

DESCRIPTION

TITLE: Railway vehicle car with holographic windows

The present invention relates to a railway vehicle car, comprising:

- a body comprising walls defining an inner compartment designed to receive passengers; and
- at least one glass pane, each glass pane being received in an opening defined in the walls, each glass pane comprising an inner face on the side of the inner compartment and an outer face on the outer side of the car.

A holographic screen can be made by applying a holographic film made up of Fresnel micro-lenses on a glass surface, such as a window panel. It then becomes possible to display three-dimensional content on the window panel using a suitable video projector, oriented toward the window panel.

The use of such screens in a vehicle, in particular on the glass panes of a rail vehicle accommodating passengers, makes it possible to display information on the journey, the surroundings, or services offered to the travelers. It is also possible to project images or videos contributing to passenger enjoyment.

The video projector used for a holographic screen generates a luminous flux of considerable intensity. For passenger comfort, it is generally located at a height, on the inner side of the screen, so as not to send a luminous flux into the eyes of the passengers.

However, for example when the rail vehicle is at a platform in a station, passersby located on the platform may be exposed directly to the luminous flux coming from the video projector, passing through the glass panes of the vehicle. This is particularly likely when a rail vehicle glass pane, seen from the outside, is generally dark, such that a lighted display naturally attracts the gaze, which increases the risks of glare.

One aim of the invention is to provide a rail vehicle car making it possible to implement a holographic display of information intended for travelers, and having a reduced risk of glare for passersby outside the car.

To that end, the invention relates to a rail vehicle car of the aforementioned type, in which the car comprises at least one projection system located in the compartment and configured to project images toward the glass pane, the glass pane comprising:

- a holographic film arranged to display the images projected by the projection system; and

- a semi-reflective film having, for any wavelength of the visible spectrum, a reflection rate of the light in normal incidence of between 20% and 70%.

According to specific embodiments, the rail vehicle car according to the invention includes one or more of the following features, considered alone or according to all technically possible combinations:

- the semi-reflective film is arranged between the holographic film and the outer face of the glass pane;
- the semi-reflective film has, for any wavelength of the visible spectrum, a reflection rate of the light in normal incidence of between 40% and 60%.
- the glass pane comprises a plurality of layers of glass, the holographic film extending between two of the layers of glass;
- the semi-reflective film extends between two of the layers of glass;
- the semi-reflective film extends over an outer face of the outermost layer of glass relative to the inner compartment among the layers of glass;
- at least one layer of glass is a layer of tempered glass;
- the innermost layer of glass relative to the inner compartment among the layers of glass is the or one of the layers of tempered glass;
- the glass pane comprises an anti-vandalism film arranged between one of the layers of glass and the inner face of the glass pane;
- the anti-vandalism film comprises a reinforced polyester.

The invention will be better understood upon reading the following description, provided solely as an example and done in reference to the appended drawings, in which:

[Fig 1] figure 1 is a partial cross-sectional view of a rail vehicle car according to the invention;

[Fig 2] figure 2 is a cross-sectional view of a glass pane of the car shown in figure 1;

[Fig 3] figure 3 is a cross-sectional view of a glass pane of a car according to another embodiment of the invention;

[Fig 4] figure 4 is a cross-sectional view of a glass pane of a car according to a variant of the embodiment of figure 3; and

[Fig 5] figure 5 is a cross-sectional view of a glass pane of a car according to another embodiment of the invention.

A rail vehicle car 10 according to the invention is shown in figure 1. It comprises a body 12 mounted on wheels (not shown). The car 10 is shown stopped opposite a platform 18, for example for passengers to enter and exit.

The body 12 comprises walls 14 delimiting an inner compartment 16 able to accommodate travelers.

Hereinafter, "inner side, face or layer" refers to the side, face or layer closest to the compartment 16, and "outer side, face or layer" refers to the side, face or layer closest to the outside of the car 10.

Additionally, "visible spectrum" refers to the set of electromagnetic waves whereof the wavelength is between 400 nm and 800 nm.

The walls 14 define a plurality of openings 20, only one of which is shown in figure 1, each receiving a glass pane 22, designed to allow the travelers to see outside the car 10. This decreases the impression of confinement and makes the trip more pleasant.

Each glass pane 22 extends between the compartment 16 and the outside of the car 10, and comprises an inner face 23 on the side of the inner compartment 16 and an outer face 25 on the outer side of the car 10.

The compartment 16 receives seats 24, only one of which is shown in figure 1, accommodating the travelers, as well as at least one video projector 26 suitable for projecting holographic images.

A traveler 28 seated on the seat 24 is shown schematically in figure 1 by a first eye. The gaze of the traveler 28 is oriented toward the opening 20 adjacent to the seat 24, on the inner side.

A second eye shows a passerby 30 located on the platform 18, for example waiting for the doors to open in order to enter the car 10. The gaze of the passerby 30 is also oriented toward the opening 20, on the outer side.

The projector 26 is suitable for projecting a holographic image toward the glass pane 22, forming an incident divergent beam 32 on the glass pane 22, on the inner side.

