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— *with international search report (Art. 21(3))*

[Continued on next page]

(54) Title: LED-TYPE MULTI-COLOURED SUNK SIGNALLING DEVICE AND TUNNEL-TYPE WALL EMERGENCY NAVIGATION LUMINAIRE IN THE TRAFFIC CONTROL SYSTEM AND THE TRAFFIC CONTROL PROCEDURE

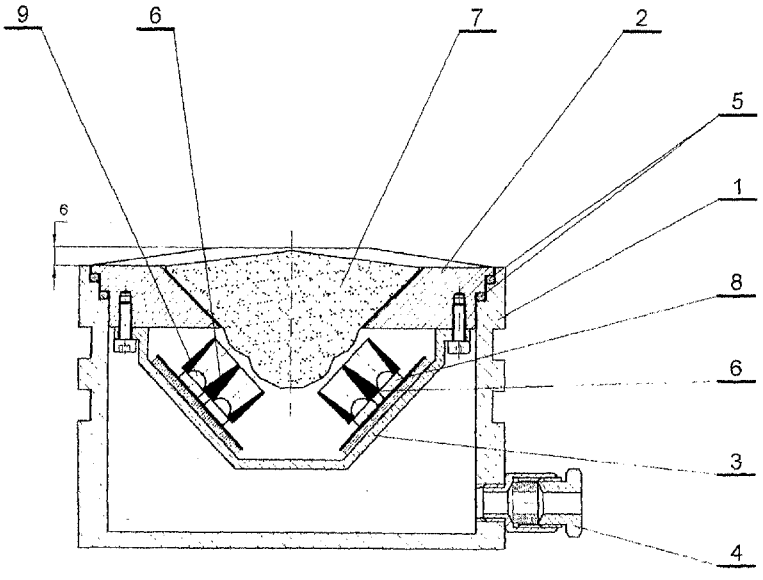

Fig. 1

(57) Abstract: LED-type multi-coloured sunk signalling device is composed of body /1/ wherein lid /3/ is arranged and fitted with LED diodes which are fitted with mirrors /6/ while lid /3/ is detachably joined with head 121 wherein prism /7/ is arranged and which uses sealing /5/ to close body /1/ to be waterproof while LED diodes of the first direction 8 and LED diodes for the other direction 9 are arranged opposite to each other which is a cause for diverging directions to be turned to each other by 180°. Tunnel-type wall emergency navigation luminaire is formed by body /11/ wherein are arranged navigation LED sources /12/ and, as the case may be, navigation arrows generated by using LED sources /14/, and stand-by lighting for escape way by means of POWER LED diodes /13/ while navigation LED sources /12/ emit in horizontal direction into visual field of persons, POWER LED diodes /13/ emit in downward direction and diagonally to sides. Employment of the four-coloured sunk signalling device and the tunnel-type wall emergency navigation luminaire is very expedient to enhance traffic safety in the traffic control system in the road tunnels.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

LED-type multi-coloured sunk signalling device and tunnel-type wall emergency navigation luminaire in the traffic control system and the traffic control procedure

The Technical Field

The invention concerns sunk signalling device as a stop-go light for traffic control either as individual element or supplementary element of the light signals of controlled junctions.

The Prior Art

The presently known single-coloured sunk bidirectional signalling devices are employed for e.g. light demarcation of the airport rolling, approach, and runway surfaces. Bulbs are used as a light source in these signalling devices. These signalling devices allow structurally a single-coloured light to be emitted only. Coloured filters can be used to alter the colour in a single-shot manner only, colours cannot be switched.

Sunk single-coloured unidirectional signalling devices are also used to demarcate the roads for land motor vehicles, namely to demarcate the centre line.

What is known as well are single-coloured bidirectional signalling devices to be sunk into ground in which light-emitting LED diodes are used as light source. These signalling devices are used on pedestrian crossings, for example. To highlight pedestrian crossings, one light is used – predominantly white that is emitted in two directions, in parallel to the road lanes.

The Nature of the Invention

The invention was aimed at developing a signalling device which utilize the light source – light-emitting LED diodes- for wider use in traffic control infrastructure, and the subject matter of the invention consists in the fact that it provides for emission of high-intensity light in more than single colour into two directions turned mutually by 180°.

