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(54) **ELECTRIC SNOWMOBILE**

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(73) Assignee: **Polaris Industries Inc.**, MN, MN (US)

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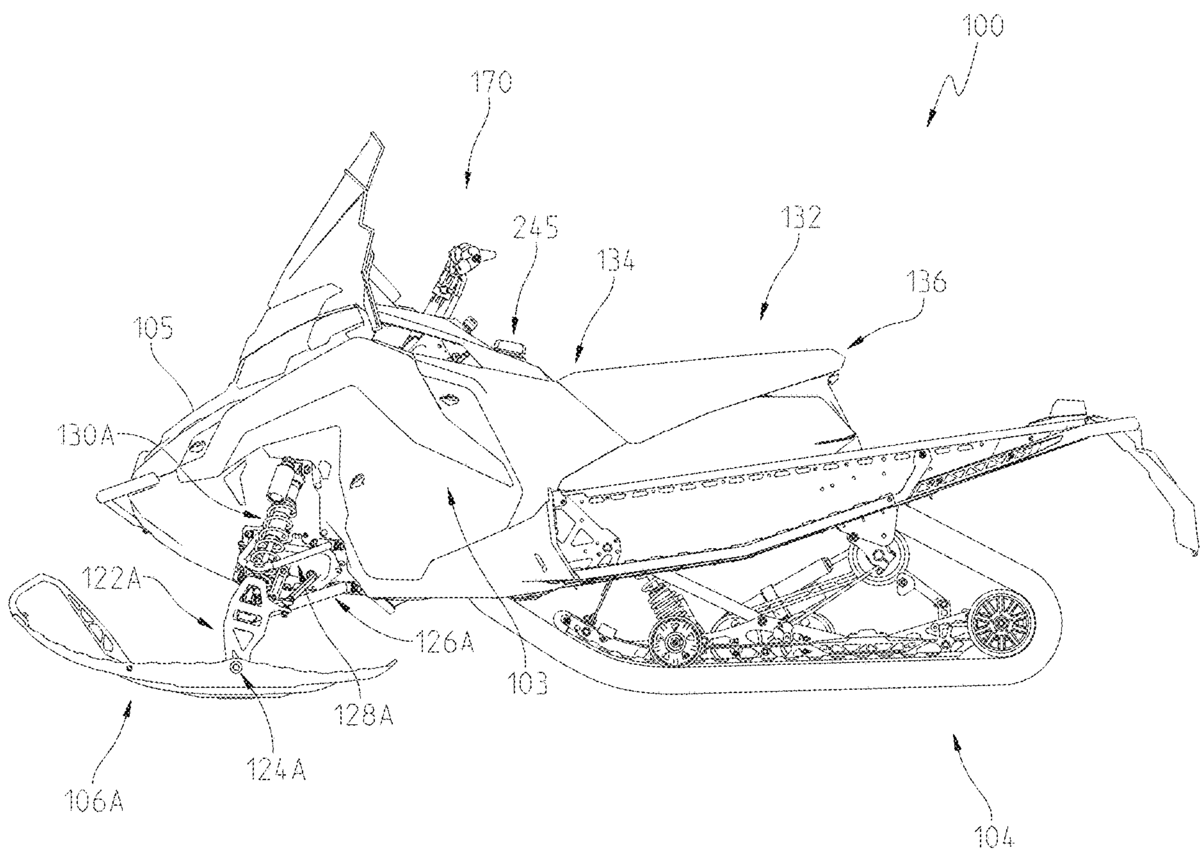
CPC ***B62M 27/02*** (2013.01); ***B62J 43/16*** (2020.02); ***B62J 43/28*** (2020.02); *B62M 2027/027* (2013.01); *B62M 2027/028* (2013.01)

(57) **ABSTRACT**

A snowmobile may have an electric powertrain. The electric powertrain may include one or more electric motors to power movement of one or more endless tracks. The electric powertrain may include a plurality of battery assemblies. At least one of the plurality of battery assemblies may be part of a structural frame of the snowmobile. At least one of the plurality of battery assemblies may be supported by a tunnel of the snowmobile.



