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Designing and pyro-production of frames for the framework of the "Formula a Student"

Design features of the tropical Unicar

Transport strategy for the development of the Eastern range

The development of the methodology for the "Lastochka"digital twin

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Конструктивные особенности юникара тропического для городских перевозок пассажиров

Design features of the tropical unicar for urban passenger transport

Аннотация

В работе исследуются конструктивные особенности юникара тропического для городских пассажирских перевозок. Дано описание устройства основных узлов юникара, представлены его преимущества перед базовой моделью.

Ключевые слова: струнный транспорт, пассажирские перевозки, городской транспорт, юникар тропический.

Abstract

The paper examines the design features of the tropical unicar for urban passenger transport. The description of the unicar main components is given, its advantages over the basic model are presented.

Keywords: string transport, passenger transport, urban transport, tropical unicar.

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Currently, UST (Unitsky String Transport), recognized as innovative by the Ministry of Transport of Russia in 2017, has become a promising mode of transport, ready to carry out freight and passenger transportation. The operating principle of string transport is to move unmanned mounted and suspended vehicles with steel wheels using electric traction on continuous prestressed string-rail track structure [1]. This technology is implemented by SkyWay Technologies Co. in EcoTechnoPark (Maryina Gorka, the Republic of Belarus) and in the SkyWay Innovation Center (Sharjah, the United Arab Emirates).

Unitsky String Technologies Co. has developed a whole line-up of vehicles designed for different purposes and transportation formats. The most comfortable mode of transport for future passenger transportation within the city is the Unicar.

The Unicar is a double-rail suspended electric vehicle on steel wheels (Unimobile) for transporting passengers along a string-rail overpass at a speed of up to 150 km/h [2]. Small-sized (4.7 m long) and comfortable (6 seats), the Unicar will significantly unclog city streets. At the same time, it will provide a higher throughput of the transport system than, for example, railway trains and airbuses, appreciable in terms of their size, cost and capacity, which precisely because of their dimensions, cannot follow each other at high frequency.

The Unicar is an unmanned vehicle, whose control is carried out automatically without a driver (operator).

A modified Unicar U4-431-01 has been developed in the tropical design on the basis of Unicar U4-430, for regions with hot and humid climates (Fig. 1).

The tropical Unicar has almost the maximum configuration and has undergone a number of upgrades relative to the base model necessary to adapt the car to a hot climate and high humidity and to ensure safety and comfortable conditions for passengers, in particular:

- the upper temperature limit for the vehicle operation has been increased to +55 °C;
- the performance of the modular microclimate system has been increased by 60% to maintain the minimum temperature in the vehicle at 23 ° C at an ambient temperature of +55 °C;
- the noise level in the vehicle is reduced to 67 dBA, the external noise does not exceed 70 dBA;
- the required level of reliability and fail safety is ensured by means of aggregate and functional duplication of all main systems and a corresponding increase in the power-to-weight ratio of the product;
- the required level of functional safety is ensured by using a hardware and software complex built according to the SIL standards and including unique UST solutions in terms of emergency prevention systems;
- the required level of structural safety of the vehicle as a whole, including the habitable module, is ensured through the use of special glazing materials;
- the specification also provides for the possibility of an individual VIP design of the interior, which includes two highly comfortable seats for the repose and two seats for the work of staff and is equipped not only with the amenities of everyday life, but also with a multimedia system for remote business operations.

Fig. 1. General view of the tropical Unicar

The overall dimensions of Unicar-T U4-431-01 are shown in Fig. 2, its technical characteristics - in table 1 [3].

Currently, a tropical Unicar of a VIP design is being tested and prepared for certification at the SkyWay Innovation Center (Sharjah, UAE).

Unicar-T has a modular design, where the main assemblies are the traction module, the passenger module and fairings (Fig. 3).

The traction module is designed to ensure the movement of the Unicar-T with the ability to change the speed, direction, acceleration and stopping of the vehicle. The traction module shown in Fig. 4, consists of a traction bogie 1, current collectors 2 and electrical equipment of the traction module 3.

