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(54) **Title:** A FRONT FACE PART FOR RAIL SYSTEM VEHICLE

(57) **Abstract:** A front face part (10) made of composite material that at least partially encloses front of the fist cabin in rail vehicles characterized in that comprises at least one sensor (11) that measures at least one of the temperature, pressure and strain data by adapting on it, and at least one processor unit (13) that sends the data collected from said sensor (11) to a memory unit (14) in order to query the physical adequacy of the front face part (10).

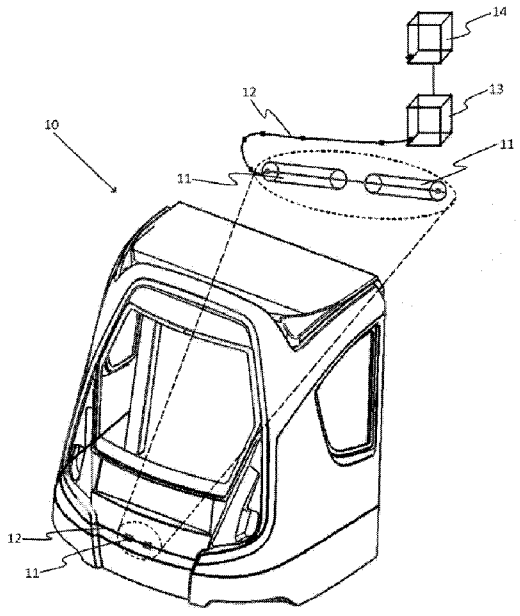

Figure 1

WO 2024/058744 A1

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A FRONT FACE PART FOR RAIL SYSTEM VEHICLE

FIELD OF INVENTION

The invention relates to a composite front face part located at the front of rail vehicles and the production method of this part.

BACKGROUND OF THE INVENTION

The front face part is provided on the front side of rail vehicles. In other words, the front face part defines the front shape of the rail vehicle. The shape of the front face part is designed to have an appropriate aerodynamic structure depending on the speed at which the rail vehicle will be used.

Composite materials are used in the production of many parts of rail vehicles. Especially polymer matrix composite materials have become preferred due to their lightweight, durable, safe and especially cost-effective characteristics in vehicle body parts. Fiber reinforcements can also be preferred to support mechanical strength. For parts with high contact with the atmosphere, thermoset polymers with higher structural stability compared to other polymer types are mostly preferred.

In order to meet the requirements for lightweight and mechanical properties, the optimal fiber and resin selection is made according to the results of tests and analyses conducted on the structure. The front face part, which is mounted on the body of the vehicle with various brackets and fittings, works under natural conditions during the vehicle's life cycle (20-30 years). During this period, it is exposed to various mechanical, physical and chemical effects. Since the test results before the product is produced are made in a laboratory environment, the effects that the product will encounter in natural living conditions are ignored or taken into account as an estimate.

This limitation is also solved in the virtual environment of the product with the help of the algebraic equation system called finite element, by using variable methods. By using the principal function results obtained by this method, the actual solution is interpolated. The analysis performed here cannot turn the effects caused by the uncertain situations that the part will encounter during the usage phase into 100% reality.

The strain created by cyclically applied loads enables the determination of the fatigue behavior of the materials and the structural life analysis. The fatigue behavior and life determination of a material are experimentally performed using fatigue test. With the fatigue test, it is generally possible to determine the theoretical life of the materials with the applied loads up to about 10^7-10^8 cycles. However, composite material production and test applications made under ideal conditions in a laboratory environment cannot be provided under ideal conditions in applications outside the laboratory. Since the destructive testing of structural composite applications is not possible during service, it may be difficult to determine the fatigue behavior of these composites and to determine the actual life.

The service operating temperatures of fiber-reinforced polymer matrix composite materials preferred in rail system vehicles are mainly related to the climate conditions of the service area of the rail system vehicle. External factors such as UV rays that cause degradation in the polymer chain structure that forms the polymer structure penetrating into the composite structure and humidity that causes delamination between layers and other structural damage are present. The effect of these external factors is reduced by protecting the composite parts with paint and other protective coatings. However, the effect of thermal radiation (Heat Radiation) caused by UV rays from the sun and the temperature in the working environment cannot be prevented.

