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(54) **Signaling device for regulating traffic with LED light source**

(57) The signaling device comprises one or more light sources (39, 39) and a converging frontal projection lens (31), which produces a beam output from the signaling device. The light source(s) are formed of a matrix of light emitting diodes (39). Moreover, at least one optical concentration system (41) is provided, which concentrates the emission lobes (L) of the LEDs (39) in the focus of the frontal projection lens (31), wherein a field diaphragm (33) is disposed.

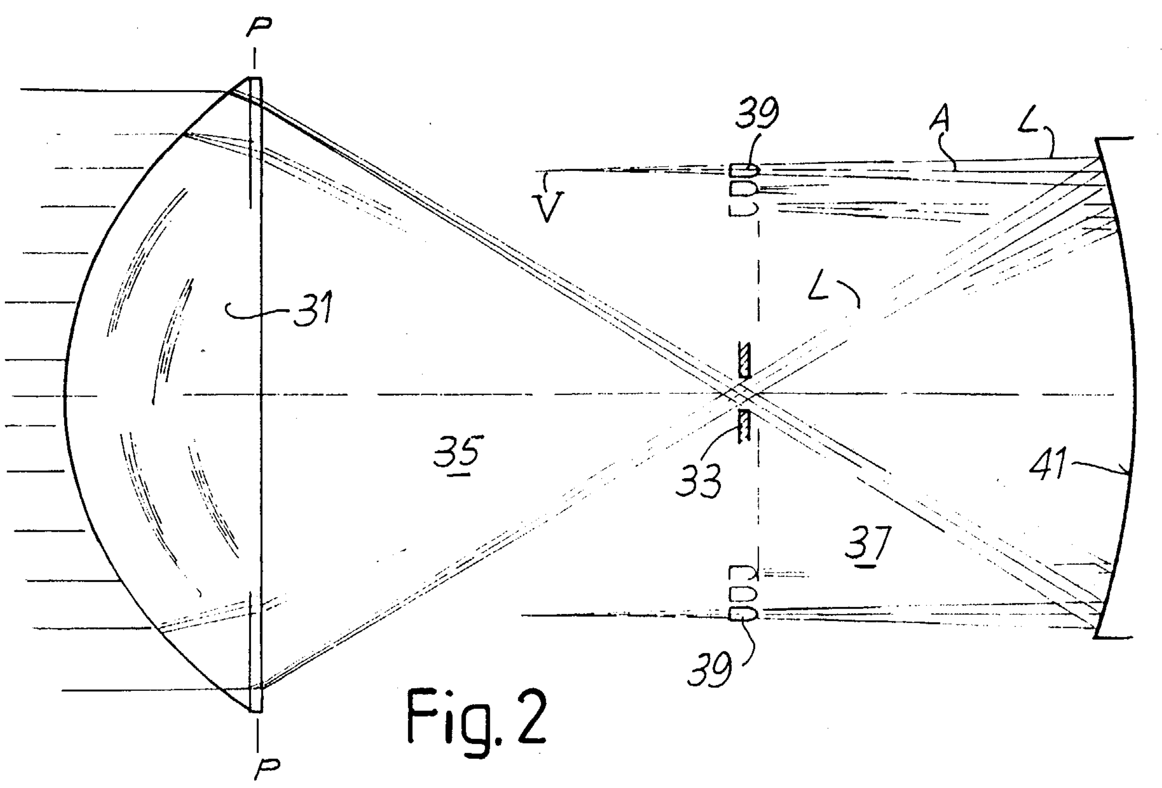

Fig. 2

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Description

Technical field

[0001] The present invention relates to an optical signaling device (also simply called "signal") for the management and control of traffic. In particular, although not exclusively, the invention relates to an optical signaling device for railway use, especially to produce a traffic signal with more than one optical source with color characteristics differing from one another.

State of the art

[0002] Optical signals comprising one or more light sources with precise color characteristics are used in railway signaling. In some cases these signals have a single source; more than one single source signals (typically three), with different color characteristics are put together to form a traffic signal. The isolated use of single source signals is also possible. This is typical in the case of the red traffic signals - fixed or intermittent - found at level crossings.

[0003] Other signaling devices for railway use are provided with more than one color source, typically three, with different color characteristics, to alternately emit optical beams of different colors. The signaling device may have a single output and therefore an optic that conveys, along a single optical path, the beam produced by the three sources. Otherwise, the same number of outputs as the number of sources may be provided.

[0004] Figure 1 shows an optical diagram of a single path traffic signal with three sources. Three reflecting parabolas 1, 3 and 5 are disposed in a housing (not shown). A respective halogen lamp 7A, 7B and 7C is disposed in the focus of each of these parabolas. In front of the three parabolas three filters, indicated with 9, 11 and 13 respectively, are disposed, centered on the wavelengths established by legislation for this type of signaling device, typically red, green and amber. Two semi-reflecting mirrors are indicated with 15 and 17, a diverging lens is indicated with 19 and a converging frontal output lens of the signaling device with 21. The optical axis X-X of the lenses 19, 21 coincides with the optical axis of the reflecting parabola 3, while the optical axis Y-Y of the parabola 5 is orthogonal to the axis X-X and the optical axis Z-Z of the parabola 1 is inclined with respect to both the axes X-X and Y-Y.

[0005] The assemblies 1-7A-9; 3-7B-11 and 5-7C-13 form three sources with different color characteristics, which may be switched on alternately. The arrangement of the semi-reflecting mirrors 15 and 17 is such that the beams emitted by the three sources are always conveyed along the axis X-X to reach the frontal lens. The lens 19 forms an image of each of the sources approximately in the output pupil of the optical system, lying on a plane P, and the converging lens 21 produces a beam F with a slight divergence, towards the outside of the device.

[0006] In railway terminology each color that can be emitted by the signaling device is called «aspect». The colors green, amber and red typically have the meanings usually given to these colors also in motor vehicle signals. Green indicates go, red indicates stop and amber warns of stop.

[0007] The adoption of light signals, although representing an unquestionable improvement in signaling compared to former mechanical and acoustic signaling, has introduced unwanted effects that due to extraneous factors, can alter the true configuration of the aspect, that is the color perceived by the driver.