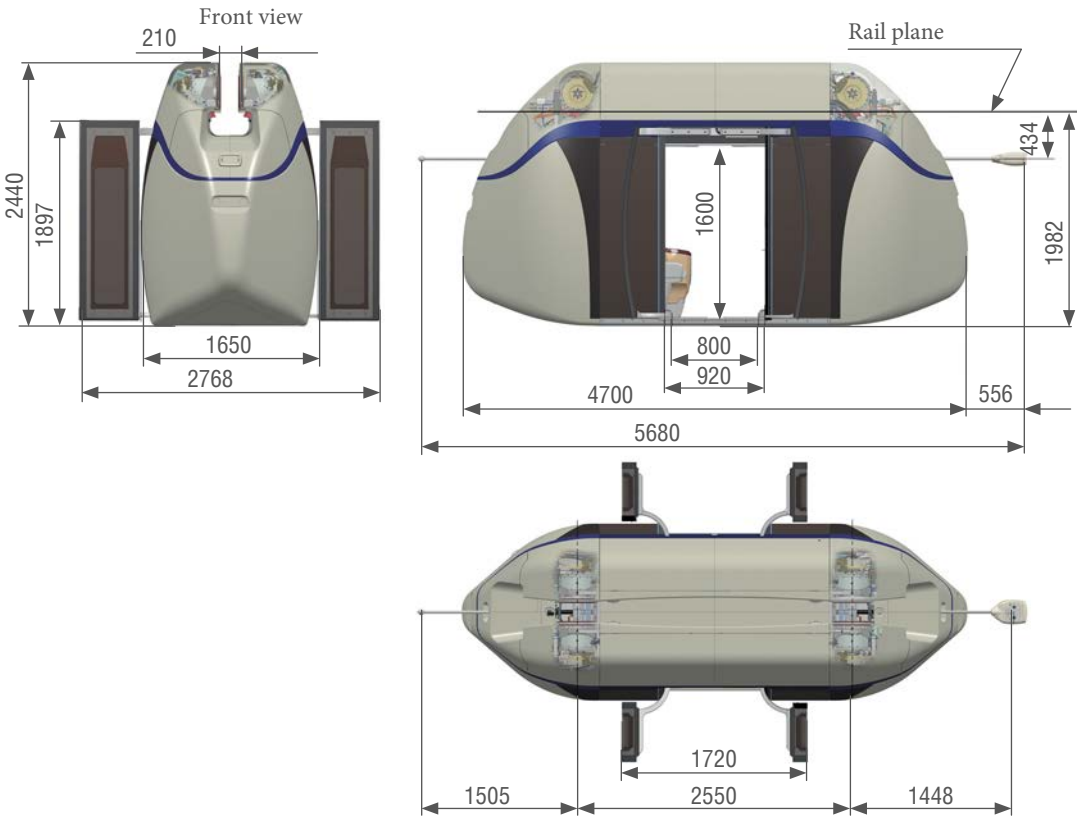


Fig. 2. Overall dimensions of the Unicar-T

Table 1

Technical characteristics of Unicar-T U4-431-01

Параметры	Значение
Passenger capacity, persons.	4; 6
Number of seats, persons	4; 6
Curb weight, kg	4200
Technically permissible maximum weight, kg	4550
Design speed, km/h	150
Operational speed, km/h	120
Autonomous mileage at a speed of 100 km/h, km	200
Power consumption at a speed of 100 km/h in terms of fuel, kg/passenger times 100 km	0,5
Maximum capacity of the transport complex, passengers per hour in both directions	7000
Minimum line interval between single Unicars in an electronic coupling, s	5
Maximum number of Unicars in a rigid or electronic coupling	7
Minimum traffic interval, s	20

The traction bogie consists of support wheels 17, front 10 and rear 4 emergency towing device (ETD), front 15 and rear 5 suspension, front 14 and rear 6 side wheels, friction brakes 9 and parking brake 7, two cooling loops 8, frame 11, two bogies 12, obstacle bumpers 13, electric motors 16.

Traction bogie frame (Fig. 5) is a rigid frame 4, with the attached braces 2 and crossbars 5. Between the frame 4 and the passenger module there are elastic elements – vibration dampers 3, which dampen the vertical vibrations arising during movement, cut off the noise arising in the traction module and can withstand large horizontal forces. Electric motors, hub assemblies with support wheels, side wheels, obstacle bumpers, as well as suspension elements connecting the bogie 1 to the frame are rigidly mounted on it.

