

(19)



(11)

EP 4 067 807 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

05.10.2022 Bulletin 2022/40

(51) International Patent Classification (IPC):

F41H 7/04 ^(2006.01) **B62D 23/00** ^(2006.01)
B60R 21/13 ^(2006.01)

(21) Application number: **21172918.1**

(52) Cooperative Patent Classification (CPC):

(22) Date of filing: **09.05.2021**

F41H 7/044

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

KH MA MD TN

(71) Applicant: **I.A.S. S.r.l.**

30037 Scorze' (VE) (IT)

(72) Inventors:

• **Di Marco, Settimio**

00142 Roma (IT)

• **Caioli, Paolo**

00060 Riano (RM) (IT)

(30) Priority: **31.03.2021 IT 202100007928**

(74) Representative: **Leganza, Alessandro**

Via Sottopasso, 14

36040 Torri di Quartesolo (VI) (IT)

(54) **ARMoured LAND VEHICLE**

(57) The object of the invention is an armoured land vehicle (1) with increased torsional and flexural resistance of the structure, and with increased ballistic resistance thanks to the combination of the monocoque with

a particular type of roll-bar wherein a plurality of bars are arranged, as well as vertically, also longitudinally with respect to the vehicle, both on the side and in the lower part.

EP 4 067 807 A1

Description

Technical field

[0001] The present invention relates to the field of armoured land vehicles, in particular of armoured vehicles for both military and civil uses.

Background of the invention

[0002] Armoured vehicles are often used for the transport, including the transport of personnel, such as military personnel, in hostile places or for the transport of people whose fame and prestige exposes them to possible personal attacks by delinquent. Armoured vehicles are equipped with armour to protect vehicle occupants from threats such as gunfire and explosions. Protection from land mines and so-called improvised explosive devices (IEDs) is typically provided by a bottom plate (belly armour), designed to have substantial resistance against explosions. The bottom plate is typically a heavy metal plate, sometimes a multilayer plate, sometimes incorporating additional layers of metal, ceramic, composite and/or plastic material.

[0003] For example, the detonation of an IED under an armoured land vehicle can cause the acceleration of the vehicle's bottom plate or floor. Locally, the bottom plate can achieve accelerations higher than 50,000 G and speeds of hundreds of m/s and globally, when the local impulse is transferred to the rest of the structure such as vehicle walls and ceiling, these parts of the structure can reach speeds of the order of 10 m/s, if they undergo accelerations higher than 100 G, for example, of the order of 300-400 G.

[0004] That is, in addition to the risk of damages and cracks represented by a deformation of the bottom plate, the detonation of a mine or an IED can also produce a substantial acceleration of the structure or a portion of the vehicle structure, such as the structure wherein the bottom plate is attached, including, for example, the vehicle's walls and ceiling and/or a vehicle interior floor. Though, the total movement of the vehicle, for example, in the vertical direction, is not very high, for example, due to the weight of the vehicle, the acceleration can be very high. This means that personnel inside the vehicle can be subjected to forces corresponding to accelerations in the order of many G, such as 100-500 G, for short periods of time such as 10 ms.

[0005] To reduce the acceleration of parts of the bottom plate and the vehicle structure, it is possible to further reinforce the bottom plate and/or make the bottom plate and/or the whole vehicle heavier, but this involves other substantial drawbacks, such as the need for more powerful engines, higher fuel consumption and reduced mobility, especially on difficult terrain. Therefore, practically, substantial accelerations of the bottom plate or portions thereof, and a substantial acceleration of the general structure of the vehicle connected to the bottom plate

cannot be avoided. Acceleration of the structure of an armoured vehicle following the explosion of a mine or IED under the vehicle can cause injuries or death to occupants in contact with the structure, as well as to accelerate objects in contact with the structure, such as lying down on the floor of the structure, whereby these objects can collide with the occupants at high speed, causing injuries or victims.

