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(54) **ELECTRIC SNOWMOBILE ARCHITECTURE**

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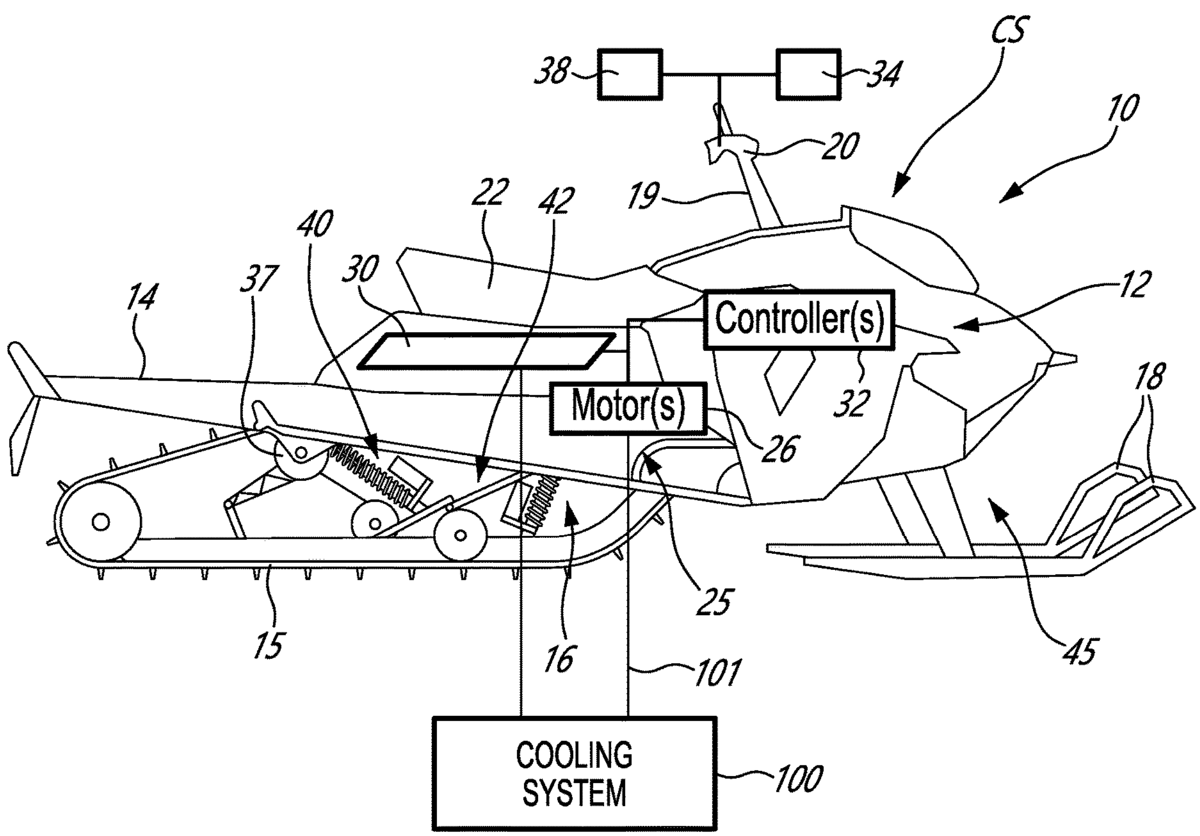
(57) **ABSTRACT**

An electric snowmobile, has: a frame extending along a longitudinal axis between a front end and a rear end, the frame including a tunnel at least partially enclosing a spacing, the tunnel having a top panel; an electric motor mounted to the frame; and a battery pack mounted to the frame and at least partially disposed rearward of the electric motor relative to the longitudinal axis, the battery pack including one or more battery modules operatively connected to the electric motor for supplying electrical energy to the electric motor, and a battery enclosure containing the one or more battery modules, the battery enclosure having a bottom panel supporting the one or more battery modules, the bottom panel of the battery enclosure secured to the top panel of the tunnel at a plurality of securing locations, the bottom panel and the top panel defining a structurally integrated double walled panel.



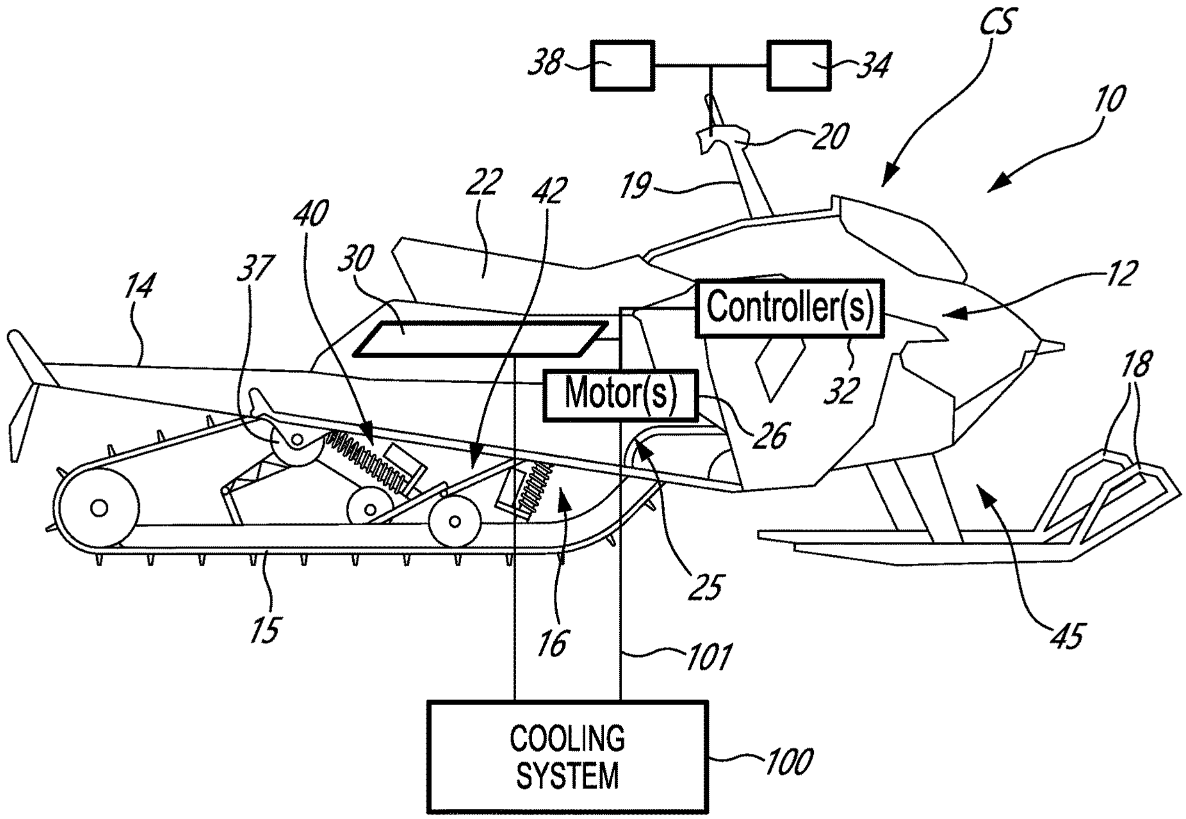

CS
38
34
10
20
19
22
42
40
12
37
30
Controller(s)
14
18
32
Motor(s)
26
25
15
16
101
45
COOLING
SYSTEM
100

