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(71) Applicant: **Sainz de los Terreros, Ignacio**
31002 Pamplona (ES)

(72) Inventor: **Sainz de los Terreros, Ignacio**
31002 Pamplona (ES)

(74) Representative: **Elion IP, S.L.**
Paseo Castellana, 150-4 dcha
28046 Madrid (ES)

(54) **LUMINOUS SYSTEM FOR HORIZONTAL ROADWAY MARKING AND METHOD FOR INSTALLING SAID SYSTEM**

(57) The invention describes a luminous system (1) for horizontal roadway marking. The system (1) comprises at least one flexible luminous emitter (3) which is housed inside a channel (4) made on the roadway. The invention further comprises a transparent or translucent filler material (5) comprising at least one transparent or translucent aggregate mixed with a binder, wherein the filler material (5) is made of at least an 85% of aggregate

with respect to the total mass of filler material. The filler material (5) is arranged on the at least one luminous emitter (3) covering the channel (4) essentially up to the surface of the roadway, such that the light emitted by the luminous emitter (3) is visible through the transparent filler material (5) to vehicles and pedestrians moving on the roadway

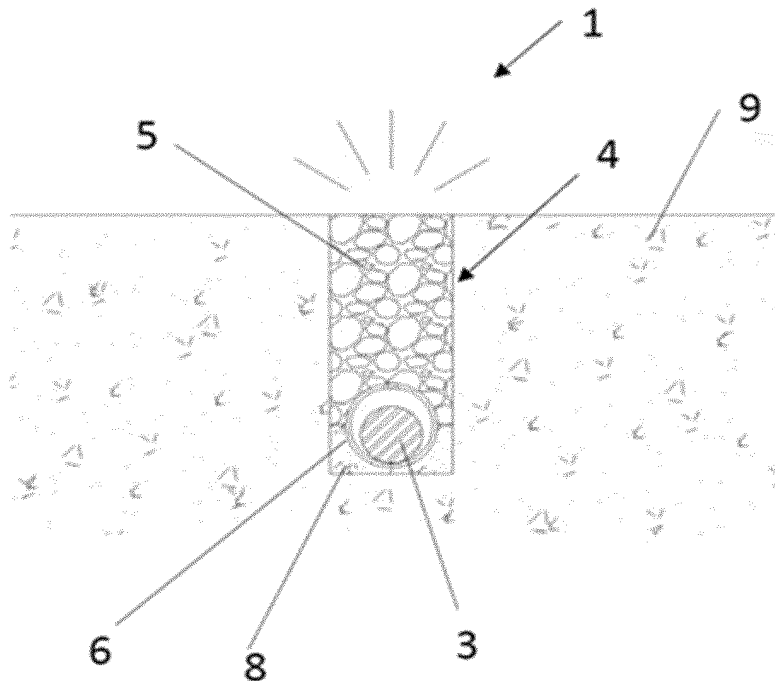


FIG. 2

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Description

FIELD OF THE INVENTION

[0001] The present invention belongs generally to the field of road safety, specifically to horizontal roadway marking. A first object of the present invention relates to a novel luminous system designed for improving horizontal marking on a roadway with structural and functional capacity on the wearing course in which it is installed. A second object of the present invention relates to a method for installing said luminous system on a roadway.

BACKGROUND OF THE INVENTION

[0002] Until a few years ago, horizontal marking installed on roads was based exclusively on painting lines and messages on the roadway usually by means of white paint. One drawback of this type of horizontal marking is the poor visibility in some cases, particularly in adverse atmospheric conditions such as with rain or fog. Although this problem could be mitigated by increasing the size of the signs or messages, painting very large areas of the roadway is not desirable because the painted surface is extremely slippery.

[0003] To solve these problems, the arrangement of luminous filaments embedded in the surface of the roadway to form lines and messages which are selectively illuminated is known. Document US 6,398,399 describes a system of this type, wherein a channel is made on the roadway in which a metal duct which houses an optical fibre cable is introduced. A plate made of Lexan[®], a transparent or translucent polycarbonate-based material, is used to cover the upper side of the channel. This results in the optical fibre being embedded in the roadway such that the emitted light is visible to the vehicles or pedestrians moving on the roadway. A control module arranged on the side of the roadway controls the illumination such that it turns on or off depending on certain conditions such as, for example, to coincide with the traffic light or the like turning on or off.

[0004] Although this solution constitutes a significant improvement over the use of paint, it still presents the drawback of poor durability. Specifically, the continuous passage of vehicles over the roadway, and more specifically over the duct housing the optical fibre, causes joints which are not properly done during construction to crack and deteriorate with use. In the solution proposed by the mentioned invention, the joint is between a flexible material (agglomerate) and a rigid material (metal duct), so it is possible for said joint to crack or break. As a result of the foregoing, the metal duct and the transparent plate covering same may end up coming out of their housing, and this may damage the optical fibre, as well as constitutes a significant risk for drivers and pedestrians.

[0005] Another significant drawback of using metal ducts lies in the difficulty in creating luminous signs with complex geometries, since the design and manufactur-

ing of ducts with such geometries is complex and furthermore increases the assembly time, manufacturing costs, involves the need for stockpiling, etc. Furthermore, since the metal duct is a rigid element, a perfect adaptation of all the points thereof to the slope can hardly be ensured, and this in turn would make it necessary to ensure great precision when making the channel and a good pre-existing levelling of the roadway so as to prevent safety problems for drivers and pedestrians. This necessarily means an increase in the assembly costs of horizontal marking systems of this type.

[0006] Therefore, a system for the horizontal illumination of roadways in which the luminous emitters are embedded in the roadway itself in a long-lasting and reliable manner, with the created joints being capable of absorbing the impacts of the vehicles traveling on the roadway without cracking or breaking, is needed in the state of the art.

DESCRIPTION OF THE INVENTION

[0007] The present invention solves the above-mentioned problems by means of a novel configuration that does not require the use of ducts or covering plates.

[0008] The wearing course of a roadway is generally made up of a flexible pavement made based on aggregates and a hydrocarbon binder. As used herein, an aggregate refers to a natural, artificial, or recycled granulated material having a specific grain size. For the construction of roadways, the aggregates in the rolling layer generally have a grain size of less than 2.2 cm in length.

[0009] In the proposed system, the luminous emitter is introduced directly in the channel made on the roadway and is covered with a filler material comprising a transparent or translucent aggregate and a binder. The binder may be opaque, translucent or transparent. This filler material has mechanical properties equivalent to those of the asphalt conventionally used for the roadway, such that continuity is achieved in terms of the behavior of the filler material and of the roadway when they are both subjected to stresses and vibrations caused by the continuous passage of vehicles. In other words, the roadway and the filler material itself undergo uniform deformation, without there being any part or element that can be "ejected" from the channel due to said deformation. The problem described in relation to document US 6,398,399 is thereby completely eliminated. Furthermore, this invention allows designing luminous signs having complex geometries in a quick and simple manner, thereby preventing other drawbacks of the prior art.

