

3. Apparatus according to claim 1, **characterized in that** the said luminous units (4) are made up of LEDs.

4. Apparatus according to claim 1, **characterized in that** the said luminous units (4) are made up of emitters connected via optical fibre elements (5) to corresponding LEDs.

5. Apparatus according to one or more preceding claims, **characterized in that** the mirror (3) has a right-cone shape with 45° aperture, said luminous units being disposed along a cylindrical surface (40) whose axis coincides with that of said mirror (3).

6. Apparatus according to one or more preceding claims, **characterized in that** between said mirror (3) and said luminous units (4; 55) there are disposed means (44) for filtering and/or orienting the light.

7. Apparatus according to claim 6, **characterized in that** the said means (44) for filtering and/or orienting the light comprise at least a pair of converging lenses able to determine a better focusing of the light beam emitted by said units (4; 55).

8. Apparatus according to claim 7, **characterized in that** the said pair of lenses consists of a first lens (45), disposed closer to the luminous unit (4; 55), of piano-spheric or plano-aspheric type, with its flat side facing the luminous unit (4; 55), and a second lens (46) of piano-cylindrical type, with its flat side facing the mirror (3).

9. Apparatus for light signalling to be used particularly, but not exclusively, in the railway and road fields for a railway signal of a type so-called "permanently luminous" to regulate the running of trains, and for semaphore use to regulate the on-road circulation, the apparatus being of a type comprising a support structure having an aperture for the emission of a signal generated by a relevant light unit, apparatus **characterized in that** each of said luminous units is made up of a matrix of light sources (4) comprising a preset number of luminous groups or sectors connected in parallel to each other: each luminous sector comprising one or more light sources connected in series to each other.

10. Apparatus according to claim 9, **characterized in that** it comprises one or more lenses associated with said luminous unit.