The cured polymer in the composite structure heated up to normal climate temperatures by thermal radiation exhibits a visibly variable ductile-brittle behavior depending on the temperature. This behavior of the polymer at different climate temperatures also changes the mechanical performance limits of the composite structure under structural static and dynamic loads, as well as the energy absorption and shape change tolerance of any impact that may occur on the structure. This variability also affects the fatigue behavior and structural life of the polymer as the matrix material in the composite structure. Although a temperature-controlled fatigue test can be applied under laboratory conditions for structural health monitoring, it is not possible to obtain realistic data.

Production is made with the application of similar or the same composite laminations under many different climate conditions. Many parameters that will affect the life cycle of the front face part change according to the climate and environmental conditions. Structural health analyses of a traditional front face part to be remain in service are carried out with methods such as ultrasonic testing and radiographic examination in maintenance processes, ignoring instantaneous and environmental data. However, it is not possible to determine

the strain characteristics and intensity of cyclic loads applied to composite parts during service.

As a result, all the problems mentioned above have made it mandatory to make an innovation in the relevant technical field.

SUMMARY OF THE INVENTION

The present invention relates to a front face part aiming to eliminate the aforementioned disadvantages and to bring new advantages to the related technical field.

The purpose of the invention is to provide a front face part with optimized physical requirements and thickness.

To achieve all the objectives mentioned above and in the detailed description below, the present invention relates to A front face part made of composite material that at least partially encloses front of the fist cabin in rail vehicles Said front face part comprises at least one sensor that measures at least one of the temperature, pressure and strain data by adapting on it, and at least one processor unit that sends the data collected from said sensor to a memory unit in order to query the physical adequacy of the front face part. Thus, data such as temperature, pressure, and stress are obtained from the front face part under real working conditions, interpreted in the processor unit, and data collection is ensured to control the geometric suitability of the front face part. Additionally, the collected data is stored in the memory unit to observe the behavior of the rail system vehicle under different temperature, humidity, and wind conditions.

In a probable embodiment of the invention, there is at least one cable connecting the sensor and the processor unit.

In a probable embodiment of the invention, the cable is essentially a fiber optic cable.

In a probable embodiment of the invention, the sensor is essentially an FBG (Fiber Bragg Grating) sensor. Thus, multiple measurements such as temperature, pressure, and strain can be performed simultaneously.

In a probable embodiment of the invention, multiple sensors are provided in different regions on the front face part. Thus, data collected from multiple regions can be compared.

In a probable embodiment of the invention, the sensor is provided between the lamination layers forming the front face part. Thus, the sensor is protected from external factors that may affect the measurement accuracy.

The invention is also a method for verifying the physical adequacy of a front face part made of a composite material at least partially surrounding the front of the first cabin in rail vehicles. Said method comprises the steps of adapting at least one sensor to the front face part, measuring at least one of temperature, pressure, and strain using the sensor, and sending the data collected from the sensor to a memory unit via at least one processor unit.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a representative isometric view of the front face part of the subject matter.

In Figure 2, a representative detail view of the layered structure of the front face part, which is the subject of the invention, is given.

DETAILED DESCRIPTION OF THE PROBABLE EMBODIMENT(S)

In this detailed description, the front face part (10) of the subject matter for rail system vehicles is explained with examples that will not have any limiting effect only for a better understanding of the subject matter.

As can be seen in Figure 1, the subject matter of the invention, the front face part (10), has at least one sensor (11). Said sensor (11) can be provided in multiple numbers in different areas on the front face part (10). In a probable embodiment of the invention, the sensor (11) is an FBG (Fiber Bragg Grating) sensor. On the other hand, there is at least one processor unit (13) associated with the sensor (11). Said processor unit (13) is connected to the sensor (11) with a cable (12) in a probable embodiment of the invention. Said cable (12) is essentially a fiber optic cable. The data collected by the sensor (11) is interpreted in a processor unit (13). The data processed in the processor unit (13) is recorded in a memory unit (14). Said memory unit (14) can be on the rail vehicle, on the cloud or in a control center.