[0006] The classic embodiment of armoured land vehicles provides a frame on which the chassis is mounted. This solution, the most used until now, allows an exceptional ease of configuration of the vehicle, since a specific frame is associated, different "bodies of the car" or rather different chassis based on the intended use and customization required. However, the present embodiment does not provide sufficient protection to the vehicle occupants since the armoured vehicle has limited ballistic resistance features. Furthermore, this is particularly evident in the case of detonation of a mine or an IED or even in the case wherein the vehicle is hit from the side by large-calibre bullets, bombs, bazooka rockets, etc. The land armoured vehicles known today, as they are structurally constituted, they offer a limited resistance to this type of explosions, that is, a limited ballistic resistance, both they occur below and to the side of the armoured land vehicle.

[0007] Furthermore, since the armoured vehicles are essentially composed of steel, a heavier but above all more rigid structure is generally obtained; therefore, it often happens that armoured vehicles suffer from a lower torsional and flexural resistance compared to a classic vehicle, made of aluminum, which however has a very limited ballistic resistance, that is, to the explosion. Therefore, it often happens that vehicles using ballistic steel suffer from fractures after even short periods of use.

Summary of the invention

[0008] The present invention relates to an armoured land vehicle (1) whose structure allows to solve the aforementioned problems highlighted in the state of the art allowing to have a vehicle that combines both high flexural and torsional resistance and ballistic resistance so as to provide advantages both in terms of mobility and, contextually, of protection and contextually solving the disadvantages mentioned above with reference to the state of the art.

[0009] The problem addressed by the present invention is therefore that of providing an armoured land vehicle (1) with improved resistance to torsional and bending stresses, up to over 65% and, at the same time, an improved ballistic resistance (to bullets and explosions in general) up to over than 35%, compared to the armoured land vehicles known today.

[0010] An object of the present invention is therefore an armoured land vehicle (1) comprising:

- a frame,
- a monocoque (2),

- a roll-bar (3) comprising:
 - a plurality of bars arranged longitudinally on the sides (4) and on the lower part (5) with respect to the vehicle and
 - a plurality of bars (6) arranged vertically with respect to the vehicle.

[0011] It has in fact been found that through the use of a roll-bar system integrated into the vehicle's chassis, a completely new structure is obtained, called "Monocoque on Frame" able to resist torsional and flexural stresses of over 65%; moreover, the roll-bar systems allow a distribution of stresses over the entire surface, thus allowing the structure to have an increase in ballistic resistance (bullets and explosions) of over 35%. Classic vehicles are made with frame structures or monocoque. The invention in question introduces for the first time a solution (Monocoque on Frame - IAS RMB System) which has been shown to allow improvements in terms of performance as highlighted above.

[0012] Further features and advantages of the armoured land vehicle (1) will result from the set of claims the definition of which forms an integral part of the present description.

Brief description of the drawings

[0013]

Fig. 1 shows a front perpendicular section of the armoured land vehicle (1) of the invention wherein the elements included in the roll-bar (3) are shown, in particular the plurality of bars arranged longitudinally on the sides (4) and on the lower part (5) with respect to the vehicle (both in section; they appear as circles) and the plurality of bars (6) arranged vertically with respect to the vehicle.

FIG. 2 shows a detail of the bars forming part of the roll-bar (3).

Detailed description of the invention

[0014] For the purposes of the description of this document, the terms "side", "below", "upper", "lower", "right", "left", "rear", "front", "vertical", "horizontal", "longitudinal" and related derivatives refer to the oriented concepts in Fig. 1.

[0015] However, it should be understood that concepts can take various alternative orientations, except where expressly specified otherwise.

[0016] As used herein, the term "and / or", when used in a listing of two or more items, means that any of the items listed can be used alone, or in any combination of two or more of the items listed.

[0017] For example, whether a combination is described as containing components A, B and/or C, the combination can only contain A; only B; only C; A and B

in combination; A and C in combination; B and C in combination; or A, B and C in combination.

[0018] The terms "comprise", "comprising" or any other variation thereof, mean to cover a non-exclusive inclusion, such that a vehicle, use, or apparatus which includes a list of elements does not include only those elements but can include other items not expressly listed or regarding such vehicle or apparatus or use.

[0019] An element followed by "comprises... a..." does not prevent, without further constraints, the existence of further identical elements in the process, use or apparatus comprising the element.

