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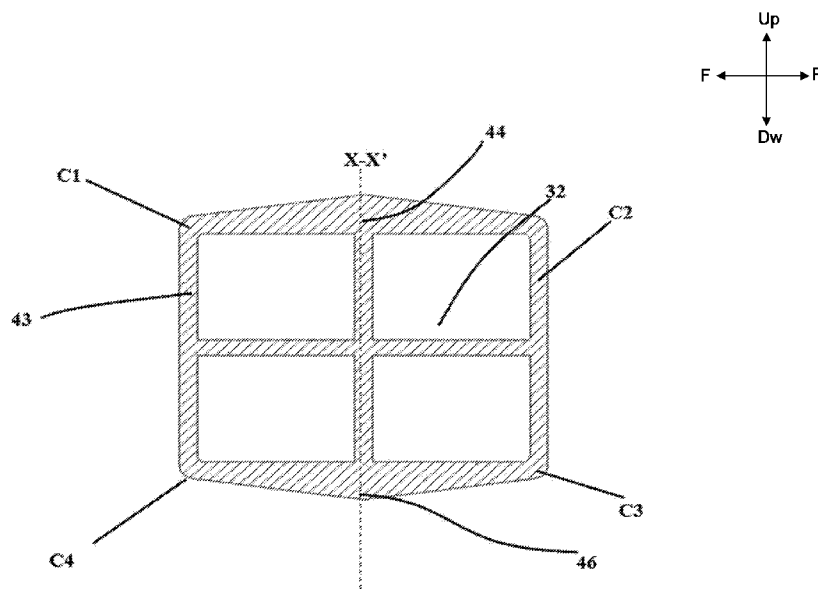


Fig. 3

(57) Abstract: The present invention relates to a frame structure (1) for a two-wheeled vehicle (10). Generally frame structures made of composite materials, i.e. carbon and fiber are weak at corners due to accumulation of resin. The present subject matter provides a frame structure (1) which has a plurality of draft hinges (44, 46) away from the corner locations to provide an adequate strength to the frame structure.



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FRAME STRUCTURE FOR A TWO-WHEELED VEHICLE

FIELD OF INVENTION

[0001] The present invention relates to a frame structure for a two-wheeled vehicle and more particularly to a two wheeler frame structure manufactured using composite materials.

5

BACKGROUND OF INVENTION

[0002] Generally, a frame structure acts as a skeleton for a vehicle supporting vehicle loads. A front wheel and a rear wheel of the vehicle are also mounted to the frame structure. The front wheel is rotatably connected to the frame structure through one or more front suspension(s), whereas the rear wheel is connected to it through one or more rear suspension(s). The engine is functionally connected to the rear wheel, which provides a forward motion to the vehicle. Typically, plurality of panels is mounted to the frame assembly of the vehicle which covers various vehicle components. The vehicle components include electrical and electronic components including an electric starter system, headlamp, side lamps etc.

[0003] A typical two-wheeled scooter or a motorcycle frame structure is made of tubular or sheet metal structure. Such a frame structure uses additional brackets and cross members at various locations either for stiffening purposes or mounting any additional parts on the vehicle. In addition to it, a frame structure made of metal structure is very heavy, and as the load capacity of the frame structure increases so does its weight. Over the recent decade, there has been a move towards greater use of composite materials in the vehicular frame structure and to replace the conventional metallic frames. Such a change is being brought upon with an aim of reducing the overall weight of the vehicle which results in various enhanced features such as improved fuel economy, less requirement of power by the vehicle. The ratio of load carrying capacity and weight of the frame structure is much better for a composite material as compared to one made of metal structure. Commonly used composite

materials include fiber reinforced polymer laminates such as carbon fiber reinforced polymers.

5 [0004] Conventional composite structures which use resin reinforced with high-strength fibers are likely to be weaker along the corners. The prime reason for this being is the high concentration of brittle resin along the corners. Thus, in case of a high pressure situation the chances of failure of the frame structure along the corners is more. Furthermore, there exists a high possibility of failure along the corners to propagate to the inner structure causing failure of the whole structure.

10 [0005] Hence, there is a need for optimizing the design for the composite structures for providing a better structural rigidity to the composite structure and to the frame structure as whole.

BRIEF DESCRIPTION OF DRAWINGS

15 [0006] The detailed description of the present subject matter is described with reference to the accompanying figures. Same numbers are used throughout the drawings to reference like features and components.

[0007] Figure 1 illustrates a side view of an exemplary vehicle, in accordance with an embodiment of the present subject matter.

20 [0008] Figure 2 illustrates a perspective view of a frame structure of the exemplary two-wheeled vehicle as shown in Fig. 1, in accordance with an embodiment of the present subject matter.

[0009] Figure 3 illustrates cross section of a structural component of the frame structure, in accordance with an embodiment of the present subject matter.

25 [00010] Figure 4(1) illustrates a cross sectional view of the arrangement of draft hinges along the structural component of the frame structure, in accordance with an embodiment of the present subject matter.

[00011] Figure 4(2) illustrates a cross sectional view of a different arrangement of draft hinges along the structural component of the frame structure, in accordance with an embodiment of the present subject matter.

5 [00012] Figure 5 illustrates a cross sectional view of the structural component of the frame structure in accordance with an embodiment of the present subject matter.