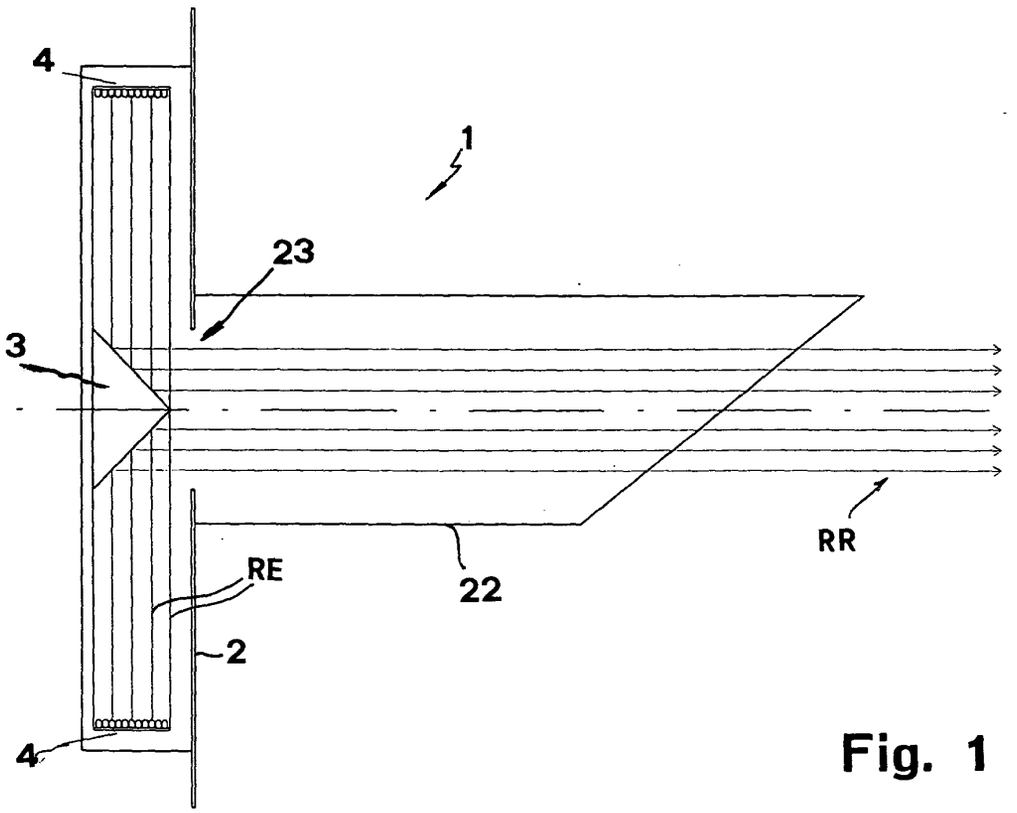

Fig. 1

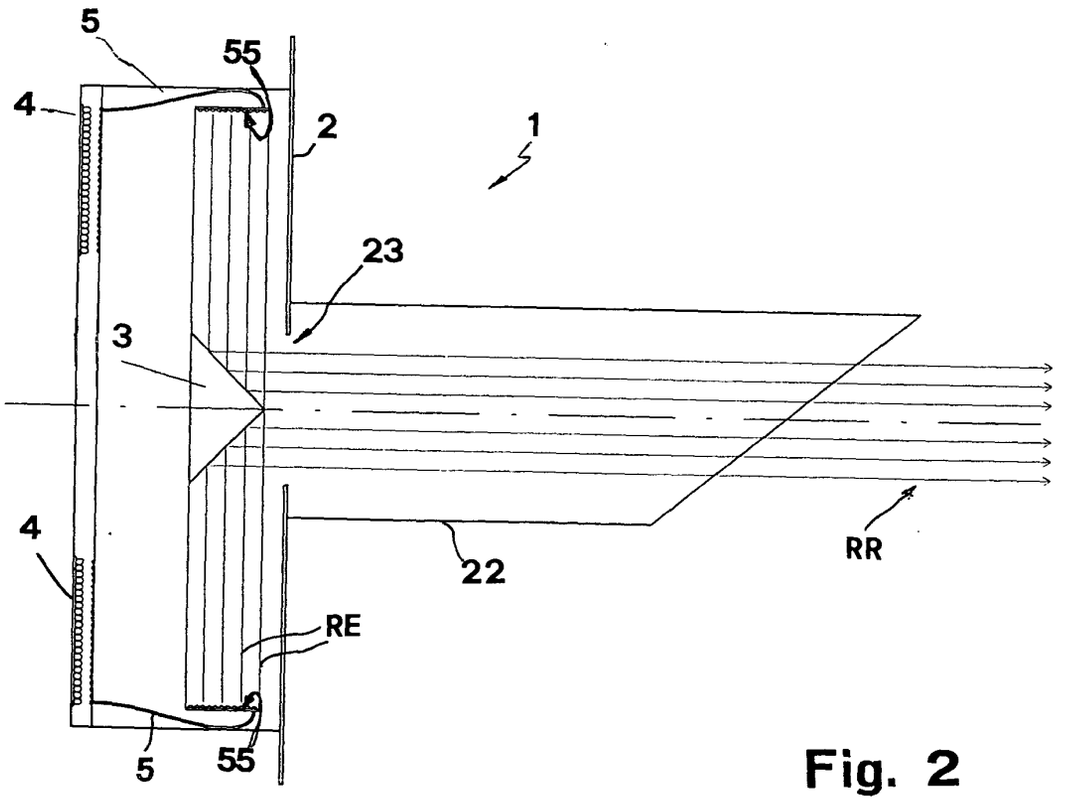

Fig. 2

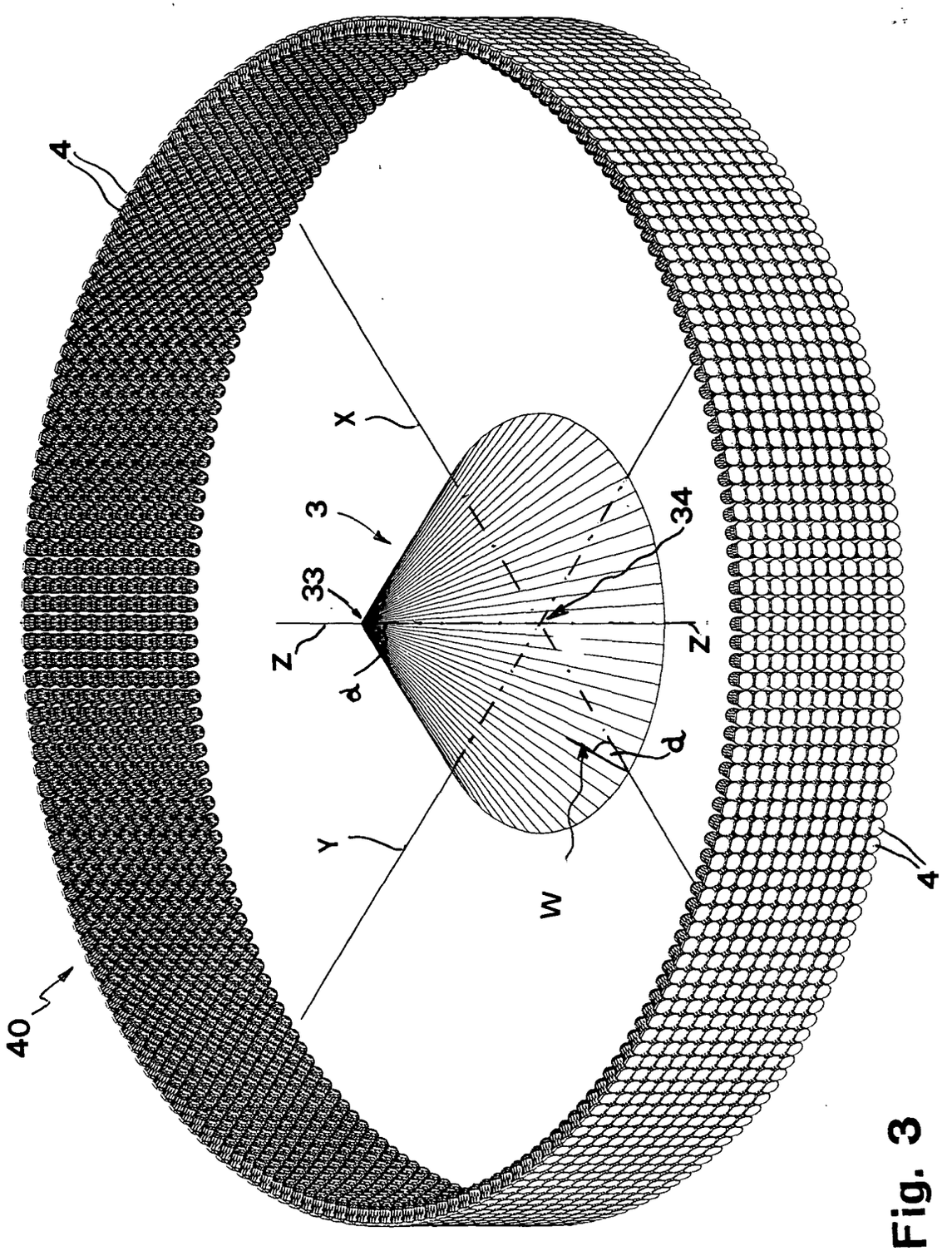

Fig. 3

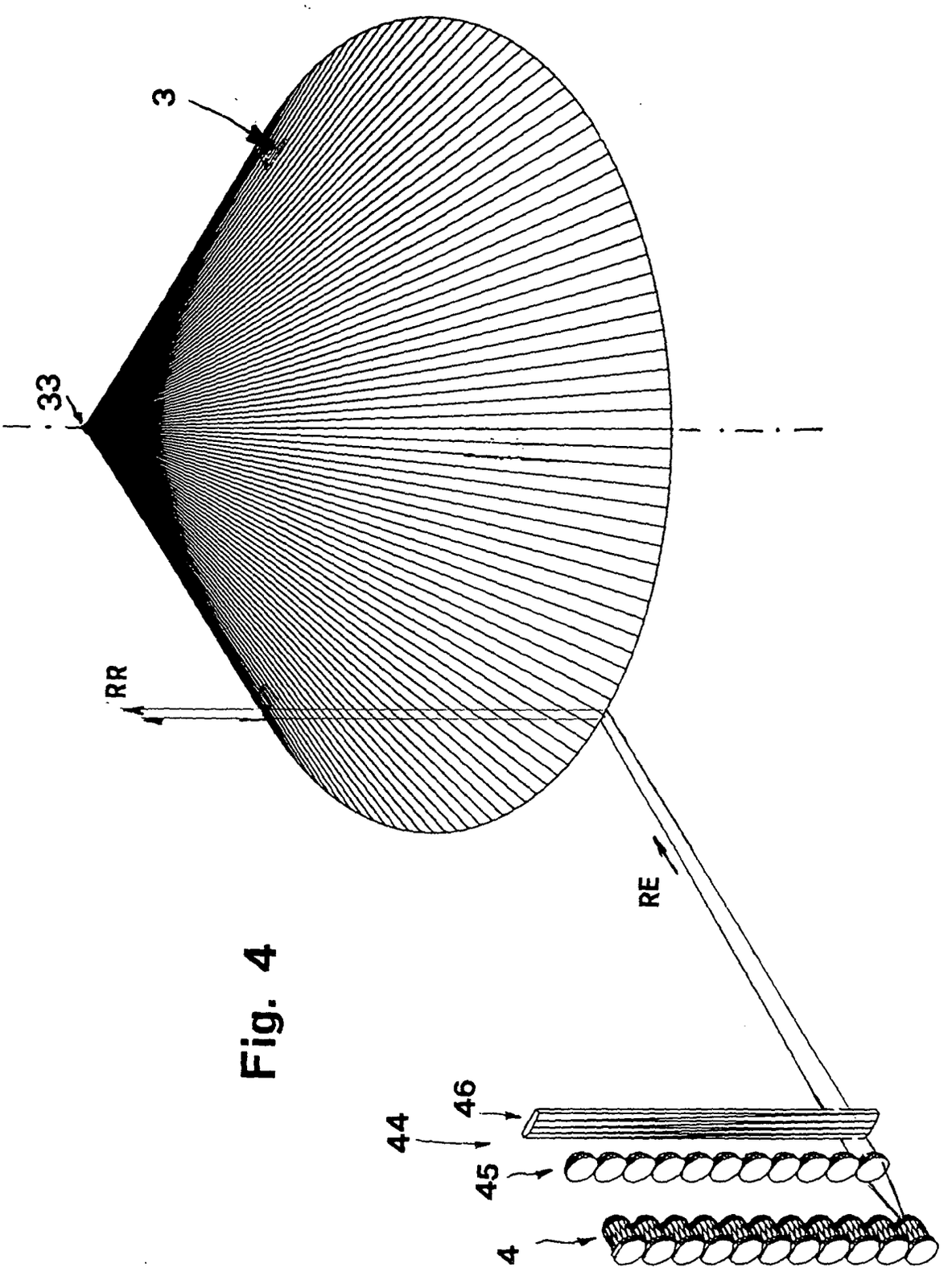