[0010] A first aspect of the present invention relates to a luminous system for horizontal roadway marking comprising at least one luminous emitter housed inside at least one channel made on the roadway. These features, which correspond to the preamble of the main claim of the present application, are known from document US 6,398,399.

[0011] The system of the invention has the particularity

that it further comprises a transparent or translucent filler material, made up of at least one transparent or translucent aggregate, and optionally glass fiber, mixed with a binder, arranged on the at least one flexible luminous emitter covering the channel or channels where the at least one flexible luminous emitter is inserted essentially up to the surface of the roadway. The filler material is composed of at least an 85% of aggregate with respect to the total mass of filler material. Therefore, the binder will be at most the other 15% of the total mass of filler material. In this way, the light emitted by the flexible luminous emitters is visible through the filler material to vehicles and pedestrians moving on the roadway. In other words, the system of the invention lacks a duct and a covering plate. In contrast, the luminous emitter is introduced directly in the channel made on the roadway and the channel is then filled with the filler material. In this context and throughout this document, the term "*transparent*" is understood to also include the possibility of the filler material being translucent, because the light emitted by the luminous emitter being diffused or somewhat distorted as it passes through the transparent filler material is irrelevant for this application. In addition, the proportion of at least an 85% of aggregate in the filler material ensures that the mechanical strength of the bond between the filler material and the roadway itself is greater as the roadway and the filler material have a similar composition, so that, as the roadway and the filler material deform in a similar way, the appearance of cracks or breaks in this bond that could cause the separation of the luminous system for horizontal roadway marking from the roadway itself is reduced.

[0012] In this document, "*luminous emitter*" refers to a device, preferably a filament, that extends longitudinally and is configured for emitting or conducting the light emitted by a light emitter or generator such that at least part of said light is emitted in an essentially transverse direction along the entire length thereof. Furthermore, the luminous emitter is flexible enough so as to form the desired symbols or texts. For example, in a preferred embodiment of the invention, the luminous emitter comprises at least one optical fibre with side illumination along the entire length thereof. The use of optical fibre with side illumination is advantageous due to its great flexibility and adaptability to the shape of the channel and to the absence of electrical components in the light point. Alternatively, the luminous guide comprises at least one luminous guide made of polymethyl methacrylate (PMMA) with side illumination along the entire length thereof. In other embodiments, the luminous guide may be an optical fiber that lights up at its tip or a luminous guide made of PMMA that lights up only at its tip (spot illumination). In said embodiments, both the optical fibers and the luminous guides made of PMMA for spot illumination will be placed inside the channel such that their tips are preferably oriented perpendicular to the rolling surface of the roadway. In other embodiments, the luminous guide may be a combination of optical fibers and lumi-

nous guides made of polymethyl methacrylate with side and/or spot illumination.

[0013] Any type of light emitter or generator capable of suitably directing enough powerful light to the luminous guide can be used to generate light when the luminous emitter is a guide that conducts light. For example, a LED projector with RGB illumination can be used. This will allow projecting light with a wide range of colors based on the needs of each installation and each given moment. Processing means such as a microcontroller, microprocessor, FPGA, DSP, ASIC, or the like can be used to control the operation of the projector for the purpose of changing the color or power of the emitted light based on parameters such as the status of a traffic light or others. As mentioned above, the luminous emitter can be optically coupled to one end of the luminous guide, such that said luminous guide conducts said light longitudinally and at the same time emits a part of said light laterally along the entire length thereof.

[0014] Alternatively, the luminous emitter could be one or more LED strips, preferably LED strips with RGD illumination, electrically connected to an external power supply such as the grid. In these embodiments, the LEDs may be located along the entire length of the strip or in specific areas of the strip. The processing means will be configured to control the operation of the LEDs or of other light sources that may be incorporated, these light sources being any emitter capable of emitting light by itself.

[0015] The transparent or translucent aggregate can be of any type provided that it allows light to pass there-through. For example, in preferred embodiments of the invention, the transparent aggregate may comprise quartz, glass, artificial aggregates manufactured from transparent or translucent resins or the like, or any combination thereof. The hardness of the selected aggregate will depend on the strength needed by the roadway in which it will be used, i.e., depending on the number and weight of the vehicles that will move on the roadway. It has been envisaged that the aggregate has a grain size similar to that of the aggregate used in the roadway, i.e., a grain size of less than 2.2 cm in length. More preferably its grain size will be less than 16 mm.

[0016] Preferably, the flakiness index of the aggregate, for example, according to UNE-EN 933-3, can be less than 50. Preferably, the polishing resistance of aggregates for wearing courses (accelerated polishing coefficient), for example, according to UNE-EN 1097-8, can be greater than 56. Preferably, the proportion of fully rounded particles in the aggregate, for example, according to UNE-EN 933-5, can be less than 1% by mass. All these characteristics of the aggregate make it mechanically compatible with the asphalt conventionally used in road construction.

[0017] However, the physical properties of the aggregate, including at least its granulometry, flakiness index, polishing resistance and proportion of rounded particles, may vary from those mentioned in the previous paragraph, depending on similar materials available in the

environment or adapting to local regulations (for example, may be similar to those indicated in the general technical specifications for road and bridge works for wearing courses established by each local regulation), to the properties or requirements of the roads where the system covered by the invention is to be installed and to the environmental characteristics of the place where the system covered by the invention is to be installed, but said aggregates being transparent or translucent.

[0018] In some embodiments, the filler material will further incorporate glass fiber. In these embodiments, the amount of glass fiber and aggregate will be an 85% or greater with respect to the total mass of the filler material, with the binder being at most the other 15% of the total mass of the filler material. The glass fiber may be any type of glass fiber that allows light to pass through it. Thus, the filler material may consist of just the mixture of the binder with the aggregate or the mixture of the aggregate with the glass fiber and the binder. The glass fiber increases the tensile strength of the filler material.

[0019] The proportions of aggregate, and optionally glass fiber, (85% or greater), and binder (15% or less) of the filler material are within the ranges typically used in aggregate/binder mixtures in roadways for streets, secondary roads and high-capacity roads such as highways and freeways. This ensures that the filler material and the road surface in which it is incorporated have similar mechanical properties, improving the bond between them and, therefore, avoiding the appearance of cracks or breaks between the filler material and the road itself. In more preferred embodiments, the filler material is composed of at least 85 to 96% aggregate of the total mass while the binder will be 15% to 4% of the total mass of filler material. In other preferred embodiments, the aggregate (and optionally glass fiber)-binder ratio of the filler material is substantially the same as that of the roadway where the system is to be installed.