[0008] This phenomenon is called «phantom effect». This effect is defined as «an aspect shown by a light signal, differing from the established aspect, caused by a light coming from an external source that is reflected by the optical system generating the main signal. For example, the rays of the sun or of any other external light source, by penetrating existing signals with an inclination between 20° and 40° with respect to the axis X-X of the optic, are conveyed towards the specular parabola positioned behind one of the lamps (for example parabola 3 in Figure 1) and reflected. The reflected rays return along the optical path towards the outside exactly as if they came from the lamp of the source. That is, they cross the filter, which colors them so that the signal emitted by the signaling device will for the driver be of a different color to the one established.

[0009] This situation may have extremely dangerous consequences.

[0010] In the case of a signaling device with a single aspect, that is designed to emit a single color, if external light penetrates when the signaling device is off with a small angle of inclination compared to the axis of the optical system of the signaling device, it is back-reflected with the color of said signaling device. The driver receives information that the signaling device is switched on, when in actual fact it is switched off. This is the most dangerous situation, as a train that should stop will continue without even slowing down.

[0011] In the case of a traffic signal with three chromatically different light sources, that is a traffic signal or signaling device with three ways or with three aspects, the situation could still be ambiguous and dangerous, even if not dramatic, as the signal activated tends to have a more restrictive aspect, in the sense that the phantom signal would have a red aspect, that is stop.

[0012] Nonetheless, also in this case more serious situations could occur, as the effect of back-reflection could take place in all three channels and, in certain particular conditions, could prevail in one of the three colors. Moreover, by superimposing the existing aspect, it could make the effective color unclear.

[0013] This effect (both in the signaling device with one aspect, and in the signaling device with three aspects) is known as «color phantom effect», as the incident light from outside (usually white light) is back-reflected with the color or with one of the colors of the signaling device.

[0014] Modification of the aspect of the signal may also be caused by other irregular situations that can influence the optical signal, such as external light reflected directly (without crossing a filter) by any component inside the signaling device. In this case the light is reflected as white light (rather than colored) which may superimpose the color emitted by the temporarily activated source. If the intensity of this white light reflected is above 100 cd (candelas), it is dangerous for correct reading of the established aspect. This is called «white phantom effect», to distinguish it from color phantom effect. Said effect is mainly due to residual reflection of the surfaces of lenticular optical components, also called «dioptric components».

[0015] Statistical data attribute a percentage of around 30% of rail accidents to false information of signals to train drivers. Moreover, the awareness that there is a possibility of error in interpreting the aspect of an optical signal causes considerable stress to train operators, to the detriment of working conditions and, ultimately, of safety.

[0016] Analogous situations, even if potentially less dangerous, may occur in optical signals for use on roads. Traffic signals on roads often seem red due to incident sunlight reflected in the internal parabola of the traffic signals and emerging from the colored frontal lens, while it is in actual fact green.

Objects and summary of the invention

[0017] The object of the present invention is to produce an optical signaling device to control traffic, in particular, although not exclusively, for railway use, which overcomes the aforesaid drawbacks and considerably reduces or eliminates both color and white phantom effect.

[0018] Essentially, the invention is based on the idea of using, as color source for a signaling device of the aforesaid type, a matrix of light emitting diodes, hereinafter referred to as "LED" (Light Emitting Diode), and of fitting inside the signaling device an optical concentration system that concentrates the emission lobes of the LEDs of the source(s) approximately in the focus of the frontal lens of the signaling device. In this way, a field diaphragm may be placed in the concentration zone of the emission lobes, which, as will be explained hereunder, has a fundamental role in drastic reduction of the phantom effect.

[0019] In fact, this diaphragm essentially forms an optical shield that divides the inside of the signaling device into two separate chambers: a chamber containing the source(s) and a projection chamber, closed at the front by the frontal protective lens. The diaphragm is suitably blackened to prevent incident light from being reflected on it. Any external light radiation (for example sunlight) can only penetrate the source chamber if its source is within the divergence field defined by the diaphragm. When this occurs, radiation is focused in a point inside the diaphragm and then re-expands, follows an optical path along which further dioptric or reflecting elements that modify configuration are disposed, and then hits the entire LED matrix, or the entire cluster formed of more than one LED matrix, from which it is diffused in all directions and only a tiny fraction crosses back through the field diaphragm. If the inside of the source chamber is suitably blackened, only the radiation reflected by the transparent covers of the LEDs can be back-reflected. Nonetheless, back-reflection given by the shape of these covers takes place over the entire angular half-space of 2π steradians. Only a minimum aperture of this, typically around 6°, that is below 1/100 of a steradian, can cross back through the diaphragm. Assuming that the residual reflectivity of the LED covers is 4%, photometric «decoupling» is more or less equal to $5x10^{-5}$. That is, only an entirely negligible quantity of incident radiation is back-reflected to the outside of the signaling device. This quantity has practically no influence with regard to white phantom effect.

[0020] The focusing system may even be formed by the actual arrangement of the LEDs in the space.

[0021] LED matrix is intended as any spatial arrangement of LEDs that produce respective emission lobes which, as a whole, form a light beam with color characteristics corresponding to a color or aspect of the signaling device.

[0022] The use of LED matrices rather than incandescent lamps combined with reflecting parabolas and colored filters intrinsically eliminates the problem of the color phantom effect. In fact, the absence of optical elements (filters) that can color the beam of white light accidentally penetrating in the signaling device, means that a colored beam cannot be back-reflected from it.

[0023] Moreover, by simplifying the optical system and decreasing the dioptric components, the risk of white phantom effect is reduced. As is clear from the explanation hereinbefore, this layout also allows specific additional measures to be adopted, that is the adoption of diaphragms, absorbent screens and paints, in combination with the particular hemispheric shape of the LEDs, which allow the white phantom effect to be further reduced, if not essentially eliminated.

[0024] The use of LEDs in place of traditional incandescent lamps allows further advantages to be attained. In particular:

- LEDs are highly efficient devices and require less energy than incandescent lamps with the same quantity of light output;
- LEDs are much more reliable than common incandescent lamps and the incidence of faulty LEDs is extremely low;
- the clear plastic cover of the LED, which - together with the absence of filters - eliminates the possibility of color phantom effect;

- the time required to switch LEDs on and off is much lower than the time required to switch incandescent lamps on and off. This can improve operation in the case of flashing signaling devices, for example in the case of level crossings;
- LEDs have a very long lifespan and can be replaced every ten years, while incandescent lamps have a lifespan of a few thousand hours.