DETAILED DESCRIPTION

10 [00013] Conventionally, frame structure of a vehicle acts as a skeleton for supporting the loads. The front wheel and rear wheel of the vehicle are also mounted to the frame structure. The front wheel is rotatably connected to the frame structure through one or more front suspension(s), whereas the rear wheel is connected to it through one or more rear suspension(s). In addition to it the internal combustion engine is also mounted over the frame structure and is functionally connected to the rear wheel to provide a forward motion to the vehicle. Typically, plurality of panels is mounted to the frame structure which covers various vehicle components. Theses vehicle
15 components include electrical and electronic components including an electric starter system, headlamp, side lamps etc.

20 [00014] Typically a two-wheeled scooter or a motorcycle frame structure is made of tubular or sheet metal structure. Such a frame structure uses additional brackets and cross members at various locations either for stiffening purposes or mounting any additional parts on the vehicle. In addition to it, a frame structure made of metal structure is very heavy, and as the load capacity of the frame structure increases so does its weight. Over recent decade there has been a move towards greater use of composite materials in the vehicular frame structure and replace the conventional metallic frames. Such a change is being brought upon with an aim of reducing the overall weight of the
25 vehicle which results in various enhanced features such as improved the fuel economy, less requirement of power by the vehicle. The ratio load carrying capacity and weight of the frame structure is much better for a composite material as compared to one made of metal structure.

[00015] A composite structure is an extremely strong and light fiber-reinforced plastic which contains carbon fibers. The binding polymer is often a thermoset resin such as epoxy, but sometimes other thermoset or thermoplastic polymers, such as polyester, vinyl ester or nylon, are also used. The composite may also contain other
5 fibers, such as aluminum, ultra high molecular weight polyethylene (UHMWPE) or glass fibers, as well as carbon fiber.

[00016] However, there have been instances when a failure has been reported even for the composite structures used. The prime reason for such failures has been the weakness of the structure at its corners. In case of application of high pressure and loads
10 the corners of the composite structure breaks and soon the failure propagates to the whole structure resulting in its failure as well. Conventionally composite structures are made by a molding process in which a bottom plate method is used. In such a press when the molten composite material is pressed by an upper mold plate the fiber is not able to take shape of the corners and only resins fills up in those places. Such an
15 accumulation at the corners is of resin which also creates a draft hinge at the corners, resulting in reduced strength at the corners and increasing the probability of failures.

[00017] Hence, an objective of the present subject matter is to provide an optimized design for the composite structures for providing a better structural rigidity to the composite structure and to the frame structure as whole. According to one aspect of
20 the present subject matter, the frame structure of the vehicle should be strong with a better load carrying capacity, which is not weak at the corners.

[00018] According to additional aspect, the accumulation of resin and draft hinge at the corners of the composite structure is to be eliminated.

[00019] In an embodiment, a vehicle comprises of a frame structure which acts as a
25 skeleton for the whole vehicle body. For the purposes of the present subject matter, the frame structure is made of composite materials and not metal sheets or structure. The prime reason for this is to decrease the vehicle weight, improve the ratio of weight of frame structure and load carrying capacity, and improve the performance of the vehicle

which included better power, better fuel economy etc. However, for the purposes of the present subject matter the design, structural rigidity, strength and load carrying capacity of the frame structure is to be increased. Draft hinge and accumulation of resin in a composite type frame structure plays an important role and also determines the strength of the frame structure. If the draft hinges are not provided, there is a possibility that the resin will concentrate on the corners. Since resin is brittle, and when frame structure made of resin material, it is bound to crack, which may propagate to the whole frame. Thus, it is the invention to keep draft hinges to reduce the resin concentration.

[00020] Therefore, as per the present subject matter the frame structure is designed to provide the draft hinges at the non-corners, such that the frame structure is strong and not weak at the corners like other known structures.

[00021] In an embodiment, the draft hinge and accumulation of the resin is provided at surface and face of the frame structure and not at the corners. This is because, the corners of the frame structure experience the maximum load and for such cases the composition of the composite structure, i.e. carbon and fiber should be proportionate and optimum to sustain the pressure, not like other known arts where at composition of brittle resin is more at the corners leading to its failure. For such a frame structure a split line is provided either on the centre of the face or anywhere at the surface and not at the corner. A split line defines the small region from where the mould plates can be removed in case of molding of frame structures made of mold structure. Prior to this, the split line used to be at the corner like in the bottom plate method which used to lead to accumulation of resin at the corner, However, as per the present subject matter, the split line is provided at the surface and face of the frame structure such that the accumulation of resin and draft hinge is there itself and not at the corners.

[00022] In addition to it, the present invention discloses the manufacturing of automotive frame structures using fiber which is molded with resins for reinforcement. The frame structure described herein is manufactured using at least a two piece mold. As per the present invention, the frame structure is made of resin reinforced with high-strength fibers. It is manufactured using a two or multi-piece molds. According to one

embodiment of the current invention, the cross section of the frame structure is made out of at least three sides. Moreover, as the number of sides increases in the frame structure, correspondingly the number of corners of the frame structure increases. However more complex cross sectional shapes might increase number of mould pieces required.