[0020] An object of the present invention is an armoured land vehicle (1) comprising:

- a frame,
- a monocoque (2),
- a roll-bar (3) comprising:
 - a plurality of bars arranged longitudinally on the sides (4) and on the lower part (5) with respect to the vehicle and
 - a plurality of bars (6) arranged vertically with respect to the vehicle.

[0021] It has indeed been surprisingly found that said armoured land vehicle (1), not only allows to increase the torsional and flexural resistance of the structure, up to over 65%, but also, contextually, to allocate the shock waves due to impact or explosion on the entire surface provide important improvement in ballistic resistance (bullets and explosions) up to over 35%, compared to the armoured land vehicles known today.

[0022] The roll-bar (3) combined with the monocoque structure (2) allows a sort of "strain distribution system" that helps the calibrated diffusion of the strains and the ability to accumulate and absorb impact energy. Actually, reacting as an energy distribution grid over the entire surface of the monocoque (See FIG. 1)

[0023] The concept of a Monocoque chassis installed on a separated frame therefore leads to the following benefits:

- Very high ballistic protection of the structure. The two-stage "V-HULL" protection provides an integrated part on the frame and one on the chassis, increasing the total resistance level. Indeed, with this system it is possible to sacrifice the components of the transmission and suspension in an attack, while maintaining the safety of the crew;
- Greater lightness with the same resistance;
- Greater versatility of the vehicle;
- Better handling on off-road vehicles due to the lower weight with the same ballistic required protection;
- Lower design and production costs compared to the classic monocoque concept;
- Shorter set-up times when the chassis has to be applied to frames of different suppliers;
- Reduction of maintenance costs due to the greater

ease of access to the various parts of the vehicle;

- Greater ease of repair of the chassis thanks to the preconfigured KITS with consequent reduction of costs.

[0024] Possibility of replacing the monocoque for different uses.

[0025] It has in fact been experimentally demonstrated by simulation that the results show an increase in performance compared to the classic monocoque solution summarized as follows (with the same weight and type of used ballistic steel):

- about 68% increase in torsional resistance of the structure,
- about 54% increase in the flexural resistance of the structure,
- 35% increase in the shock wave (explosion) absorption capacity - mainly due to the ability to distribute the strength applied over the entire structure of the vehicle-cell of the invention.

[0026] The roll-bar (3) is made of high-resistance steel integrated into the structure itself. An integral shell is created with both torsional and flexural resistance of 65% higher than the best of classic solutions. Ability to resist the pressure waves of explosions higher than 35% compared to a normal chassis, this is due to the ability to redistribute all the strain stresses to the entire body structure, avoiding concentrating them on a single stress point (impact/ explosion) and on the anchoring supports to the chassis.

[0027] The vehicle's chassis becomes a highly resistant "single cell". To achieve this result, the structure of the body of the car provides for the design of all the parts considered a single set of surfaces without solution of continuity. This conceptualization ensures that every single square centimetre of the body of the car takes part in the robustness and, especially, in the absorption of energy in the event of impact from both a bullet and an accident.

[0028] The term armoured land vehicle (1) comprises troop transport vehicles, generally referred to as APC (Armoured Personnel Carrier) or Armoured Logistic Utility Vehicle (logistic support vehicle) or Armoured Ambulance (armoured ambulance), armoured patrol vehicles and in any case armoured vehicles for specific military or police use (riot control, SWAT ...)

[0029] The term frame means the load-bearing structure of the various parts that make up the vehicle, typically consisting of a set of metal axles suitable for creating a more or less flat structure on which the chassis or monocoque is positioned and on which all the other characteristic components are mounted, such as, for example, the wheels.

[0030] The term a monocoque (2) means load-bearing structure of a vehicle made up of a monolithic element.

[0031] The term roll-bar (3) means torsional bar.

[0032] Plurality of bars (6) arranged vertically with respect to the vehicle, it means at least 2 bars (6), preferably from 2 to 20 vertical bars (6). The term vertical means that the bars (6) are arranged in the direction from the lower to the upper part of the vehicle (1).