[0020] According to a preferred embodiment of the invention, the binder is a bituminous binder selected from those commonly employed in roadways such as bitumen or the like. Preferably, in the case of bitumen, the proportion of the binder with respect to the total mass of the filler material will be about 5%. Since the binder will be less than 15%, and preferably about 5%, of the total mass of the filler material, the resulting mixture will be translucent allowing an amount of light to pass through it which will be sufficient to be visible to the user of the vehicle driving on the roadway, regardless of the existing weather conditions.

[0021] Preferably, the bituminous binder is intended to have the following physical-chemical characteristics:

- a penetration at 25°C (e.g., according to UNE-EN 1426) of 15-220x(0.1 mm);
- a softening point (for example, according to UNE-EN 1427) of 76-35°C;
- a resistance to aging such that it exhibits:

a mass change (e.g., according to UNE-EN 12607-1) less than or equal to 1%.

a retained penetration (e.g., according to UNE-EN 1426) greater than or equal to 37%; and
a softening point increase (e.g., according to UNE-EN 1427) less than or equal to 12°C.

- a penetration index (for example, according to UNE-EN 12591 and 13924) of -1.5 to +0.7;
- a FRASS breaking point (e.g., according to UNE-EN 12593) less than or equal to 15°C; and
- a solubility (e.g., according to UNE-EN 12592) greater than or equal to 99%.

[0022] However, the physical-chemical properties of the bituminous binder, including at least its penetration at 25°C, softening point, resistance to aging, penetration index, FRASS breaking point and solubility may vary from those mentioned in the two previous paragraphs, being adapted to local regulations (e.g., they may be similar to those indicated in the general technical specifications for road and bridge works for wearing courses established by each local or national regulation), to the properties or requirements of the roads where the system covered by the invention is to be installed and to the environmental characteristics of the place where the system covered by the invention is to be installed.

[0023] According to a more preferred embodiment of the invention, the binder can be a transparent polymer-type binder or the like. In other words, the bituminous binder conventionally used in roadways (usually bitumen or the like) is replaced by a transparent polymer binder, such as a suitable resin. The transparent binder comes together with the aggregate suitably without negatively affecting the light transmission properties thereof. Furthermore, both the aggregate and the selected transparent binder will be chemically and physically compatible with the aggregate and binder making up the roadway in which the luminous system will be installed.

[0024] According to another embodiment of the invention, phosphorescent or fluorescent pigments, or a combination of both, can be mixed with the transparent binder, providing greater illuminating capacity to the invention.

[0025] As described herein above, the transparent filler material covers the channel essentially up to the surface of the roadway. This includes the possibilities in which the filler of the channel reaches a level slightly lower or higher than the surface of the roadway, thereby forming a type of protruding or sunken obstacle which provides an audible warning to a vehicle when it passes over the same. However, in a particularly preferred embodiment of the invention, the filler material is level with the surface of the roadway, such that said material in no way interferes with the movement of pedestrians and vehicles.

[0026] Sometimes, the light emitted by the luminous emitter does not have to be visible in the entire length of the channel inside which it is housed. For example, it

may be desirable for the light not to be visible in a segment of the channel joining independent symbols, or in a segment of the channel between the position in which the light source is located, usually outside the rolling course of the roadway, and the position in which luminous marking will be carried out. To achieve this, according to a preferred embodiment of the invention, at least one segment of the luminous emitter is wrapped with an opaque layer. Alternatively, or in combination with this solution, at least one segment of the channel comprises a filler made of an opaque material (similar to the one existing in roadway, such as for example, agglomerate, concrete, etc.) arranged on the luminous emitter. In any of both cases, in the segment of luminous emitter wrapped or covered by an opaque rolling agglomerate, the lateral light emitted by the luminous emitter is not visible to drivers and pedestrians traveling on the roadway.

[0027] In another preferred embodiment of the invention, the system further comprises a flexible and transparent protective tube covering the luminous emitter. This protection has several functions among which absorbing possible stresses of the roadway, preventing the luminous emitter from sustaining damage due to impacts or chafing, and facilitating the insertion and removal of the luminous emitter should the replacement thereof is required, stand out. For example, this protective tube may have a diameter slightly larger than the diameter of the luminous emitter to facilitate the introduction or removal of the luminous emitter through/from same, and it may be made of a plastic material with glass fiber reinforcements. In any case, the material from which the flexible protective tube will be made will be any material with sufficient structural rigidity so as to allow absorbing the stresses of the roadway, protecting the emitter from impacts and chafing, as well as allowing the introduction/removal of the emitter through/from same.

[0028] According to yet another preferred embodiment of the invention, for the proper priming and adherence of the new materials with existing materials, a layer of waterproof and adherent material, for example, a bituminous emulsion, is applied to the inner faces of the channel. This layer allows priming the surfaces of the channel, as well as favours the adherence of the filler material to the roadway, reinforcing the joint between the filler material and the roadway, and thereby increasing the service life of the system of the invention.

[0029] In still another preferred embodiment of the invention, the system further comprises a sand bed arranged inside the channel under the luminous emitter. This sand bed, to which binder can be added, provides a continuous support for the luminous emitter, distributing the pressures of the emitter on its support and preventing it from sustaining any damage due to friction against asphalt aggregates. Preferably, this sand will be transparent sand, for example, transparent quartz or transparent glass sand, such that if, when the emitter is deposited on said sand bed, part of said sand is deposited on the luminous emitter, the sand will allow the light emitted by

the emitter to pass through it. This bed allows the lower surface or base of the protective tube flexible to be properly seated. Preferably, the sand bed will be deposited at the bottom of the channel such that it covers the outer surface of the protective tube halfway, i.e., up to half the height thereof, such that the filler material rests on side portions of the sand bed located between the side walls of the channel and the protective tube. These side portions of the sand bed are therefore capable of receiving the stresses generated by the filler material itself and by the vehicles traveling over it, transmitting them directly to the sand bed and to the roadway below same, and not to the tube.

[0030] In some preferred embodiments of the invention, the system further comprises at least one photovoltaic cell, preferably a longitudinal photovoltaic cell, which is inserted into at least one channel made in the roadway, for power generation. The channels housing the photovoltaic cells will also be covered with the same filler material used with the luminous emitters up to essentially the surface of the roadway. These channels may be the same channels where the luminous emitters are housed or specific channels to house the photovoltaic cells. These channels will have dimensions that will be adjusted to the dimensions of the cells they house and will preferably have a bed of sand at the bottom on which the corresponding photovoltaic cell rests. The filler material used to fill the channels will allow the passage of solar radiation for the generation of photovoltaic energy that could feed the luminous system for horizontal roadway marking or could be injected directly into the grid. In addition, the energy generated could be stored, for example, in external batteries located in a pit next to the system. When the channels are specifically to house the photovoltaic cells, they will be located in proximity to the channels where the luminous emitters are inserted. For example, said channels with the photovoltaic cells could run parallel to the channels with the luminous emitters, or they could surround them. More preferably, in the case where the luminous emitters are substantially transparent, as is the case with the optical fiber, the photovoltaic cells could be included in the same channels where the optical fibers are inserted, being located between the bottom of the channel and the optical fiber itself.