5 **[00023]** As described, a split line for a mold is a line across which the mold cavities are segregated. Depending upon the requirement of cross section, a mold in the described frame structure may comprise of a single split line or more than one split line. The split line can either be in a longitudinal or latitudinal direction with respect to the sides of the frame structure. However, as per the present subject matter, the split lines
10 can not be at the corners of the sides, and can only be provided on face or surface of the frame structure. According to the present invention, the split line of the mold is formed after the formation of required corner radius or at middle where a draft hinge is generally placed. As an effect, it reduces the required draft height, which results in optimum resin build up and provides better strength to the fiber component when the
15 member is subjected to torsional stress.

[00024] In addition, the corners of the frame structure are further provided with smooth round profile to provide strength at the corner location which undergoes maximum stress during the torsional load. The rounding of the corners of the fiber component increases the strength to bear the torsional loads. The current invention helps
20 to avoid accumulation of resins in the corner and hence the frame structure achieves higher strength.

[00025] Thus, the present subject matter provides a frame structure made of composite materials having a better design structure leading to enhanced structural rigidity. In furtherance to it, the present subject matter provides a frame structure which
25 is stronger with a better load carrying capacity, and is not weak at the corners. According to additional aspect, the accumulation of resin and draft hinge at the corners of the composite structure is also eliminated.

[00026] The aforesaid and other advantages of the present subject matter would be described in greater detail in conjunction with the figures in the following description.

[00027] Arrows provided in the top right corner of each figure depicts direction with respect to the vehicle, wherein an arrow F denotes front direction, an arrow R indicated R direction, an arrow Up denotes upward direction, an arrow Dw denoted downward direction, an arrow Rh denotes right side, an arrow Lh denoted left side, as and where applicable.

[00028] Fig. 1 illustrates a side view of an exemplary two-wheeled vehicle (10) in accordance with an embodiment of the present subject matter. The vehicle comprises of a frame structure (1) made of carbon fiber and resin material and is conventionally an underbone chassis frame which provides a generally open central area to permit "step-through" mounting by a rider. Typically, the frame structure (1) comprises of a head tube (2), a main tube (3), and a pair of side tube LH (4) and side tube RH (5) (only one shown). The head tube (2) is disposed towards the front portion, wherein the main tube (3) extends downwardly and rearwardly from the head tube (2) forming a flat horizontal step-through portion (3S). The other end of the main tube (3) is connected with the pair of side-tubes (4, 5) through a bracket (not shown).

[00029] The head tube (2) is configured to rotatably support a steering tube (not shown) and further connected to the front suspension system (6) at the lower end. A handlebar support member (not shown) is connected to an upper end of the steering tube (not shown) and supports a handlebar assembly (9). The upper portion of a front wheel (7) is covered by a front fender (8). The pair of side-tubes (4, 5) extend from the other end of the main tube (3) being disposed parallel on either side of the vehicle (10) width direction. Each of the said side tube (4, 5) extends from the main tube (3) in an upward inclined fashion and gradually after a certain length extends rearward in a substantially horizontal and parallel fashion being placed in the vehicle widthwise direction. A plurality of cross pipes (not shown) is secured in between the pair of side-tubes (4, 5) at selected intervals to support vehicular attachments including a utility box (12), a seat

assembly (11) and a fuel tank assembly (not shown). The vehicle furthermore, comprises of a side panel LH (19) and side panel RH (not shown) which covers the side tubes (4, 5) and covers the vehicle (10) structure from the sides.

[00030] Generally, the utility box (12) is supported between the side tube LH (4) and side tube RH (5) so as to be disposed below the seat (11). A fuel tank assembly (not shown) may be disposed on between the rear portions of the pair of the side-tubes (4, 5). The vehicle (10) further comprises of a rear wheel (13) covered by a rear fender (14) with a tail light (15) disposed above it and a support bar (16) place above the tail light (15) at the end of the seat assembly (11). The rear wheel (13) is supported towards the rear side of the main frame (1) by an internal combustion (IC) engine (shown in Fig. 4) which is horizontally coupled swingably to the rear of the frame assembly (1) of the two-wheeled vehicle (10) through a rear suspension system (17). The IC engine (not shown) transfers the drive directly to the rear wheel (13) as it is coupled directly to it through a continuously variable transmission (CVT) system (18). The vehicle further comprises of an air cleaner assembly (shown in Fig. 4) to provide filtered air to the IC engine for combustion.

[00031] Fig. 2 illustrates a perspective view of the frame structure (1) of the exemplary two-wheeled vehicle (10) as illustrated in Fig. 1, in accordance with an embodiment of the present subject matter. The frame structure (1) comprises of head tube (2) placed in a front portion of the vehicle (10), from where the main tube (3) extends in a downward rearwardly fashion. In an embodiment, the side tubes (4, 5) extend in a rearward upward fashion from the step through portion (3S). A floorboard cross tube (22) is provided which supports a floorboard in the step through portion (3S) on which the rider can rest his/her legs. In an embodiment, a cross member (23) is provided between the side tubes (4, 5) to support the utility box. The cross section of the head tube (2) is propagated through all other structural component members namely said floorboard cross tube (22), cross member (23), and side tubes (4, 5). The above structural members namely the head tube (2), main tube (3), floorboard cross tube (22), cross member (23), and side tubes (4, 5) may further comprise an en-molded fastening

component for supporting various other automotive parts. In an embodiment, Fig. 2 further illustrates the head tube (2) and main tube (3) along the central longitudinal axes AA' and BB'. Hereinafter, for the purposes of this application, the invention is explained on basis of one structural component (28), since the frame structure is made by molding different structural components (28) as such and welded together to form a complete frame structure (1). The structural component made (28) of composite materials formed in the head tube (2) and main tube (3) etc. are integrated through out the frame structure (1) providing a standard rigidity to the whole vehicle (10). In an embodiment, the structural component (28) comprises of at least three sides, however for the purpose of this application the invention has been explained through a structural component (28) comprising of four sides.