Moreover, the use of LEDs makes it possible to produce a very simple optical circuit with the use of a minimum number of components. Both these factors reduce the number of special maintenance operations and the time and costs for regular maintenance, a crucial aspect in signals of this type.

[0025] As a rule, the signaling device may have a single aspect, that is equipped with a single light source that emits a light signal of one color, for example green, red or amber. A signaling device of this type will therefore have a single LED matrix and a respective optic to form the collimated, or slightly diverging, beam emitted from the signaling device. The signaling device may be used individually or more than one signaling device, each with a respective source with different color characteristics from the others and its own optical system, may be used in combination to form a traffic signal with more than one aspect, typically three aspects. Alternatively, the various sources and various optical paths can in any case be housed in a single container, to form a signal with more than one aspect and more than one output.

[0026] Alternatively, the signaling device can comprise a plurality of light sources with color characteristics differing from one another, forming a traffic signal and a single optic to produce the output beam. Each light source will be composed of a LED matrix.

[0027] The LED matrices are combined with one another and disposed in a common space, with the LEDs of the various matrices intercalated with one another, to form a single cluster of LEDs. The optic that forms the output beam will include a single frontal projection lens defining a single output for the optical signal of the signaling device. The LEDs of one or other matrix will be switched on alternately according to the aspect to be adopted by the signaling device. Through the single frontal lens, a light beam produced by the LEDs of the activated matrix will be emitted, the color of which will vary according to which group or matrix of LEDs have been switched on.

[0028] Therefore, in this way the signaling device obtained has more than one aspect (that is, it is capable of emitting signals of different colors) and one output. The layout is of the static type, that is with no moving members required to change the aspect of the signaling device. This condition is essential when producing traffic signals for railway use.

[0029] Cluster is intended as an assembly of two or more matrices, wherein the LEDs of one matrix are interposed with the LEDs of the other, so that the two or more sources defined by the two or more matrices are positioned in a common space and the emission lobes of the LEDs of the various matrices can follow a common optical path, along which the optical components of the signaling device are disposed.

[0030] According to an advantageous embodiment, the optic of the signaling device can comprise at least one frontal projection lens, converging (essentially equivalent to the frontal projection lenses currently used in existing signaling devices), which produces an output beam, and at least one optical concentration system that concentrates the emission lobes of the LEDs of at least one source in the focus of said frontal lens. With an arrangement of this type it is possible to maintain the layout and external dimensions of the signaling device essentially the same, or even better than those of existing signaling devices. It is even possible to replace the internal optic of a traditional signaling device and the source, maintaining the existing frontal projection lens.

[0031] In order to produce a particularly reliable signaling device which requires minimal maintenance, according to an advantageous embodiment the optical concentration system has a concave mirror. The LED matrix or matrices are disposed between the frontal projection lens and the concave mirror and the LEDs are positioned so that the emission lobes are emitted towards said concave mirror. The frontal lens and the concave mirror may constitute the only optical components of the entire signaling device (besides the LEDs with the respective covers). In this layout, the concave mirror concentrates the axes of the emission lobes of the LEDs forming the source(s), at the center of the field diaphragm and at the same time conjugates the image of the matrix or matrices in the output pupil of the optic of the signaling device.

[0032] In this layout the LEDs are advantageously disposed essentially on a plane and may be carried by a flat support, which may simultaneously form or constitute the field diaphragm.

[0033] Instead of a converging mirror, the optical concentration system may have one or more lenses, optionally in combination with reflecting surfaces, and be physically disposed between the LED matrix or matrices and the frontal projection lens. The LEDs are disposed on a support so that they are facing the frontal projection lens, rather than the opposed part as in the case in which the optical concentration system has a concave mirror.

[0034] This layout may be advantageously combined with an arrangement of LEDs along a concave surface rather than a flat surface. This surface may be spherical, or even be a different shape, for example obtained by the rotation of an ellipse.

[0035] As well as the advantages mentioned hereinbefore of reduced maintenance and decrease or elimination of the color or white phantom effect, the use of sources formed of LEDs allows a signaling device with further characteristics and functions, which cannot be obtained with traditional signaling devices, to be produced.

[0036] In fact, as mentioned the times required to switch a LED on and off are much lower than the times required to switch on and off the traditional incandescent lamps currently used in signaling devices. This allows light emitted from the LEDs to be modulated at a frequency that is imperceptible to the human eye. In other terms, to the observer the LED matrix may seem permanently on, while in actual fact the LEDS of which it is composed emit high frequency and suitably modulated light pulses. These pulses may contain information that can be captured and decoded by means of a receiver and a decoding circuit installed on a vehicle, for example on the locomotive of a train, destined to travel in the system containing the signaling device. In practice, only a few of the LEDs require to and should emit modulated signals, so that this modulation does not reduce, or reduces only imperceptibly, the overall power of the beam. For example, only two or three of the LEDs of each source can be allocated to modulate the signal, while all the rest emit a continuous signal.

[0037] With this modulation it is possible to use the optical signaling device as a means to transmit information to the driver of the vehicle, information that may reach the driver in various forms: from a simple acoustic or optical signal in the vehicle, to detailed and complex information on a monitor installed in the vehicle and/or communicated to the driver by a voice synthesizer. For example, information may be sent on the conditions of the line downstream of the signaling device.

[0038] This function may also be useful in the case of road traffic signals, by equipping motor vehicles with specific instruments to receive and interpret the signal, and the necessary user interfaces, for example analogous to the case of satellite navigators currently in use. Modulation of the optical signal may also be used to transmit commands to be executed automatically to the vehicle (especially a train), for example an emergency stop command.

[0039] Further advantageous characteristics of the signaling device according to the invention and of a traffic management or control system employing said signaling device are indicated in the attached dependent claims.

<u>Brief description of the drawings</u>

[0040] The invention shall now be better understood by following the description and accompanying drawings, which show a non-limiting practical embodiment of the invention. More specifically, in the drawings:

Figure 1 is an optical diagram of a signaling device of the traditional type with three aspects;
Figure 2 is an optical diagram of a first embodiment;
Figure 3 is a simplified mechanical diagram of the embodiment in Figure 2;
Figure 4 is a diagram of a single LED;
Figure 5 is a front view according to V-V in Figure 3 of the cluster of LEDs forming three color sources;
Figure 6 is an optical diagram of a modified embodiment;
Figure 7 is an optical diagram of a further modified embodiment; and
Figure 8 is a diagram of a portion of a railway system using the signaling device according to the invention, integrated with the modulation function of the optical signal emitted by the signaling device.