. The bogie and the frame of the traction module are the load-bearing structural elements of the vehicle.

The traction module bogie is equipped with four support wheels connected to four electric motors and four side wheels with constant abutting, centering the vehicle on the rail during movement and being an anti-derailment system.

The Unicar suspension is designed to take up the applied external and inertial forces from the wheel propelling units and the transport module, to damp the arising vibrations and, accordingly, to provide the required level of comfort (Fig. 6). The suspension consists of elastic, guiding, damping elements, anti-roll bar and mounting elements.

The Unicar suspension is hydropneumatic, dependent, on double wishbones.

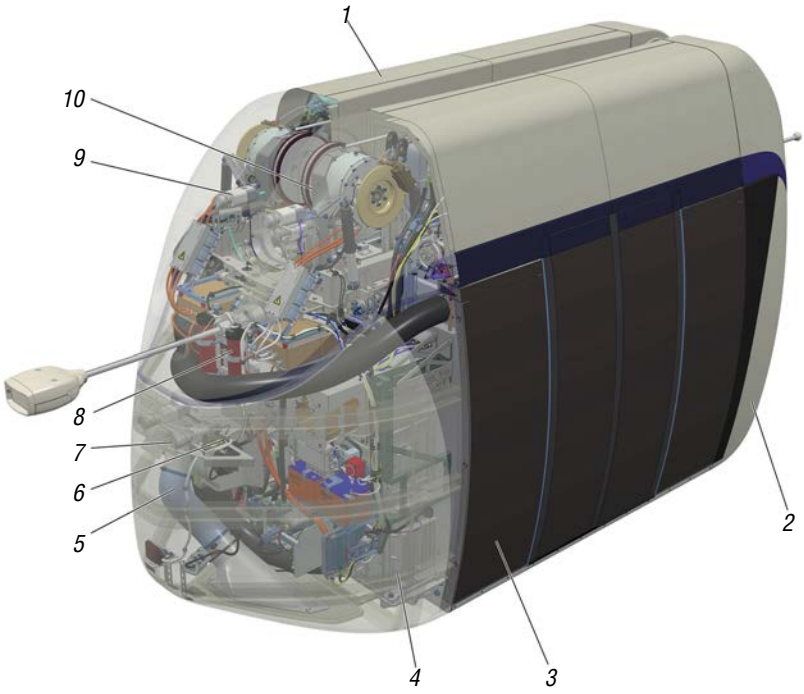


Fig. 3. Unicar-T design:
1 - empennage of the traction module; 2 - fairing; 3 - passenger module; 4 - power supply system; 5 - microclimate system; 6 - additional electrical equipment; 7 - communication and machine vision equipment (in the passenger module); 8 - fire extinguishing system; 9 - communication and machine vision equipment (in the traction module); 10 - traction module