As can be seen in Figure 2, the composite material that forms the front face part (10) is made up of multiple layers of lamination (20). The sensor (11) is positioned between these laminated layers (20).

To produce the front face part (10) of the invention, firstly, the mold is produced and prepared. Then, lamination is created and applied to the mold. During the application of the lamination layers (20), sensors (11) and cables (12) are placed in desired positions between the lamination layers (20). Then, resin application, curing, removal of the part from the mold, trimming and surface treatments are applied to finalize the front face part (10).

After the front face part (10) of the invention is installed on the rail system vehicle and the rail system vehicle starts operating in the actual geography where it will be used, the sensor (11) starts measuring. With the help of the sensor (11), parameters such as temperature, pressure, and strain are measured simultaneously. These measurements allow the status of the front face part (10) of the rail system vehicle to be measured under the external effects that will occur in the actual geography where it will be used. In other words, the front face part (10) is monitored under the weather conditions such as temperature, humidity, and wind in the actual working conditions. The strain distributions and stress accumulations in the front face part (10) are determined under different weather conditions and actual working conditions. The collected data is analyzed to question the adequacy of thickness or geometry of the relevant part of the front face part (10). Thus, the weak points are detected, they are supported, and the relevant part of the next front face part (10) to be produced is made thicker. On the other hand, if there are unnecessarily thick parts, the relevant parts are thinned, and thus the total weight and the amount of material used are reduced. This also reduces the energy consumption and environmental damage of the rail system vehicle.

In addition, thanks to the mentioned structure, deformations that may occur as a result of foreign object impacts on the front face part (10) can also be detected.

In the front face part (10) of the invention, the sensors (11) are located between the lamination layers (20), which allows the sensor (11) to operate healthily without being affected by external factors.

It is possible to produce geography-specific standards by analyzing the data collected on the front face part (10), which is the subject of the invention. In other words, standards that

will meet the needs of the region's geography more effectively than the currently valid EN 12663 and ASME RT-2 2014 standards can be determined.

The scope of the invention's protection is specified in the claims provided in the attachment and cannot be limited to what is described for sampling purposes in this detailed description. It is clear that a technical expert can develop similar structures without deviating from the main theme of the invention based on the information described above.

REFERENCE NUMBERS

10 Front face part
11 Sensors
12 Cables
13 Processor units
14 Memory units
20 Lamination layers

CLAIMS

1. A front face part (10) made of composite material that at least partially encloses front of the fist cabin in rail vehicles **characterized in that** comprises at least one sensor (11) that measures at least one of the temperature, pressure and strain data by adapting on it, and at least one processor unit (13) that sends the data collected from said sensor (11) to a memory unit (14) in order to query the physical adequacy of the front face part (10).

2. The front face part (10) according to claim 1, wherein comprises at least one cable (12) which connects the sensor (11) and the processor unit (13).

3. The front face part (10) according to claim 2, wherein said cable (12) being primarily a fiber optic cable.

4. The front face part (10) according to preceding claims, the sensor (11) being primarily an FBG (Fiber Bragg Grating) sensor.

5. The front face part (10) according to preceding claims, wherein comprises multiple sensors (11) provided at different regions on the front face part (10).

6. The front face part (10) according to preceding claims, wherein the sensor (11) being provided between at least two lamination layers (20) that form the front face part (10).

7. A method for verifying the physical adequacy of a front face part (10) made of a composite material at least partially surrounding the front of the first cabin in rail vehicles **characterized in that** comprises the steps of adapting at least one sensor (11) to the front face part (10), measuring at least one of temperature, pressure, and strain using the sensor (11), and sending the data collected from the sensor (11) to a memory unit (14) via at least one processor unit (13).