<u>Detailed description of embodiments of the invention</u>

[0041] Hereunder the invention is described with reference to a typical railway application. However, as mentioned previously, it must be understood that the invention may also be applied advantageously to produce signaling devices for other uses, such as to produce road traffic signals.

[0042] With initial reference to Figures 2 to 5, the signaling device comprises a frontal projection lens 31 with optical axis X-X. The lens frontally closes a housing, not shown and of a per se known type, inside which the other components of the signaling device are disposed. The lens 31 is a converging lens from which a collimated or slightly diverging beam is emitted, typically with an aperture of 2°.

[0043] Disposed along the axis X-X of the lens 31 is a field diaphragm 33 that divides the inside of the signaling device into two chambers: a first frontal or projection chamber, indicated with 35, and a second back chamber or source chamber, indicated with 37. The diaphragm 33 is produced in a flat support 38 that bears a special arrangement of LEDs, shown in detail in Figure 5. The LEDs are of three different types, with emissions in the red, amber and green wavelength ranges.

[0044] The LEDs that emit in the three wavelength ranges defined above are indicated in Figure 5 by different letters: the red, green and amber LEDs are indicated with the letters R, G and A respectively.

[0045] As can be seen in this figure, the arrangement obtained is a cluster of LEDs formed by the combination of three LED matrices, red, amber and green respectively. The assembly or matrix of LEDs emitting in the red, amber and green wavelength ranges form three respective sources with distinct color characteristics, which can be switched on alternatively to one another or which can all be switched off.

[0046] The arrangement of the LEDs, indicated with 39, on the support 38 is produced according to an hexagonal geometry with a red LED at the center and four amber LEDs and two green LEDs at the vertices of the hexagon. In this way a ratio of 1:2 is obtained between amber and green LEDs and a ratio of 1:6 between red and amber LEDs. By using LEDs with emission in the range of 40-50 candelas, and considering the enlargement factor of the optical system, it is possible to reach the emission intensities required by legislation for the three colors with a number of LEDs for each color that form a cluster layout with sufficiently limited dimensions to be housed in a standard container or housing.

[0047] The LEDs 39 are positioned so that the respective axes A of the emission lobes L (Figure 2) are parallel to one another and to the optical axis X-X of the frontal projection lens 31. The LEDs are positioned on the support 38 so that they emit on the face of the support 38 opposed to the face facing the frontal projection lens 31, i.e. towards the inside of the source chamber 37.

[0048] Disposed in front of the LEDs 39 in the source chamber 37 is a concave mirror 41, spherical or parabolic in shape, which receives the emission lobes L of the LEDs 39. The mirror 41 is a concentrating mirror that concentrates the emission lobes in the center of the field diaphragm 33, as can be seen in particular in the optical diagram in Figure 2.

[0049] Each LED 39 has a plastic cover 39C, as shown schematically in Figure 4, that focuses the wide emission lobe (characteristic of the junction of the LED) forming the emission lobe L that has divergence typically in the range of 6°, the cover having a diameter of 5 mm. The emission lobes L have a vertex V (in which the virtual image of the single LED is located) positioned farther back with respect to the plane of the LED matrix. The extent of this position depends on the type of LED, although it may be estimated at around 50 mm. Therefore, the beam emitted by each LED may be considered as coming from a point disposed in the vertex V of the lobe, 50 mm behind the actual LED. The concentrating mirror 41 creates an image of this point in a zone around the output pupil of the system, placed on the plane P.

[0050] Therefore, with this arrangement, the output optical beam is formed by an optic with only two elements: the concave mirror 41 and the frontal projection lens 31.

[0051] Disposed in front of the field diaphragm 33 produced in the support 38 is a conical wall 51 with an aperture α, typically in the range of 70°, integral with which is a disk 53. Both the disk 53 and the conical wall 51 are blackened, at least on the surface facing the frontal lens 31, as are the supporting surfaces 38 of the LEDs 39 and the walls of the housing (not shown). The aperture of the conical wall 51 is large enough to accept essentially all the rays coming from outside the signaling device, for example the rays of the sun, focused by the frontal projection lens 31. The electronic control elements of the LEDs forming the sources, indicated as a whole and schematically with R, can be housed between the disk 53 and the support 38.

[0052] When an external light source, for example the sun, which is outside the angle of projection of the signaling device, strikes the frontal projection lens 31 with its rays of light, the rays are focused by the lens 31 but are intercepted and absorbed by the wall 51. If the external source is located within the angle of projection of the signaling device, its rays are focused in the diaphragm 33 and re-open in the source chamber 37 encountering the spherical mirror 41,which collimates them. The rays reflected by the mirror 41 reach the support 38 and the spherical covers 39C of each LED carried by the support. The surface of the support 38 is suitably blackened and therefore absorbs the radiation coming from the mirror 41 without back-reflecting it. The radiation incident on the spherical covers 39C of the LEDs 39 is reflected by these with relatively modest efficiency, in the range of 4% on a very wide angle. As mentioned hereinbefore, only a minimum fraction of this radiation back-reflected by the LED covers reaches and crosses the diaphragm in the reverse direction, so that in practice the white phantom effect is eliminated. Back-reflected emission is without always below the safety limit of 100 cd.

[0053] Figure 6 shows the optical diagram of a modified arrangement of the signaling device according to the invention. Equivalent or corresponding parts are indicated with the same reference numbers increased by 100. Inside the housing (not shown), behind the frontal projection lens 131 that closes said housing, are a field diaphragm 133 and a support 138 for the LEDs 139. These are disposed with a layout equivalent to the one in Figure 5. However, in this case the support 138 is not flat, but curved and more specifically has the shape of a spherical cover and the LEDs are disposed so that they emit from the concave surface of the support. In this way the axes of the lobes L emitted by the LEDs 139 converge towards the field diaphragm 133.

[0054] Between the support 138 and the field diaphragm 133 an optical concentration system may be disposed (as shown in the example), constituted by two lenses 142 and 144, diverging and converging respectively. The optical concentration system 142, 144, in combination with the particular geometrical arrangement of the axes of the emission lobes of the LEDs 139, mean that these axes are focused in the center of the diaphragm 133 and then diverge, until they form an image of the source again approximately on the plane P on which the output pupil of the optical system lies.