FIG. 1

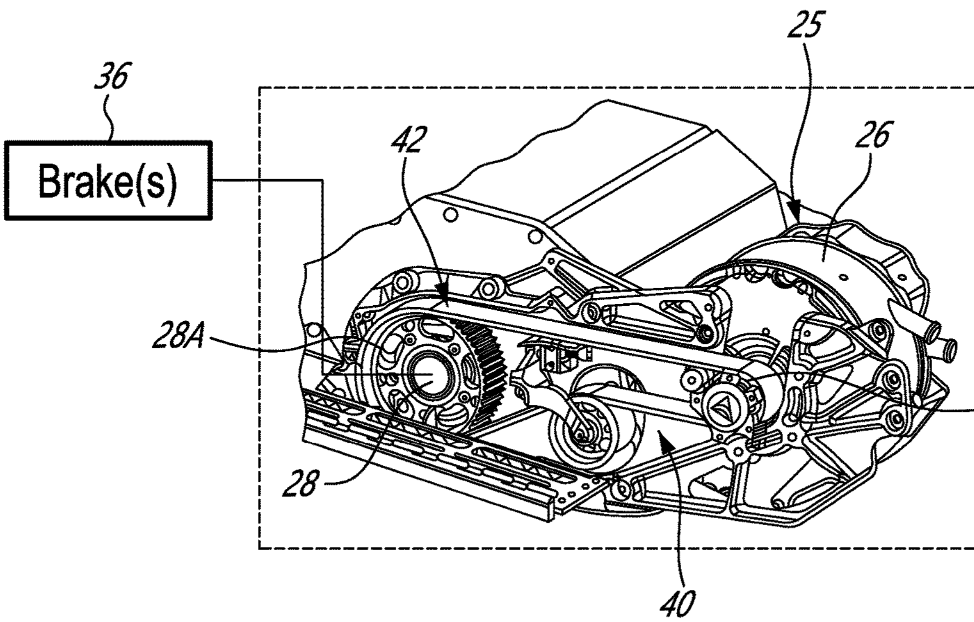

36
25
Brake(s)
42
26
28A
26A
28
40

FIG. 2

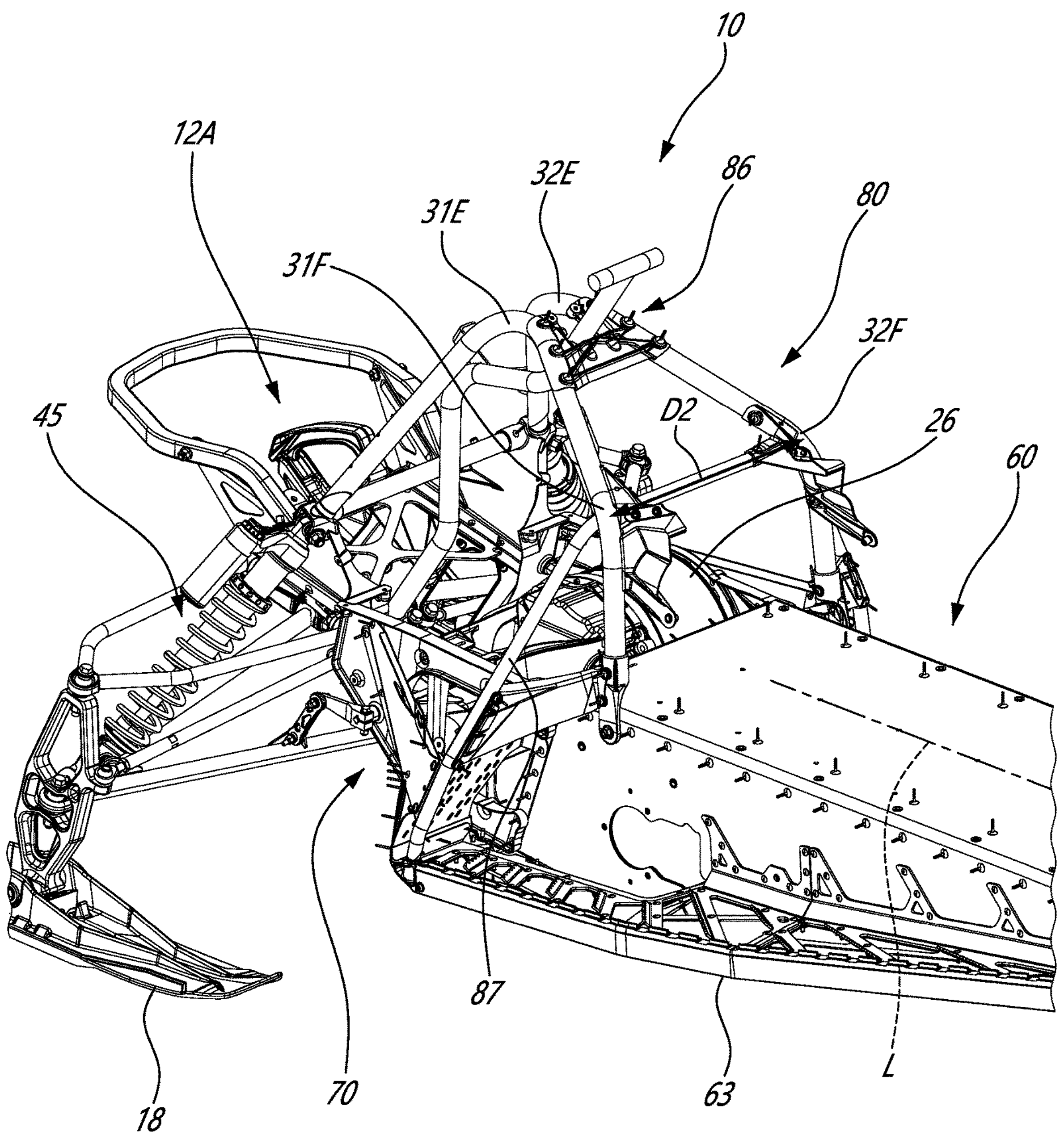


FIG. 3

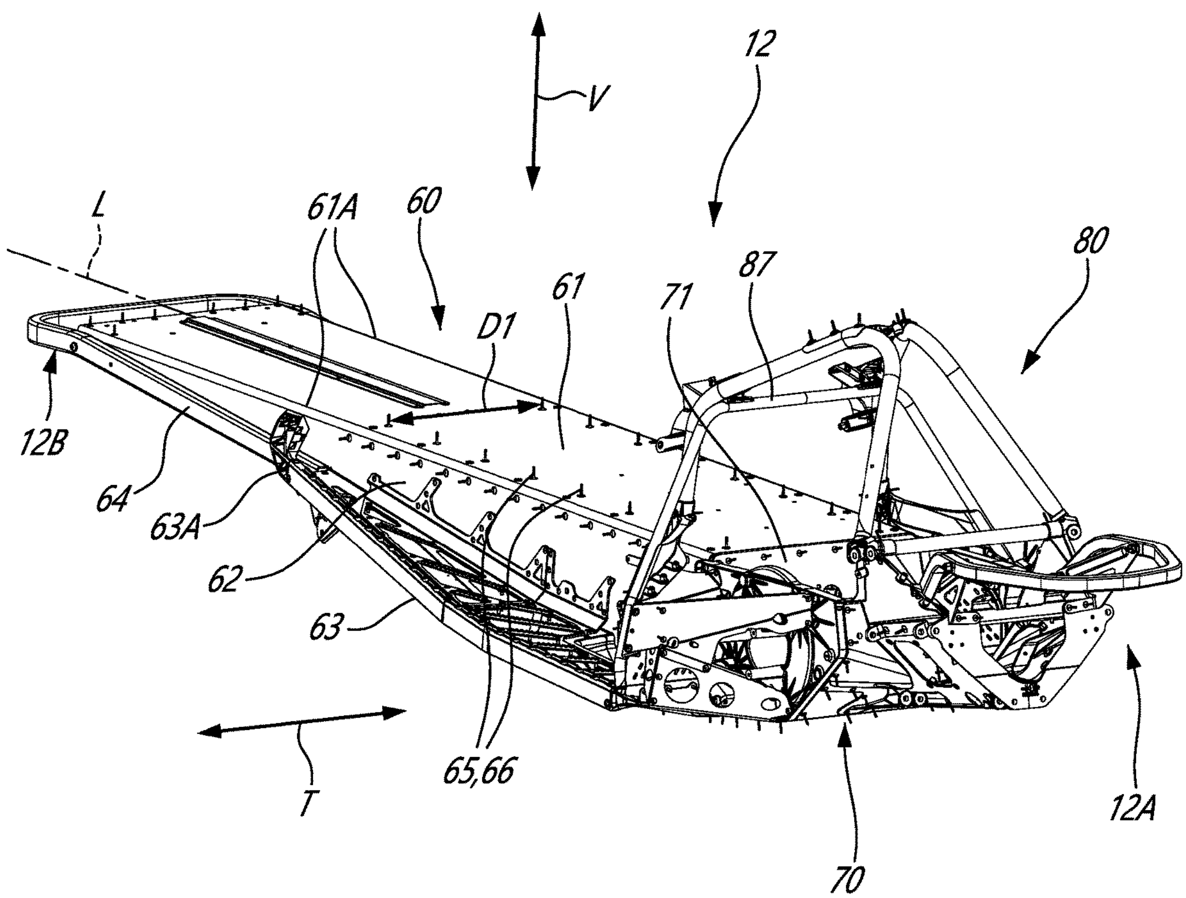


FIG. 4

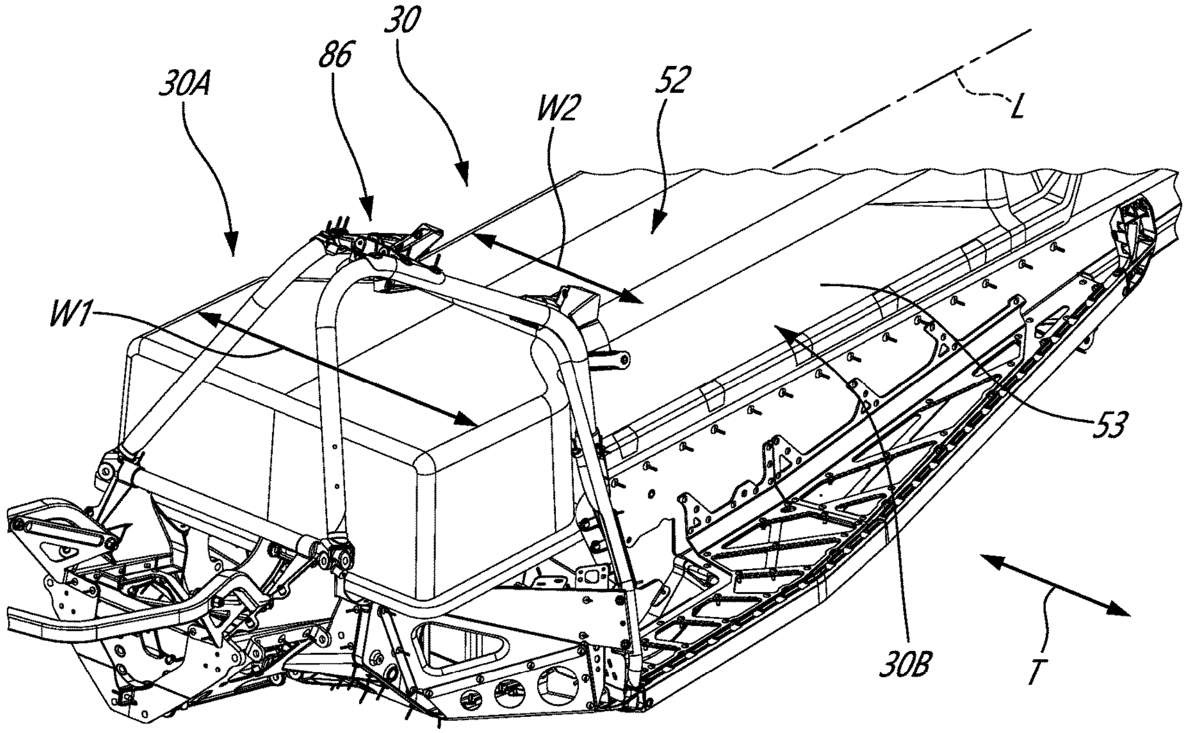


FIG. 5

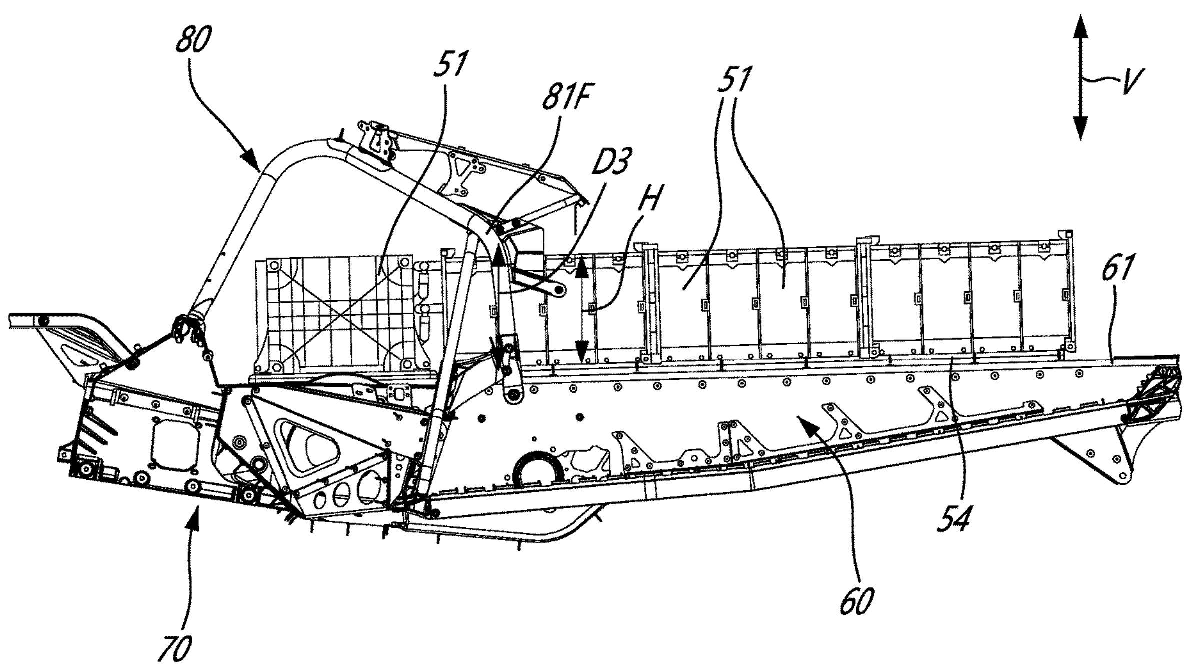


FIG. 6

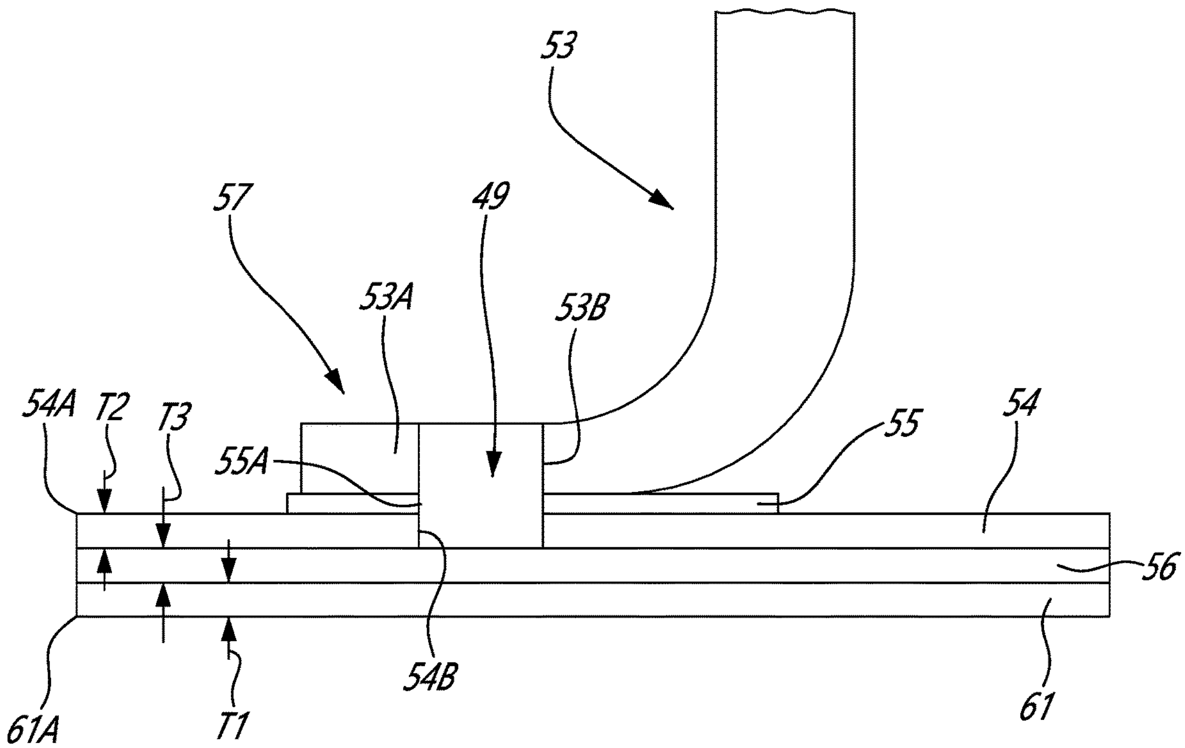
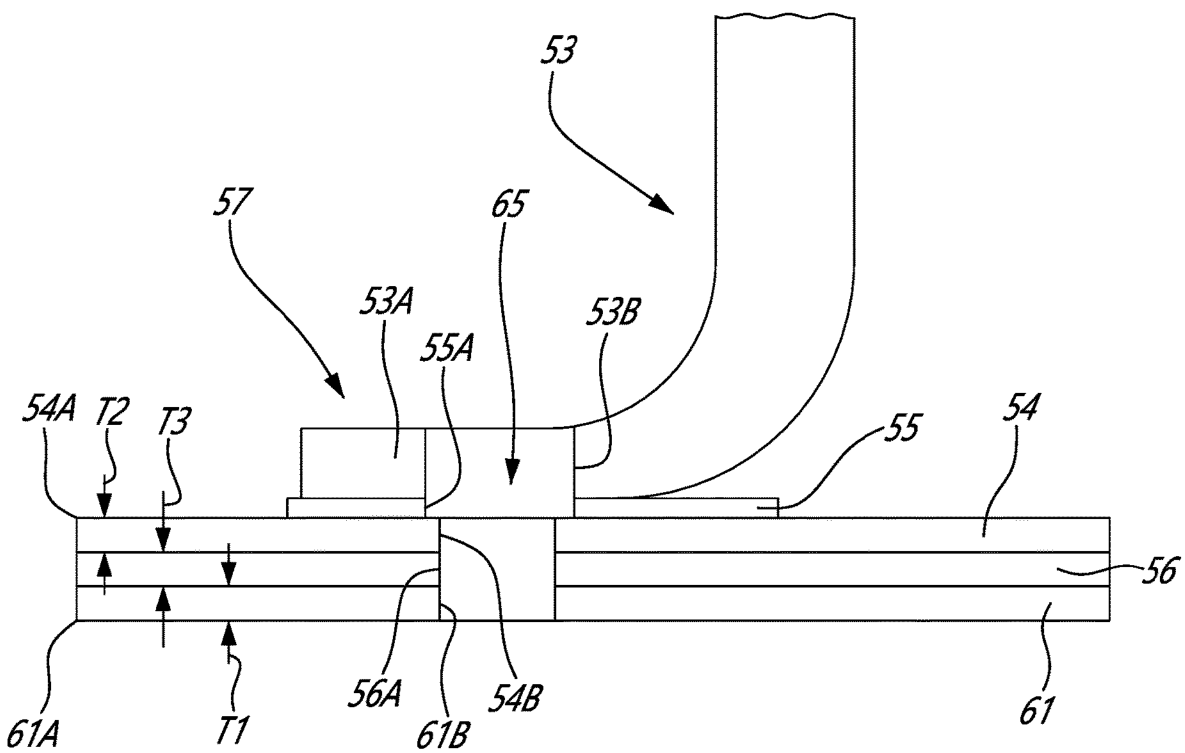