[0031] In some preferred embodiments of the invention, the system comprises a plurality of flexible luminous emitters housed in at least one channel made on the roadway. The luminous emitters could be housed individually or in groups in the channels, which in turn could be made in the roadway with any geometry or pattern. The luminous emitters could also be housed in parallel or perpendicular channels. The luminous emitters can be configured to emit light continuously or intermittently so that luminous figures that are continuously illuminated, flashing or giving the sensation of movement, can be generated. The system can also generate arrays of points of light. For example, in the case where the luminous emitters are a plurality of LED strips forming a matrix

of points of light, the system can be configured so that the LEDs can be activated individually, by groups or by strips, so that specific groups of LEDs can be illuminated defining specific static or dynamic images. Groups of luminous emitters could also be illuminated alternately so that different geometries or shapes are alternately illuminated that can also give the sensation of movement in the illuminated figure, as for example happens in some pedestrian traffic lights. Alternatively, these luminous emitters could be illuminated only at their tip, so that the plurality of luminous emitters, whose tip would preferably be oriented substantially in a direction perpendicular to the rolling surface of the roadway, could form a matrix of light points to generate all kinds of figures or indications, and could even be programmed to be moving figures simulating, for example, animated pedestrian traffic lights.

[0032] A second aspect of the present invention relates to a method for installing a luminous system for roadway marking, wherein said luminous system comprises at least one flexible luminous emitter which is housed inside at least one channel made on the roadway. The method for installing comprises the following steps:

1. Making a channel on the roadway. This channel can be made using conventional means used for works of this type. Preferably, this channel may have a depth of between 2 and 10 cm deep, more preferably between 2 and 5 cm, and a width of about 4 cm. In other embodiments, the dimensions of the channel may be different depending on the specific application.
2. Introducing the at least one luminous emitter in the channel. The luminous emitters could be Led strips, strips incorporating any other light source, optical fibers, optical fibers with side emission along the entire length thereof or luminous guides made of PMMA with lateral emission along the entire length thereof is normally used. The optical fiber with lateral emission can be 8 mm in diameter, for example.
3. Filling the channel with a transparent or translucent filler material comprising a transparent or translucent aggregate and optionally glass fibre, mixed with a binder, wherein the filler material is composed of at least 85% aggregate (and optionally glass fiber) with respect to the total mass of filler material, covering the luminous emitter up to essentially one surface of the roadway. The aggregate may be quartz, glass, transparent polymer-based artificial aggregate, or the like, or any combination thereof. The binder may be a bituminous type such as bitumen or may be a transparent polymeric type binder, e.g., resin.

[0033] Naturally, this method may also comprise making a pit or the like outside the rolling course of the roadway, for example, in the shoulder or sidewalk, for housing the light emitter/source, if luminous guides such as fiber optics are used, as well as auxiliary elements such as a

photovoltaic panel, power regulators, batteries, processing means, or others. In any case, the pit is made in a conventional manner.

[0034] In a particularly preferred embodiment of the invention, the method further comprises the step of coating the inner faces of the channel with a waterproof and adherent layer, for example, a bituminous emulsion, before introducing the luminous emitter in the channel.

[0035] According to yet another preferred embodiment, the method further comprises introducing said luminous emitter inside a flexible and transparent protective tube before introducing the luminous emitter in the channel.

[0036] In yet another particularly preferred embodiment of the invention, the method comprises arranging a sand bed at the bottom of said channel before introducing the luminous emitter in the channel.

[0037] The channel filling stage comprises preheating the binder together with the aggregate, and optionally the glass fiber, to a temperature well above ambient temperature, preferably between 130° and 260° depending on the binder used, and once the mixture is heated, it is spread along the channel, compacted and allowed to cool to ambient temperature, as is done with conventional asphalt agglomerate.

[0038] In another preferred embodiment of the invention, the method comprises either incorporating a photovoltaic cell between the bottom of the channel and the at least one luminous emitter; or making at least one additional channel in the roadway where the photovoltaic cell is introduced and subsequently filling said additional channel with filler material. The energy generated could be stored in external batteries, consumed on site or injected into the grid. When the channels are specific to house the photovoltaic cells, they will be located in proximity to the channels where the luminous emitters are inserted. Preferably, the same channels will be used to insert both the photovoltaic cells and the luminous emitters when the luminous emitters are essentially transparent, for example, as is the case with fiber optics.

[0039] The luminous system object of the present invention can be activated in different ways, such as for example, manually, with sensors for detecting the presence of pedestrians in the case of sidewalks, or with induction coils for detecting the passage of vehicles (these coils are placed on the roadway at a distance before the luminous system such that the passage of the vehicle is detected and the activation of the luminous system is synchronized when the vehicle reaches said luminous system). In turn, the luminous emitters can be activated in a continuous manner, in an ad hoc manner (for example, when they detect the presence of a pedestrian or vehicle), or at intervals (for example, in synchronization with the activation of other vertical luminous markings of the roadway such as traffic lights). Furthermore, it has been envisaged that the luminous signs emitted by the luminous emitters may change in color in order to synchronize, for example, with the lights emitted by other

vertical luminous markings of the roadway such as traffic lights.

[0040] In turn, depending on needs, recycled glass could be used as aggregate, and this favors a circular economy.

BRIEF DESCRIPTION OF THE FIGURES

[0041]

Figure 1 shows a cross-section view of a luminous system according to the prior art.

Figure 2 shows a cross-section view of the luminous system according to the present invention.

Figures 3a-3d show the main steps of the method for installing a luminous system according to the invention.

Figure 4 shows an example of a luminous marking made by means of the system of the invention.

Figure 5 shows another example of a luminous marking made by means of the system of the invention.

Figure 6 shows another example of a luminous marking made by means of the system of the invention.

Figure 7 shows another example of a luminous marking made by means of the system of the invention.

PREFERRED EMBODIMENT OF THE INVENTION

[0042] Figure 1 shows the luminous system described in prior art document US 6,398,399. This system (100) is formed by a luminous guide (110) housed inside a metal duct (120) arranged inside a channel made on the road. The upper side of the duct (120) is closed by means of a transparent plate (130) made of polycarbonate and fixed to the sides of the duct (120) by means of screws (140). As mentioned herein above, this system (100) has the drawback that the duct (120) may undergo deformation and even come out of the channel in which it is housed as a result of the deformation of the roadway due to the continuous passage of vehicles.