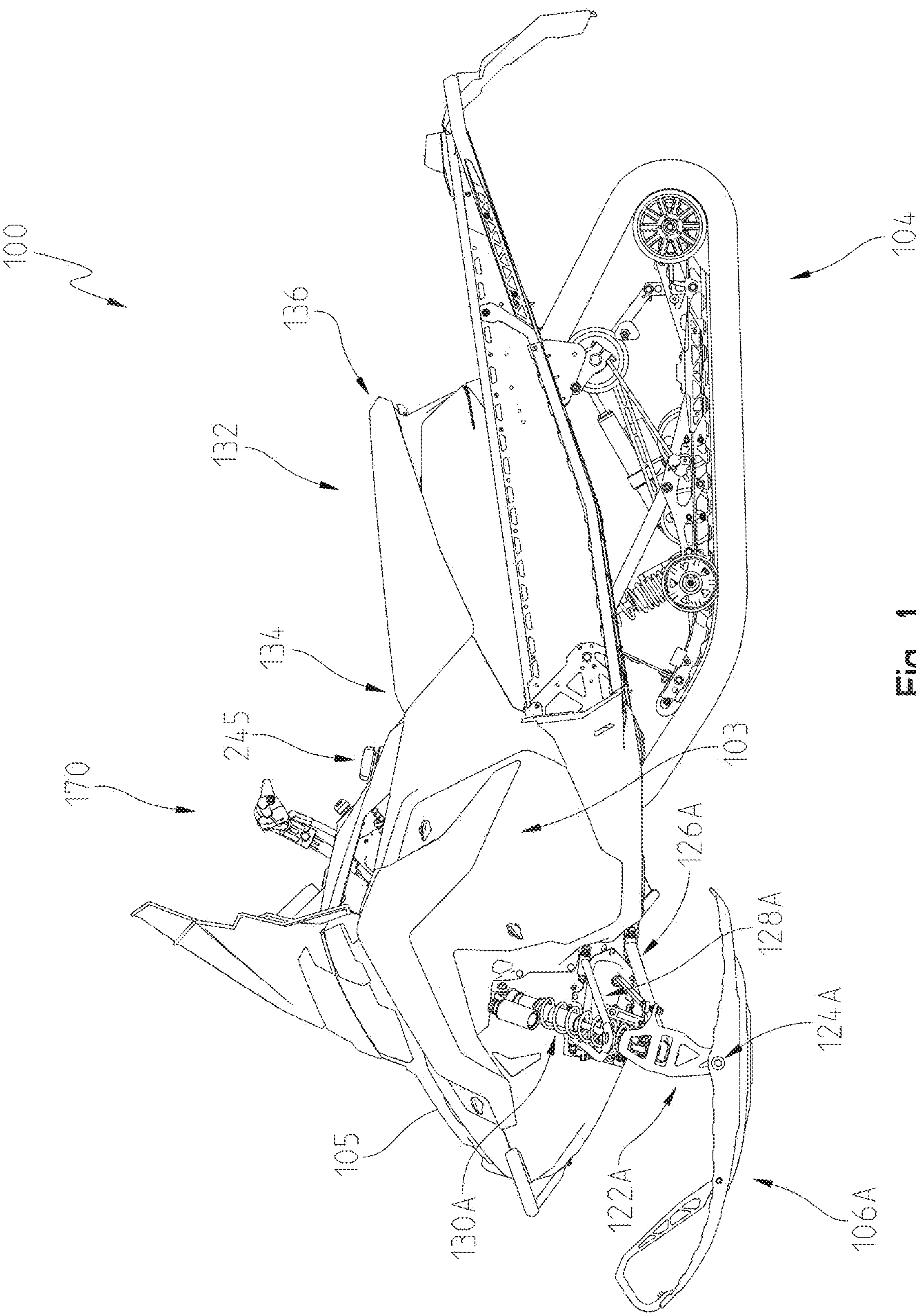

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Fig. 1

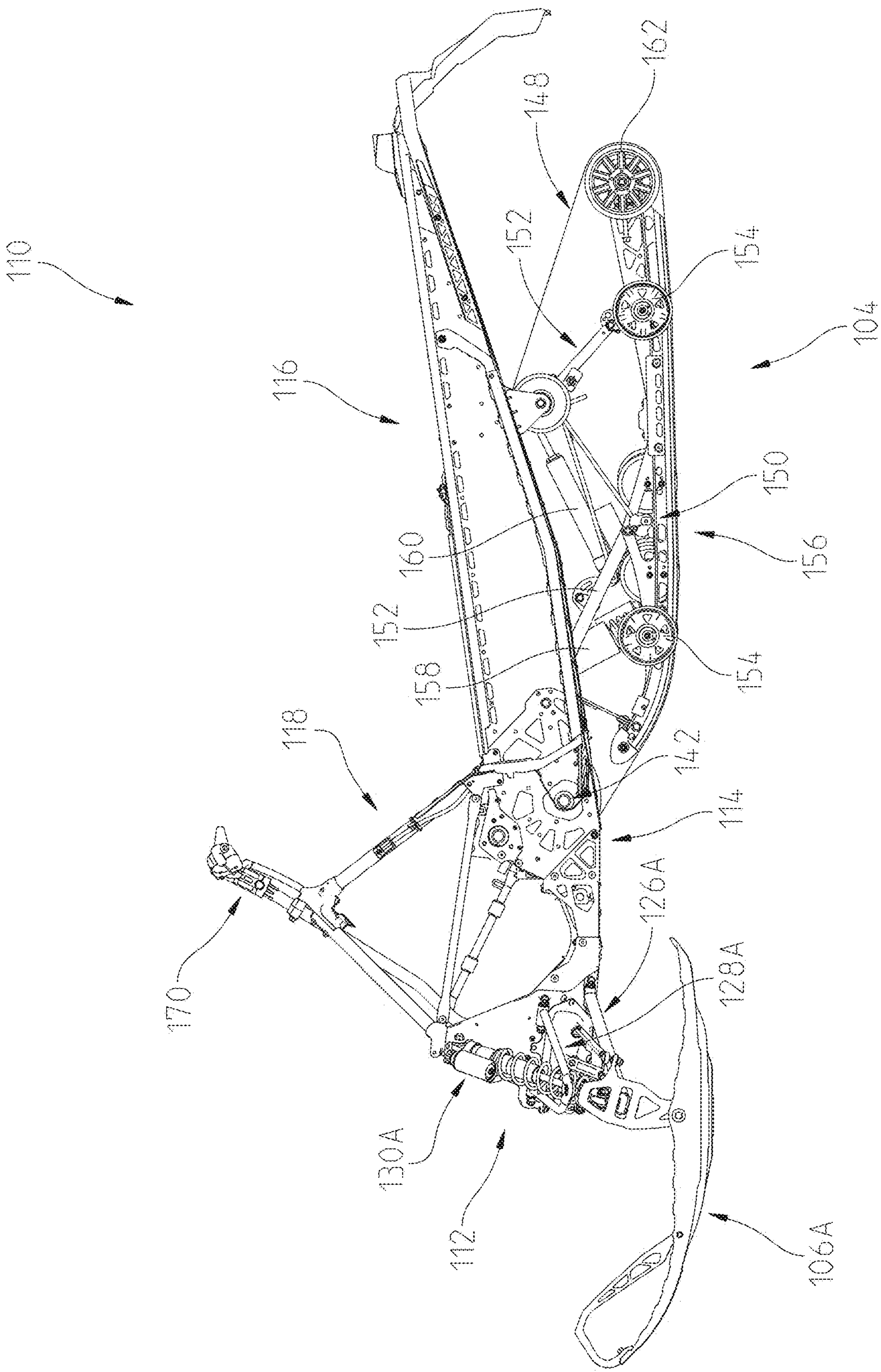
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Fig. 2