53
57
49
53A
53B
54A
T2
T3
55A
55
54
56
54B
61
61A
T1

FIG. 7A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65
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T2
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61B
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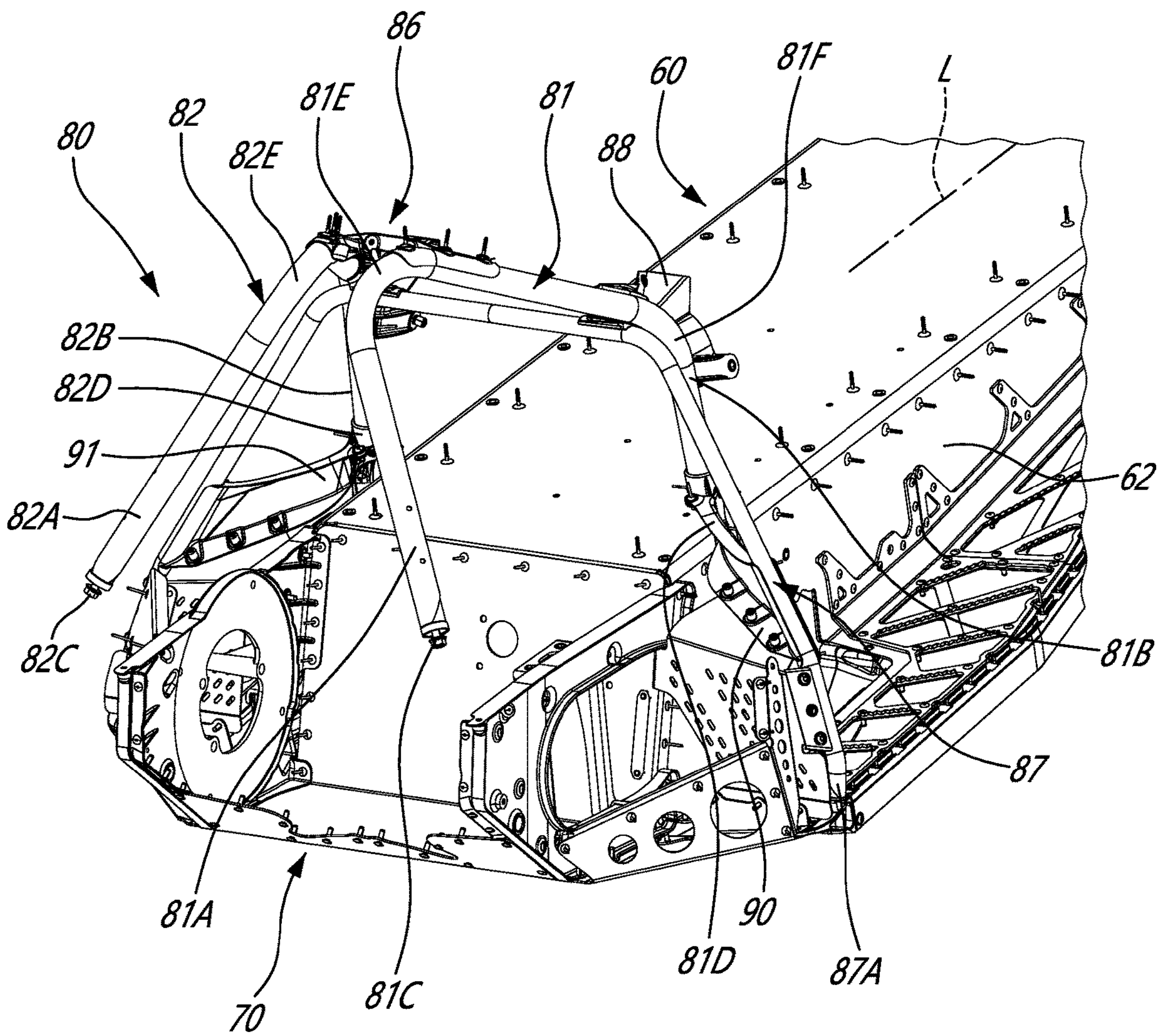
61A
T1

FIG. 7B


86
81F
60
L
81E
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88
80
82
82E
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82D
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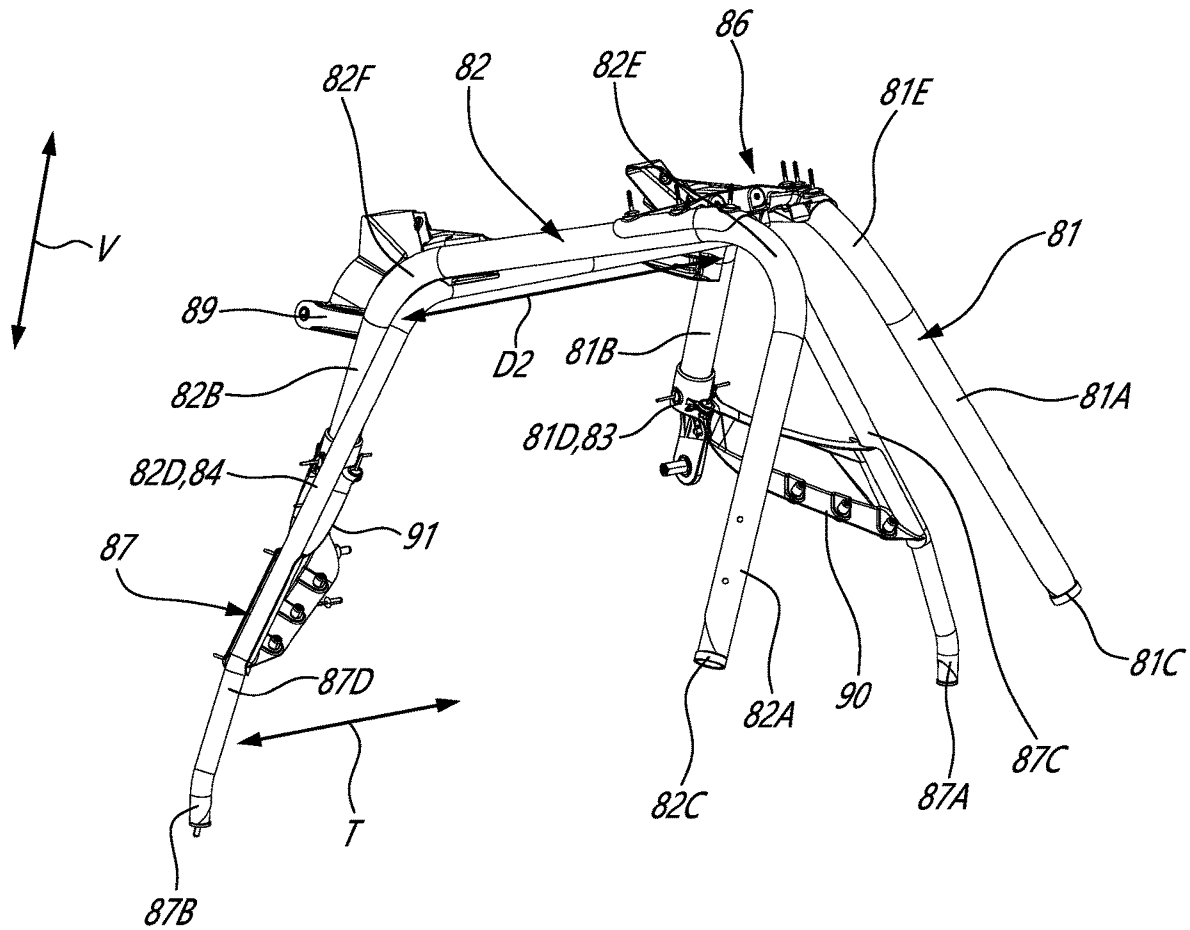
62
82A
81B
82C
87
81A
90
81D
87A
70
81C

FIG. 8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82E
81E
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V
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D2
81B
81A
82B
81D,83
82D,84
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82A
81C
87C
82C
87A
T
87B