[0043] Figure 2 partially shows an example of the system (1) according to the present invention. The luminous emitter (3) which, in this example, is an optical fiber cable with side illumination, is housed inside a channel (4) having a rectangular cross-section. A sand bed (8) is arranged under the luminous guide (3) to keep the guide supported at a constant stress and prevent it from being damaged as a result of possible chafing against the bottom of the channel (4). For greater protection, the luminous guide (3) is furthermore housed in a protective tube (6). The sand bed (8) covers the outer surface of the protective tube (6) up to half the height thereof such that respective side portions of the sand bed (8) are defined on both sides of said protective tube (6). These side portions receive the loads generated by the filler material (5) itself and by the vehicles traveling over same, transmitting them directly to the sand bed (8) and the roadway (9) below it. The channel (4) is covered by means of a

filler material (5) which is essentially level with the surface of the roadway (9). In this example, the filler material is formed by a transparent aggregate, for example, quartz, glass, artificial aggregates based on transparent polymers, or any combination thereof, mixed with a transparent polymer binder, for example, a transparent resin. Therefore, when the luminous guide (3) lights up, the emitted light goes through the filler material (5) and is visible to pedestrians and vehicles moving on the roadway (9). The filler material (5) could also include glass fiber to reinforce the mechanical properties of the aggregate-binder mixture. In this embodiment, since the system (1) is being installed on a conventional road, the aggregate-binder proportions of the filler material (5) will be substantially the same than the aggregate-binder proportions of the road itself, being aggregate, e.g., quartz, glass or transparent polymer-based artificial aggregate or any combination thereof, at least 85% of the total mass of the filler material (5) with the rest of the filler material (5) being resin. This aggregate-binder ratio substantially corresponds to the aggregate-binder ratio used in the construction of the roadway (9) on which the system (1) is installed. Therefore, depending on the roadway on which it is to be installed, this proportion may vary to adapt to that used in the roadway (9) which will improve the bonding of the filler material (5) to the existing asphalt agglomerate.

[0044] Figures 3a-3d show the main steps of an example of a process for installing a system (1) like the one described above. In a first step shown in Figure 3a, a channel (4) is made on the roadway (9). For example, the channel (4) may have a width of 4 cm and a depth of 5 cm. Nevertheless, the depth of the channel (4) will depend on the amount and type of traffic that the luminous system will support. Next, as seen in Figure 3b, prime and tack coating is applied by means of a bituminous emulsion on all the inner faces of the channel (4), thereby creating a waterproof and adherent layer (7) which reinforces the joint thereof. Once this is done, sand is introduced in the bottom of the channel (4) to create a sand bed (8) on which the luminous guide (3) housed inside the protective tube (6) described above is placed, as seen in Figure 3c. The type of luminous guide (3) used will essentially depend on the depth of the channel (4). For channels (4) that are closer to the surface, guides (3) having a smaller diameter which transmit a smaller amount of light laterally can be used, whereas for channels (4) that are deeper, luminous guides (3) having a larger diameter which transmit a larger amount of light laterally will be used. In turn, the selection of the diameter of the protective tube (6) will depend on the diameter of the luminous guide (3) and the width of the channel (4) will depend on the diameter of the protective tube (6). Lastly, the luminous guide (3) is covered by introducing the filler material (5) formed by an aggregate mixed with transparent resin in the channel (4). The end result of this process is shown in Figure 3d.

[0045] Figures 4 and 5 show the final aspect of two

examples of systems (1) according to the present invention, wherein the luminous emitters are luminous guides (3). The light emitter or source (2) is housed in a pit located on the side of the roadway. The luminous guide (3) has an end optically connected to the light emitter (2), such that the light emitted by the emitter (2) is conducted by the luminous guide (3) and, at the same time, a part of said light is emitted laterally along the entire luminous guide (3). In addition to the light emitter (2), some auxiliary elements such as a battery which provides electrical energy, a photovoltaic panel for charging the battery, and processing means which control the operation of the light emitter (2) can be arranged in the pit. The light emitter (2) can thus be turned on and off at specific intervals relative, for example, to the status of a traffic light or the like. Furthermore, it is possible to change the color of the light emitted by the light emitter (2), for example, from green to red. Figure 5 shows an example of an application of this type, in which the illuminated band is green when the passage of vehicles is allowed and red when there are pedestrians crossing the zebra crossing.

[0046] Figure 6 shows another example of the luminous system (1) for horizontal roadway marking according to a particular embodiment of the invention. This example presents an assembly similar to that shown in Figures 4 and 5 but with the luminous guide (3) arranged in a channel displaying the word "STOP" over the actual word "STOP" that is commonly found painted on the roadway. In this embodiment, the light emitter (2) may perform emission in a continuous manner or in a manner such that the luminous guide blinks. There may also be a detection system for detecting the presence of vehicles, such as induction coils (not shown in the figure) located several meters before the "STOP" sign and connected to the light emitter (2), such that the light emitter (2) is only activated for a predetermined time in response to the induction coils detecting the passage of a vehicle.

[0047] Figure 7 shows another example of the luminous system (1) for horizontal roadway marking according to a particular embodiment of the invention. This example presents an assembly similar to that shown in Figures 4, 5, and 6 but with the particularity that a plurality of luminous guides (3) are placed in parallel, such that specific sections thereof are illuminated, creating specific geometries, in this case the figure of a pedestrian, although other geometries may also be possible. Figure 7A shows the entire length of the optical fibers (9) inserted in the channels or micro-ditches (4) for the purpose of emitting light signal only in the desired segments. Nevertheless, to change the illuminated figure, the plurality of luminous guides (3) may be replaced, taking them out of their respective protective tubes (6) through the box where the light emitter (2) is located, with another group of luminous guides (3) in which the sections thereof, which are designed to light up, are adapted to the new figure the illumination of which is to be visible to pedestrians and/or drivers of vehicles. More than one luminous guide (3) may also be included in each of the protective

tubes (6), each of these guides (3) belonging to a group of guides (3) configuring a specific image on the roadway (9), such that the light emitter (2), depending on the group of fibres which it illuminates (it will illuminate only one guide of the plurality of guides (3) of each tube (6) at any given time), will cause one of the images on the roadway to light up. Said light emitter (2) will be programmed to illuminate one group of guides (3) or another depending on several factors. There may also be an independent light emitter (2) for each group of guides (3). Figure 7B shows the guides (3) illuminating the desired segment such that only the figure of the pedestrian which is illuminated on the roadway is seen. Alternatively, groups of luminous guides (3) may also be illuminated such that different geometries or shapes which can furthermore give the sensation of the illuminated figure moving, like what occurs with some pedestrian traffic lights, for example, are alternately illuminated. Alternatively, only the tip of these luminous guides (3) may be illuminated, such that the plurality of luminous guides (3), the tip of which would preferably be oriented substantially perpendicular to the rolling surface of the roadway (9), may form an array of light points to generate all types of figures or indications, and such that said guides can even be programmed to be moving figures, simulating animated pedestrian traffic lights.