The sunk signalling device is composed of a body wherein a lid is arranged and fitted with LED diodes for the first radiation direction and for the second radiation direction, these LED diodes are fitted with the blocks of mirrors while the lid is detachably joined with the head wherein prism is arranged. The head uses seal to close the

body from above to be waterproof. Bushing for connecting cable to the power source is led out of the signalling device's body.

The further goal was development of a tunnel-type wall emergency navigation luminaire which is formed by body wherein are arranged navigation LED sources, navigation arrows which also use LED sources, and stand-by lighting for escape way by using POWER LED diodes. The luminaire forms a compact, multi-functional device. The navigation LED sources emit in horizontal direction into visual fields of persons, the POWER LED diodes emit in downward direction and diagonally to sides at the angle of 80° from vertical line. The luminaire has high protection rating - IP65.
The invention was further aimed at including the four-colour sunk signalling device in traffic control system both as individual element and supplementary element of the control systems.
The four-colour sunk signalling device can be conveniently used in road tunnels for traffic control. In such a case the procedure is as follows :

- The four-colour sunk signalling devices are installed in the centre of individual lanes of tunnel tubes (lined up to the control system)
- change in colour and intensity generates alert – driving ban in case of hazard or information for vehicle drivers announcing clear road by using three colours – red, orange and green
- blue colour is intended for demarcating the escape direction from the tunnel if vehicle collision takes place followed by a fire and fuming of tunnel tube when persons in the tunnel loose their bearings. If fire is detected by fire detector, the tunnel's electronic system allocates the focus and makes the ground signalling device give alert automatically for the persons to head for their safety along the shortest escape way. On top of it, the tunnel operator's camera system in central control may be of assistance. Signalling devices' alert will take place in such a way that blue coloured lights (running point) will go on gradually and repeatedly from the crash site towards escape egresses while red coloured lights will shine intensively in the opposite direction.
- In its expedient design, the system is completed with wall escape lateral lights which are adapted to give navigation information – blue colour and added direction symbol into escape area, these lights are placed 1 m high above tunnel sidewalk.

Advantage of such navigation is high probability of its visibility and comprehensibility. Under fire in a tunnel the vertical traffic signage and traffic information boards are the first to be usually obscured by smoke. On the contrary, it is the bottom area that is usually filled by smoke much later so intensive lights near the ground are visible. This navigation is simple and internationally comprehensible.

The four-colour sunk signalling device for traffic control can be further used in convenient manner on the junctions controlled by security lighting equipment. Use is made of three colours here – red, orange, and green, similarly to the stop-go light indicators for pertinent driving direction. The sunk signalling devices shall be arranged in suitable number and positions (depending on the junction's geometry) at the junction, namely to stop lines and turn-out lanes and lines. Given the fact that the light going through optical prism in one direction has no influence on the light passing into the other direction, it is possible to emit red light in one direction and, at the same time, green or orange light in another direction. Switching of colours to individual directions is provided by the junction's control system.

Another advantageous application of the four-coloured sunk signalling device to enhance traffic safety is its utilization on pedestrian crossings. The existing systems use sunk signalling devices of one colour for one driving direction. Pedestrian crossing location is highlighted either by continuous illumination or intermittent light of the sunk signalling devices. Indication of actual pedestrian occurrence on the crossing or pedestrian's close proximity (pedestrian crossing zone) is implemented either by switching the light from continuous to intermittent and vice versa or transition from the off status to continuously shining or intermittent status for a period the pedestrian is actually present in the limited zone of pedestrian crossing. Newly, by using four-coloured sunk signalling device with application of three colours – red, orange, and white. White – to highlight pedestrian crossing point and provide information within the visual field of drivers in the running cars on the absence of pedestrian(s). Intermittent red and orange (switched dynamically) – alert for actual pedestrian's presence in the pedestrian crossing zone. Physical location of signalling devices – across the roadway in front of or, ideally, in the centre of ZEBRA lanes of the horizontal traffic-line marking V7 or, as the case may be, between the lanes.

Another advantageous application of the four-coloured sunk signalling device to enhance traffic safety is its utilization in front of railway crossings to warn the drivers of road vehicles. Two colours are used here – red and white, similarly to the railway signalling. Physical location of signalling devices – across the roadway in front of railway crossing in a minimum number of 2 pcs or its multiple for each driving direction.