[00032] Fig. 3 illustrates cross section of the structural component (28) of the exemplary two-wheeled vehicle (10) as shown in Fig. 1, in accordance with an embodiment of the present subject matter. In an embodiment, the cross section illustrates plurality of inner foam members (32) and a split line X-X'. The gap (43) between the foam members (32) is occupied by carbon fiber resin material. A mould cavity used for molding the structural component (28) is wrapped around the split line X-X'. Thus, as resultant the structural component (28) does not comprises of resin built up around the corners and draft hinges (44, 46) are provided on the face of the frame structure at non-corner locations. In an embodiment, the frame structure (1) is describes to be comprising of four corner locations C1, C2, C3 and C4. A first draft hinge (44) and second draft hinge (46) is formed on the frame structure. The pair of draft hinges (44, 46) formed are away from the corners (C1, C2, C3, C4) disposed at center of straight edges on periphery of the structural component (28).

[00033] Fig. 4(1) illustrates a cross sectional view of the arrangement of draft hinges (44, 46) along the structural component (28) of the two-wheeled vehicle (10) as shown in Fig. 1, in accordance with an embodiment of the present subject matter. In an embodiment, the present subject matter illustrates a draft angle (51) and draft height (52) of the structural component (28) of the frame structure (1). As explained above, the draft

hinges (44, 46) are away from the corners (C1, C2, C3, C4) which reduce the draft height (52) and draft angle (51) meaning accumulation of resin at the corner does not exist.

[00034] Fig. 4(2) illustrates a cross sectional view of a different arrangement of draft hinges (44, 46) along the structural component (28) of the two-wheeled vehicle (10) as shown in Fig. 1, in accordance with an embodiment of the present subject matter. In an embodiment, the present subject matter illustrates a draft angle (51) and draft height (52) of the structural component (28) of the frame structure (1). However the split line in this case is not at the centre of the straight edges of the structural component (28) and is offset. As a result, the draft hinges (44, 46) are not at the centre of the straight edges of the frame structure (1), and are formed offset to it. However, still the resin build up is not there at the corners (C1, C2, C3, C4), and draft height (52) and draft angle (51) is less which fulfills the objective of the present subject matter. In an embodiment, the structural component (28) comprises of draft hinges (44, 46) formed at least two of the sides of said structural component (28). However, the draft hinges (44, 46) can be formed at more than two sides also.

[00035] Fig. (5) illustrates a cross sectional view of the structural component (28) surrounded by a set of mould plates (31, 32), in accordance with an embodiment of the present subject matter. In an embodiment, a set of mould plates (31, 32) surrounding a composite structure type structural component (28). The present of set of mould plates (31, 32) help in manufacturing of the structural component (28) as per the present subject matter. The first mould plate (31) and second mould plate (32) are brought closer to each other to obtain a structural component (28) with draft hinges (44, 46) away from the corners (C1, C2, C3, C4), formed at the centre of the straight edges of the structural component (28) of the frame structure (1). However, the draft hinges (44, 46) can be formed on an offset location of the straight edge of the frame structure (1) as well, depending upon the split line X-X'.

[00036] Thus, the present subject matter provides a frame structure for a two-wheeled vehicle with an optimized design and increases strength. The frame structure

made of composite materials comprises of draft hinges formed at non corner locations at the straight edges of the frame structure. Furthermore, the present subject matter also eliminates the accumulation of resin at the corners of the frame structure improving the strength.

- 5 **[00037]** It is to be understood that the aspects of the embodiments are not necessarily limited to the features described herein. Many modifications and variations of the present subject matter are possible in the light of above disclosure. Therefore, within the scope of claims of the present subject matter, the present disclosure may be practiced other than as specifically described.

1. A frame structure (1) for a two-wheeled vehicle (10), said frame structure (1) comprising:
 - a plurality of structural components (28), wherein said plurality of structural components (28) include plurality of foam members (32) accommodated along longitudinal length (AA $\square$, BB $\square$) separated by a gap (43);
 - a plurality of draft hinges (44, 46) provided in said plurality of structural components (28) for eliminating accumulation of resin at corner locations (C1, C2, C3, C4) therein.
2. The frame structure (1) as claimed in claim 1, wherein said gap (43) between said plurality of foam members (32) is filled by a composite structure composition, and wherein said plurality of structural components (28) is strengthened by disposing said plurality of draft hinges (44,46) at non-corner locations (C1, C2, C3, C4) of said plurality of structural components (28).
3. The frame structure (1) as claimed in claim 1, wherein said plurality draft hinges (44, 46) are provided at centre of straight edges on periphery of said plurality of structural components (28).
4. The frame structure (1) as claimed in claim 1, wherein said plurality draft hinges (44, 46) are provided offset to centre of straight edges on periphery of said plurality of structural components (28).
5. The frame structure (1) as claimed in claim 1, wherein said plurality of structural components (28) comprises of a split line (XX $\square$) at which said plurality of draft hinges (44, 46) are formed, and wherein said split line (XX $\square$) passes through centre of straight edges on periphery of said plurality of structural components (28).
6. The frame structure (1) as claimed in claim 1 or 5, wherein said split line (XX $\square$) passes through an offset portion from centre of straight edges on periphery of said plurality of structural components (28).