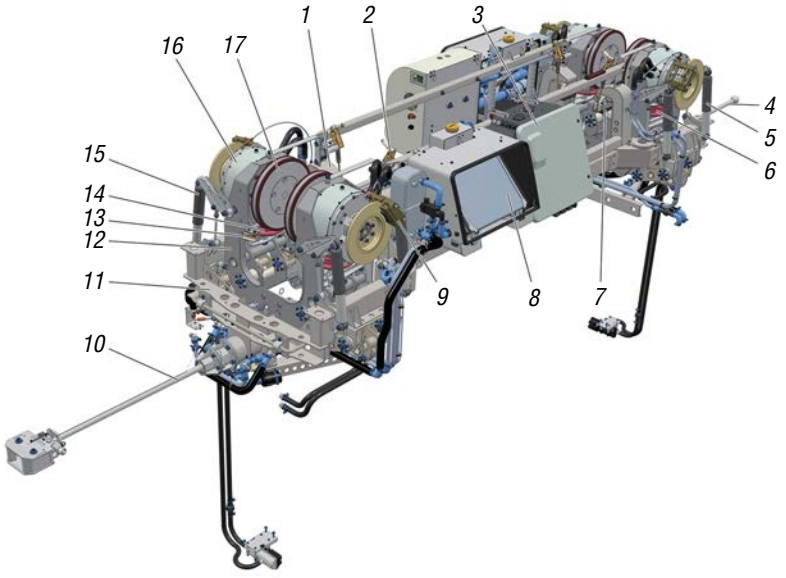


Fig. 4. Traction module of the Unicar:
1 - traction bogie; 2 – current collector; 3 - electrical equipment of the traction module; 4 - rear ETD; 5 - suspension (rear); 6 - side wheel (rear); 7 - parking brake; 8 - cooling system; 9 - friction brake; 10 - front ETD; 11 - frame; 12 - bogie; 13 - obstacle bumper; 14 - side wheel (front); 15 - suspension (front); 16 - electric motor; 17 - support wheel

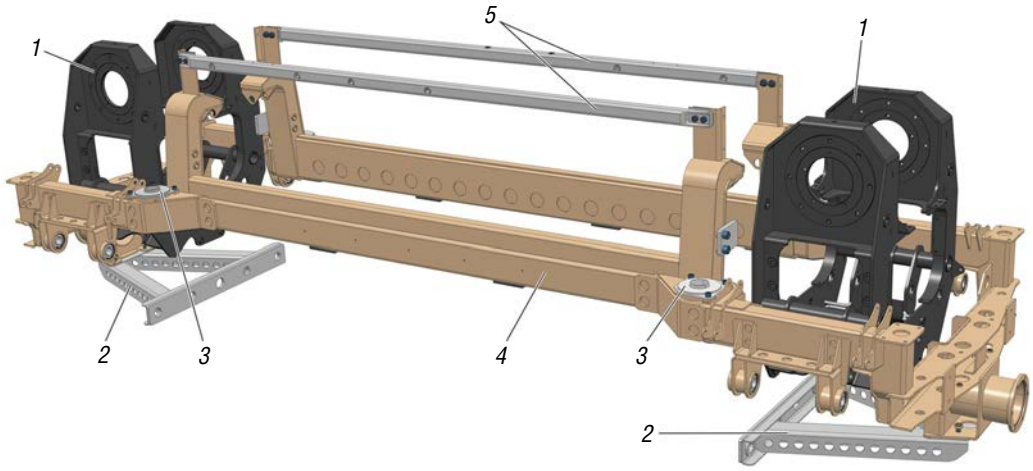


Fig. 5. Traction bogie frame:
1 - bogie; 2 - brace; 3 - vibration damper; 4 - frame; 5 – crossbar