Fig. 4

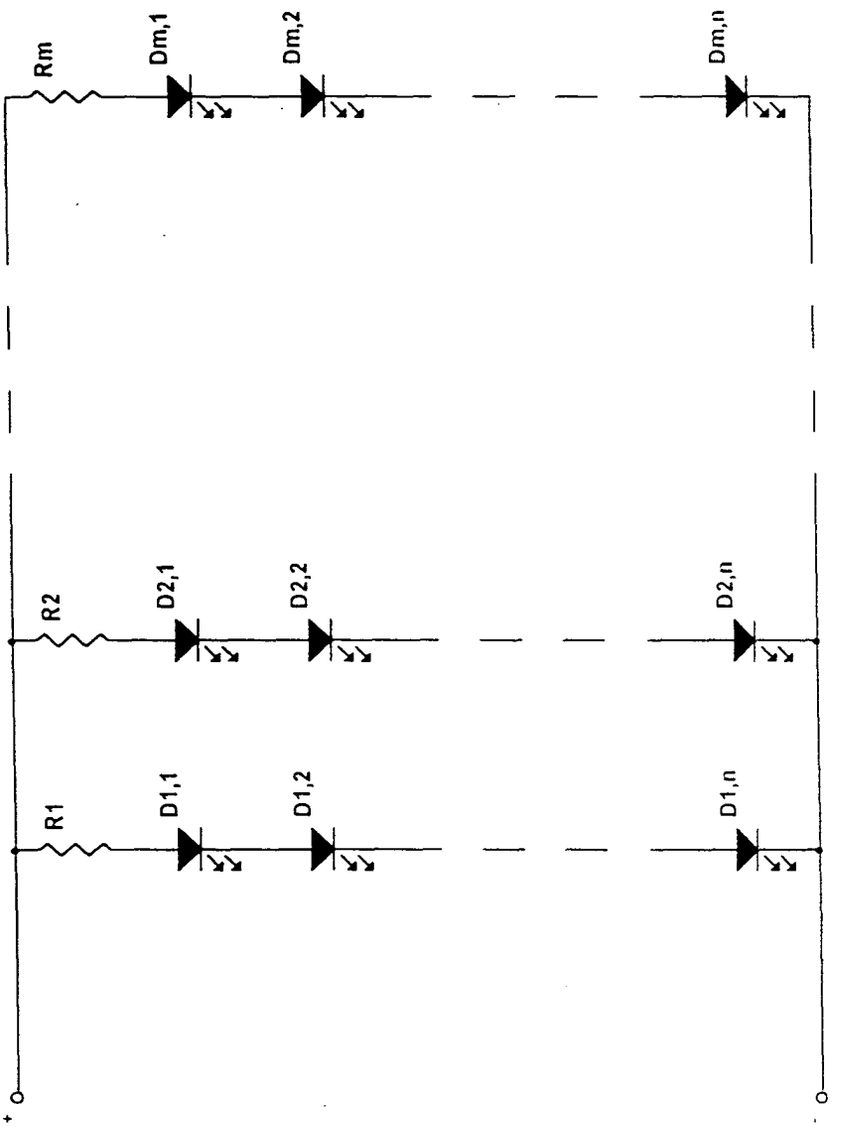

Fig. 5

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Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	19 July 2004	Massalski, M

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EUROPEAN SEARCH REPORT

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