[0055] Figure 7 shows a modified embodiment of the device. Equal or corresponding parts to those in the example in Figure 6 are indicated with the same reference numbers, increased by 100. The LEDs forming the cluster constituted by the three matrices that define the three sources are carried by a flat support 238. The LEDs project their emission lobes L towards the frontal projection lens 231. Disposed between this lens and the support 238 is an optical component called «one piece Cassegrain concentrator» 242 and a field diaphragm 233. Said optical component performs the same concentration function described for the mirror 41 in Figure 2, but in a reduced overall dimension.

[0056] The Cassegrain concentrator 242 has a flat, transparent surface S1 facing the LEDs 239 and surrounding a concave and metallized spherical surface S2. On the opposite side the component 242 has a convex surface S3, spherical or aspherical, metallized externally except for a central zone. The metallization of the surface S3, facing the lens 231, is covered by an absorbent coating.

[0057] The lobes L emitted by the LEDs 239 cross the surface S1 and are reflected and concentrated inside the Cassegrain concentrator from the internal reflecting surface S3 towards the spherical surface S2. This reflects the concentrated beam that again crosses the component 242 and emerges from the untreated central area of the surface S3, focusing on the field diaphragm 233. The field diaphragm 233 has the same functions as the diaphragm 33 and 133 of the previous embodiments

[0058] Figure 8 schematically shows a railway line F with a train C and a light signaling device S produced according to the invention. The light signaling device S is associated with a control circuit R that manages switching on and off of the LEDs forming the light source (s) of the signaling device S. The control circuit R (which is actually inside the housing of the signaling device S) is connected by a transmission line T, to an operation center U. The line T may be any kind of line and may also be simply composed of a radio transmission.

[0059] Control signals are sent from the operation center U to switch on and off the signaling device S and to switch its aspects (when it has more than one aspect). By means of the transmission line T complex information or instructions can also be sent, which are transformed by the circuit R into control signals of at least some of the LEDs of one or other source, which can emit a modulated light signal at a frequency imperceptible to the eye of the driver of the train C. In practice, some LEDs of each matrix will be associated with modulation means of the signal. However, it is also possible for the LEDs allocated to the production of the modulated signal to be LEDs that emit in the infrared range, so that they can be used notwithstanding the aspect adopted by the signaling device and if necessary with the signaling device switched off.

[0060] Disposed on the locomotive of the train C is an optical receiver RO that receives the optical modulated signal and, by means of a processor E, decodes it to provide the driver with the corresponding information, commands or the like through an interface I. This may be a monitor, an acoustic or visual signaling device, a voice synthesizer, a combination of these devices or another suitable type of interface.

[0061] Using the LEDs of the sources of the signaling device S as elements to produce a modulated signal it is thus possible to provide the driver of the train C with additional information to the information provided directly and visually by the signaling device S. In this way the driver can, for example, be provided with information on the conditions of the line downstream of the signaling device S, instructions regarding the speed to maintain, or the like. It is also possible, for example, simply to activate an acoustic alarm or the like inside the train. This allows the driver to be warned in the event of a dangerous situation. For example, an acoustic signal can be produced when the signaling device S is red.

[0062] It is understood that the drawing purely shows non-limiting possible embodiments of the invention, which may vary in shapes and arrangements without however departing from the scope of the concept on which the invention is based.

Claims

1. A light signaling device for regulating traffic, comprising at least one light source and a converging frontal projection lens, which produces a beam output from said signaling device; **characterized in that:** said at least one light source is formed of a matrix of light emitting diodes (LED); at least one optical concentration system that concentrates the emission lobes of the LEDs of said at least one source approximately in the focus of said frontal projection lens is provided; and a field diaphragm is disposed approximately in the focus of said frontal projection lens.

2. Signaling device as claimed in claim 1, **characterized in that** it comprises a plurality of light sources with color characteristics differing from one another, forming a traffic signal.

3. Signaling device as claimed in claim 2, **characterized in that** said matrices are combined to form a single cluster of LEDs, and **in that** said frontal projection lens defines a single output for the optical signal of the signaling device, which receives the optical signal from the three sources.

4. Signaling device as claimed in claim 3, **characterized in that** said converging frontal projection lens receives the radiation of all the sources and produces a beam output from said signaling device, and **in that** said optical concentration system concentrates the emission lobes of the LEDs of all the sources in the focus of said frontal projection lens.

5. Signaling device as claimed in one or more of the previous claims, **characterized in that** said field diaphragm has optically absorbing surfaces.

6. Signaling device as claimed in one or more of the previous claims, **characterized in that**: said optical concentration system has a concave mirror; **in that** said matrix or said matrices of LEDs are disposed between the frontal projection lens and the concave mirror; and **in that** the LEDs are positioned so that the emission lobes are emitted towards said concave mirror.

7. Signaling device as claimed in claim 6, **characterized in that** the only optical components disposed along the optical path of the radiation emitted by said LEDs are formed of said concave mirror and said frontal projection lens.

8. Signaling device as claimed in at least claim 6 or 7, **characterized in that** said concave mirror concentrates the axes of the emission lobes of said LEDs forming the source(s) at the center of the field diaphragm and conjugates the image of the matrix or matrices in the output pupil of the signaling device optic.

9. Signaling device as claimed in one or more of the previous claims, **characterized in that** the LEDs forming said matrix or matrices are disposed essentially on a plane.

10. Signaling device as claimed in claim 9, **characterized in that** said LEDs are carried by a mechanical supporting structure and **in that** said field diaphragm is associated with said mechanical supporting structure.

11. Signaling device as claimed in claim 10, **characterized in that** said diaphragm is produced in said mechanical supporting structure.

12. Signaling device as claimed in claim 10 or 11, **characterized in that** a conical wall is connected to said mechanical supporting structure, extending from the face of said supporting structure opposite the face from which said LEDs emit, and open towards the frontal projection lens, by means of a conical screening wall.

13. Signaling device as claimed in claim 12, **characterized in that** an essentially flat screening disk-shaped wall is connected to said conical wall.

14. Signaling device as claimed in one or more of the previous claims, **characterized in that** said optical concentration system is disposed between a supporting structure on which the LEDs are disposed and the frontal projection lens.

15. Signaling device as claimed in claim 14, **characterized in that** said optical concentration system is composed of two or more spherical or aspherical lenses forming a diverging and a converging group.

16. Signaling device as claimed in one or more of the previous claims, **characterized in that** the LEDs of each of said sources are disposed on a concave surface.