The projector 26 is located close to the glass pane 22, for example at a distance of between 30 cm and 70 cm, preferably between 40 cm and 60 cm. The projector 26 is located in the upper part of the compartment 16. The projector 26 is a short focus video projector having a projection ratio (ratio between the size of the projected image and the projector-glass pane distance 22) of less than 1, preferably less than 0.5.

The glass pane 22 is a holographic glass pane, that is to say, able to constitute a holographic screen for displaying images projected by the video projector 26 to the

traveler 28. The glass pane 22 is thus suitable for refocusing the divergent beam 32 and forming a convergent beam 34, so as to form a holographic image 36 observable from the compartment 16.

The convergent beam 34 has a significant light intensity, in particular greater than 1000 lumens. Such a light intensity does not constitute a significant risk in itself, but a prolonged observation may cause glare for a passerby 30, in particular if he is located near the holographic image 36, as shown in figure 1.

In the embodiment shown in figure 2, the glass pane 22 comprises two layers of glass 40a, 40b, as well as a holographic film 42 arranged to display the images projected by the video projector 26, and a semi-reflective film 44.

The layers of glass 40a, 40b are for example substantially planar, arranged parallel to one another and separated by layers of transparent plastic (not shown) in order to form a laminated glass, in a manner known in itself. Such a laminated glass has the advantage of breaking without projecting shards, which reduces the risk of injuries due to broken glass panes.

The layer of glass 40b is arranged inwardly relative to the inner compartment 16, and the layer of glass 40a is arranged outwardly.

The holographic film 42 is able to refocus the divergent beam 32 when it passes through the glass 22 in order to form a convergent beam 34 so as to form the holographic image 36.

The holographic film 42 forms, in a known manner, a plurality of Fresnel micro-lenses, that is to say, the holographic film 42 defines geometric patterns, repeated regularly a large number of times on its surface, the diameter of each pattern being less than a millimeter. This gives the holographic film 42 optical properties of focusing the light in the visible spectrum.

The holographic film 42 is in particular a thin film made from a polymer material, and not a layer of glass.

The holographic film 42 advantageously extends between the two layers of glass 40a, 40b, which makes it possible to isolate the holographic film 42 from the outside and from the compartment 16.

In particular, the holographic film 42 is directly laminated between the layers of glass 40a, 40b during the manufacturing of the glass pane 22.

Indeed, the holographic film 42 is a fragile element, which may be damaged by the frequent cleaning of the train using cleaning agents, in particular when it is applied on the outer face 25 of the glass pane 22. Additionally, it is particularly vulnerable to

accidental damage or damaged due to vandalism, in particular when it is applied on the inner face 23 of the glass pane 22. Lastly, it generally does not satisfy the safety standards regarding fire and smoke applicable to vehicles receiving travelers.

This in particular makes it possible to protect the holographic film 42 from accidental damage or damage due to vandalism or caused by cleaning the outside of the car 10. This additionally makes it possible to improve the correspondence of the glass pane 22 to safety standards regarding fire and smoke.

In a variant, the holographic film 42 is positioned on the inner face 23 of the glass pane 22, that is to say, on an inner face of the innermost layer of glass 40b. Advantageously, an anti-vandalism film is then arranged on the holographic film.

The semi-reflective film 44 is able to transmit part of the incident light, in the visible spectrum, and to reflect a significant part thereof, at least for the rays of light coming from outside the car 10, the reflected part being sufficient to give the glass pane 22 a reflective appearance when it is observed from outside the car 10.

A reflective appearance means that objects 45 in the environment of the passerby 30 generate respective reflections 46 in the glass pane 22, and that the reflections 46 are perceived by the passerby 30 with an intensity comparable to that of the convergent beam 34.

The semi-reflective film 44 in particular has a reflection rate of the light in the visible spectrum of between 20% and 70%, for each of the frequencies in the visible spectrum, advantageously between 40% and 60%. The reflection rate of the light of the semi-reflective film is measured in normal incidence.

The semi-reflective film 44 in particular comprises a matrix of polymer material in which a metal layer or a plurality of metal particles are embedded, for example made from silver, which give it optical properties of reflection of the visible light.

Advantageously, the semi-reflective film 44 is arranged outwardly relative to the holographic film 42, so as to effectively reduce the transmission of the convergent beam 34.

The semi-reflective film 44 extends over an outer face 50 of the outermost layer of glass 40a of the glass pane 22, in contact with the outside of the car 10. This allows easy access to the semi-reflective film 44, for example to replace it, but increases the risk of damage to the semi-reflective film 44.

Advantageously, an anti-vandalism film is arranged on the semi-reflective film 44.

The compartment 16 is significantly less luminous than the outside of the car 10, which allows the glass pane 22 provided with the semi-reflective film 44 to act as a mirror without silvering.

In a variant of the first embodiment, the glass pane 22 comprises a single layer of glass and the holographic film 42 is positioned on an inner face of the layer of glass, that is to say, of the glass pane 22, while the semi-reflective film 44 extends over an outer face of the layer of glass, that is to say, of the glass pane 22.

A car 10 according to a second embodiment, shown in figure 3, will now be described. The car 10 according to the second embodiment is identical to the car 10 described above, except as follows.