[0048] While figures 2 to 7 have been described including luminous guides such as optic fibers, such light systems (1) could instead incorporate other types of luminous emitters such as LED strips, or a combination of both. The use of this type of luminous emitters avoids having to have a light source that illuminates the guides and also allows individualized control over each of the sources or points of light that incorporates, bulbs, LEDs, etc. Therefore, the use of luminous emitters such as LED strips is especially convenient in applications such as the one described in Figure 7, which present complex geometries or where use is made of point arrays for the illumination of static or dynamic figures.

Claims

1. A luminous system (1) for horizontal roadway marking, comprising at least one flexible luminous emitter (3) which is housed inside a channel (4) made on the roadway, **characterized in that** it further comprises a transparent or translucent filler material (5) comprising at least one transparent or translucent aggregate mixed with a binder, wherein the filler material (5) is made of at least an 85% of aggregate with respect to the total mass of filler material and wherein the filler material (5) is arranged on the at least one luminous emitter (3) covering the channel (4) essentially up to the surface of the roadway, such that the light emitted by the luminous emitter (3) is visible through the transparent filler material (5) to vehicles and pedestrians moving on the roadway.

2. The luminous system (1) according to claim 1, wherein the amount of aggregate is greater than 85% of the total mass of filler material (5), and more preferably, wherein the amount of aggregate is about 95% of the total mass of filler material (5). 5
3. The luminous system (1) according to claim 1 or 2, wherein the aggregate-binder ratio of the filler material (5) is substantially the same as that of the roadway where the luminous system (1) is to be installed. 10
4. The luminous system (1) according to any one of the preceding claims, wherein the aggregate comprises quartz, glass, artificial aggregates based on transparent or translucent polymers or any combination thereof. 15
5. The luminous system (1) according to any one of the preceding claims, wherein the binder is a bituminous binder or a transparent polymer binder. 20
6. The luminous system (1) according to claim 5, wherein when the binder is a transparent polymeric binder, the filler material (5) comprises glass fiber. 25
7. The luminous system (1) according to claim 5 or 6, wherein when the binder is a transparent polymeric binder, the binder comprises fluorescent pigments, phosphorescent pigments, or a combination of both. 30
8. The luminous system (1) according to any one of the preceding claims, wherein the at least one luminous emitter (3) is a luminous guide optically connected to a light source (2), preferably an LED projector with RGB illumination. 35
9. The luminous system (1) according to claim 8, wherein the at least one luminous guide comprises at least one optical fiber, at least one luminous guide made of polymethyl methacrylate (PMMA), at least one optical fiber with side illumination, at least one optical guide made of PMMA with side illumination, or any combination of the foregoing. 40
10. Luminous system (1) according to any one of claims 1 to 7, wherein the at least one luminous emitter (3) is an LED strip, preferably an LED strip with RGB illumination, electrically connected to a power supply. 45
11. The luminous system (1) according to any one of the preceding claims, comprising photovoltaic cells which are housed inside channels made in the roadway, these channels being the same channels (4) where the luminous emitters (3) are housed or additional specific channels for the photovoltaic cells, these channels being filled up to essentially the surface of the roadway with the filler material (5). 50
12. The luminous system (1) according to any one of the preceding claims, comprising a plurality of flexible luminous emitters (3) housed in a plurality of channels (4) practiced in the roadway, wherein the plurality of luminous emitters (3) are configured to be illuminated so as to generate static or moving luminous figures or arrays of points of light. 55
13. A method for installing a luminous system (1) for roadway marking, wherein said luminous system (1) comprises a power source connected to at least one flexible luminous emitter (3) which is housed inside at least one channel (4) made on the roadway, **characterized in that** it comprises the following steps:
- making at least one channel (4) on the roadway;
 - introducing the at least one luminous guide (3) in the at least one channel (4); and
 - filling the at least one channel (4) with a filler material (5), previously heated and mixed, comprising at least one of a transparent or translucent aggregate mixed with a binder, wherein the filler material (5) is made of at least an 85% of aggregate with respect to the total mass of filler material, covering the at least one luminous emitter (3) essentially up to the surface of the roadway.
14. The method for installing a luminous system (1) according to claim 16, comprising the step of coating inner faces of the channel (4) with a layer of waterproof and adherent material (7) before introducing the luminous guide (3) in the channel (4).
15. The method for installing a luminous system (1) according to any one of claims 13-14, comprising:
- incorporating a photovoltaic cell between the bottom of the channel (4) and the at least one luminous emitter (3); or
 - making at least one additional channel in the roadway into which the photovoltaic cell is inserted; and
 - filling the additional channel with filler material (5).