FIG. 9

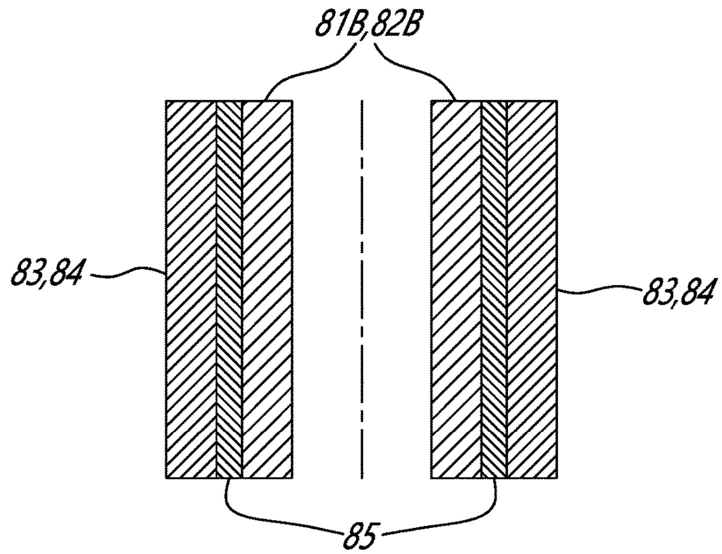

FIG. 10

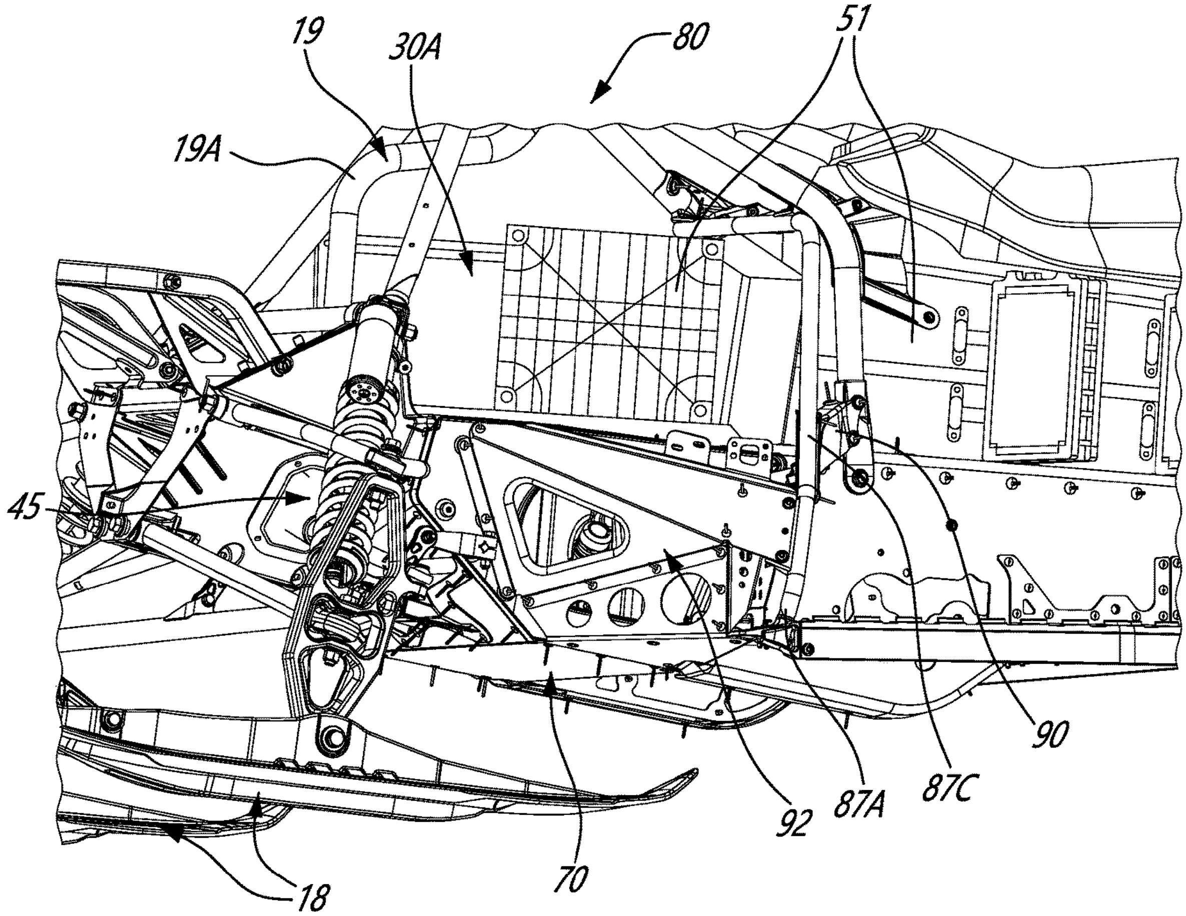

FIG. 11

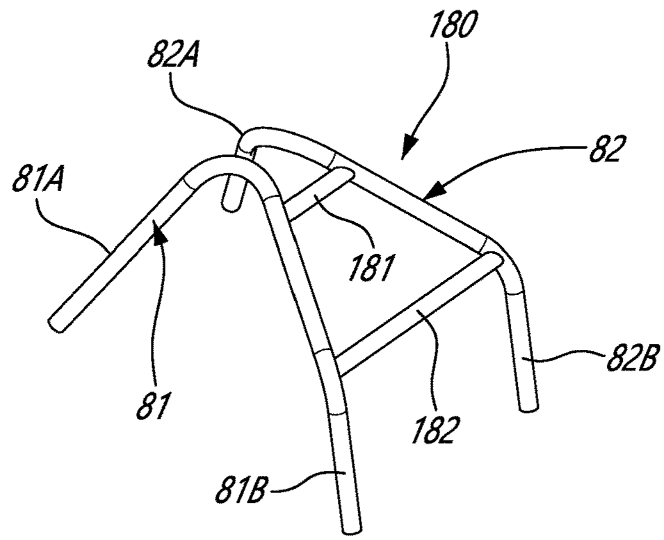

FIG. 12

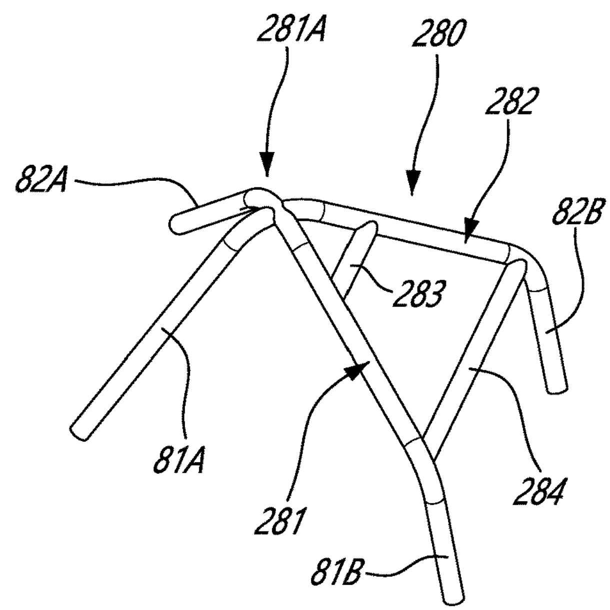

FIG. 13

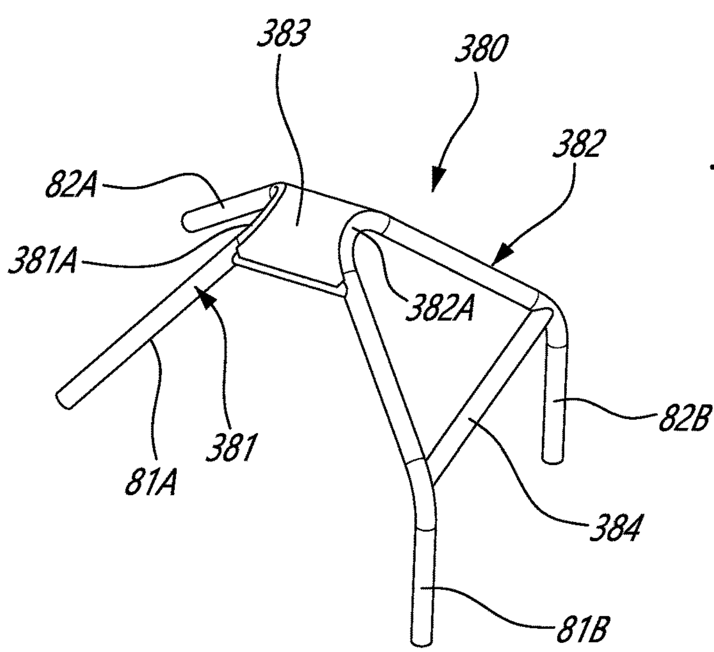

FIG. 14

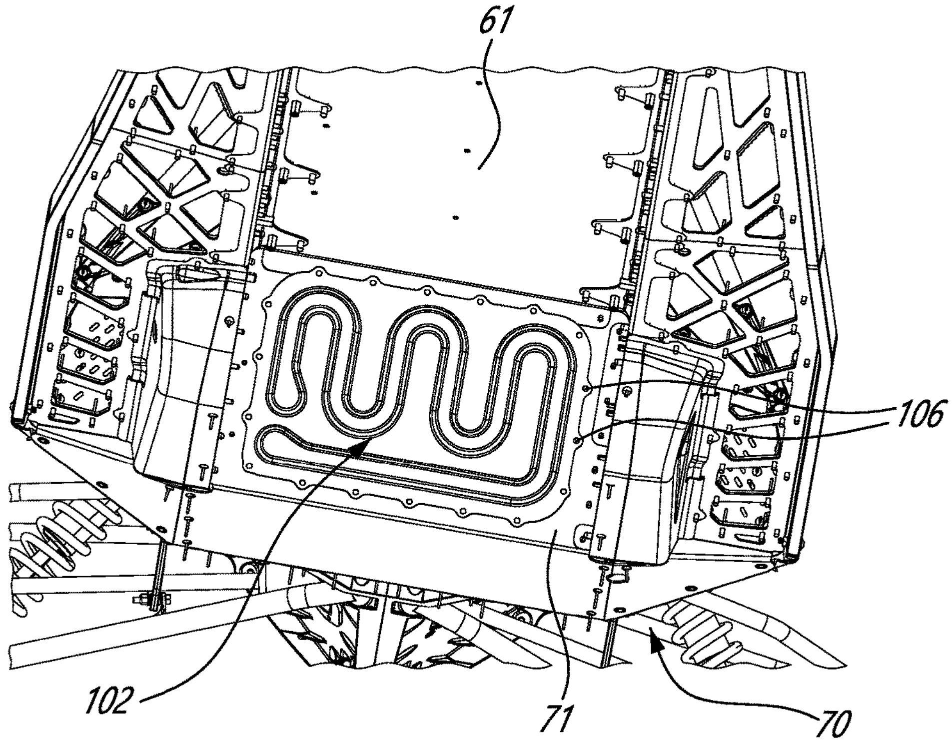

FIG. 15

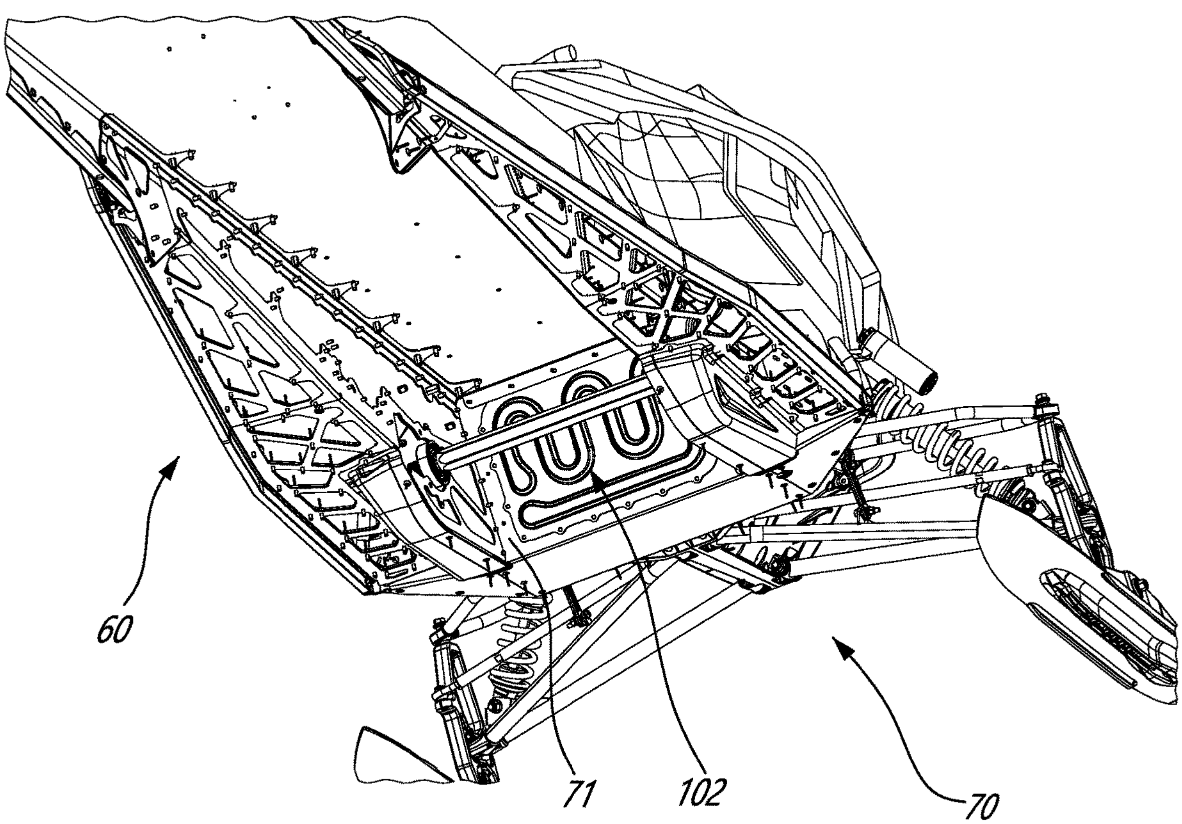

FIG. 16

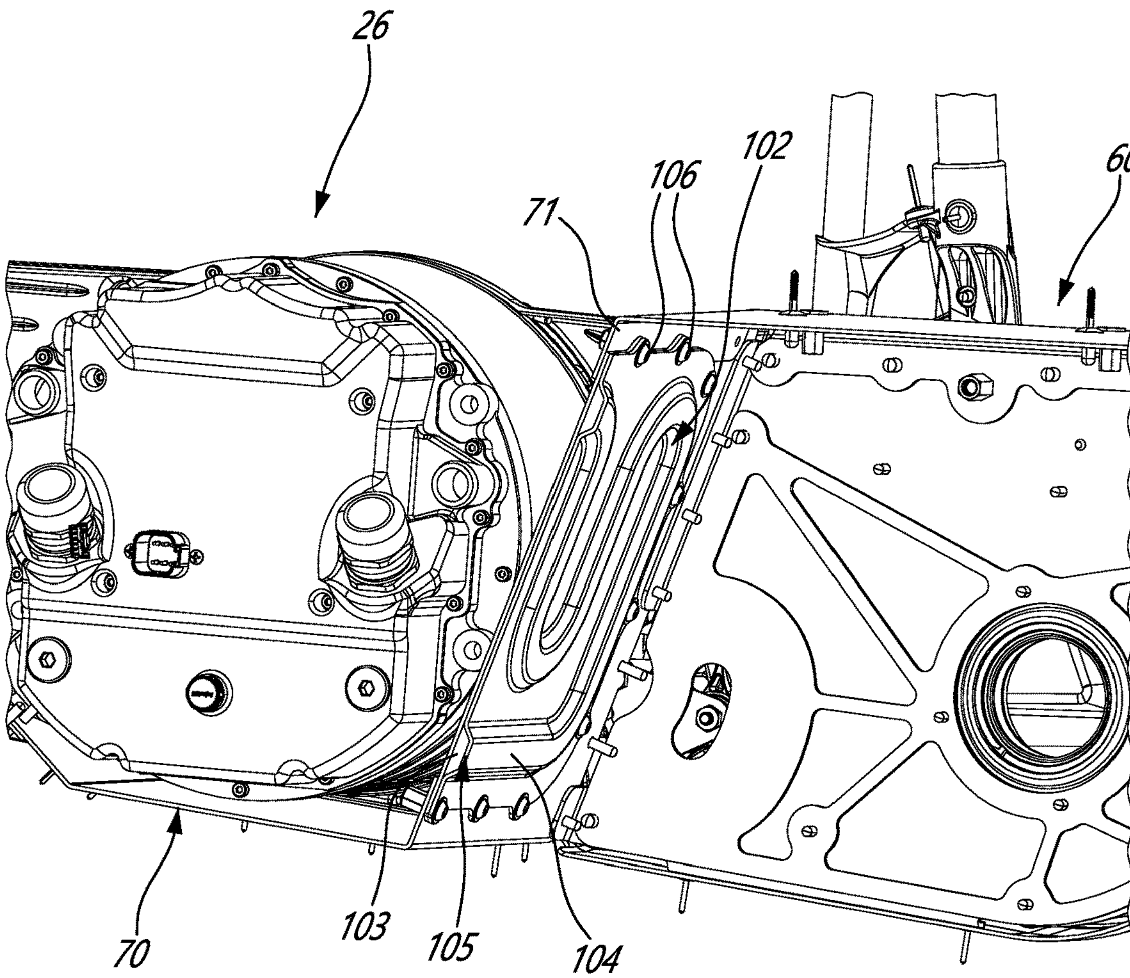

FIG. 17

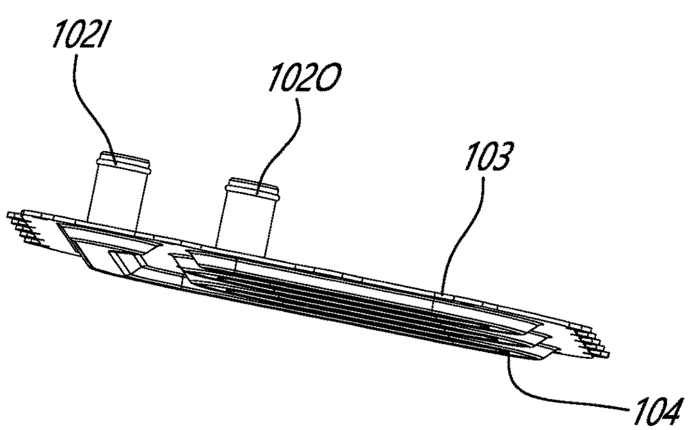

FIG. 18

ELECTRIC SNOWMOBILE ARCHITECTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from U.S. Provisional Patent Application No. 63/368,679, filed Jul. 18, 2022, and from U.S. Provisional Patent Application No. 63/370,969, filed Aug. 10, 2022, both of which are incorporated by reference in their entirety herein.

TECHNICAL FIELD

[0002] The application relates generally to snowmobiles and, more particularly, to electrically-powered snowmobiles.

BACKGROUND

[0003] Some snowmobiles combust fuel in an internal-combustion engine. The architecture of such fuel-consuming snowmobiles is designed to accommodate the size, weight and loads generated by the internal-combustion engine during operation of the snowmobile. The architecture of such fuel-consuming snowmobiles is also designed to accommodate the evacuation of hot combustion gases, cooling of components, and the lubrication of still other components.

[0004] For snowmobiles having batteries which supply electrical power to one or more electric motors for propulsion, the architecture of the snowmobile may be different than that of fuel-consuming snowmobiles.

SUMMARY

[0005] In one aspect, there is provided an electric snowmobile, comprising: a frame extending along a longitudinal axis between a front end and a rear end of the frame, the frame including a tunnel at least partially enclosing a spacing receiving a drive track, the tunnel having a top panel; an electric motor mounted to the frame; and a battery pack mounted to the frame and at least partially disposed rearward of the electric motor relative to the longitudinal axis, the battery pack including one or more battery modules operatively connected to the electric motor for supplying electrical energy to the electric motor, and a battery enclosure containing the one or more battery modules, the battery enclosure having a bottom panel supporting the one or more battery modules, the bottom panel of the battery enclosure secured to the top panel of the tunnel at a plurality of securing locations, the bottom panel and the top panel defining a structurally integrated double walled panel.