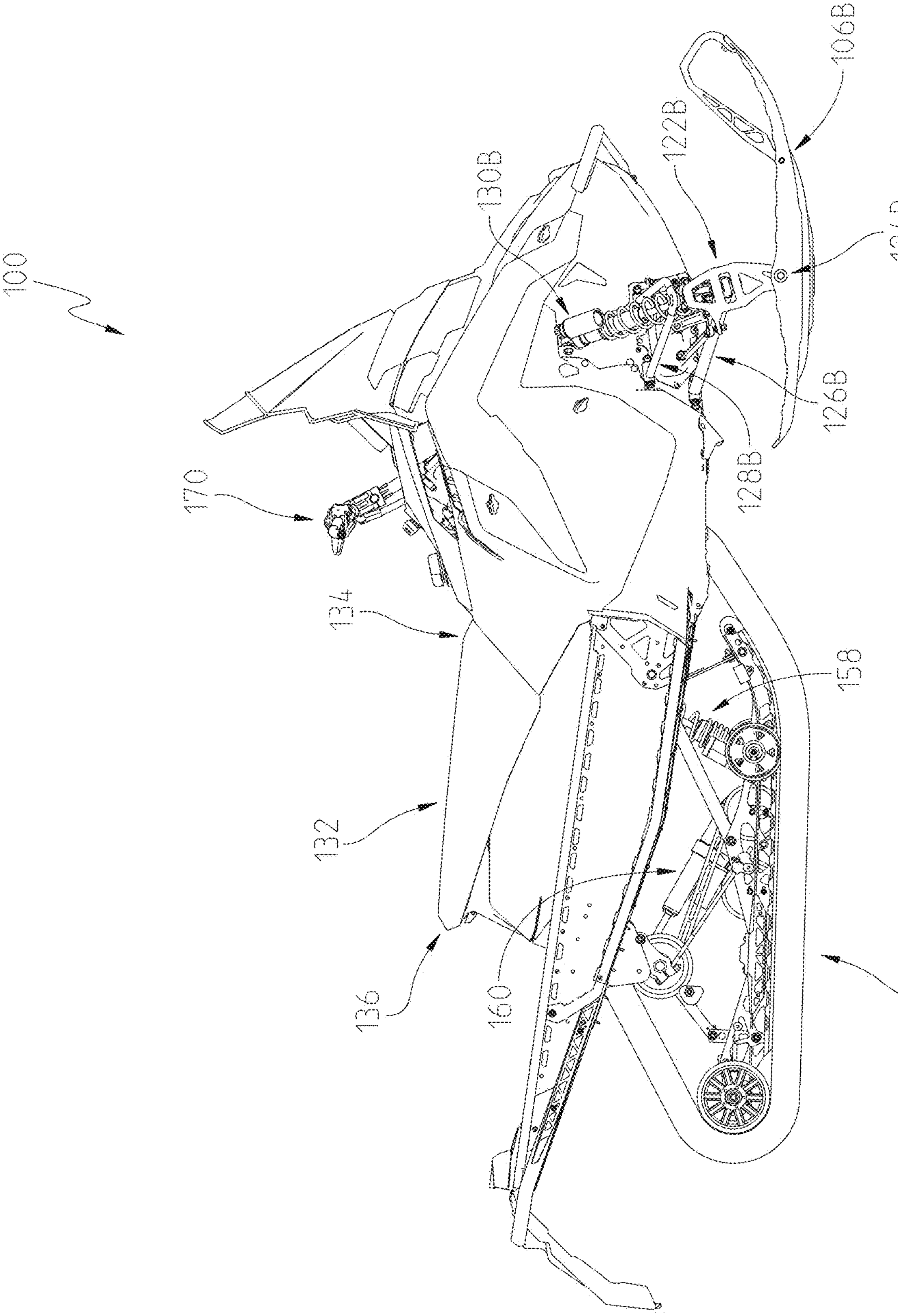


Fig. 3

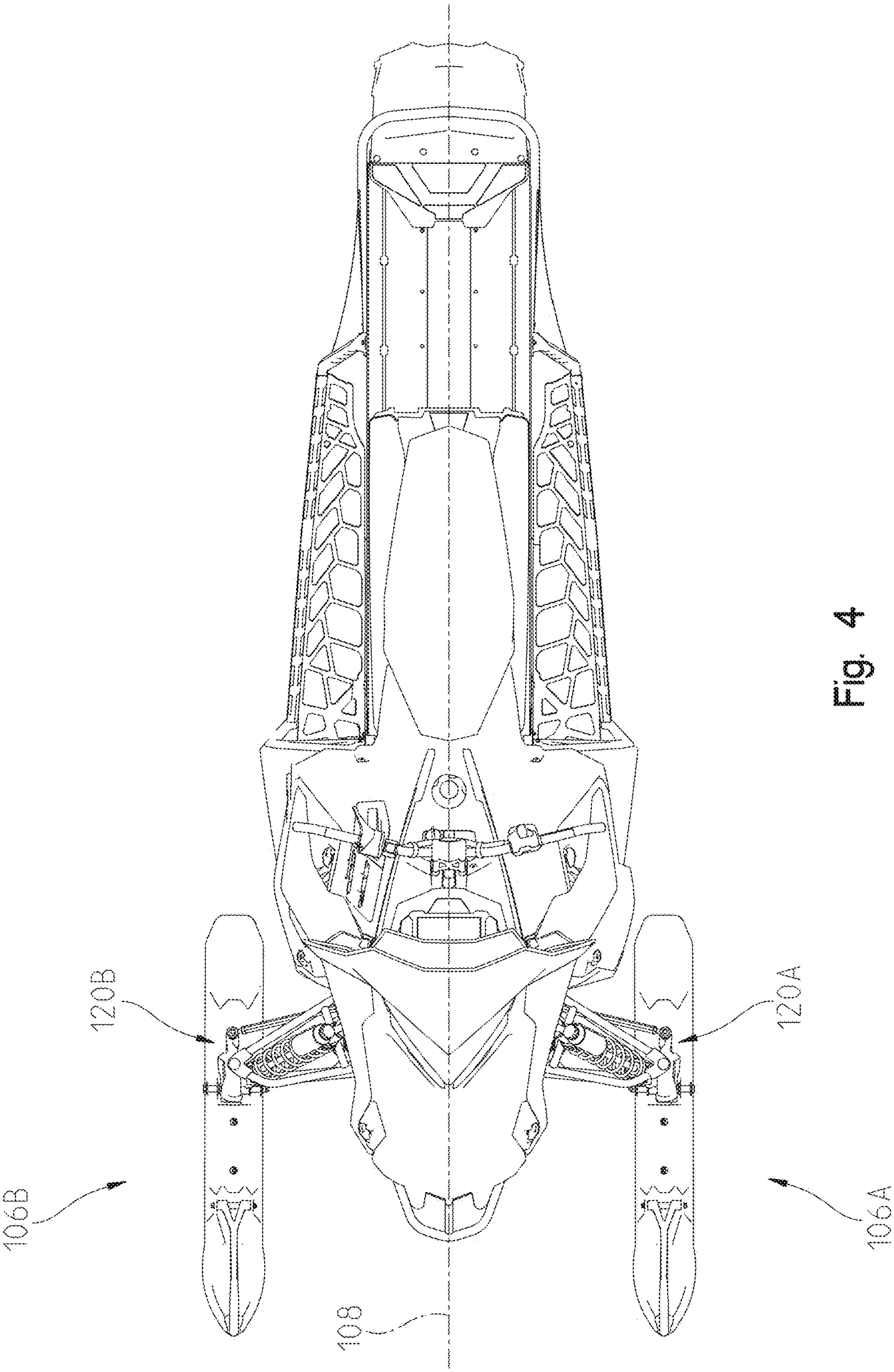


Fig. 4