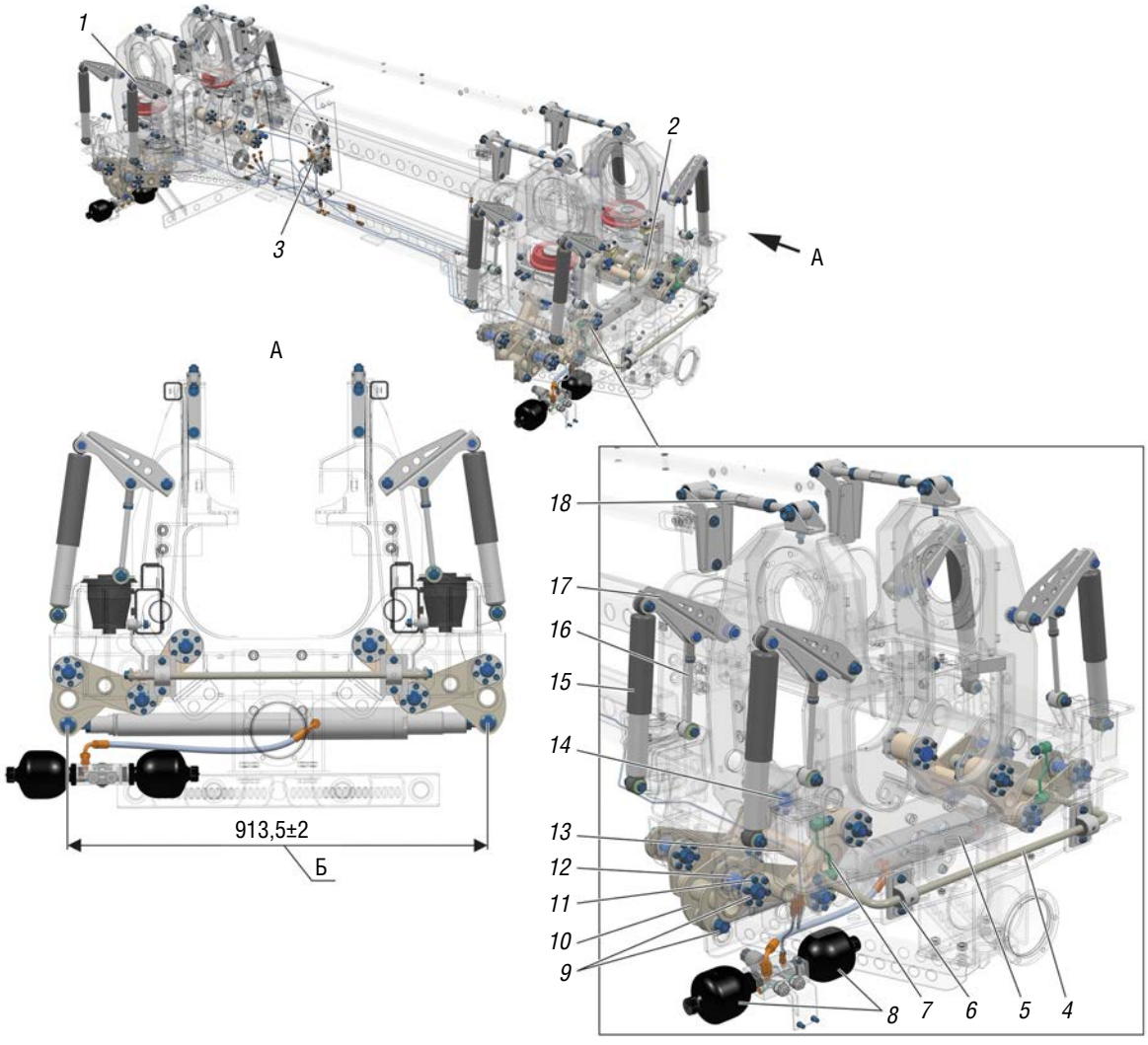


Fig. 6. Unicar suspension:
1 - rear suspension; 2 - front suspension; 3 - suspension block; 4 - link rod; 5 - hydraulic prop; 6 - bushing; 7 - stabilizer link; 8 - HPA; 9 - nut; 10 - lever; 11 - screw; 12 - axis; 13 - intermediate lever; 14 - axis; 15 - shock absorber; 16 - link rod; 17 - lever; 18 - link rod

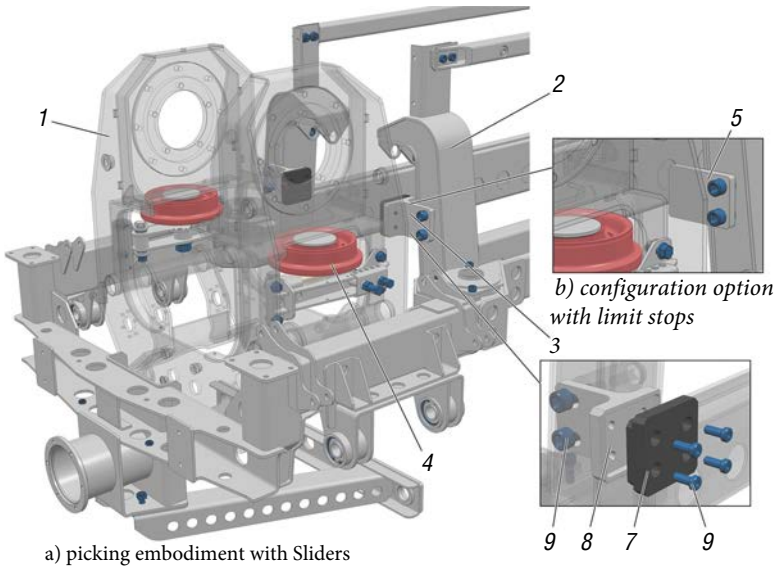
The elastic element of the suspension is a hydropneumatic accumulator (HPA) 8 with nitrogen pre-pumped inside under pressure. The force is transmitted from the wheel to the elastic suspension element via the hydraulic prop 5, which also allows to adjust the position of the vehicle in the vertical plane in relation to the platform and the rail. Levers 10 and 13 are load-bearing strength elements of the suspension, which are connected through metal-rubber mountings (rubber bushings) between themselves and the frame of the traction module.