[0006] The electric snowmobile described above may include any of the following features, in any combinations.

[0007] In some embodiments, an effective thickness of the top panel of the tunnel corresponds to a thickness of the top panel plus a thickness of the bottom panel.

[0008] In some embodiments, a ratio of a thickness of the top panel of the tunnel to a thickness of the bottom panel of the battery enclosure ranges from 1.0 to 1.5.

[0009] In some embodiments, a distance between the bottom panel of the battery enclosure and the top panel of the tunnel ranges from about 1.5 mm to 2 mm.

[0010] In some embodiments, the bottom panel of the battery enclosure and the tunnel are made of two different materials.

[0011] In some embodiments, the bottom panel is made of aluminum, and the tunnel is made of aluminum.

[0012] In some embodiments, the bottom panel is free of contact with the tunnel.

[0013] In some embodiments, a damping layer is disposed between the top panel of the tunnel and the bottom panel of the battery enclosure.

[0014] In some embodiments, the top panel of the tunnel is parallel to the bottom panel of the battery enclosure.

[0015] In some embodiments, the plurality of securing locations are disposed along a perimeter of the bottom panel.

[0016] In some embodiments, the plurality of securing locations are distributed in two rows each extending longitudinally relative to the longitudinal axis and disposed adjacent a respective one of two side longitudinal edges of the bottom panel.

[0017] In some embodiments, the battery enclosure includes a cover removably securable to the bottom panel.

[0018] In some embodiments, the bottom panel is removable from the top panel of the tunnel.

[0019] In some embodiments, bolts are at the plurality of securing locations.

[0020] In another aspect, there is provided an electric snowmobile, comprising: a frame extending along a longitudinal axis between a front end and a rear end of the frame, the frame including a tunnel at least partially enclosing a spacing receiving a drive track, and a sub-frame disposed forward of the tunnel relative to the longitudinal axis, the sub-frame supporting a front suspension; an electric motor mounted to the frame; and a structure disposed over the sub-frame, the structure including members interconnected to one another, the members made of a first material, a bracket secured to an end of a member of the members via an adhesive, the bracket secured to the tunnel, the bracket made of a second material different than the first material.

[0021] The electric snowmobile described above may include any of the following features, in any combinations.

[0022] In some embodiments, the first material is steel and the second material is aluminum.

[0023] In some embodiments, the adhesive is one or more of an epoxy and an acrylic.

[0024] In some embodiments, the structure defines two fore ends and two rear ends, the bracket including two brackets each secured to a respective one of the two rear ends, the two brackets secured to the tunnel.

[0025] In some embodiments, the structure defines two fore ends each secured to a respective one of a right suspension and a left suspension of the front suspension.

[0026] In some embodiments, the members include a left member extending upwardly from a front left end to a left apex and from the left apex downwardly to a rear left end, a right member extending upwardly from a front right end to a right apex and downwardly from the right apex to a rear right end.

[0027] In some embodiments, the right member is secured to the left member proximate the left apex and the right apex.

[0028] In some embodiments, the structure includes a bracing member connecting the left member to the right member, the bracing member secured to the left member proximate or at the left apex and secured to the right member proximate or at the right apex.

[0029] In some embodiments, the structure includes a transverse member extending substantially transversally to the longitudinal axis from a left end to a right end, the transverse member secured to the left member and to the right member.

[0030] In some embodiments, a left foot rest is secured to a left side of the tunnel and a right foot rest secured to a right side of the tunnel, the left foot rest and the right foot rest extending along the longitudinal axis from the sub-frame towards the rear end of the frame, the left end of the transverse member secured to the left foot rest proximate the sub-frame, the right end of the transverse member secured to the right foot rest proximate the sub-frame.

[0031] In some embodiments, the transverse member is secured to the left member and to the right member via left and right connecting members made of the second material, the left and right connecting members secured to the transverse member and to the left and right members via the adhesive.

[0032] In some embodiments, the left member defines a left elbow and the right member defines a right elbow, the transverse member secured to the left member proximate or at the left elbow and secured to the right member proximate or at the right elbow.

[0033] In some embodiments, a left shear plate is connecting the transverse member to the sub-frame and a right shear plate connecting the transverse member to the sub-frame.

[0034] In yet another aspect, there is provided an electric snowmobile, comprising: a frame extending along a longitudinal axis between a front end and a rear end of the frame, the frame including a tunnel at least partially enclosing a spacing receiving a drive track, a sub-frame disposed forward of the tunnel relative to the longitudinal axis, the sub-frame supporting a front suspension; an electric motor mounted to the frame; a battery pack mounted over the tunnel and at least partially disposed rearward of the electric motor relative to the longitudinal axis, the battery pack having a front portion and a rear portion, a width of the front portion relative to a transverse direction normal to the longitudinal axis being greater than a width of the rear portion; and a structure disposed over the sub-frame and over the front portion of the battery pack, the structure defining at least four legs ending at four ends, the at least four legs including two front legs secured to the front suspensions and two rear legs secured to the tunnel, each of the two rear legs defining a respective one of two elbows and a respective one of two rear ends of the four ends, the two elbows located above the two rear ends, a distance along the transverse direction between the two elbows being greater than the width of the rear portion of the battery pack to receive the rear portion between the two rear legs.

[0035] The electric snowmobile described above may include any of the following features, in any combinations.

[0036] In some embodiments, a distance along a vertical direction being normal the transverse direction between the two elbows and a top wall of the tunnel is greater than a height of the battery pack taken along the vertical direction.

[0037] In some embodiments, the two elbows are located at an intersection between the front portion and the rear portion of the battery pack.

[0038] In some embodiments, the at least four legs are defined by two members each extending upwardly from a front end to an apex and downwardly from the apex to a respective one of the two rear ends.

[0039] In some embodiments, the two members are secured to one another proximate the apexes.

[0040] In some embodiments, the structure includes a bracing member connecting the two members.

[0041] In some embodiments, the structure includes a transverse member extending substantially transversally to the longitudinal axis from a left end to a right end, the transverse member secured to the two rear legs.

[0042] In some embodiments, a left foot rest is secured to a left side of the tunnel and a right foot rest secured to a right side of the tunnel, the left foot rest and the right foot rest extending along the longitudinal axis from the sub-frame towards the rear end of the frame, the left end of the transverse member secured to the left foot rest proximate the sub-frame, the right end of the transverse member secured to the right foot rest proximate the sub-frame.

[0043] In some embodiments, the transverse member is secured to two rear legs via connecting members.

[0044] In some embodiments, a left shear plate is connecting the transverse member to the sub-frame and a right shear plate connecting the transverse member to the sub-frame.

[0045] In still another aspect, there is provided an electric snowmobile, comprising: a frame extending along a longitudinal axis between a front end and a rear end of the frame, the frame including a tunnel at least partially enclosing a spacing receiving a drive track, a sub-frame disposed forward of the tunnel relative to the longitudinal axis, the sub-frame supporting a front suspension, and a bulkhead connecting the sub-frame to the tunnel; an electric motor mounted to the frame; a battery pack mounted to the frame and at least partially disposed rearward of the electric motor relative to the longitudinal axis; and a cooling system including a liquid coolant circuit in heat exchange relationship with one or both of the electric motor and the battery pack, and a heat exchanger mounted to the bulkhead, the heat exchanger having two plates secured to the bulkhead, one of the two plates exposed to the spacing, one or more conduits defined between the two plates, the one or more conduits hydraulically connected to the liquid coolant circuit.

[0046] The electric snowmobile described above may include any of the following features, in any combinations.

[0047] In some embodiments, the two plates include a first plate secured to the bulkhead and a second plate secured to the first plate, the second plate exposed to the spacing, being embossed, and defining one or more channels, the one or more conduits extending within the one or more channels.

[0048] In some embodiments, the heat exchanger is secured to the bulkhead at a plurality of securing locations thereby increasing a stiffness of the bulkhead.

[0049] In some embodiments, the plurality of securing locations are disposed along perimeters of the two plates.

[0050] In some embodiments, the two plates are made of metal.

[0051] In some embodiments, the two plates have each a thickness of about 1.6 mm.

[0052] In another aspect, there is provided a structure for an electric snowmobile having a battery pack having a front portion and a rear portion, a width of the front portion relative to a transverse direction normal to a longitudinal axis of the electric snowmobile being greater than a width of the rear portion, the structure comprising: two front legs to secure to front suspensions of the electric snowmobile; and two rear legs to secure to a tunnel of the electric snowmobile, each of the two rear legs defining a respective one of two elbows and a respective one of two rear ends, the two elbows located above the two rear ends, a distance along the transverse direction between the two elbows being greater than a width of the rear portion of the battery pack to receive the rear portion between the two rear legs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053] Reference is now made to the accompanying figures in which:

[0054] FIG. **1** is a schematic representation of an electric snowmobile;

[0055] FIG. **2** is an enlarged three dimensional view of a transmission of the electric snowmobile of FIG. **1**;

[0056] FIG. **3** is a three dimensional view of the electric snowmobile of FIG. **1**;

[0057] FIG. **4** is a front three dimensional view of a frame of the electric snowmobile of FIG. **3**;

[0058] FIG. **5** is another front three dimensional view of the frame of the electric snowmobile of FIG. **3** with a battery pack secured thereto;

[0059] FIG. **6** is a side vide of the frame and battery pack of the electric snowmobile of FIG. **3**;

[0060] FIG. **7**A is a cross-sectional view illustrating a connection arrangement between the battery pack and the frame of the electric snowmobile of FIG. **3** at first securing locations;

[0061] FIG. **7**B is a cross-sectional view illustrating a connection arrangement between the battery pack and the frame of the electric snowmobile of FIG. **3** at second securing locations;

[0062] FIG. **8** is a front three dimensional view of the frame of the electric snowmobile of FIG. **3**;

[0063] FIG. **9** is a three dimensional view of a structure to be secured to the frame of the electric snowmobile of FIG. **3**;

[0064] FIG. **10** is a three dimensional view illustrating a connection arrangement between a member of the structure and a bracket of the structure of FIG. **9**;

[0065] FIG. **11** is another side view of the electric snowmobile of FIG. **3** illustrating the frame and the structure;

[0066] FIG. **12** is a three dimensional view of a structure in accordance with another embodiment;

[0067] FIG. **13** is a three dimensional view of a structure in accordance with another embodiment;

[0068] FIG. **14** is a three dimensional view of a structure in accordance with another embodiment;

[0069] FIG. **15** is a bottom three dimensional view illustrating a heat exchanger secured to the frame of the electric snowmobile of FIG. **3**;

[0070] FIG. **16** is a bottom side three dimensional view illustrating the heat exchanger and the frame;

[0071] FIG. **17** is a cross-sectional view of the heat exchanger of FIG. **15**; and

[0072] FIG. **18** is a side view of the heat exchanger of FIG. **15**.

DETAILED DESCRIPTION

[0073] The following disclosure relates to straddle seat vehicles and associated methods for operating the straddle seat vehicles. The straddle seat vehicles are drivingly engaged to motors for effecting propulsion of the vehicles in both forward and reverse directions. In some embodiments, the straddle seat vehicles and methods described herein may be applicable to electric powersport vehicles that may be operated off-road and/or in relatively rugged environments. Examples of suitable off-road electric and non-electric powersport vehicles include snowmobiles, all-terrain vehicles (ATVs), and utility task vehicles (UTVs). As used herein, the term off-road vehicle refers to vehicles to which at least some regulations, requirements or laws applicable to on-road vehicles do not apply. In some embodiments, the vehicles and methods described herein may, based on one or more positions of an input device operatively connected to a motor, determine the forward direction and reverse direction of propulsion for the vehicle.

[0074] The terms “connected”, “connects” and “coupled to” may include both direct connection and coupling (in which two elements contact each other) and indirect connection and coupling (in which at least one additional element is located between the two elements).

[0075] With reference to FIG. **1**, an electric snowmobile in accordance with one embodiment is shown at **10**. The electric snowmobile **10** may include a frame **12** (also known as a body or a chassis) which may include a tunnel **14**, a drive track **15** having the form of an endless belt for engaging the ground (e.g., snow) and disposed under the tunnel **14**, and a powertrain **16** mounted to the frame **12** and configured to displace the drive track **15**. Skis **18** are disposed in a front portion of the electric snowmobile **10**, and a straddle seat **22** is disposed above the tunnel **14** for accommodating an operator of the electric snowmobile **10** and optionally one or more passengers. Skis **18**, namely left and right skis, may be movably attached to the frame **12** to permit steering of the electric snowmobile **10** via a steering assembly including a steering column **19** connected to a handle **20**. Front suspensions **45** (shown in FIG. **3**) are connected to the skis **18** and used to dampen movements of the snowmobile **10** when in use.

[0076] Referring to FIGS. **1** and **2**, the powertrain **16** of the electric snowmobile **10** includes an electric motor assembly **25**. The electric motor assembly **25** is a collection of components and features which function to deliver an electric drive to displace the electric snowmobile **10**. The electric motor assembly **25** includes one or more electric motor(s) **26** drivingly coupled to the drive track **15** via a drive shaft **28**. In one embodiment, the electric motor **26** has a maximum output power of between 120 and 180 horse power. In other embodiments, the electric motor **26** has a maximum output power of at least 180 horse power. The drive shaft **28** may be drivingly coupled to the drive track **15** via one or more toothed wheels or other means so as to transfer motive power from the electric motor **26** to the drive track **15**. The powertrain **16** may also include a battery pack **30** for providing electric energy (i.e. electric current) to the electric motor **26** and driving the electric motor **26**. The operation of the electric motor **26** and the delivery of drive current to the electric motor **26** from the battery pack **30** may be controlled by a controller **32** based on an actuation of an input device **34**, sometimes referred to as a “throttle” or “accelerator”, by the operator. The controller **32** and the input device **34** are part of a control system CS for controlling operation of the electric snowmobile **10**. In some embodiments, the battery pack **30** may be a lithium ion or other type of battery pack **30**.