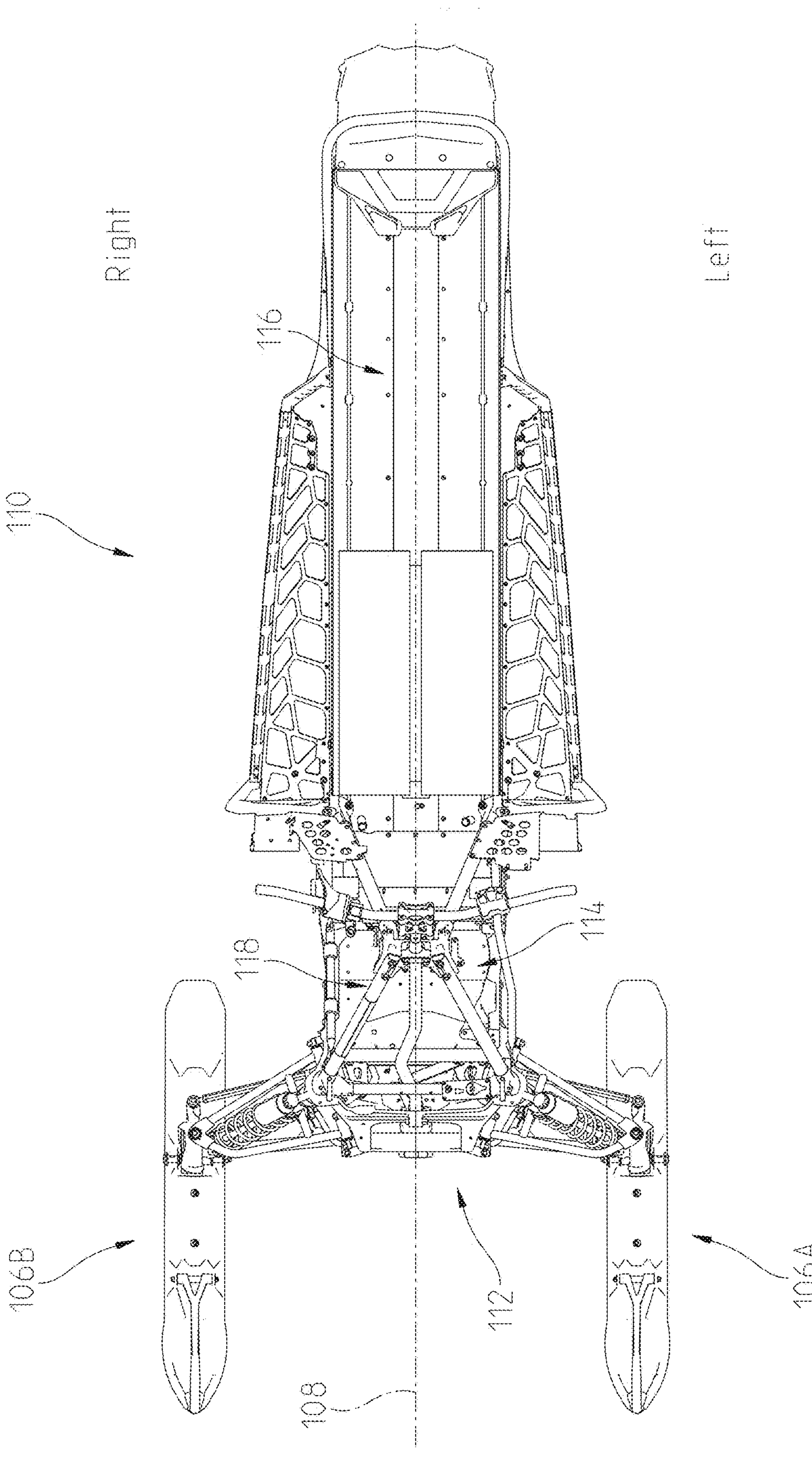


Fig. 5

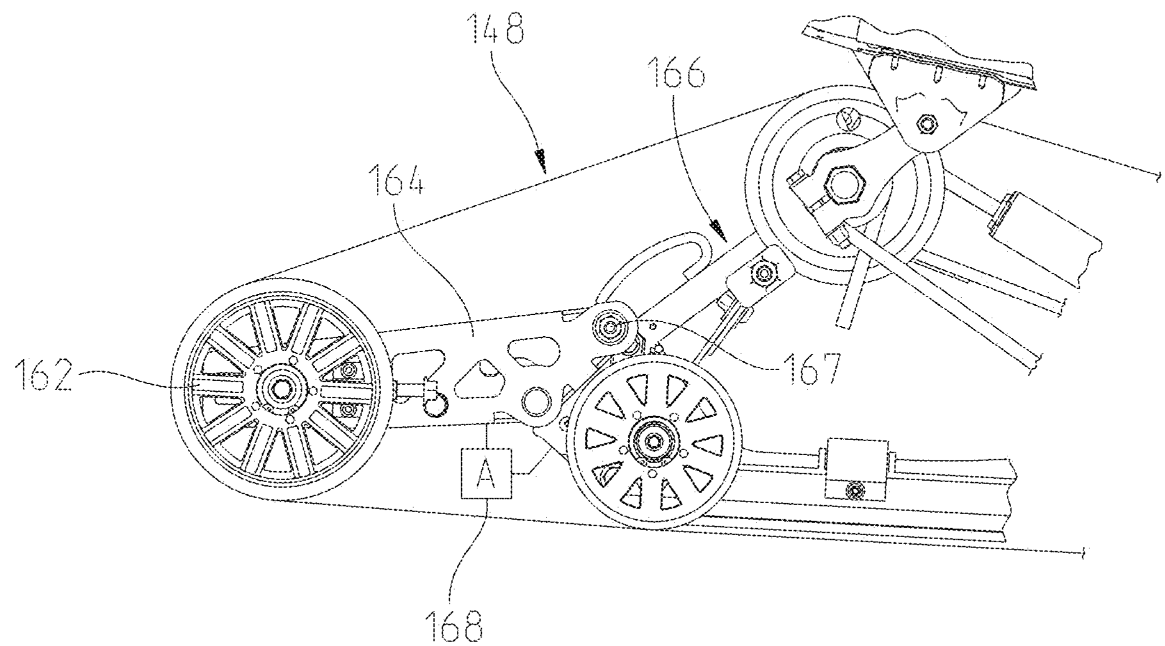


Fig. 6

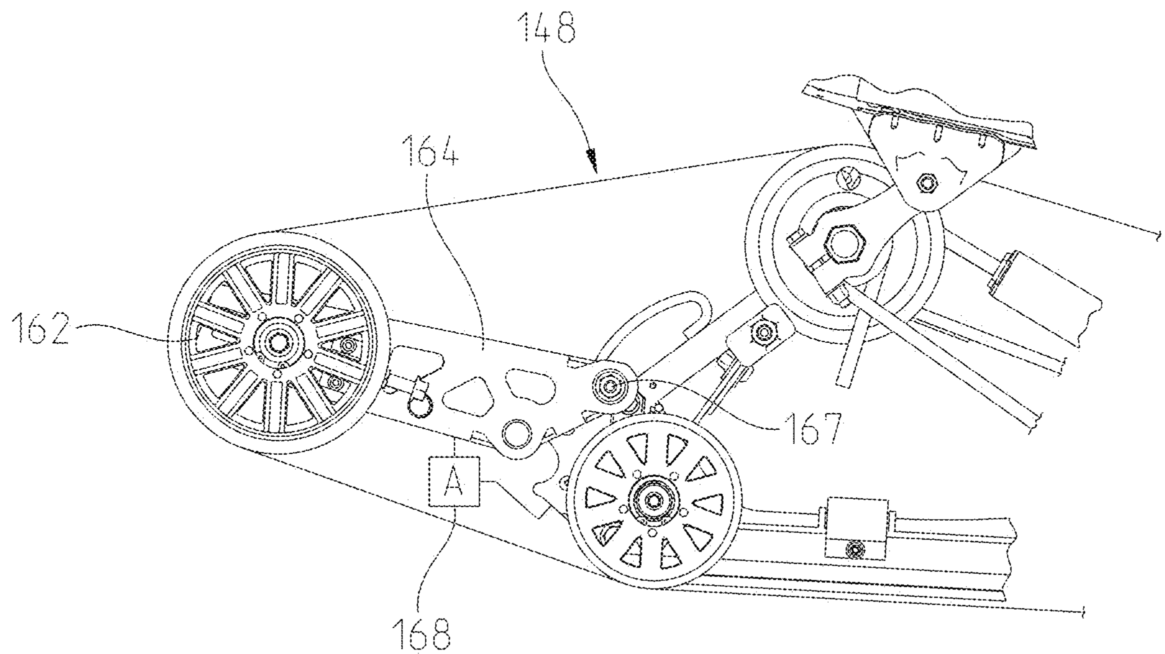