Another advantageous application of the four-coloured sunk signalling device to enhance traffic safety is its utilization in front of the intersection of roadway and streetcar body to warn the drivers of road vehicles and pedestrians. Two colours are used here – red and blue, alternatively orange. The red colour will be switched similarly to the red light switching in case of the railway crossings – alternative intermittent switching – always two signalling devices or their multiples – to indicate approaching streetcar. Blue (orange) colour will permanently draw attention to intersection point. It will also operate in similar way for the intersection points of pedestrian crossings and streetcar body.

Another advantageous application of the four-coloured sunk signalling device to enhance traffic safety is its utilization in front of the exit of rescue brigade vehicles to warn the drivers of road vehicles and pedestrians. Here, only one colour (red) will be used in up to quadruple intensity. The red colour will be switched similarly to the red light switching in case of the railway crossings – alternative intermittent switching – always two signalling devices or their multiples – to indicate the exit of rescue brigade vehicles giving them a priority.

Another advantageous application of the four-coloured sunk signalling device for traffic control and enhancement of traffic safety is in the areas with lowered structure clearance – garages, underground parking lots, parking houses, and so on. It is often impossible to install standard traffic signalling devices here due to the lowered structure clearance. It is further possible to apply the sunk signalling devices to navigate vehicle drivers to free parking bays.

Another advantageous application of the four-coloured sunk signalling device to enhance traffic safety is its utilization at bridge structures. Two colours will be used

here – white and blue. The continuously shining white colour informs a vehicle driver on the passage over bridge structure while the intermittent blue colour informs on the probability of ice-accretion on bridge structure. Location of signalling devices in the centre of lanes or in the centre line.

Outline of the Figures in the Drawing

The invention is explained in detail on the attached drawing where Fig. 1 depicts exemplary design of the sunk signalling device in section, Fig. 2 depicts signalling device in spatial design, Fig. 3 illustrates application of signalling devices in road tunnel, Fig. 4 depicts connection of sunk signalling devices in the control and security system in road tunnel where the input information on fire and fire position are rendered by the installed fire detectors, and Figure 5 illustrates a wall luminaire with lateral illumination as fitted with arrows in spatial design.

Example version of the Invention

The sunk signalling device 0 in exemplary design is composed of a body 1 wherein is arranged a lid 3 fitted with LED diodes for the first radiation direction 8 and for the second radiation direction 9, these LED diodes are arranged on printed circuit boards while the LED diodes are fitted with mirrors 6 while the lid 3 is detachably joined with the head 2 wherein a glass prism 7 is arranged. The head 2 uses sealing 5 to close the body 1 from above to be waterproof. Bushing for connecting cable to the power source is led out of the signalling device's body.

LED diodes of the first direction 8 and LED diodes for the other direction 9 are arranged opposite to each other which is a cause for diverging directions to be turned to each other by 180°.

Four power LED diodes 8 emitting monochromatic light of various, pre-selected wavelengths, are placed on a printed circuit board in a shape or regular tetragon to be firmly connected with a block of four mirrors 6 - by one mirror for each LED diode where the mirrors focus light beams of POWER LED diodes with emissive angle of 120° into narrow angle of about 40°. Such focused beam is incident upon fracture surfaces of glass prism 7. Here, at air – glass interface, the beams refract to pass on through glass prism 7 all the way to the second fracture surface. The beams refract again here, at the second glass-air interface to go out into required direction. Given the fact the glass prism 7 is symmetrical in its vertical plane, this one prism also

deflects the luminous flux of LED diodes 9 placed at the opposite side of the prism. Activation and switching between individual colours is done by several methods, namely :

1) Each LED diode has its own feed line. Both classical and switched low-voltage sources are used for feeding. It is not essential for feeding of the sunk signalling devices whether or not they are fed with direct or alternating voltage. Maximum supply voltage is 35 V, minimum about 10 V, the recommended minimum value of supply voltage is 24V with regard to the losses during energy transfer. Switching between individual colours is done by active semiconductor elements of the control electronic systems on the supply sources' side.
2) By means of supply and control bus. The supply bus is formed by a pair of supply conductors which transfer low supply voltage from the source or more sources to individual luminaires. To energize larger networks of signalling devices/luminaires use can be made of unlimited quantity of supply voltage sources that energize the defined groups of luminaires. Supply bus can be put on circuit in optional manner within one supply source. Construction of signalling devices, luminaires, and system enables connection of both direct and alternating low-voltage source while the connection polarity in the direct source is not important. This fact makes the resultant installation easier. The control bus is composed of 8-core standard UTP cable with tighter requirements for resistance. Control bus transfers the control commands, the information from monitored circuits of individual luminaires, the line synchronizing impulses, and the standby supply voltage for energizing signalling device's control circuitry in case of main power failure. The line synchronizing impulses are generated in the luminaire control circuit to be used for time synchronization of all the connected signalling devices and luminaires that are necessary to create a "running light" type effect.