Shock absorbers 15 are installed to reduce the fluctuation amplitude of the passenger module caused by the operation of the elastic suspension element. Anti-roll bar is installed in order to reduce the lateral pitch of the passenger module, it is a bar 4 connected through the stabilizer links 7 to the Unicar bogie.

The vehicle's anti-derailment system consists of two subsystems (Fig. 7). The first subsystem excludes the lateral drift of the vehicle on the track and has two degrees of protection:

- the first degree is provided by the design consisting of four side wheels 4. The side wheels 4 are pressed against the rail via elastic elements and have a mechanical limitation of the back run by 5 mm each. Therefore, the deviation of the vehicle track path from the conventional longitudinal axis of the rail track is ± 5 mm;
- the second degree is provided by a system of limit stops 5 or side bearings 3, depending on the configuration, and prevents the wheel from derailing if the first degree system is faulty. The second subsystem precludes

the vehicle from falling from the track after a collision,



a) picking embodiment with Sliders

b) configuration option with limit stops

Fig. 7. Anti-derailment system
1 - cart; 2 - frame; 3 - slider; 4 - side wheel; 5 - limit stop; 6 - screw; 7 - insert; 8 - bracket; 9 - screw

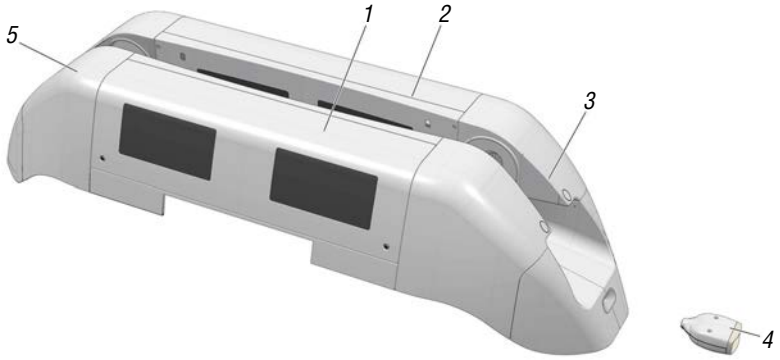


Fig. 8. Traction module facing:
1 - hood (right); 2 - hood (left); 3 - fairing (front); 4 - ABU fairing; 5 - fairing (rear)

destruction of the main load-bearing structural elements, for example, support wheel, suspension arms, etc. Safety is achieved by the design that provides geometric maneuverability only in dedicated sections of the track. Therefore, the vehicle is put on the rail in dedicated sections of the track.

Obstacle bumpers are a passive protective element of the wheel propelling unit and are used to remove obstacles from the rail surface on the track structure.

The plating of the Unicar traction module is made of fiberglass fairings 3 and 4 and hoods 1 and 2 (Fig. 8). Emergency towing devices (ETD) are installed in the rear fairings 5.

The passenger module is designed to carry seated passengers (Fig. 9) and has a dust and water-proof prefabricated structure with internal plating, seats and armrests, glazing, doors, fairings, as well as components of the climate system, lighting, audio and video information systems and duplex voice communication.

Fig. 9. Passenger module of the Unicar of a VIP design:
1 - service seat; 2 - folding table; 3 - shoulder support; 4 - monitor; 5 - speaker; 6 - microphone; 7 - traffic controller emergency communication button; 8 - interior panels; 9 – cable rescue gear (CRG) bracket; 10 - door; 11 - glazing; 12 - refrigerator; 13 - VIP passenger seat; 14 - armrest; 15 - CRG; 16 - fire extinguisher; 17 – fairing

The Unicar passenger module is a framed, all-welded, carriage-type, bearing module with sandwich panels, thermal and noise insulation, two doorways and windows made of tempered heat-reflecting glass. Internal plating is made of composite materials (fiberglass).).