Fig. 7

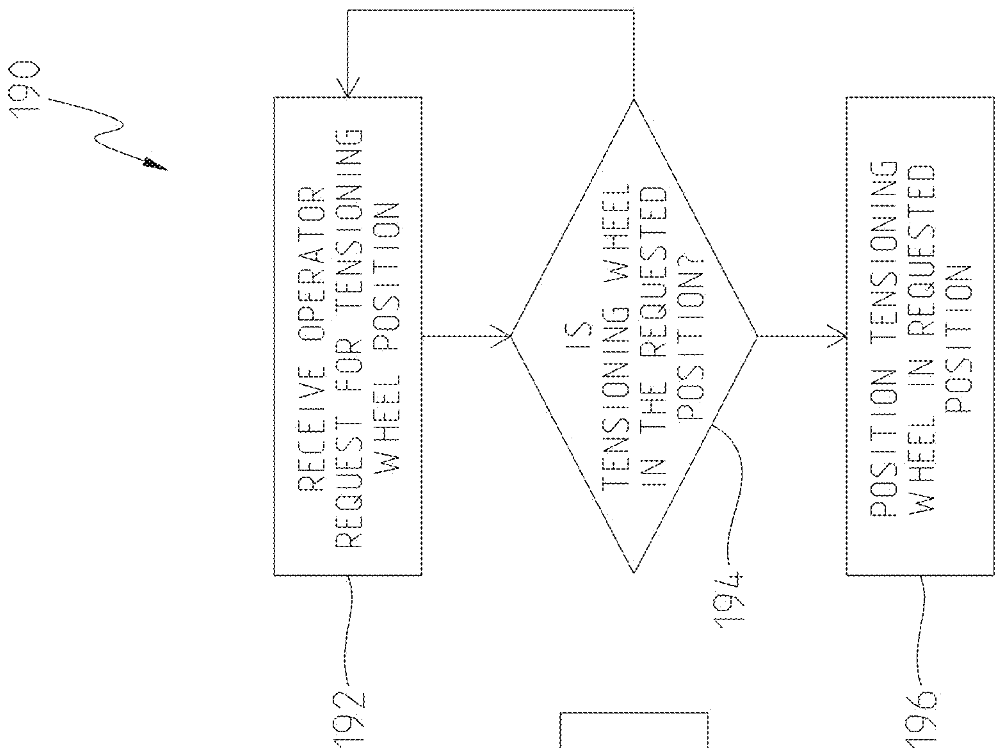

190
RECEIVE OPERATOR REQUEST FOR TENSIONING WHEEL POSITION
192
IS TENSIONING WHEEL IN THE REQUESTED POSITION?
194
POSITION TENSIONING WHEEL IN REQUESTED POSITION
196