The glass pane 22 comprises three layers of glass 40a, 40b, 40c. The layer of glass 40a is arranged furthest to the outside and the layer of glass 40c furthest to the inside relative to the inner compartment 16, the median layer of glass 40b extending between the layers of glass 40a, 40c.

An air knife 47 separates the innermost layer of glass 40c and the median layer of glass 40b. The air knife 47 improves the thermal and acoustic insulation of the glass pane 22.

Advantageously, the layer of glass 40c is a layer of tempered glass, that is to say, glass reinforced by a thermal or chemical process in order to improve its mechanical strength. This makes it possible to reduce the risks of damage to the window 22 following accidents and vandalism.

Advantageously, the glass pane 22 also comprises an anti-vandalism film 48 arranged on the inner face 23 of the glass pane 22, extending over an inner face of the innermost layer of glass 40c. The anti-vandalism film 48 in particular comprises a reinforced polyester. This makes it possible to still better protect the glass pane 22 from damage.

The holographic film 42 extends between the layers of glass 40a, 40b, and the semi-reflective film 44 extends over the outer face 50 of the layer of glass 40a.

According to a variant of the second embodiment, the holographic film 42 is positioned on the inner face 23 of the glass pane 22, that is to say, on an inner face of the innermost layer of glass 40c. Advantageously, an anti-vandalism film is then arranged on the holographic film.

A car according to a third embodiment of the invention will now be described, comprising at least one glass pane 22 shown in figure 5. The car according to the third

embodiment is similar to the car 10 described in the first embodiment, and the common elements bear the same references and are not described again hereinafter.

The glass pane 22 comprises, from the outside toward the inside, a first layer of glass 40a, a first layer of transparent plastic 52a, the holographic film 42, a second layer of transparent plastic 52b and a second layer of glass 40b.

The semi-reflective film 44 of the glass pane 22 extends over the outer face 50 of the outermost layer of glass 40a.

The layers of transparent plastic 52a, 52b form a laminated glass with the layers of glass 40a, 40b, as described above.

The layers of transparent plastic are in particular made from polyvinyl butyral, or PVB.

The insertion of the holographic film 42 between the layers of transparent plastic 52a, 52b improves the protection thereof.

Owing to the described features, the rail vehicle car 10 makes it possible to implement a holographic display of information intended the traveler 28, while having a reduced risk of glare for the passersby 30 outside the car 10.

The passenger 28 located in the compartment 16 can thus observe the outside in a substantially unchanged manner, while the passerby 30, in particular located on a platform, has the impression that the glass pane 22 is a fully reflective mirror.

The spot of light formed by the light emitted by the video projector 26 is then less perceptible for the passerby 30 among the reflections 46 of the objects 45 in his environment, and does not attract the gaze, which greatly reduces the risks of glare.

The embodiments and alternatives considered above can be combined with one another to create new embodiments of the invention.

CLAIMS

1. A railway vehicle car (10), comprising:
 - a body (12) comprising walls (14) defining an inner compartment (16) designed to receive passengers; and
 - at least one glass pane (22), each glass pane (22) being received in an opening (20) defined in the walls (14), each glass pane (22) comprising an inner face (23) on the side of the inner compartment (16) and an outer face (25) on the outer side of the car (10);characterized in that the car (10) comprises at least one projection system (26) located in the compartment (16) and configured to project images toward the glass pane (22), the glass pane (22) comprising:
 - a holographic film (42) arranged to display the images projected by the projection system (26); and
 - a semi-reflective film (44) having, for any wavelength of the visible spectrum, a reflection rate of the light in normal incidence of between 20% and 70%.
2. The car (10) according to claim 1, wherein the semi-reflective film (44) is arranged between the holographic film (42) and the outer face (25) of the glass pane (22).
3. The car (10) according to claim 1 or 2, wherein the semi-reflective film (44) has, for any wavelength of the visible spectrum, a reflection rate of the light in normal incidence of between 40% and 60%.
4. The car (10) according to one of claims 1 to 3, wherein the glass pane (22) comprises a plurality of layers of glass (40a, 40b, 40c), the holographic film (42) extending between two of the layers of glass (40a, 40b).
5. The railway vehicle car (10) according to claim 4, wherein the semi-reflective film (44) extends between two of the layers of glass (40a, 40b).
6. The car (10) according to claim 4 or 5, wherein the semi-reflective film (44) extends over an outer face (50) of the outermost layer of glass (40a) relative to the inner compartment (16) among the layers of glass (40a, 40b, 40c).

7. The car (10) according to one of claims 4 to 6, wherein at least one layer of glass is a layer (40c) of tempered glass.
8. The car (10) according to claim 7, wherein the innermost layer (40c) of glass relative to the inner compartment (16) among the layers of glass (40a, 40b, 40c) is the or one of the layers of tempered glass.
9. The car (10) according to one of claims 4 to 8, wherein the glass pane (22) comprises an anti-vandalism film (48) arranged between one of the layers of glass (40c) and the inner face (23) of the glass pane (22).
10. The car (10) according to claim 9, wherein the anti-vandalism film (48) comprises a reinforced polyester.