[0033] Plurality of bars arranged longitudinally on the sides (4) with respect to the vehicle, it means at least 2 bars (4) arranged on each side of the vehicle. The longitudinal term indicates that the bars (4) are arranged along the length of the vehicle and in parallel to the ground. The term side of the vehicle means, with reference to Fig. 1, the right or left side of the vehicle with respect to the vehicle's vertical symmetry axis.

[0034] Plurality of bars arranged longitudinally on the lower part (5) with respect to the vehicle, it means at least 2 bars (5) arranged on the lower part with respect to the vehicle on each side. The same definitions given above apply to the terms longitudinal and side.

[0035] According to a preferred embodiment, the terminology "on the lower part with respect to the vehicle" is intended to refer to the underside of the lower part of the monocoque (2); with reference to Fig. 1 concerning orientations.

[0036] In the armoured land vehicle (1) the roll-bar (3) is therefore integrated into the monocoque (2).

[0037] Therefore, in the armoured land vehicle (1) the bars (4) arranged longitudinally on the sides with respect to the vehicle and/or the bars arranged longitudinally on the lower part (5) with respect to the vehicle are an integral part of the monocoque (2).

[0038] According to a preferred embodiment, in the armoured land vehicle (1) the bars (4) arranged longitudinally on the sides with respect to the vehicle are placed on the internal side to the vehicle of the monocoque (2). The internal side means the side of the passenger compartment of the vehicle.

[0039] In the armoured land vehicle (1) the bars (4) arranged longitudinally on the sides with respect to the vehicle are at least 2 for each side of the vehicle.

[0040] According to a preferred embodiment, in the armoured land vehicle (1) the bars (5) arranged longitudinally on the lower part with respect to the vehicle are placed on the external side to the vehicle of the monocoque (2). The external side to the vehicle of the monocoque means the side of the monocoque that appears the outside of the vehicle.

[0041] In the armoured land vehicle (1) the bars (5) arranged longitudinally on the lower part with respect to the vehicle are at least 2 for each side of the vehicle.

[0042] According to a preferred embodiment, in the armoured land vehicle (1) the bars (4) arranged longitudinally on the sides with respect to the vehicle and/or the bars (5) arranged longitudinally on the lower part with respect to the vehicle have a diameter comprised between 20% and 90% compared to the diameter of the bar having a greater diameter than the plurality of bars respectively arranged longitudinally on the sides (4) and on the lower part (5) with respect to the vehicle.

[0043] According to a more preferred embodiment, in the armoured land vehicle (1) the bars (4) arranged longitudinally on the sides with respect to the vehicle are in number comprised between 3 and 7 for each side of the vehicle and have a diameter comprised between 20% and 90% compared to the diameter of the bar having a greater diameter than the plurality of bars arranged longitudinally on the sides (4) with respect to the vehicle.

[0044] According to a more preferred embodiment, in the armoured land vehicle (1) the bars (5) arranged longitudinally on the lower part with respect to the vehicle are in number comprised between 5 and 9 for each side of the vehicle and have a diameter comprised between 20% and 90% compared to the diameter of the bar having a greater diameter than the plurality of bars arranged longitudinally on the lower part (5) with respect to the vehicle.

[0045] The person in the field, taking into account the above teachings, enriched by Fig. 1, will be able to easily realize the vehicle of the invention, achieving the effects in terms of improved flexibility, torsionality and contextual ballistic resistance described above.

Claims

1. Armoured land vehicle (1) comprising:

- a frame,
- a monocoque (2),
- a roll-bar (3) comprising:
 - a plurality of bars (6) arranged vertically with respect to the vehicle and
 - a plurality of bars arranged longitudinally on the sides (4) and on the lower part (5) with respect to the vehicle.

2. Armoured land vehicle (1) according to claim 1, wherein the roll-bar (3) is integrated into the monocoque (2).

3. Armoured land vehicle (1) according to any one of claims 1 to 2, wherein the bars (4) arranged longitudinally on the sides with respect to the vehicle and/or the bars arranged longitudinally on the lower part (5) with respect to the vehicle are an integral part of the monocoque (2).

4. Armoured land vehicle (1) according to any one of claims 1 to 3, wherein the bars (4) arranged longitudinally on the sides with respect to the vehicle are placed on the internal side to the vehicle of the monocoque (2).