Fig. 9

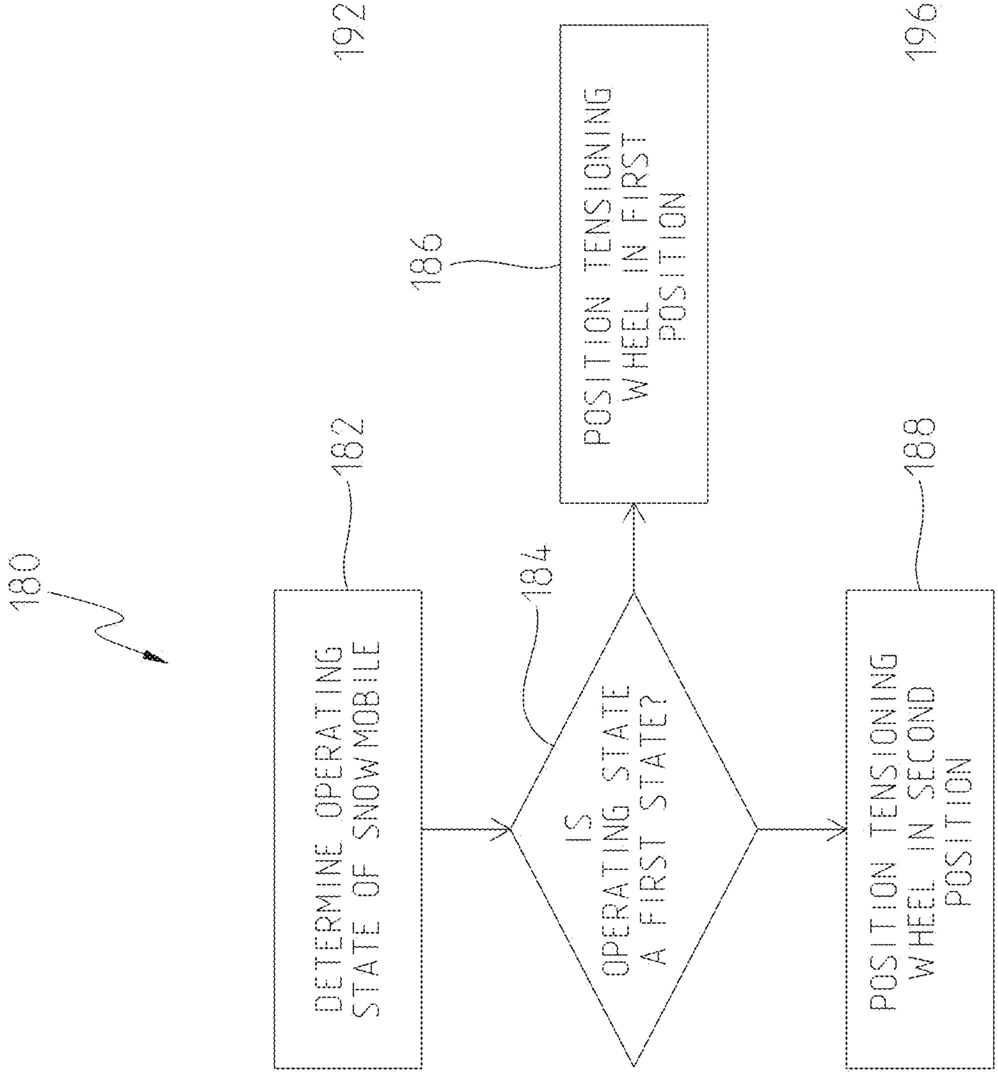
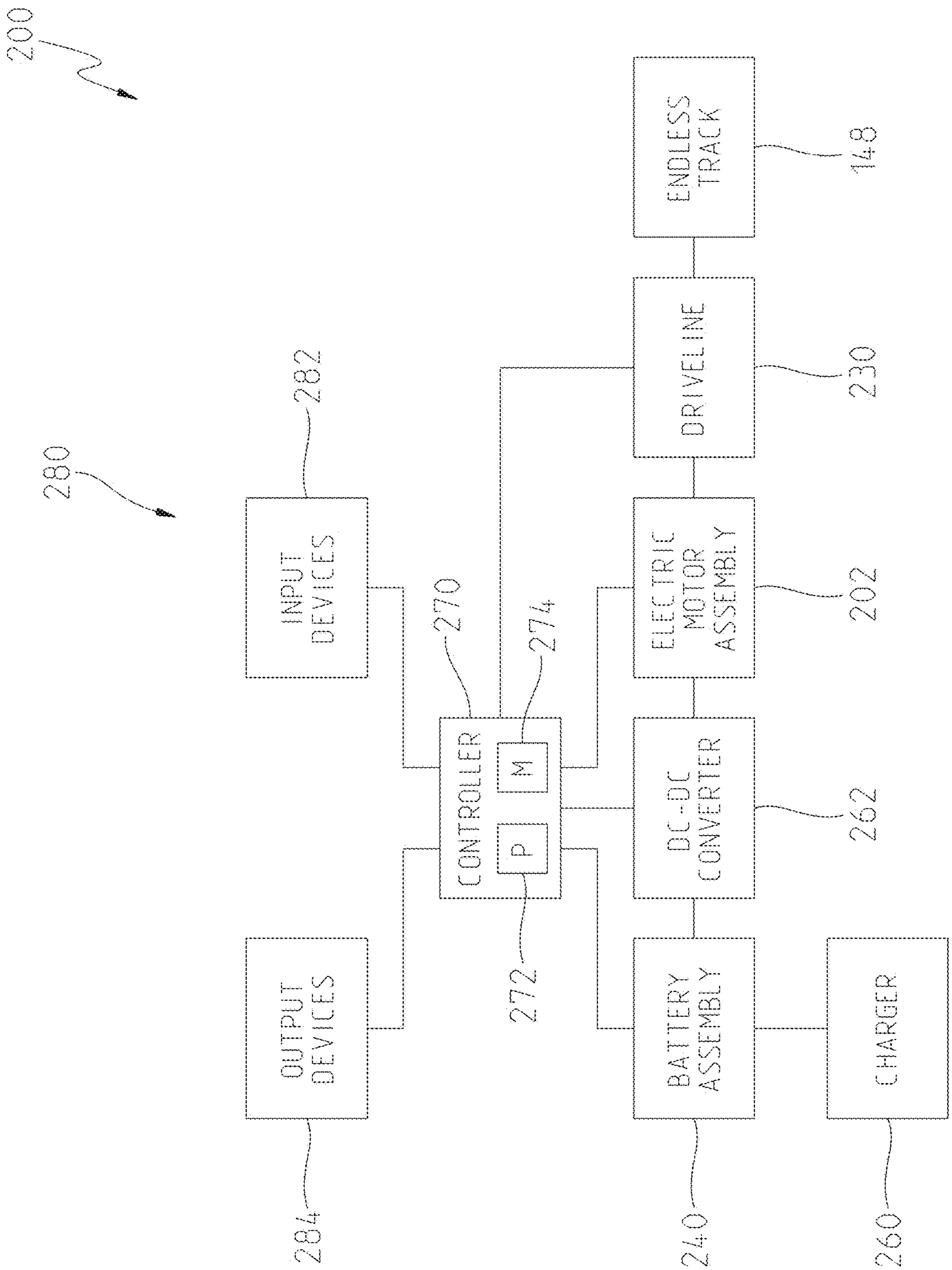