Tunnel-type wall emergency navigation luminaire 10 is formed in exemplary design by body 11 wherein are arranged navigation LED sources 12, navigation arrows (by using LED sources as well) 14, and stand-by lighting for escape way by means of POWER LED diodes 13. The luminaire forms compact, multi-functional device. Navigation LED sources 12 emit in horizontal direction into visual fields of persons,

POWER LED diodes 13 emit in downward direction and diagonally to sides at the angle of 80° from vertical line. The luminaire has high protection rating - IP65.

PATENT CLAIMS

1. The LED-type multi-coloured sunk signalling device, characterized by the fact that it is composed of body /1/ wherein lid /3/ is arranged and fitted with LED diodes which are fitted with mirrors /6/ while lid /3/ is detachably joined with head /2/ wherein prism /7/ is arranged and which uses sealing /5/ to close body /1/ from above to be waterproof.

2. LED-type multi-coloured sunk signalling device according to claim 1, characterized by the fact that LED diodes of the first direction 8 and LED diodes for the other direction 9 are arranged opposite to each other which is a cause for diverging directions to be turned to each other by 180°.

3. Tunnel-type wall emergency navigation luminaire, characterized by the fact that it is formed by body /11/ wherein are arranged navigation LED sources /12/ and, as the case may be, navigation arrows generated by using LED sources /14/, and stand-by lighting for escape way by means of POWER LED diodes /13/, navigation LED sources /12/ emit in horizontal direction into visual field of persons, POWER LED diodes /13/ emit in downward direction and diagonally to sides.