17. Signaling device as claimed in claim 16, **characterized in that** said concave surface is a spherical cover.

18. Signaling device as claimed in claim 14, **characterized in that** said supporting structure is essentially flat.

19. Signaling device as claimed in one or more of the previous claims, **characterized in that** said concentration system comprises a one piece Cassegrain concentrator.

20. Signaling device as claimed in one or more of the previous claims, **characterized in that** it comprises a control circuit to produce an optical signal modulated by at least some of the LEDs associated with the signaling device.

21. Signaling device as claimed in claim 20, **characterized in that** said LEDs that produce a modulated optical signal form part of one or more of said sources.

22. Signaling device as claimed in claim 20 or 21, **characterized in that** the modulated signal has a frequency at which modulation of the optical signal is imperceptible to the human eye.

23. A system for the management of traffic **characterized in that** it comprises at least one signaling device as claimed in one or more of the previous claims.

24. System as claimed in claim 23, **characterized in that** it comprises a control center and at least one transmission line between said control center and said at least one signaling device.

25. System as claimed in claim 24, **characterized in that** it comprises a plurality of vehicles or trains, at least some of which are equipped with an optical receiver to receive a modulated optical signal produced by said at least one signaling device.

26. System as claimed in claim 25, **characterized in that** said optical receiver is associated with processing means that, according to said modulated optical signal, produce information that can be interpreted or understood by man.