7. The frame structure (1) as claimed in claim 1, wherein said plurality of structural components (28) comprises of at least three sides, and said plurality of draft hinges (44, 46) are formed on at least two of said at least three sides of said plurality of structural components (28).
8. The frame structure (1) as claimed in claim 1, wherein said plurality of draft hinges (44, 46) have a greater draft angle (51) and a draft height (52) compared to said corner locations (C1, C2, C3, C4) of said plurality of structural components (28).
9. The frame structure (1) as claimed in claim 2, wherein said composite structure composition includes carbon and fiber.
10. A two-wheeled vehicle (10) comprising:
 - a fiber reinforced frame structure (1) used for supporting various automotive parts and load distribution, wherein said frame structure (1) includes a head tube (2) disposed in a front portion of said vehicle (10), at least one main tube (3) extending in a downward rearward direction from said head tube (2), said frame structure (1) also includes a plurality of structural components (28), wherein said plurality of structural components (28) includes plurality of foam members (32) accommodated along longitudinal length (AA', BB') separated by a gap (43), and wherein said plurality of structural components (28) is provided with a plurality of draft hinges (44, 46) for eliminating accumulation of resin at corner locations (C1, C2, C3, C4) therein.

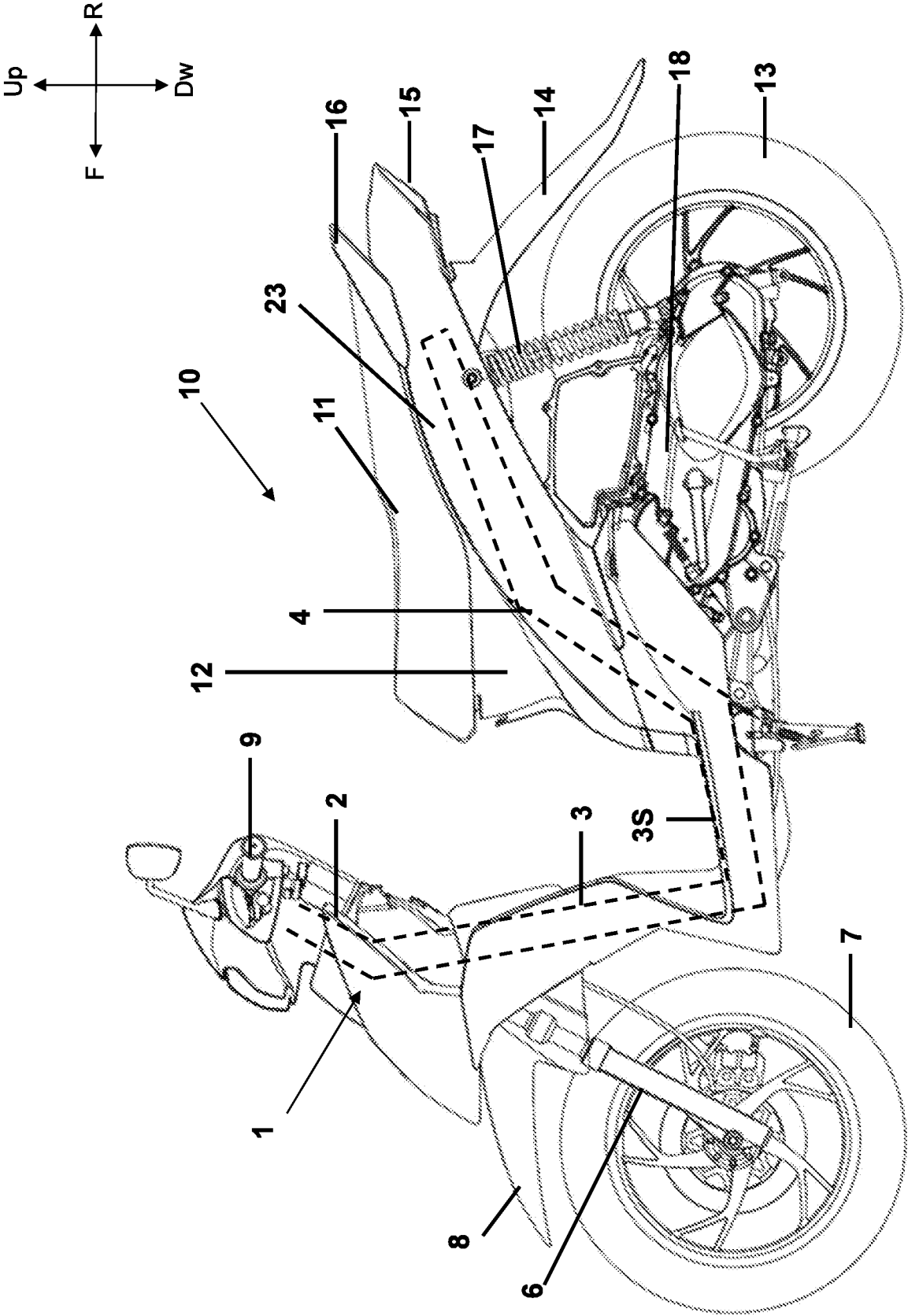


Fig. 1

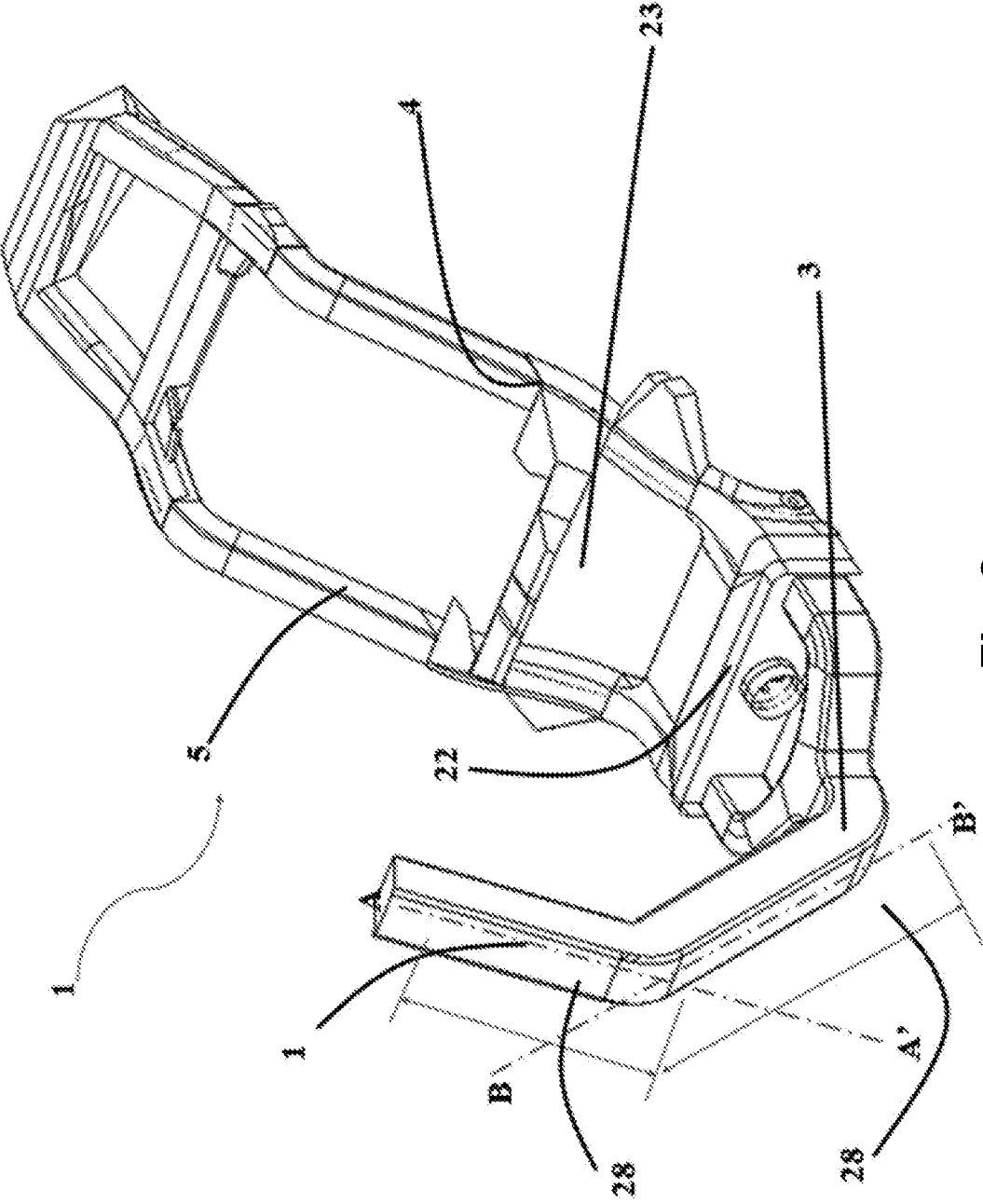
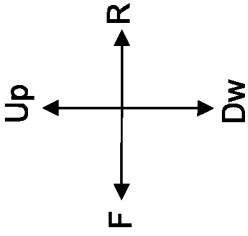