[0077] In the embodiment shown, the electric snowmobile **10** has a cooling system **100** including a liquid coolant circuit **101** in heat exchange relationship with one or both of the electric motor **26** and the battery pack **30**. The liquid coolant circuit **101** may extend through cooling passages defined within or around the electric motor **26** and/or within cooling passages defined within the battery pack **30**. A liquid coolant may flow within the cooling passages of the liquid coolant circuit **101** to pickup heat generated by these components. This heat may then be expelled to an environment via a heat exchanger, which will be described further below.

[0078] The electric snowmobile **10** may also include one or more brake(s) **36** (referred hereinafter in the singular) that may be applied or released by an actuation of a brake actuator (e.g., lever) **38** by the operator for example. The brake **36** may be operable as a main brake for the purpose of slowing and stopping the electric snowmobile **10** during motion of the electric snowmobile **10**. The brake **36** may comprise a combination of tractive braking and regenerative braking. In some embodiments, the brake **36** may be operable as described in U.S. patent application Ser. No. 17/091,712 entitled "Braking system for an off-road vehicle", the entirety of which is incorporated herein by reference. Alternatively or in addition, the brake **36** may be operable as a parking brake, sometimes called "e-brake" or "emergency brake", of the electric snowmobile **10** intended to be used when the electric snowmobile **10** is stationary. In various embodiments, such main and parking brake functions may use separate brakes, or may use a common brake **36**. In some embodiments of tractive braking, the brake actuator **38** may be lockable when the brake **36** is applied in order to use the brake **36** as a parking brake. The brake **36** may be electrically or hydraulically operated. For example, the brake **36** may include a master cylinder operatively coupled to a brake caliper that applies brake pads against a brake rotor that is coupled to the powertrain **16**. In some embodiments, such brake rotor may be secured to and rotatable with the drive shaft **28**. In some embodiments of regenerative braking shown in FIG. **1**, the brake **36** is electrically connected to the battery pack **30**. The brake **36** is a regenerative brake **36**, or applies regenerative braking, such that the brake **36** or components thereof are able to supply the battery pack **30** with electric energy when the brake **36** is applied to a component of the powertrain **16**, and/or when the operator releases the input device **34** (e.g., accelerator).

[0079] Still referring to FIGS. **1** and **2**, the electric motor **26** is in torque-transmitting engagement with the drive shaft **28** via a transmission **40**. The transmission **40** may be of a belt/pulley type, a chain/sprocket type, or a shaft/gear type for example. Referring to FIG. **2**, the transmission **40** is of a belt/pulley type. The transmission **40** includes a drive belt **42** that is mounted about a motor output **26**A of the electric motor **26**, and is also mounted about a drive track wheel **28**A for driving the drive shaft **28**. The drive belt **42** therefore extends between the motor output **26**A and the drive track wheel **28**A for conveying torque from the electric motor **26** to the drive shaft **28**. The drive shaft **28** provides torque to the drive track **15**. The drive belt **42** is thus displaced or driven by the motor output **26**A in a linear manner between the motor output **26**A and the drive track wheel **28**A, and in a circumferential manner about the motor output **26**A and the drive track wheel **28**A.

[0080] Referring now to FIGS. **3-4**, the electric snowmobile **10** includes front suspensions **45** connected to the skis **18**. Namely, each of the front suspensions **45** is connected to a respective one of the skis **18**. The frame **12** of the electric snowmobile **10** extends along a longitudinal axis L between a front end **12**A and a rear end **12**B. The frame **12** includes a tunnel **60** (which may be similar to tunnel **14**), a sub-frame **70**, and a structure **80**. The sub-frame **70** is disposed forward of the tunnel **60** relative to the longitudinal axis L. The sub-frame **70** may define a cavity or spacing that is sized for receiving the electric motor **26**. The electric motor **26** may be secured (e.g., fastened to the sub-frame **70**). The tunnel **60** at least partially encloses a spacing receiving the drive track **15** (FIG. **1**). The sub-frame **70** defines a bulkhead **71** that connects the sub-frame **70** to the tunnel **60**. The structure **80** is disposed over the sub-frame **70**. The structure **80** may be secured to the tunnel **60**, to the sub-frame **70**, and to the front suspensions **45**. More specifically, and in the embodiment shown, the structure **80** is connected to the front suspension **45** and to the sub-frame **70** at the same one or more locations. For example, one or more brackets may each couple the structure **80** to the front suspension **45** and to the sub-frame **70**. Alternatively or additionally, the structure **80**, which may include transverse member **87**, is connected to the front suspension **45** via left and right front legs **81**A, **82**A (see FIG. **8**), and to the sub-frame **70** via transverse member **87**. Thus, loads are transferred from the skis **18** to the front suspensions **45** and from the front suspensions **45** to the structure **80**, and from the structure **80** to the tunnel **60** and sub-frame **70**.

[0081] Referring more particularly to FIG. **4**, the tunnel **60** may be made of sheet metal having a thickness of about 1 to 3 mm, preferably about 1.6 mm. The tunnel **60** may be made of aluminum, or any other suitable material such as steel, composite (e.g., carbon fiber or fiber glass in epoxy). The tunnel **60** has a top panel **61** defining a substantially planar surface that faces upwardly in a vertical direction V. The expression "substantially" used in the context of the present disclosure is meant to encompass slight variations caused by manufacturing tolerances. The tunnel **60** includes two side panels **62** each extending downwardly from longitudinal edges **61**A of the top panel **61**. The two side panels **62** are therefore substantially transverse to the top panel **61** to partially enclose the spacing sized for receiving the drive track **15**. The tunnel **60** may be a sheet bended to define the longitudinal edges **61**A located at intersections between the top panel **61** and the two side panels **62**. The tunnel **60** includes foot rests **63** (sometimes referred to as "running boards"), namely left and right foot rests each sized for receiving a foot of a user sitting on the straddle seat **22** (FIG. **1**) of the electric snowmobile **10**. The foot rests **63** may each extend transversally in a transverse direction T from a respective one of the two side panels **62**. In the embodiment shown, the foot rests **63** are secured to bottom edges of the two side panels **62**. The foot rests **63** extend longitudinally relative to the longitudinal axis L from the sub-frame **70** towards the rear end **12**B of the frame **12**.

[0082] Still referring to FIG. **4**, in the embodiment shown, a peripheral beam **64** is secured to the tunnel **60** and extends from a rear end **63**A of one of the foot rests **63**, wraps around a rear portion of the tunnel **60** at the rear end **12**B of the frame **12** and reaches the rear end **63**A of the other of the foot rests **63**. The peripheral beam **64** may be secured to the tunnel **50** adjacent the rear ends **63**A of the foot rests **63** and at one or more locations along its length. The peripheral beam **64** may increase a stiffness of the tunnel **60**. The peripheral beam **64** may provide a bumper at the rear end **12**B of the frame **12**.

[0083] Referring now to FIGS. **5-6**, the battery pack **30** is mounted to the frame **12** and disposed at least partially rearward of the electric motor **26** relative to the longitudinal axis L. The battery pack **30** includes one or more battery modules **51** operatively connected to the electric motor **26** for supplying electrical energy to the electric motor **26**. The battery pack **30** further includes a battery enclosure **52** containing the one or more battery modules **51**. In the embodiment shown, the battery pack **30** has a front portion **30**A and a rear portion **30**B located rearward of the front portion **30**A relative to the longitudinal axis L. A width W**1** of the front portion relative to the transverse direction T normal to the longitudinal axis L is greater than a width W**2** of the rear portion **30**B. The width W**2** of the rear portion **30**B may generally correspond to the width of the straddle seat **22** disposed above the rear portion **30**B, allowing an operator to straddle the rear portion **30**B and access the foot rests **63**. The structure **80** is designed to accommodate this battery pack **30**. More details about the structure **80** are presented herein below. The rear portion **30**B of the battery pack **30** is disposed above the tunnel **60**. More specifically, the rear portion **30**B of the battery pack **30** is secured (e.g., glued, fastened) to the top panel **61** of the tunnel **60**.

[0084] The battery enclosure **52** includes a cover **53** and a bottom panel **54**. The cover **53** may be removably secured to the bottom panel **54**. In other words, the cover **53** may be removed from the bottom panel **54** to access the battery modules **51** and/or other components of the battery pack **30** for maintenance purposes. The battery pack **30** may be secured to the tunnel **60** via the bottom panel **54** of the battery enclosure **52**. In a further embodiment, the battery pack **30** may be secured to the tunnel **60** via a combination of the bottom panel **54** and the cover **53** of the battery enclosure **52**. The battery modules **51** may be supported by the bottom panel **54** and secured thereto using any suitable techniques.

[0085] One of the functions of the tunnel **60** is to support the straddle seat **22** (FIG. **1**) and the user sitting on the straddle seat **22**. Another function of the tunnel **60** is to transmit loads imparted to the electric snowmobile **10** via the drive track **15**. These loads may include, for instance, acceleration and deceleration forces and moments about the longitudinal axis L. To resist the moments imparted to the tunnel **60**, the tunnel **60** requires a suitable torsional stiffness. The torsional stiffness in the context of the present disclosure corresponds to the resistance of the tunnel **60** against deformation when subjected to a torque defined about the longitudinal axis L.

[0086] In the embodiment shown, the torsional stiffness of the tunnel **60** may be increased by the battery pack **30**. More specifically, the bottom panel **54** of the battery enclosure **52** is secured to the top panel **61** of the tunnel **60** in a manner such that a torsional stiffness of the tunnel **60** is increased by the bottom panel **54** of the battery enclosure **52**. Stated differently, the bottom panel **54** of the battery enclosure **52** is secured to the top panel **61** of the tunnel **60** at a plurality of securing locations **65** (see FIG. **4**). Therefore, the bottom panel **54** and the top panel **61** of the tunnel **60** define a structurally integrated double walled panel.

[0087] Referring to FIGS. **4** and **7A-7B**, in the embodiment shown, the securing locations **65** are distributed in two rows each extending longitudinally relative to the longitudinal axis L and disposed adjacent a respective one of the two longitudinal edges **61**A of the top panel **61** of the tunnel **60**. The securing locations **65** of each rows may be separated from one another by between 130-170 mm, and in some embodiments by about 150 mm. Other separations of the securing locations **65** are also contemplated. These two rows of the securing locations **65** are disposed along opposed longitudinal edges **54**A of the bottom panel **54** of the battery enclosure **52**. Stated differently, the top panel **61** of the tunnel **60** and the bottom panel **54** of the battery enclosure **52** are secured to one another along respective portions of their perimeters. At each of those securing locations **65**, the bottom panel **54** of the battery enclosure **52** is clamped to the top panel **61** of the tunnel **60**. Longitudinal edges **61**A of the top panel **61** of the tunnel **60** may be substantially aligned or flush with the longitudinal edges **54**A of the bottom panel **54** of the battery enclosure **52**. Alternatively, the longitudinal edge **54**A of the bottom panel **54** may be located laterally inwardly from the longitudinal edges **61**A of the top panel **61** of the tunnel **60**.

[0088] Referring to FIG. **7**A, in the present embodiment, the cover **53** is secured to the bottom panel **54** at a plurality of first securing locations **49** that are spaced apart from one another by between 130-170 mm, and in some embodiments by about 150 mm. Referring to FIG. **7**B, the bottom panel **54** is secured to the tunnel **60** at a plurality of second securing locations **65** that are spaced apart from one another by between 130-170 mm, and in some embodiments by about 150 mm. The first securing locations **49** of the cover **53** to the bottom panel **54** are interspaced between the second securing locations **65** of the bottom panel **54** to the tunnel **60**. Hence, in an embodiment, a first securing location **49** between the cover **53** and the bottom panel **54** is spaced apart from a second securing location **65** between the bottom panel **54** and the tunnel **60** by about mm.

[0089] Referring now to FIG. **7**A, a cross-sectional view illustrating a securing arrangement between the cover **53** and the bottom panel **54** at a first securing location **49** is shown. In the embodiment shown, a layer **56** of damping material, such as foam, is disposed between the top panel **61** of the tunnel **60** and the bottom panel **54** of the battery enclosure **52** to dampen vibrations. Also, a seal **55**, such as a gasket made of elastomeric material, may be disposed between the bottom panel **54** of the battery enclosure **52** and a flange **53**A of the cover **53** of the battery enclosure **52**. This seal **55** may be used to protect the battery modules **52** contained in the battery enclosure **52** from snow, water, and other debris.

[0090] In the present embodiment, the cover **53** is secured to the bottom panel **54** at the first securing locations **49** spaced apart from one another by between 130-170 mm, and in some embodiments by about 150 mm. Threaded inserts (e.g., standoffs/clinch nuts) are secured to the bottom panel **54** at the first securing locations. Thus, threaded holes **54**B may be defined by the threaded inserts. Bolts may then be inserted through registering apertures **53**B, **55**A defined through the flange **53**A of the cover **53** and through the seal **55** until it threadingly engages the threaded holes **54**B. The bolt has a head abutting the flange **53**A to secure the flange **53**A to the bottom panel **54**. A washer may be used in some configurations.

[0091] Referring now to FIG. **7**B, a cross-sectional view illustrating a securing arrangement between the bottom panel **54** and the tunnel **60** at a second securing location is shown. Registering apertures **53**B, **55**A, **54**B, **56**A, **61**B may be defined through the flange **53**A, the seal the bottom panel **54**, the layer **56**, and the top panel **61** to receive a fastener for securing the battery enclosure **52** to the top panel **61** of the tunnel **60**. This fastener may include a rivet-nut secured to the top panel **61** and defining inner threads. A bolt **66**

(FIG. **4**) may be threadingly engaged to the inner threads of the rivet-nut and received through the registering apertures **53**B, **54**B, **56**A, **61**B. A nut may thus be threadingly engaged to the bolt **66** to abut against the bottom panel **54** to clamp the bottom panel **54**, the layer **56**, and the top panel **61** together. Washers may be used in some configurations.