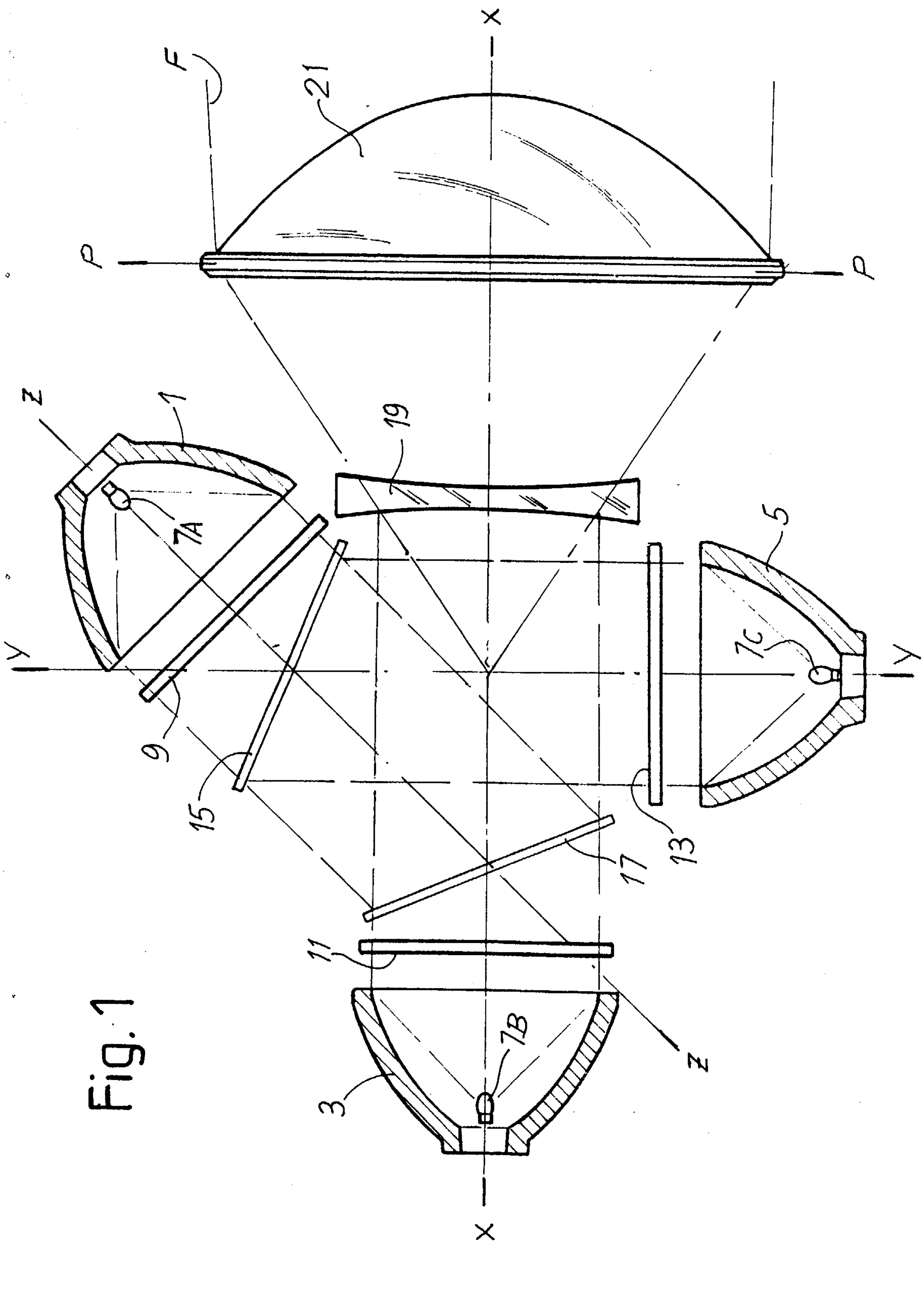


Fig. 1

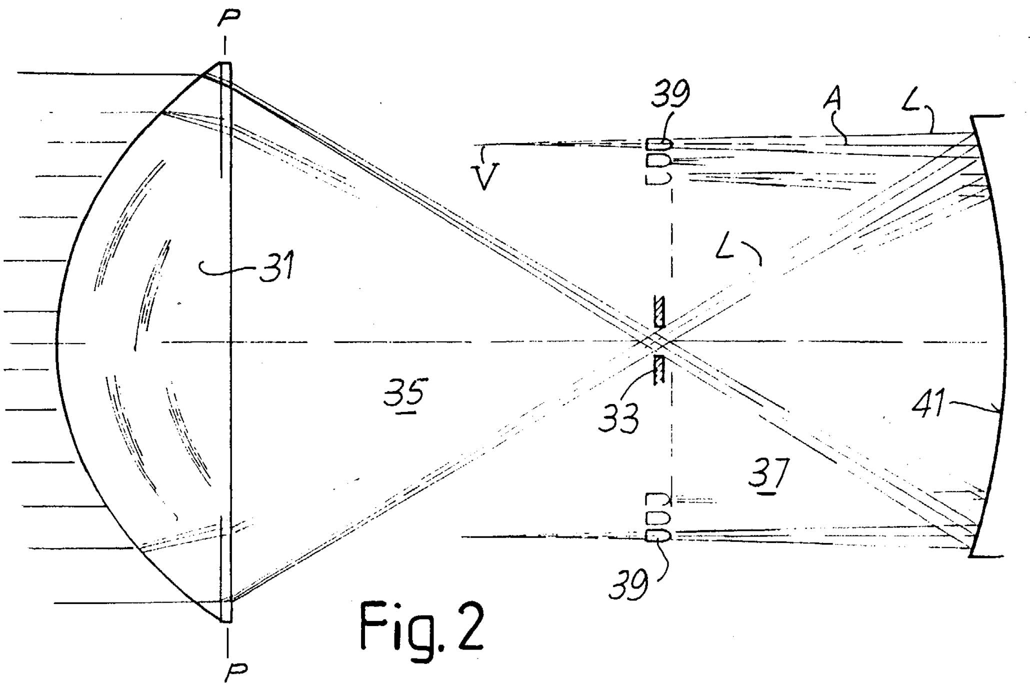


Fig. 2

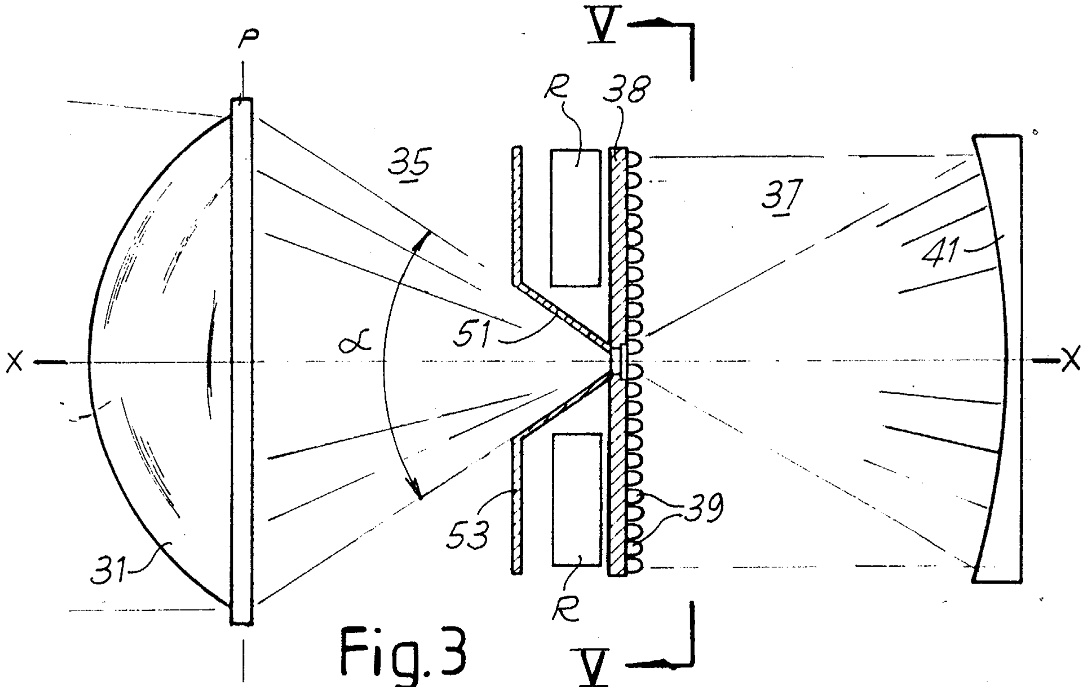


Fig. 3

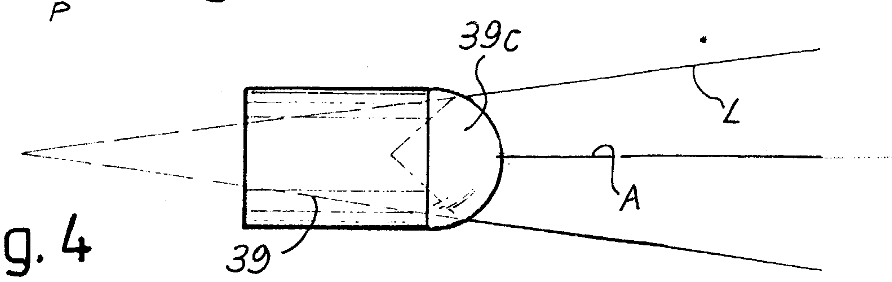
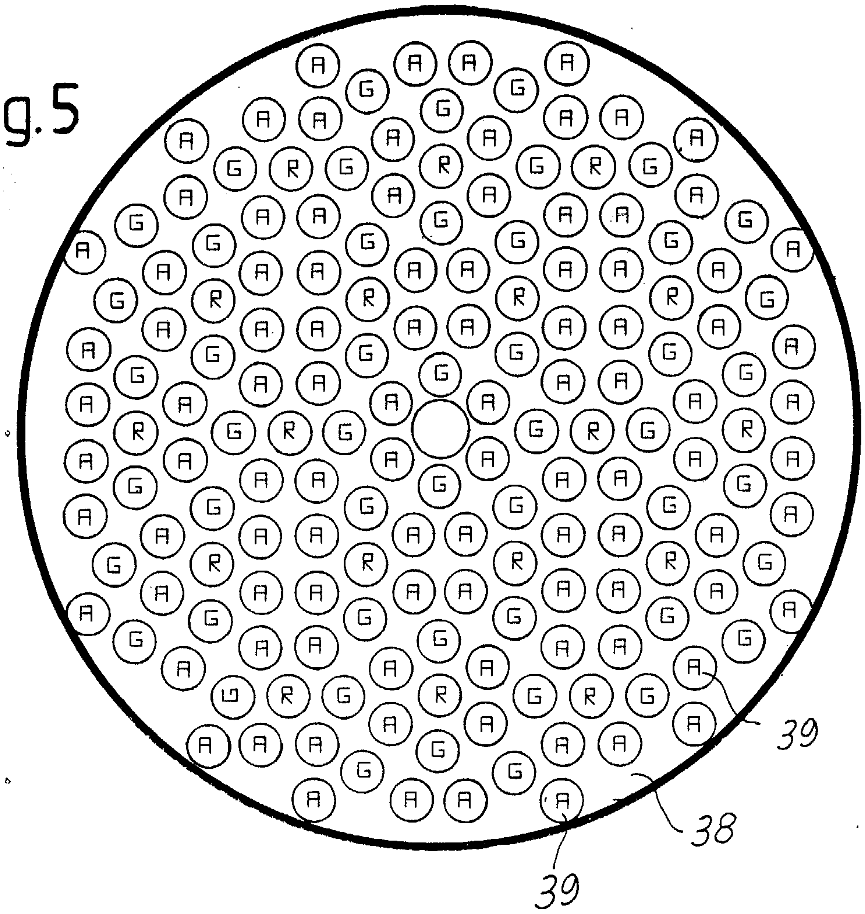