The load-bearing frame consists of a welded frame, a sandwich floor and a sandwich roof. The frame provides for connecting places to the traction module and other systems installation.

The roof, like the floor, is made as a three-layer sandwich panel.

The frame consists of rectangular shaped tubes.

Double-glazed windows made of tempered low-emission glass are glued between the vertical pillars of the frame, the floor and the roof.

The fairing of the Unicar passenger module is a fiberglass panel with a frame, additionally reinforced with a stiffener and covered with soundproofing 3 (Fig. 10) on the inside. There is an access cover of the fairing 6 for servicing the equipment located in the under-the-hood space.

The inside plating of the passenger module is made of high-quality non-flammable composite materials and fabrics.

In the future, the Unicar, which is distinguished by its capacity, comfort and traffic safety, can become an ideal replacement for personal transport.

ИТ

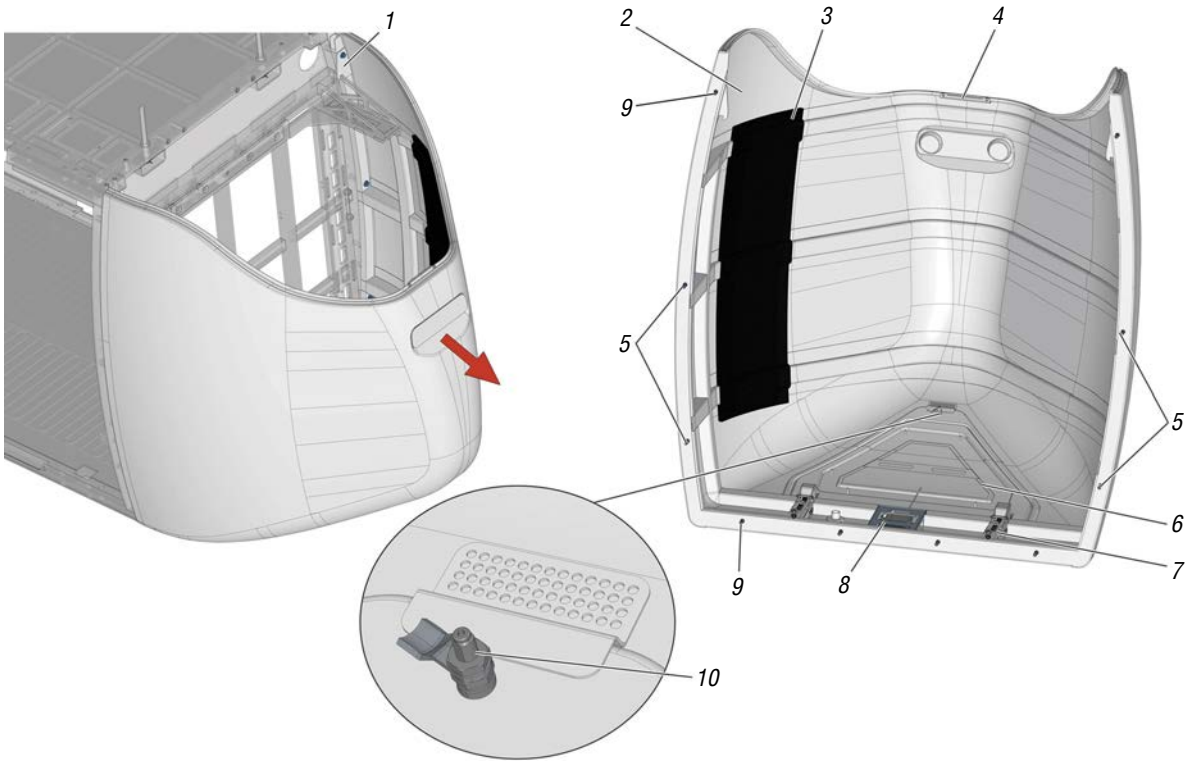


Fig. 10. Fairing of the Unicar passenger module:
: 1 - plate; 2 - fairing; 3 – soundproofing; 4 - lock; 5 - guide pin; 6 - fairing access cover; 7 - loop; 8 - energy storage charging access hole; 9 - screw; 10 - lock

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