5. Armoured land vehicle (1) according to any one of claims 1 to 4, wherein the bars (4) arranged longitudinally on the sides with respect to the vehicle are

at least 2 for each side of the vehicle.

6. Armoured land vehicle (1) according to any one of claims 1 to 5, wherein the bars (5) arranged longitudinally on the lower part with respect to the vehicle are placed on the external side to the vehicle of the monocoque (2).

7. Armoured land vehicle (1) according to any one of claims 1 to 6, wherein the bars (5) arranged longitudinally on the lower part with respect to the vehicle are at least 2 for each side of the vehicle.

8. Armoured land vehicle (1) according to any of claims 1 to 7, wherein the bars (4) arranged longitudinally on the sides with respect to the vehicle and/or the bars (5) arranged longitudinally on the lower part with respect to the vehicle have a diameter comprised between 20% and 90% compared to the diameter of the bar having a greater diameter than the plurality of bars respectively arranged longitudinally on the sides (4) and on the lower part (5) with respect to the vehicle.

9. Armoured land vehicle (1) according to any one of claims 1 to 8, wherein the bars (4) arranged longitudinally on the sides with respect to the vehicle are in number comprised between 3 and 7 for each side of the vehicle and have a diameter comprised between 20% and 90% compared to the diameter of the bar having a greater diameter than the plurality of bars arranged longitudinally on the sides (4) with respect to the vehicle.

10. Armoured land vehicle (1) according to any one of claims 1 to 9, wherein the bars (5) arranged longitudinally on the lower part with respect to the vehicle are in number comprised between 5 and 9 for each side of the vehicle and have a diameter included comprised between 20% and 90% compared to the diameter of the bar having a greater diameter than the plurality of bars arranged longitudinally on the lower part (5) with respect to the vehicle.