Fig. 4

Fig.5



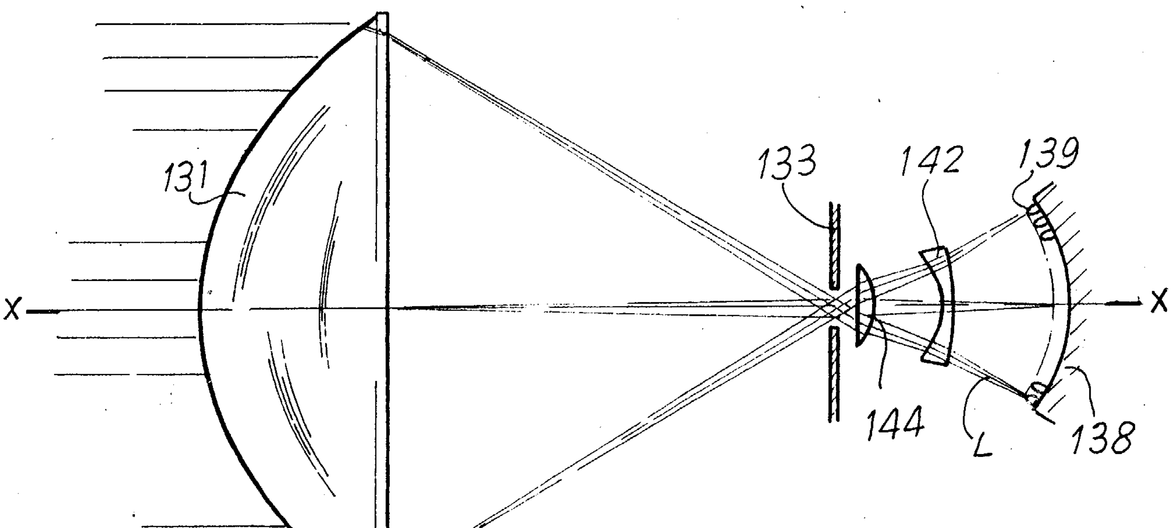


Fig.6

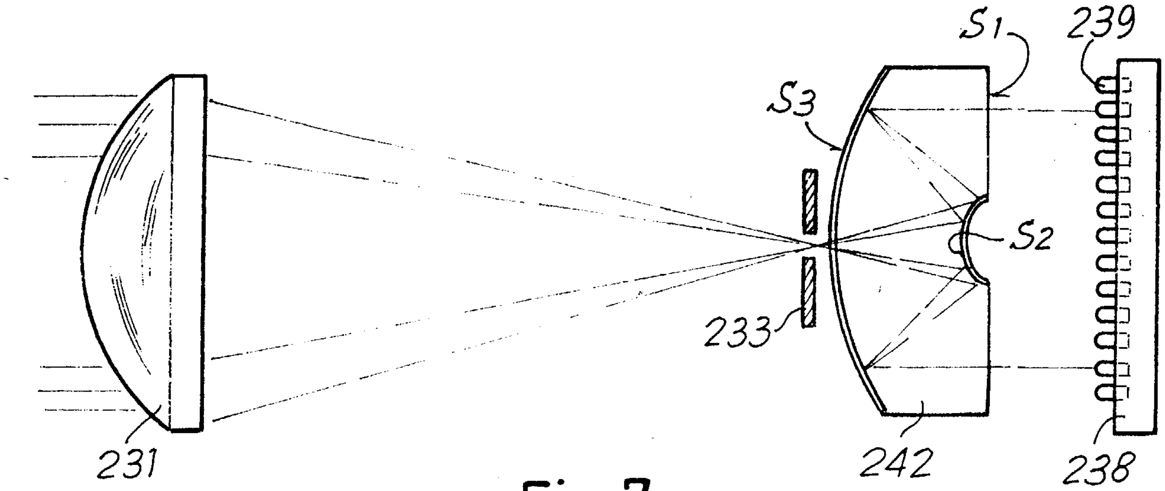


Fig.7

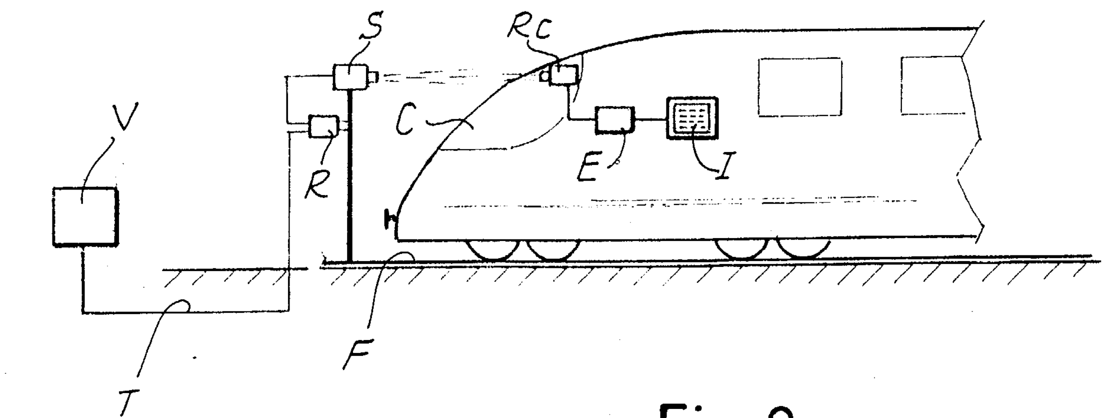


Fig.8

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EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5030

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H01L
G09F
B61L
F21K
F21S
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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	12 July 2004	Coffa, A

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