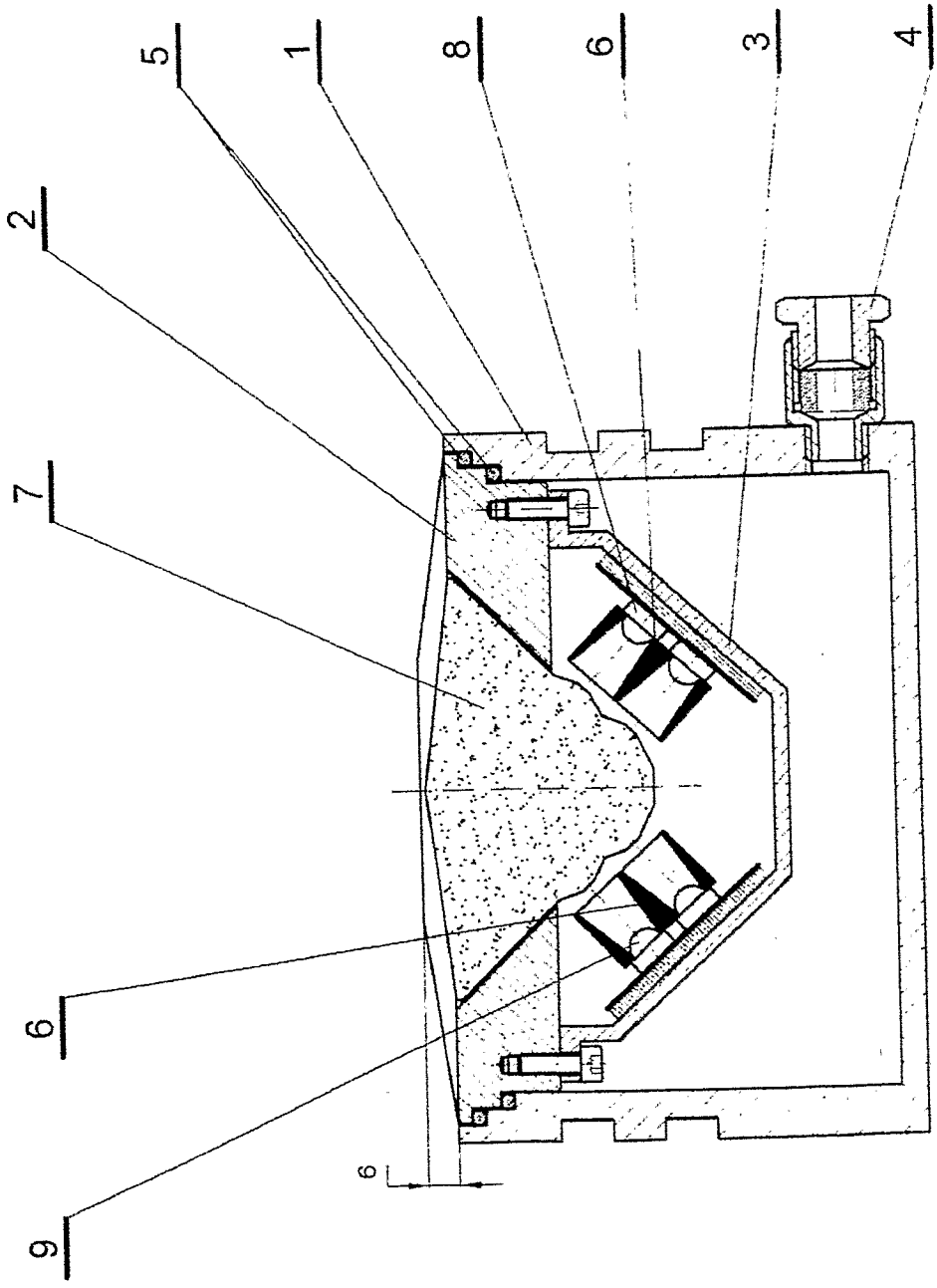

Fig. 1

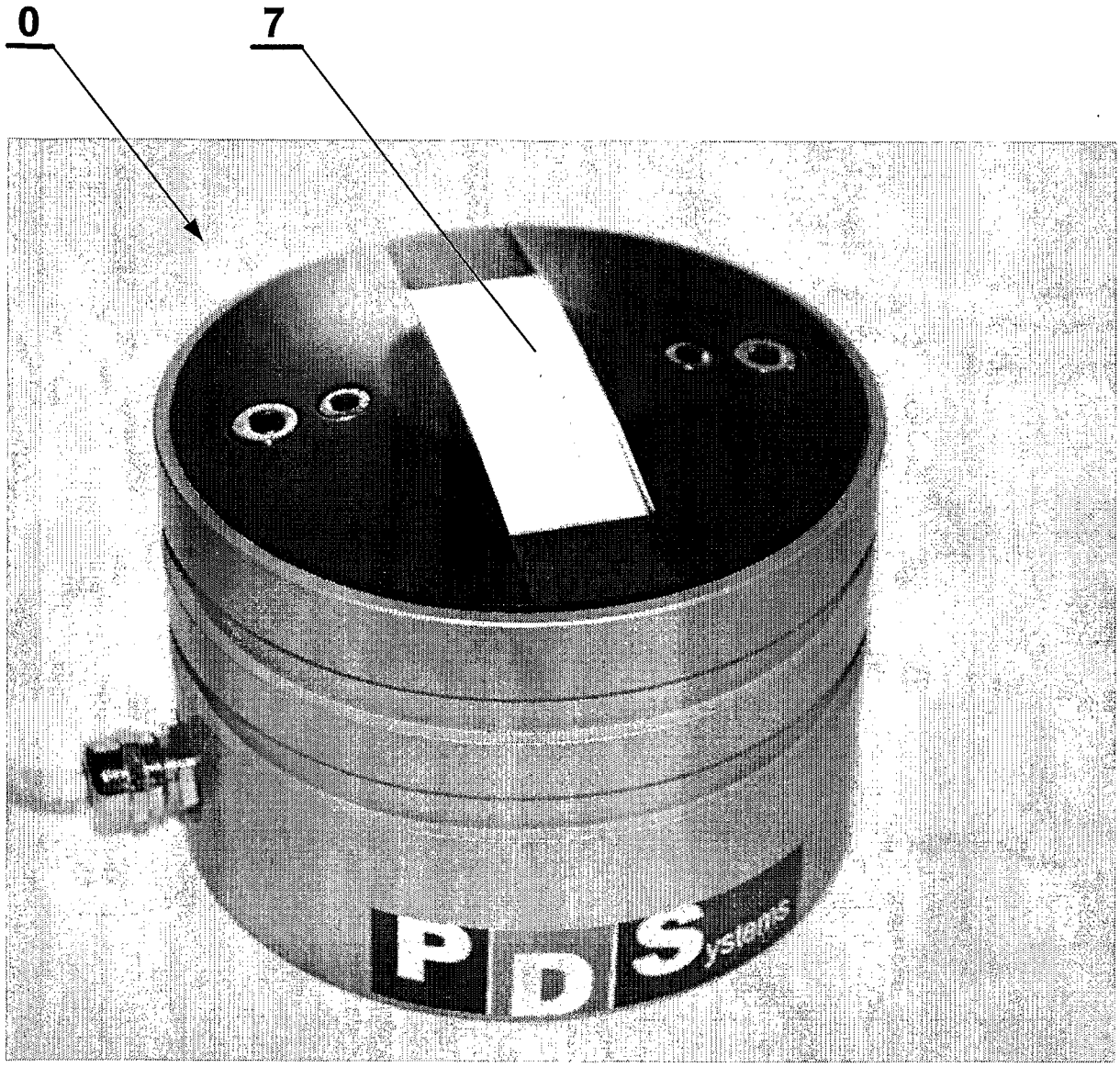

Fig. 2

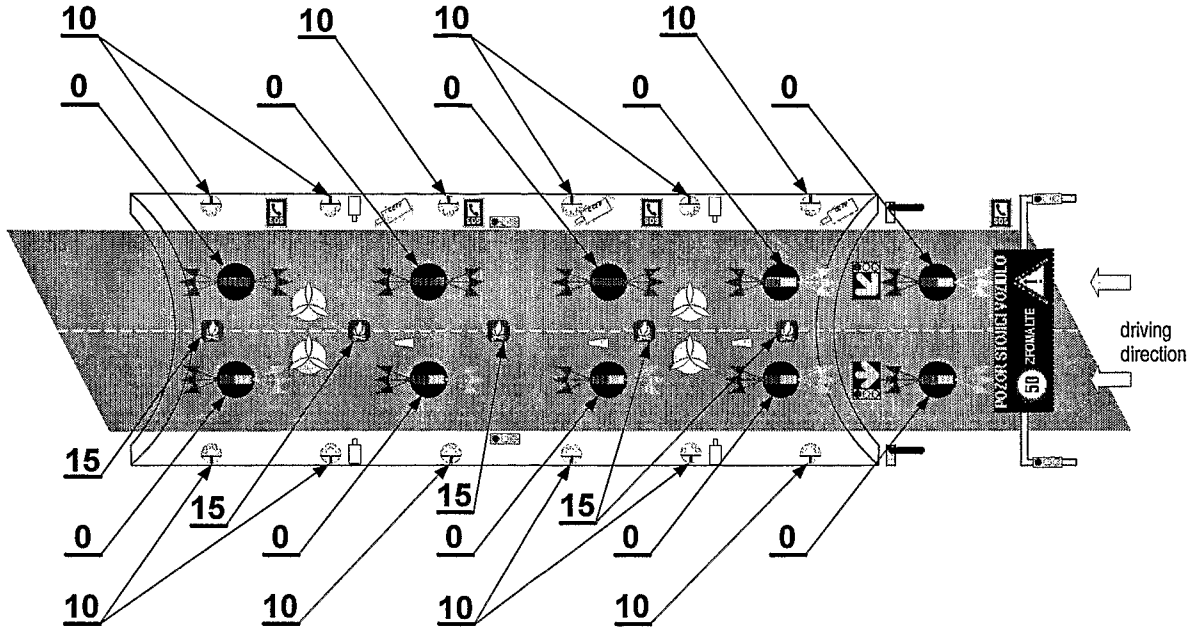

Fig. 3

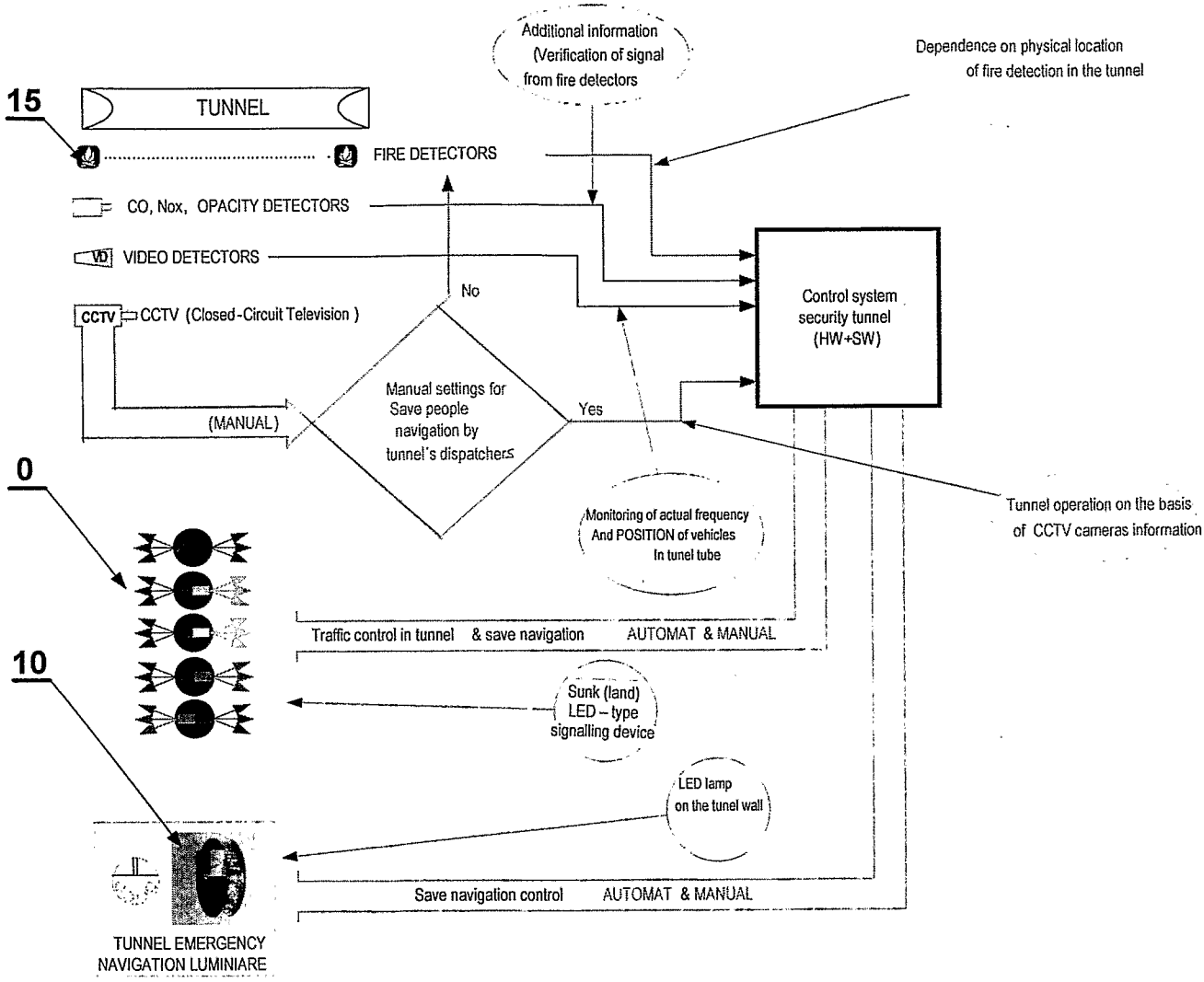
Additional information
(Verification of signal
from fire detectors
Dependence on physical location
of fire detection in the tunnel
15
TUNNEL
FIRE DETECTORS
CO, Nox, OPACITY DETECTORS
VIDEO DETECTORS
CCTV (Closed-Circuit Television)
No
Control system
security tunnel
(HW+SW)
(MANUAL)
Manual settings for
Save people
navigation by
tunnel's dispatchers
Yes
0
Monitoring of actual frequency
And POSITION of vehicles
In tunel tube
Tunnel operation on the basis
of CCTV cameras information
Traffic control in tunnel & save navigation AUTOMAT & MANUAL
10
Sunk (land)
LED – type
signalling device
LED lamp
on the tunel wall
Save navigation control AUTOMAT & MANUAL
TUNNEL EMERGENCY
NAVIGATION LUMINIARE