[0092] As shown in FIG. **7**B, a diameter of the apertures **53**B, **55**A defined through the flange **53**A of the cover **53** and through the seal **55** may be greater than that of the apertures **54**B, **56**A defined through the bottom panel **54** of the battery enclosure **52** and through the layer **56**. The diameter of these apertures **53**B, **55**A defined through the flange **53**A of the cover **53** and through the seal **55** is selected to be greater than a diameter of a nut used to threadingly engage the bolt **66**. Thus, at the second securing locations, only the bottom panel **54** is clamped to the top panel **61** of the tunnel **60** and no clamping force is exerted on the cover **53** at the second securing locations. This may allow for removal of the cover **53** from the bottom panel **54**, without detaching the bottom panel **54** from the top panel **61** of the tunnel **60**. Alternatively, the cover **53** may be clamped to the top panel **61** of the tunnel **60** at a plurality of securing locations. In other words, in an alternate embodiment, at each of the securing locations **49**, **65** the flange **53**A, the seal **55**, the bottom panel **54**, the layer **56**, and the top panel **61** may be clamped together.

[0093] These fasteners at the second securing locations **65** may allow the removal of the bottom panel **54** from the top panel **61** of the tunnel **60**. Stated differently, the whole battery enclosure **52** may be removable from the tunnel **60**. The seal **55** and/or the layer **56** of damping material may be avoided in some embodiments.

[0094] Still referring to FIGS. **7**A-**7**B, the top panel **61** of the tunnel **60** has a first thickness T**1** and the bottom panel **54** of the battery enclosure **52** has a second thickness T**2**. A ratio of the first thickness T**1** to the second thickness (T**1**/T**2**) may range from 1 to 1.5. In the present embodiment, an effective thickness of the top panel **61** of the tunnel **60** may correspond to the first thickness T**1** of the top panel **61** plus the second thickness T**2** of the bottom panel **54** of the battery enclosure **52**. Herein, the expression effective thickness means that structural properties of the top panel **61** of the tunnel **60** may be increased by the bottom panel **54** of the battery enclosure **52**. In other words, the torsional stiffness of the tunnel **60** may be increased by the bottom panel **54** such that the torsional stiffness of the tunnel **60** combined with the bottom panel **54** is substantially equal to what the torsional stiffness of the tunnel **60** would be if the top panel **61** had a thickness increased by the second thickness T**2** of the bottom panel **54**. The top panel **61** and the bottom panel **54** are substantially parallel to one another. When connected, the top panel **61** and the bottom panel **54** may compress the layer of damping material **56** such that there is no visible gap between the top panel **61** and the bottom panel **54**.

[0095] Moreover, having the longitudinal edges **54**A of the bottom panel **54** being substantially aligned or flush with the longitudinal edges **61**A of the top panel **61** of the tunnel **60** may allow to maximize a distance D**1** (FIG. **4**) in the transverse direction T between the two rows of the securing locations **65**. In turn, this may increase an effective width of a combination of the top panel **61** of the tunnel **60** and the bottom panel **54** of the battery enclosure **52**. This increase in the effective width may increase the torsional stiffness of the combination of the bottom panel **54** of the battery enclosure **52** and the top panel **61** of the tunnel. Those securing locations **65** may therefore be as close as possible to the longitudinal edges **54**A, **61**A of the bottom panel **54** and the top panel **61**. Moreover, having the top panel **61** and the bottom panel **54** close to one another may allow a reduction of the thickness of the sheet metal of the tunnel **60**, which may provide significant weight savings. In one embodiment, the thickness of the top panel may be reduced by approximately 0.4 mm, which may provide about 2 kilograms of weight savings.

[0096] The bottom panel **54** and the tunnel **60** may be made of the same material, such as aluminum. Alternatively, they may be made from two different materials (e.g., steel and aluminum). In some embodiments, composite materials may be used.

[0097] In the depicted embodiment, the top panel **61** of the tunnel **60** is free of contact with the bottom panel **54** of the battery enclosure **52**. A spacing or gap between the tunnel **60** and the bottom panel **54** may be sized to receive the layer **56** of damping material. A third thickness T**3** of this layer **56**, which substantially corresponds to a dimension of the spacing or distance between the tunnel **60** and the bottom panel **54**, may be about from 1.5 mm to 2 mm. The third thickness T**3** corresponds to a distance between the tunnel **60** and the bottom panel **54**. The layer **56** may be compressed when the bottom panel **54** is fastened to the tunnel **60**. The gap between the tunnel **60** and the bottom panel **54** may increase the effective torsional and/or bending stiffness of the tunnel **60**. For example, spacing the bottom panel **54** and the top panel **61** apart from one another may improve stiffness similar to an I-beam. This may for allow a reduced thickness of the material of the tunnel **60**, thereby saving weight.

[0098] In some other embodiments, the layer **56** may be removed and the top panel **61** of the tunnel **60** may be in contact against the bottom panel **54** of the battery enclosure **52**. In some cases, the bottom panel **54** may be glued to the top panel **61** of the tunnel **60**.

[0099] A number of the second securing locations **65** between the bottom panel **54** of the battery enclosure **52** and the top panel **61** of the tunnel **60** is selected to increase a clamping surface area between these two panels. The greater the clamping surface area, the greater the loads transferred between the two panels.

[0100] Referring now to FIGS. **8**-**9**, the structure **80** is described in greater details. The structure **80** may be made with tubular members, which may be made of a first material, such as steel, or other suitable materials. The use of steel may improve the strength of the tubular members as compared to other materials, for example. In the embodiment shown, the structure **80** includes left and right primary members **81**, **82** interconnected to one another and defining four legs, namely, left and right front legs **81**A, **82**A and left and right rear legs **81**B, **82**B. In the embodiment shown, the left primary member **81** defines the left front leg **81**A and the left right leg **81**B, the right primary member **82** defines the right front leg **82**A and the right rear leg **82**B. In an alternative embodiment, the left front leg **81**A, left rear leg **81**B, right front leg **82**A and right rear leg **82**B may each be separate components joined together at a bracing member **86**. In the embodiment shown, the structure **80** includes transverse member **87** that extends substantially transversally to the longitudinal axis L from a left end **87**A to a right end **87**B. Each of the four legs **81**A, **82**A, **81**B, **82**B define a respective end via which the structure **80** is secured to the tunnel **60** and sub-frame **70**. More specifically, the left front leg **81**A defines a left front end **81**C secured to one of the front suspensions **45** (FIG. **4**), the left rear leg **81**B defines a left rear end **81**D secured to the tunnel **60**, the right front leg **82**A defines a right front end **82**C secured to the other of the front suspensions **45**, and the right rear leg **82**B defines a right rear end **82**D secured to the tunnel **60**. Moreover, a transverse member **87** is secured to the left and right primary members **81**, **82**. The transverse member **87** is further secured to the sub-frame **70** and is used to secure the structure **80** to the sub-frame **70**.

[0101] In the embodiment shown, a left rear bracket **83** is secured to the left rear end **81**D of the left rear leg **81**B. Similarly, a right rear bracket **84** is secured to the right rear end **82**D of the right rear leg **82**B. The left and right rear brackets **83**, **84** may be made of a second material, such as aluminum, or other suitable materials. The use of aluminum may reduce the weight of the left and right rear brackets **83**, **84** as compared to other materials, for example. The second material of the left and right rear brackets **83**, **84** may be different than the first material of the left and right primary members **81**, **82**. This use of dissimilar materials may provide an improved trade-off between the weight, strength and cost of the structure **80** when compared to a structure made of a uniform material, for example.

[0102] The left and right rear brackets **83**, **84** define flanges for being secured to the side panels **62** of the tunnel **60**. In some embodiments, the aluminum brackets **83**, **84** are casted components, allowing for relatively intricate geometries. In some embodiments, the bracing member **86** may be a forged component, providing increased strength to take on greater loads from the steering column than casted components. In other embodiments, all of brackets **83**, **84** and bracing member **86** may be either casted or forged.

[0103] Referring to FIG. **10**, a cross-sectional view of one of the left and right rear legs **81**B, **82**B, which are hollow and secured to the left and right rear brackets **83**, **84** in the embodiment shown. An adhesive **85** is used to secure the left and right rear brackets **83**, **84** to the left and right rear legs **81**B, **82**B. Put differently, the left and right rear brackets **83**, **84** are secured to the left and right rear legs **81**B, **82**B via the adhesive **85**. The adhesive **85** may be epoxy, acrylic, or any suitable adhesive used for adhesive bonding of metallic materials. The adhesive may be a 2-part system where a resin and a hardener or accelerator is mixed with the resin and left to cure at room temperature. The adhesive may be a 1-part system where the adhesive is oven-cured. The epoxy-based adhesives may provide superior bond strength whereas acrylic adhesives may be more tolerant to imperfection in surface finishes of substrates. In the embodiment shown, using two different materials for the members and the brackets may allow for costs and weight savings. Moreover, the adhesive **85** used for securing the brackets may avoid relying on brazing or welding. Typically, welding or brazing components together impart residual stresses within the materials of these components. To alleviate the residual stresses, the components are subjected to a heat treatment. Thus, securing the brackets via the adhesive **85**, rather than via brazing or welding, may avoid imparting residual stresses within the materials and may avoid having to subject the structure **80** to a heat treatment. This may further reduce costs. The attachment between the brackets and the members may be free of a braze joint and weld joint.

[0104] Referring back to FIGS. **8-9**, in the depicted embodiment, the left primary member **81** extends upwardly in the vertical direction V from the left front end **81**C to a left apex **81**E, downwardly from the left apex **81**E to a left elbow **81**F, and downwardly from the left elbow **81**F to the left rear end **81**D. Similarly, the right primary member **82** extends upwardly in the vertical direction V from the right front end **82**C to a right apex **82**E, downwardly from the right apex **82**E to a right elbow **82**F, and downwardly from the right elbow **82**F to the right rear end **82**D. A distance in the transverse direction T between the left and right primary members **81**, **82** increases from the left and right apexes **81**E, **82**E to the left and right elbows **81**F, **82**F. A second distance D**2** defined between the left and right elbows **81**F, **82**F is greater than the width W**2** (FIG. **5**) of the rear portion **30**B (FIG. **5**) of the battery pack **30** to receive the rear portion **30**B of the battery pack **30** between the left and right rear legs **81**B, **82**B.

[0105] In the present embodiment, the left primary member **81** is secured to the right primary member **82** via bracing member **86**. The bracing member **86** may be made of the second material, which may be aluminum, and secured to the left and right primary members **81**, **82** via the adhesive **85** as described herein above with reference to FIG. **10**. Herein, the bracing member **86** is located proximate the left and right apexes **81**E, **82**E, but may alternatively located at the left and right apexes **81**E, **82**E or at another suitable location.

[0106] Referring to FIG. **6**, a third distance D**3** along the vertical direction V between the left and right elbows **81**F, **82**F and the top panel **61** of the tunnel **60** is greater than a height H of the battery pack **30** taken along the vertical direction V. This may allow the structure **80** to fit over the battery pack **30**, by accommodating its width W**2** and its height H. In the present embodiment, the left and right elbows **81**F, **82**F are substantially longitudinally aligned with the intersection between the front portion **30**A and the rear portion **30**B of the battery pack **30**.

[0107] As shown in FIGS. **8-9**, the structure **80** includes a transverse member **87** that extends substantially transversally to the longitudinal axis L from a left end **87**A to a right end **87**B. The transverse member **87** is secured to both of the left and right primary members **81**, **82** via left and right connecting members **88**, **89** made of the second material, which may be aluminum. An adhesive may be used to bond the left and right connecting members **88**, **89** to both of the left and right primary members **81**, **82**, more specifically, the left and right rear legs **81**B, **82**B, and to the transverse member **87**. The connecting members **88**, **89** may be casted components.

[0108] The left end **87**A of the transverse member **87** is secured to one of the foot rests **63** and the right end **87**B of the transverse member **87** is secured to the other of the foot rests **63**. Thus, the two foot rests **63** may be secured to one another via the transverse member **87**. As illustrated in FIG. **8**, the left and right ends **87**A, **87**B of the transverse member **87** are secured proximate front ends of the foot rests **63** proximate to the sub-frame **70** and to or proximate outer edges of the foot rests **63**. Stated differently, securing locations between the first and second ends **87**A, **87**B of the transverse member **87** and the foot rests **63** are separated from (e.g., disposed as far as possible from) the tunnel **60** thereby increasing a distance between those securing locations. In turn, this may provide an increase stiffness to the foot rests **63**. More specifically, the foot rests **63** are substantially cantilevered from the side panels **62** of the tunnel and, thus, may be subjected to flexion about the longitudinal axis L. Securing both foot rests **63** to the transverse member **87** may reduce this flexion, thereby increasing a perceived stiffness of the foot rests **63** to the user. Moreover, the attachment of the foot rests **63** to the transverse member **87** may create a load path that extends from the tunnel **60**, along the foot rests **63**, to the transverse member **87**, to the structure **80**, and to the front suspensions **45**. The electric snowmobile **10** may thus be better at handling the loads imparted to it during use because of this transverse member **87**.

[0109] Securing the first and second ends **87**A, **87**B of the transverse member **87** to the foot rests **63** may provide room for the front portion **30**A of the battery pack **30**. As noted above, the width W**1** of the front portion **30**A of the battery back **30** may be greater than the width W**2** of the rear portion **30**B, and therefore extending the transverse member **87** beyond the width of the tunnel **60** may provide additional room to accommodate the front portion **30**A within the structure **80**.

[0110] As shown in FIG. **9**, a secondary left member **90** and a secondary right member **91** are used to secure a left leg **87**C of the transverse member **87** to the left rear leg **81**B of the left primary member **81** and to secure a right leg **87**D of the transverse member **87** to the right rear leg **82**B of the right primary member **82**. The secondary left and right members **90**, **91** may increase a stiffness of the structure **80** and, more particularly, may increase a stiffness of the transverse member **87**. Connecting members made of the second material, such as aluminum, may be used to secure the secondary left and right members **90**, **91** to the left and right primary members **81**, **82**. As depicted in FIG. **8**, the left and right members **90**, **91** may be further connected to the sub-frame **70**. The connection between the sub-frame **70** and the left and right legs **87**C and **87**D may assist with countering moment loads exerted on the structure **80** by loads received by the foot rests **63** during riding.