Fig.1

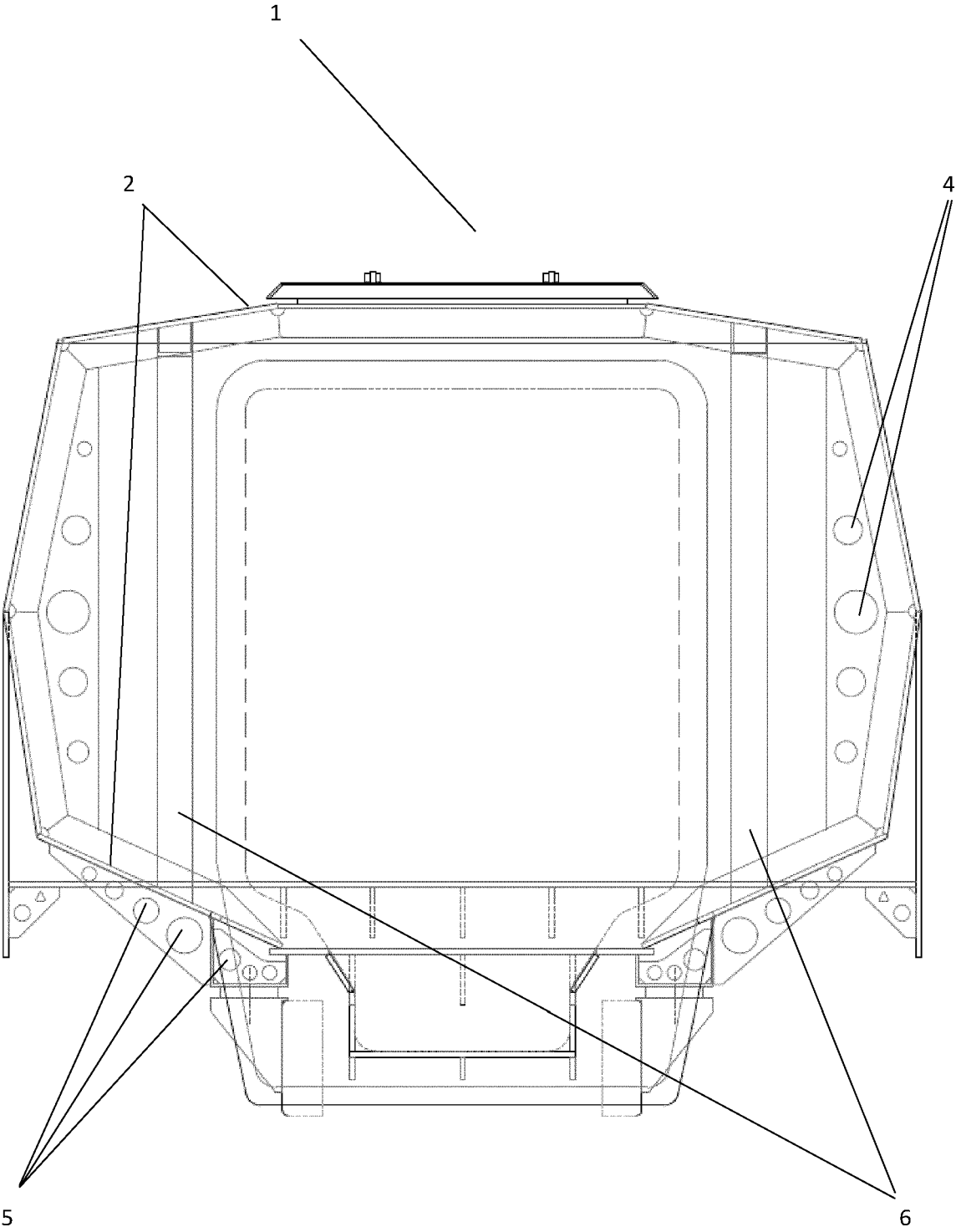
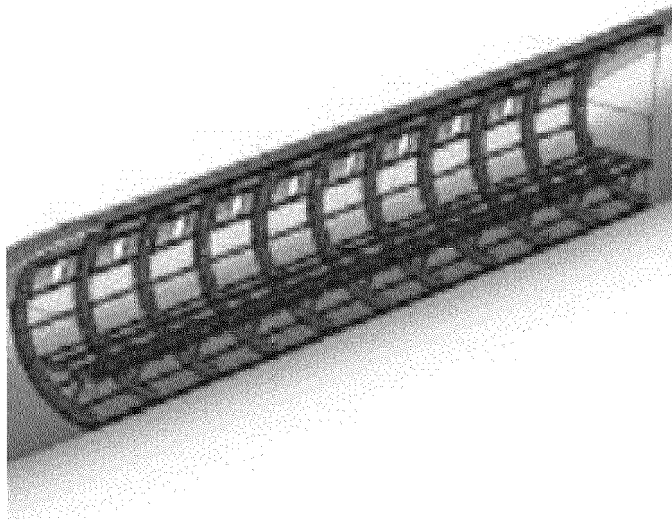


Fig. 2



P.I. : I.A.S. S.r.l.



EUROPEAN SEARCH REPORT

Application Number
EP 21 17 2918

5

10

15

20

25

30

35

40

45

50

55

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	US 2011/314999 A1 (LUTHER REGIS [US] ET AL) 29 December 2011 (2011-12-29) * paragraph [0015]; figures 5,15,14,14A *	1-4,6,8-10	INV. F41H7/04 B62D23/00 B60R21/13
X	DE 78 14 554 U1 (BEYER) 30 April 1981 (1981-04-30) * figure 1 *	1-5,8-10	
X	FR 2 831 511 A1 (RENAULT VEHICULES IND [FR]) 2 May 2003 (2003-05-02) * page 1, lines 1-15; figures 1,6 *	1-5,7-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			F41H B62D B60R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 5 October 2021	Examiner Lahousse, Alexandre
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 17 2918

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-10-2021

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011314999 A1	29-12-2011	CA 2741237 A1	23-12-2011
		GB 2481489 A	28-12-2011
		GB 2487486 A	25-07-2012
		GB 2487487 A	25-07-2012
		GB 2487488 A	25-07-2012
		US 2011314999 A1	29-12-2011
		ZA 201104049 B	29-02-2012

DE 7814554 U1	30-04-1981	NONE	

FR 2831511 A1	02-05-2003	NONE	