Fig. 4

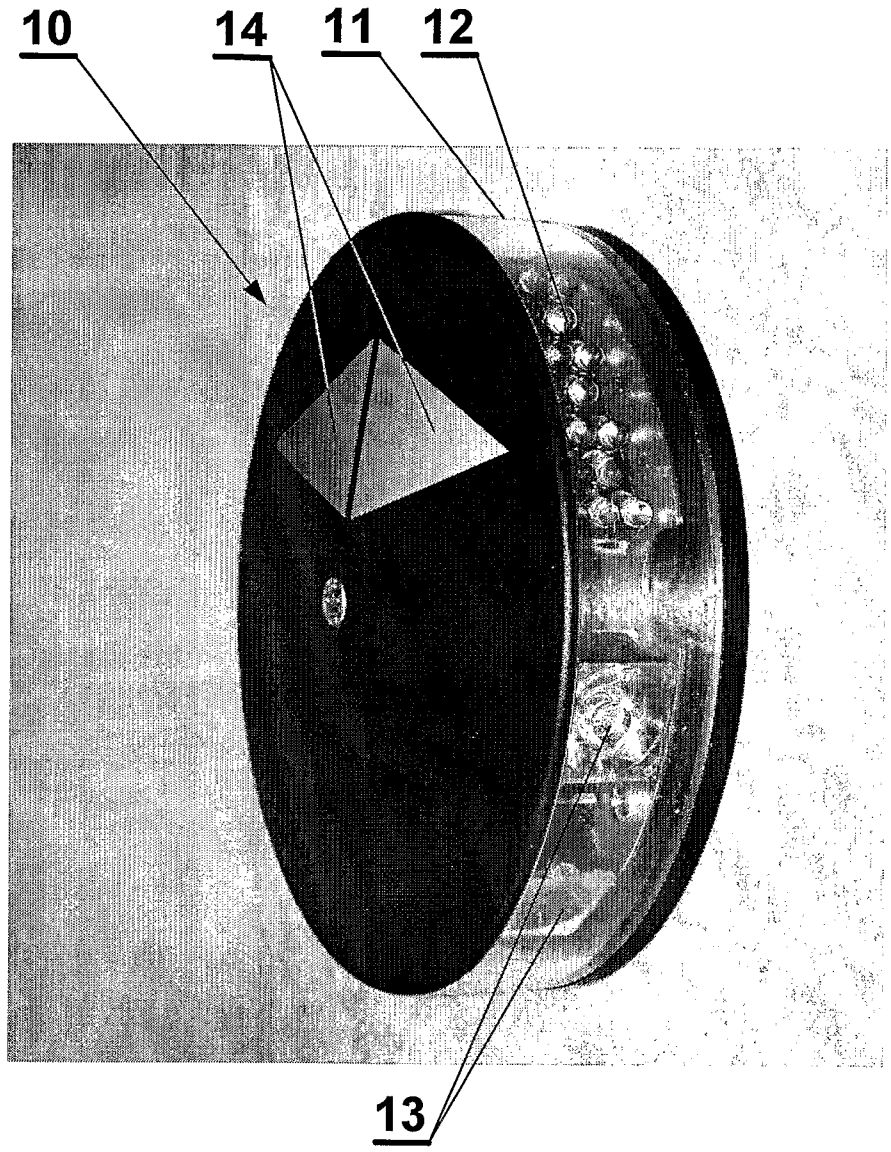

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2009/000067

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21S8/00 F21S8/02 F21V5/02 F21V7/00 F21V13/04
F21V31/00 E01F9/06 G09F19/22
ADD. F21W131/101 F21Y101/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F21S F21V E01F G09F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 940 626 A (ERNI ERNST R [CH]) 8 September 1999 (1999-09-08) paragraphs [0001], [0018] - [0037]; figures 1-9	1,2
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Y	DE 297 12 283 U1 (SIEMENS AG [DE]) 4 December 1997 (1997-12-04) pages 16-28; figures 1-18	1,2

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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 October 2009	02/11/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	von der Hardt, M

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2009/000067

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CZ2009/000067

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search reportcovers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-2

LED multi-coloured in-ground signalling device

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2. claim: 3

Tunnel-type wall emergency navigation luminaire

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2009/000067

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2009/000067

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