[0111] The structure **80**, including the left and right primary members **81**, **82**, the transverse members **87**, the brackets **83**, **84**, the connecting members **88**, **89**, the bracing member **86**, and the left and right secondary members **90**, **91**, may become a single integral unit. The structure **80** may be secured to the frame **12** at six different locations, each corresponding to a respective one of the ends **81**C, **81**D, **82**C, **82**D, **87**A, **87**B. The structure **80** may be secured to the tunnel **60** and the sub-frame **70** as a whole single unit lowered down over the battery pack **30**.

[0112] In some embodiments, fasteners such as bolts may be used to connect the structure to the tunnel **60** and the sub-frame **70**. For example, each of the ends **81**C, **82**C may include a threaded hole to receive a bolt extending through a respective one of the front suspensions **45** to connect to the front suspensions **45**. The threaded holes may extend axially into the left and right primary members **81**, **82** at the ends **81**C, **82**C, respectively. Similarly, each of the ends **87**A, **87**B may include an threaded hole extending axially into the transverse member **87** at a respective one of the ends **87**A, **87**B. These threaded holes may receive bolts extending through the foot rests **63**. The left and right rear brackets **83**, **84** may also be coupled to the tunnel **60** using fasteners.

[0113] Referring now to FIG. **11**, in the present embodiment, the structure **80** includes shear plates **92** each disposed on a respective side of the structure **80**. The shear plates **92** connect the transverse member **87** to the sub-frame **70**. The shear plates **92** are secured to the left and right legs **87**C, **87**D proximate the left and right ends **87**A, **87**B of the transverse member **87**. The shear plates **92** may limit a deflection of the left and right legs **87**C, **87**D of the transverse member **87** along the longitudinal axis L. Each of the shear plates **92** may be secured to a respective one of the left and right legs **87**C, **87**D of the transverse member **87** at three securing locations distributed vertically along a length of the left and right legs **87**C, **87**D. Any suitable number of securing locations is contemplated. Each of the shear plates **92** may be secured to the sub-frame along perimeters of the shear plates **92**.

[0114] In the present embodiment, the structure **80** may be removed from the sub-frame **70** and the tunnel **60** to access the battery pack **30**. This may be useful if a replacement or repair of the battery pack **30** is required. To assemble the electric snowmobile **10**, the battery pack **30** may be disposed over the tunnel **60** and the sub-frame **70**. Then, the structure **80** may be lowered vertically over the battery pack **30** and be secured to the tunnel **60** and sub-frame **70**. As explained above, the two elbows of the structure **80** are sufficiently spaced apart and elevated to accommodate the battery pack **30**.

[0115] Still referring to FIG. **11**, in the embodiment shown, the steering column **19** defines a bend or elbow **19**A to accommodate the front portion **30**A of the battery pack **30**. This may allow to increase a size of the battery pack **30** without interference with the steering column **19**.

[0116] Referring now to FIG. **12**, an alternate embodiment of the structure is shown at **180**. For the sake of conciseness, only features differing from the structure **80** described above are described below.

[0117] The structure **180** includes the left and right primary members **81**, **82** defining the four legs **81**A, **81**B, **82**A, **82**B. The left and right primary members **81**, **82** are secured together via two secondary transverse members **181**, **182** extending generally transversally to the longitudinal axis L.

[0118] Referring now to FIG. **13**, an alternate embodiment of the structure is shown at **280**. For the sake of conciseness, only features differing from the structure **80** described above are described below.

[0119] The structure **280** includes the left and right primary members **281**, **282** defining the four legs **81**A, **81**B, **82**A, **82**B. In the embodiment shown, the left and right primary members **281**, **282** are secured together at an apex **281**A of the structure **280**. In other words, the left and right primary members **281**, **282** cross one another at the apex **281**A. The left and right primary members **281**, **282** are secured together via two secondary transverse members **283**, **284** extending generally transversally to the longitudinal axis L. The two secondary transverse members **283**, **284** are located above one another and may be parallel to one another.

[0120] Referring now to FIG. **14**, an alternate embodiment of the structure is shown at **380**. For the sake of conciseness, only features differing from the structure **80** described above are described below.

[0121] The structure **380** includes the two primary members **381**, **382** defining the four legs **81**A, **81**B, **82**A, **82**B. In the embodiment shown, the two primary members **381**, **382** are offset from one another relative to the longitudinal axis L and define U-shapes and apexes **381**A, **382**A. The two primary members **381**, **382** are secured together at their apexes **381**A, **382**A via a plate **383**. The two primary members **381**, **382** are secured together via a secondary transverse members **384** extending generally transversally to the longitudinal axis L.

[0122] In some embodiments, two or more members of the structures **180**, **280**, **380** may be secured together using fasteners, welds and/or adhesives. Optionally, brackets may be used to help secure the members.

[0123] Referring now to FIGS. **15-18**, an embodiment of a heat exchanger is shown at **102**. The heat exchanger **102** is herein mounted to the bulkhead **71** of the sub-frame **70**. The heat exchanger **102** may be removable from the bulkhead **71**. The heat exchanger **102** faces the spacing that is defined by the tunnel **60** and that receives the drive track **15** (FIG. **1**). The heat exchanger **102** may thus be exposed to snow and cold air circulating around the drive track **15**. The heat exchanger **102** covers a major portion of a surface of the bulkhead **71** exposed to the spacing. In the embodiment shown, the heat exchanger **102** covers more than 50%, and optionally as much as 90% of the surface of the bulkhead **71** exposed to the spacing.

[0124] Referring more particularly to FIGS. **17-18**, the heat exchanger **102** includes two plates namely a first plate **103** and a second plate **104** mounted to the first plate **103**. The first plate **103** is mounted to the bulkhead **71**. The first plate **103** may contact the bulkhead **71**. The bulkhead **71** may include a cut-out portion at a location where the heat exchanger **102** is positioned. As such, the first plate **103** is mounted to the bulkhead **71** along its periphery such that the first plate **103** forms the surface of the bulkhead **71** that faces the motor **26**. The second plate **104** is secured to the first plate **103** and may be sealingly engaged to the first plate **103**. The second plate **104** is exposed to the spacing receiving the drive track **15**. The second plate **104** is embossed to define one or more channels **105** for flowing the liquid coolant of the cooling system **100** (FIG. **1**). The one or more channels **105** is thus defined between the first plate **103** and the second plate **104**. The one or more channels **105** is in fluid flow communication with an inlet **1021** of the exchanger **102** and with an outlet **1020** of the heat exchanger **102**. The inlet **1021** and the outlet **1020** of the heat exchanger **102** are in fluid flow communication with the liquid coolant circuit **101** (FIG. **1**) of the electric snowmobile **10**.

[0125] In use, the liquid coolant flows through the different components (e.g., electric motor **26**, battery pack **30**) to pick up heat from said components. The liquid coolant then flows through the one or more channels **105** of the heat exchanger **102** via the inlet **1021** and outlet **1020**. Heat of the liquid coolant may be transferred to ambient air via the one or more channels **105**, via internal convection within the one or more channels **105**, conduction through the second plate **104**, and external convection with the ambient air.

[0126] As better illustrated in FIG. **15**, the first and second plates **103**, **104** of the heat exchanger **102** are secured to the bulkhead **71** at a plurality of locations **106** distributed around perimeters of the first and second plates **103**, **104**. The heat exchanger **102** may therefore increase a stiffness of the bulkhead **71**. The first and second plates **103**, **104** may be made of a metallic material, such as stainless steel or aluminum, and may each have a thickness of about 1.6 mm.

[0127] The disclosed frame **12** and structure **80** of the electric snowmobile **10** may provide the necessary stiffness and may be lighter than existing snowmobile configurations. It may be more cost efficient and easier to manufacture. The stiffness in torsion of the tunnel **60** may be improved by the battery pack **30**, and more particularly by the bottom panel **54** of said battery pack **30**. The structure **80** may be adequately sized to accommodate the battery pack **30** while providing the required stiffness.

[0128] In the context of the present disclosure, the expression "about" includes variations of plus or minus 10%.

[0129] The embodiments described in this document provide non-limiting examples of possible implementations of the present technology. Upon review of the present disclosure, a person of ordinary skill in the art will recognize that changes may be made to the embodiments described herein without departing from the scope of the present technology. Yet further modifications could be implemented by a person of ordinary skill in the art in view of the present disclosure, which modifications would be within the scope of the present technology.

1. An electric snowmobile, comprising:

a frame extending along a longitudinal axis between a front end and a rear end of the frame, the frame including a tunnel at least partially enclosing a spacing receiving a drive track, a sub-frame disposed forward of the tunnel relative to the longitudinal axis, the sub-frame supporting a front suspension;

an electric motor mounted to the frame;

a battery pack mounted over the tunnel and at least partially disposed rearward of the electric motor relative to the longitudinal axis, the battery pack having a front portion and a rear portion, a width of the front portion relative to a transverse direction normal to the longitudinal axis being greater than a width of the rear portion; and

a structure disposed over the sub-frame and over the front portion of the battery pack, the structure defining at least four legs ending at four ends, the at least four legs including two front legs secured to the front suspensions and two rear legs secured to the tunnel, each of the two rear legs defining a respective one of two elbows and a respective one of two rear ends of the four ends, the two elbows located above the two rear ends, a distance along the transverse direction between the two elbows being greater than the width of the rear portion of the battery pack to receive the rear portion between the two rear legs.

2. The electric snowmobile of claim **1**, wherein a distance along a vertical direction being normal the transverse direction between the two elbows and a top wall of the tunnel is greater than a height of the battery pack taken along the vertical direction.

3. The electric snowmobile of claim **1**, wherein the two elbows are located at an intersection between the front portion and the rear portion of the battery pack.

4. The electric snowmobile of claim **1**, wherein the at least four legs are defined by two members each extending upwardly from a front end to an apex and downwardly from the apex to a respective one of the two rear ends.

5. The electric snowmobile of claim **4**, wherein the two members are secured to one another proximate the apexes.

6. The electric snowmobile of claim **5**, wherein the structure includes a bracing member connecting the two members.

7. The electric snowmobile of claim **1**, wherein the structure includes a transverse member extending substantially transversally to the longitudinal axis from a left end to a right end, the transverse member secured to the two rear legs.

8. The electric snowmobile of claim **7**, comprising a left foot rest secured to a left side of the tunnel and a right foot rest secured to a right side of the tunnel, the left foot rest and the right foot rest extending along the longitudinal axis from the sub-frame towards the rear end of the frame, the left end of the transverse member secured to the left foot rest proximate the sub-frame, the right end of the transverse member secured to the right foot rest proximate the sub-frame.

9. The electric snowmobile of claim **7**, wherein the transverse member is secured to two rear legs via connecting members.

10. The electric snowmobile of claim **7**, comprising a left shear plate connecting the transverse member to the sub-frame and a right shear plate connecting the transverse member to the sub-frame.

11. An electric snowmobile, comprising:

a frame extending along a longitudinal axis between a front end and a rear end of the frame, the frame including a tunnel at least partially enclosing a spacing receiving a drive track, and a sub-frame disposed forward of the tunnel relative to the longitudinal axis, the sub-frame supporting a front suspension;

an electric motor mounted to the frame; and

a structure disposed over the sub-frame, the structure including members interconnected to one another, the members made of a first material, a bracket secured to an end of a member of the members via an adhesive, the bracket secured to the tunnel, the bracket made of a second material different than the first material.

12. The electric snowmobile of claim **11**, wherein the first material is steel and the second material is aluminum.

13. The electric snowmobile of claim **11**, wherein the adhesive is one or more of an epoxy and an acrylic.

14. The electric snowmobile of claim **11**, wherein the structure defines two fore ends and two rear ends, the bracket including two brackets each secured to a respective one of the two rear ends, the two brackets secured to the tunnel.

15. The electric snowmobile of claim **11**, wherein the structure defines two fore ends each secured to a respective one of a right suspension and a left suspension of the front suspension.

16. The electric snowmobile of claim **11**, wherein the members include a left member extending upwardly from a front left end to a left apex and from the left apex downwardly to a rear left end, a right member extending upwardly from a front right end to a right apex and downwardly from the right apex to a rear right end.

17. The electric snowmobile of claim **16**, wherein the right member is secured to the left member proximate the left apex and the right apex.

18. The electric snowmobile of claim **16**, wherein the structure includes a bracing member connecting the left member to the right member, the bracing member secured to the left member proximate or at the left apex and secured to the right member proximate or at the right apex.

19. The electric snowmobile of claim **16**, wherein the structure includes a transverse member extending substantially transversally to the longitudinal axis from a left end to a right end, the transverse member secured to the left member and to the right member.

20. The electric snowmobile of claim **19**, comprising a left foot rest secured to a left side of the tunnel and a right foot rest secured to a right side of the tunnel, the left foot rest and the right foot rest extending along the longitudinal axis from the sub-frame towards the rear end of the frame, the left end of the transverse member secured to the left foot rest proximate the sub-frame, the right end of the transverse member secured to the right foot rest proximate the sub-frame.

21. The electric snowmobile of claim **19**, wherein the transverse member is secured to the left member and to the right member via left and right connecting members made of the second material, the left and right connecting members secured to the transverse member and to the left and right members via the adhesive.

22. The electric snowmobile of claim **19**, wherein the left member defines a left elbow and the right member defines a right elbow, the transverse member secured to the left member proximate or at the left elbow and secured to the right member proximate or at the right elbow.

23. The electric snowmobile of claim **19**, comprising a left shear plate connecting the transverse member to the sub-frame and a right shear plate connecting the transverse member to the sub-frame.

24. A structure for an electric snowmobile having a battery pack having a front portion and a rear portion, a width of the front portion relative to a transverse direction normal to a longitudinal axis of the electric snowmobile being greater than a width of the rear portion, the structure comprising:

two front legs to secure to front suspensions of the electric snowmobile; and

two rear legs to secure to a tunnel of the electric snowmobile, each of the two rear legs defining a respective one of two elbows and a respective one of two rear ends, the two elbows located above the two rear ends, a distance along the transverse direction between the two elbows being greater than a width of the rear portion of the battery pack to receive the rear portion between the two rear legs.

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