Fig. 2

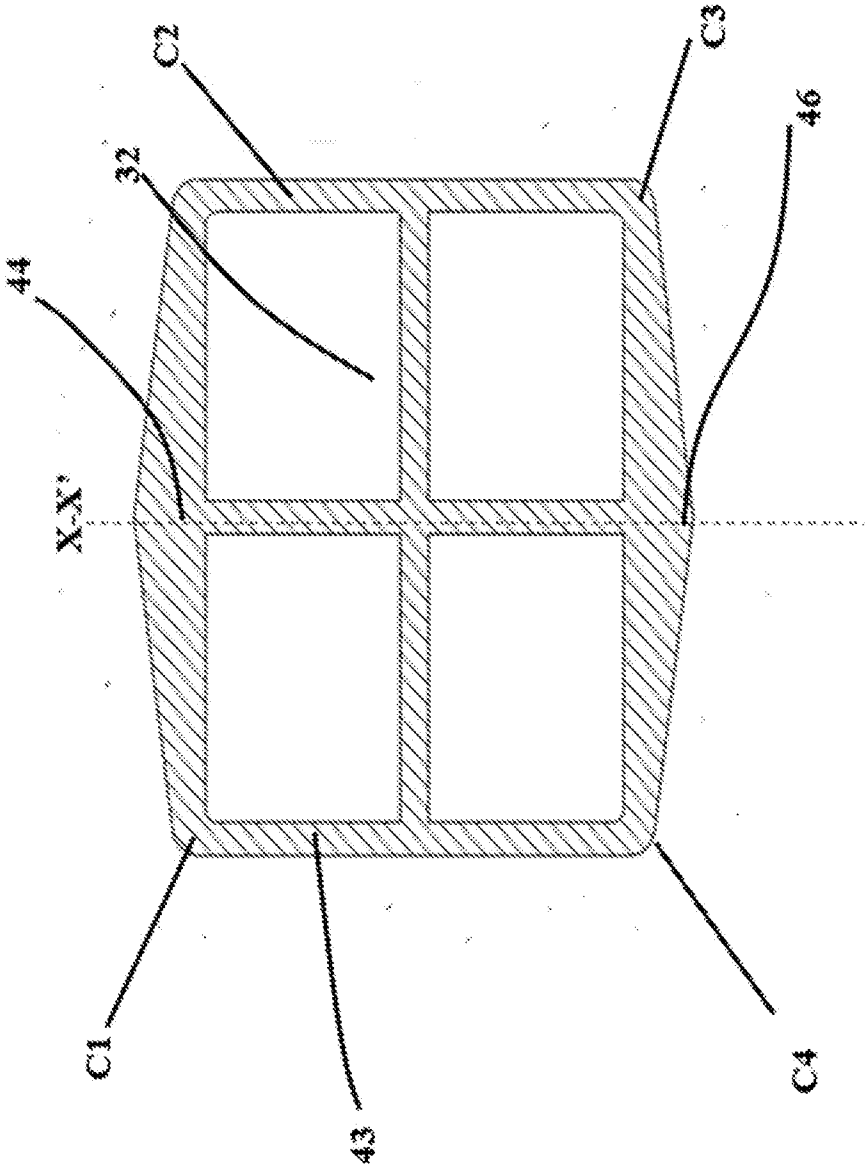
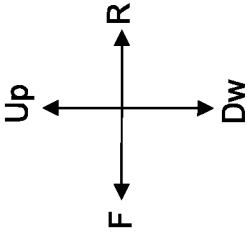


Fig. 3

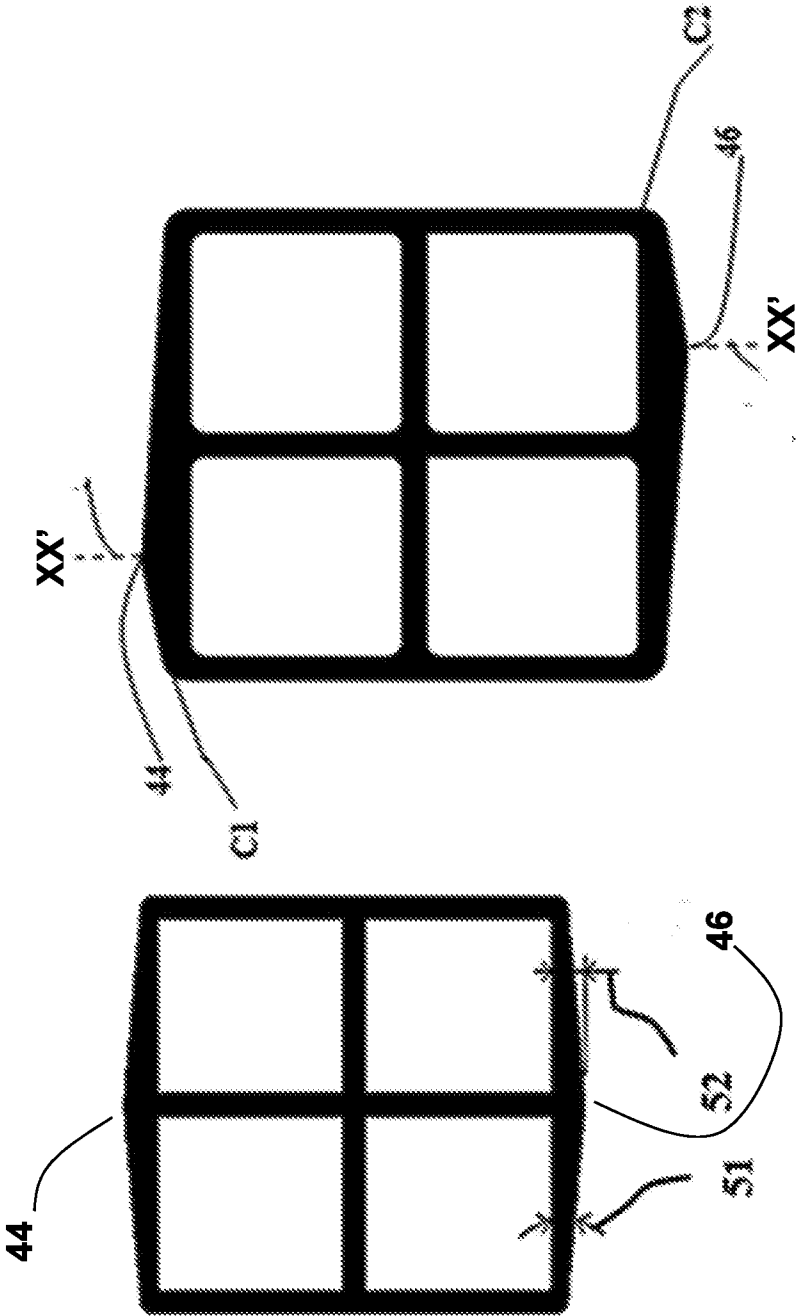
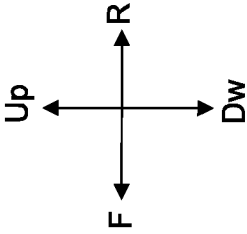