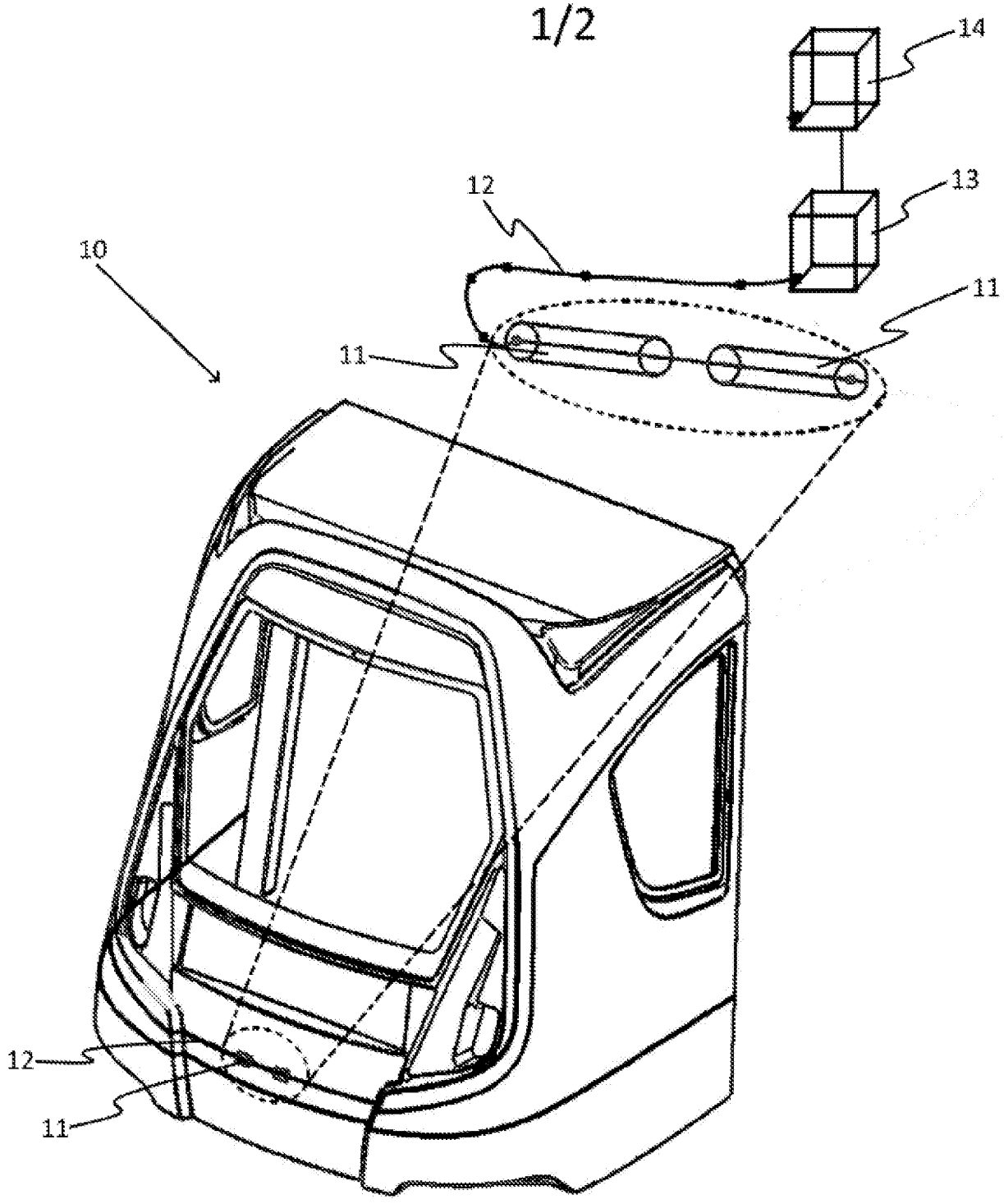

Figure 1

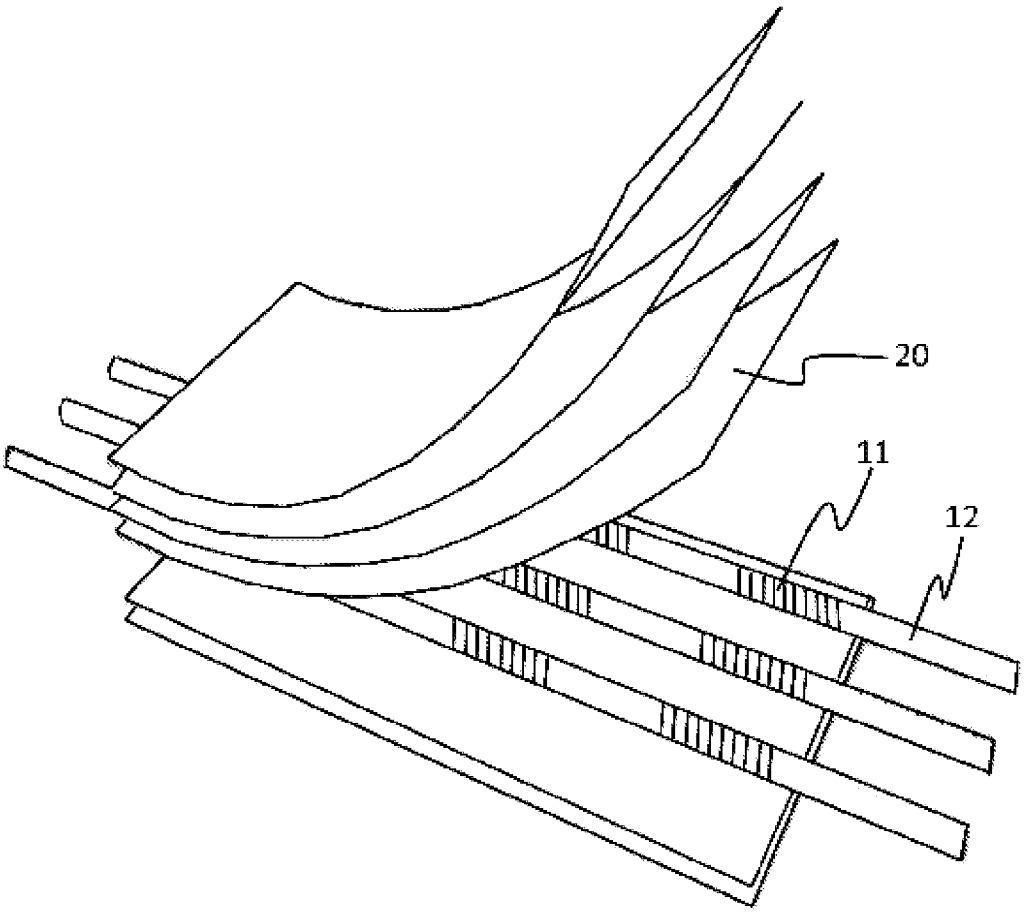

Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/TR2023/050234

A. CLASSIFICATION OF SUBJECT MATTER

B32B 7/02 (2019.01)i

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)

B32B 7/02

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 practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014304203 A2 (APPUHAMILLAGE GAYAN CHANAKA KAHANDAWA [AU]) 09 October 2014 (2014-10-09) Description par. 24-27,31-35	1-7
Y	EP 4033210 A1 (NITTO DENKO CORP [JP]) 27 July 2022 (2022-07-27) Description par. 104,226	1-7
Y	CN 208488187 U (XIANGYANG GOTOO MACHINERY & ELECTRONIC APPLIANCE CO LTD) 12 February 2019 (2019-02-12) Abstract,Description par.32,33	1-7

☐ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

* Special categories of cited documents:

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"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

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"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
20 July 2023	**20 July 2023**

Name and mailing address of the ISA/TR	Authorized officer
Turkish Patent and Trademark Office (Turkpatent) **Hipodrom Caddesi No. 13** **06560 Yenimahalle** **Ankara** **Türkiye** Telephone No. **+903123031000** Facsimile No. **+903123031220**	**Gökhan KARANFİL** Telephone No. **+903123031645**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/TR2023/050234

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
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CN 208488187 U	12 February 2019	NONE	