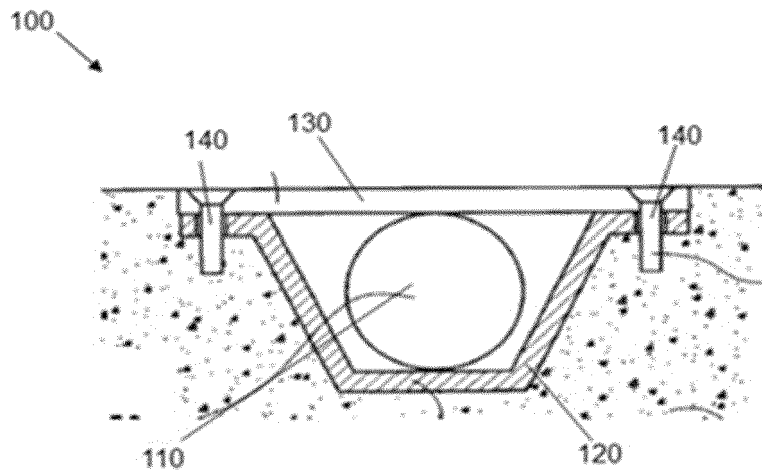


FIG. 1
PRIOR ART

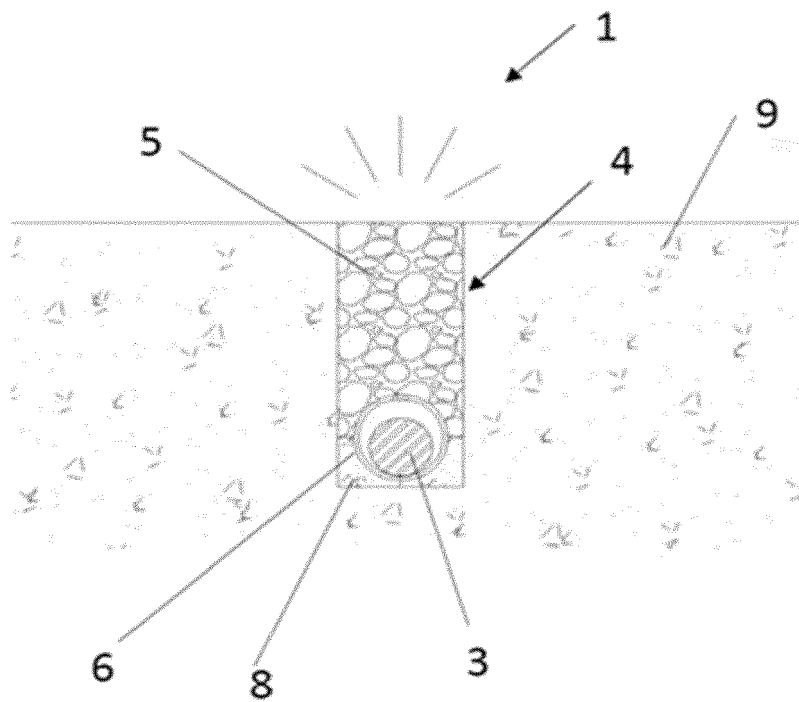


FIG. 2

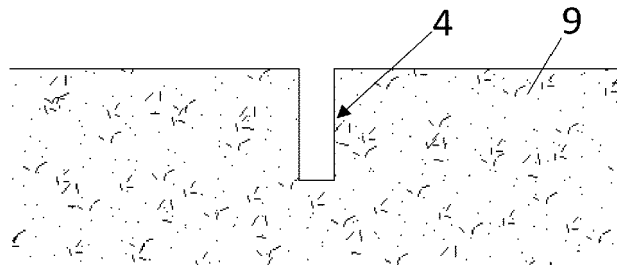


FIG. 3a

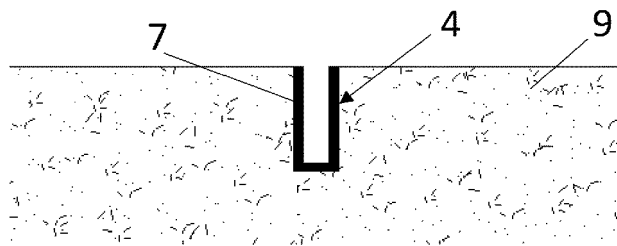


FIG. 3b

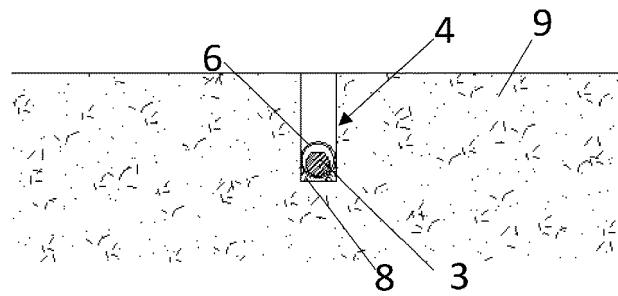


FIG. 3c

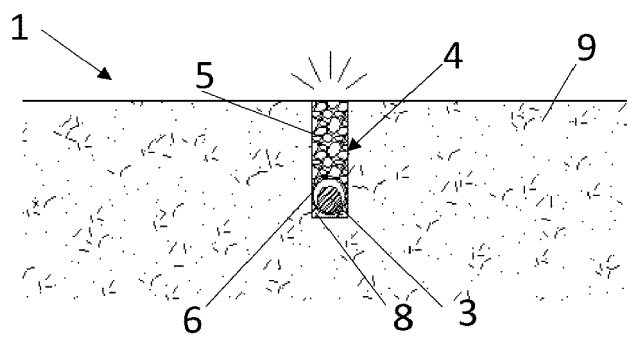


FIG. 3d

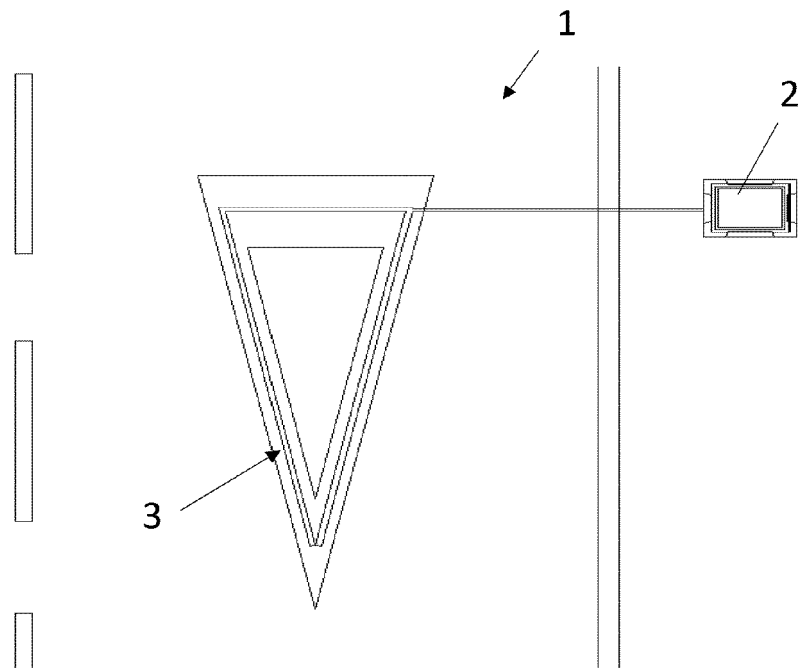


FIG. 4

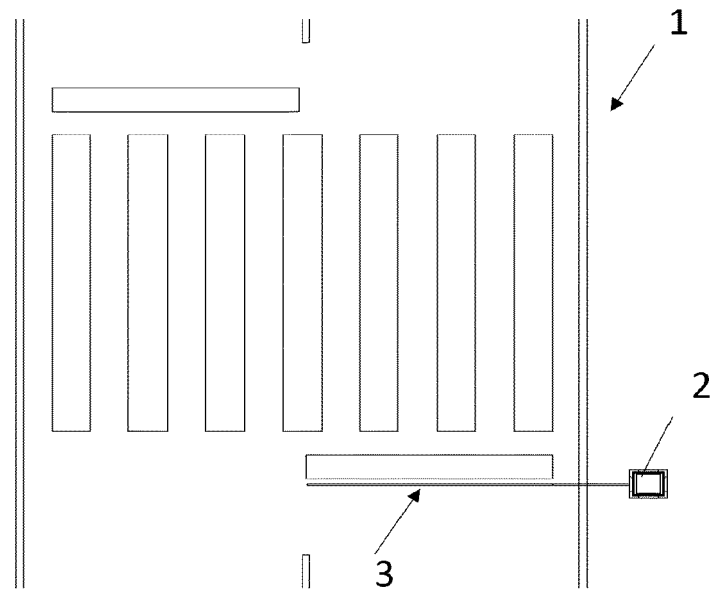


FIG. 5

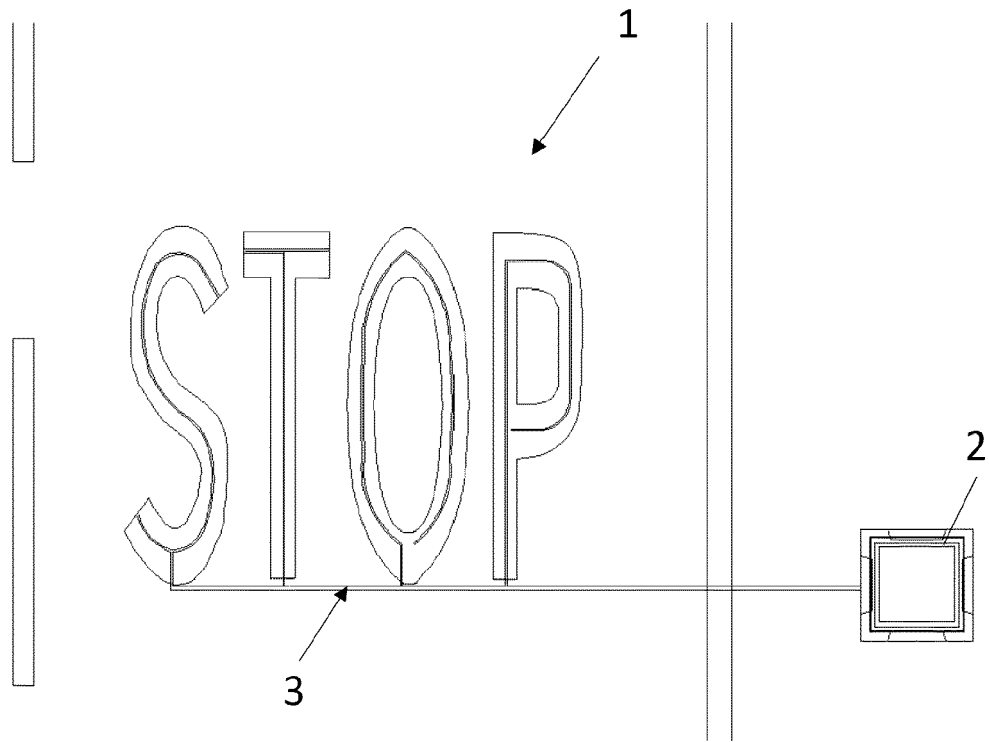


FIG. 6

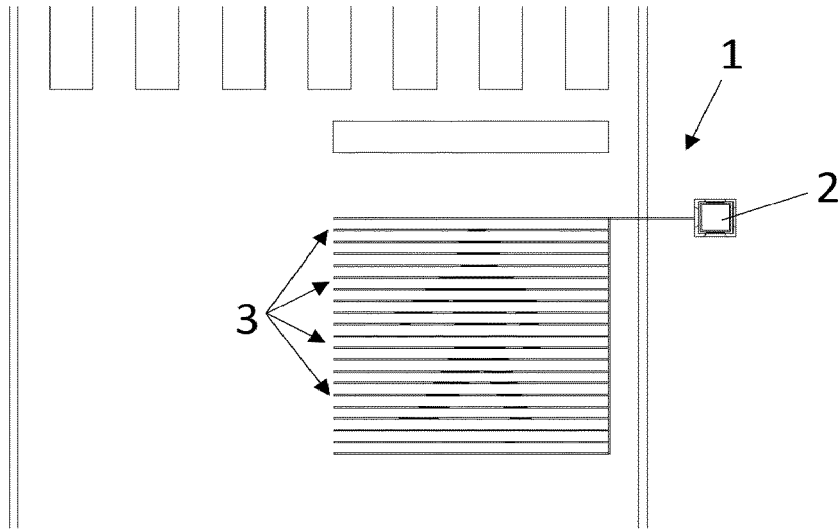


FIG. 7A

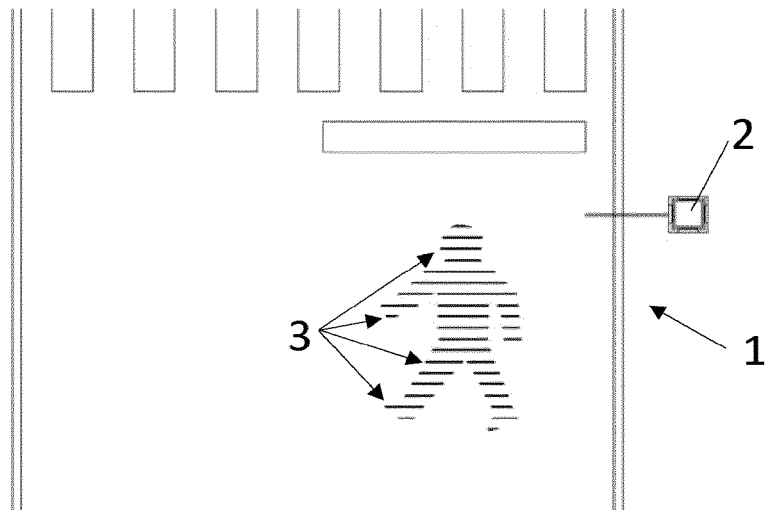


FIG. 7B



EUROPEAN SEARCH REPORT

Application Number

EP 22 38 2559

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 627 035 A1 (HUCKSCHLAG CHRISTIAN [DE]) 25 March 2020 (2020-03-25) * the whole document *	1-15	INV. E01F9/20 E01F9/582
A	JP H07 220506 A (NEKUSUTO I KK) 18 August 1995 (1995-08-18) * paragraphs [0010] - [0055]; figures 1-7 *	1-15	
A	DE 10 2004 035756 A1 (DIETZLER ANDREAS [DE]) 16 February 2006 (2006-02-16) * paragraphs [0060] - [0064], [0078] - [0080]; figure 1 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 24 November 2022	Examiner Flores Hokkanen, P
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24-11-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3627035 A1	25-03-2020	DE 102018123028 A1 EP 3627035 A1	19-03-2020 25-03-2020
JP H07220506 A	18-08-1995	NONE	
DE 102004035756 A1	16-02-2006	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6398399 B [0003] [0009] [0010] [0042]