Fig. 4(2)

Fig. 4(1)

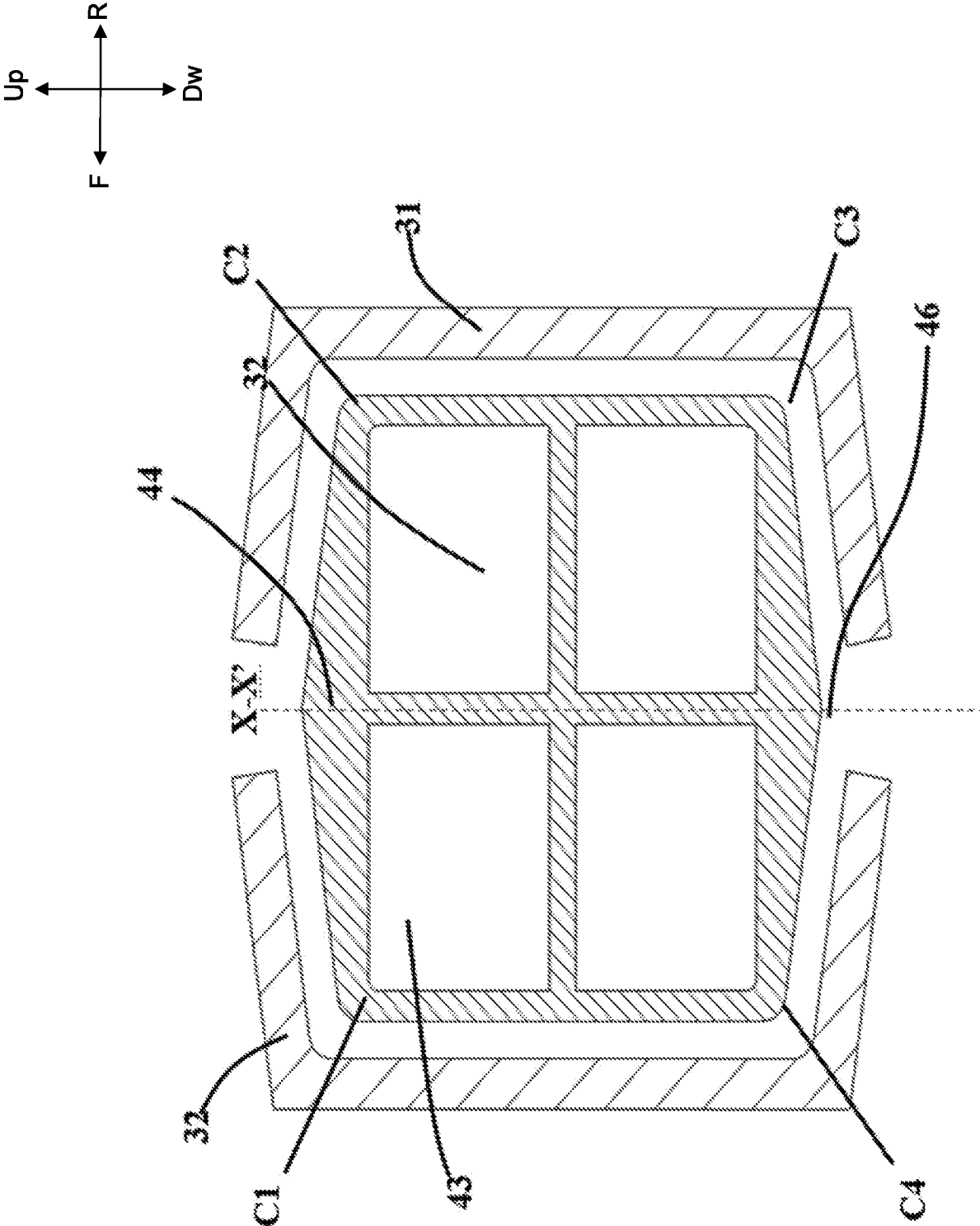


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2017/055474

A. CLASSIFICATION OF SUBJECT MATTER
B62K11/02 Version=2017.01

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)

B62K

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)

Patseer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003/0094067 A1 (SANDPOINT DESIGN, INC.; 22 May 2003) Para. [0008], [0021], [0026], [0039], [0040]; Fig. 4, 7, 10.	1-10
A	EP2530004 A1 (CAMPAGNOLO S.R.L.; 05 Dec 2012) Para. [0023], [0035], [0044]; Fig. 5, 15, 19.	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"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
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