180
DETERMINE OPERATING STATE OF SNOWMOBILE
182
IS OPERATING STATE A FIRST STATE?
184
POSITION TENSIONING WHEEL IN FIRST POSITION
186
POSITION TENSIONING WHEEL IN SECOND POSITION
188

Fig. 8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INPUT DEVICES
282
OUTPUT DEVICES
284
CONTROLLER
270
P
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M
274
ENDLESS TRACK
148
DRIVELINE
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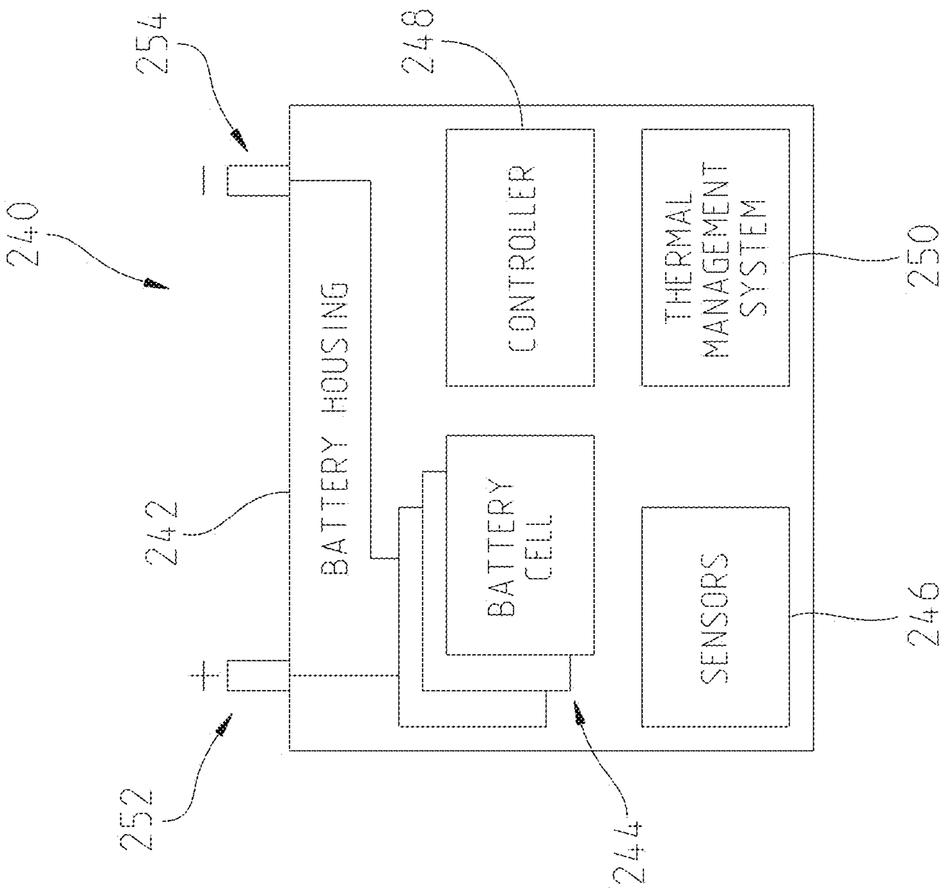
ELECTRIC MOTOR ASSEMBLY
202
DC-DC CONVERTER
262
BATTERY ASSEMBLY
240
CHARGER
260

Fig. 10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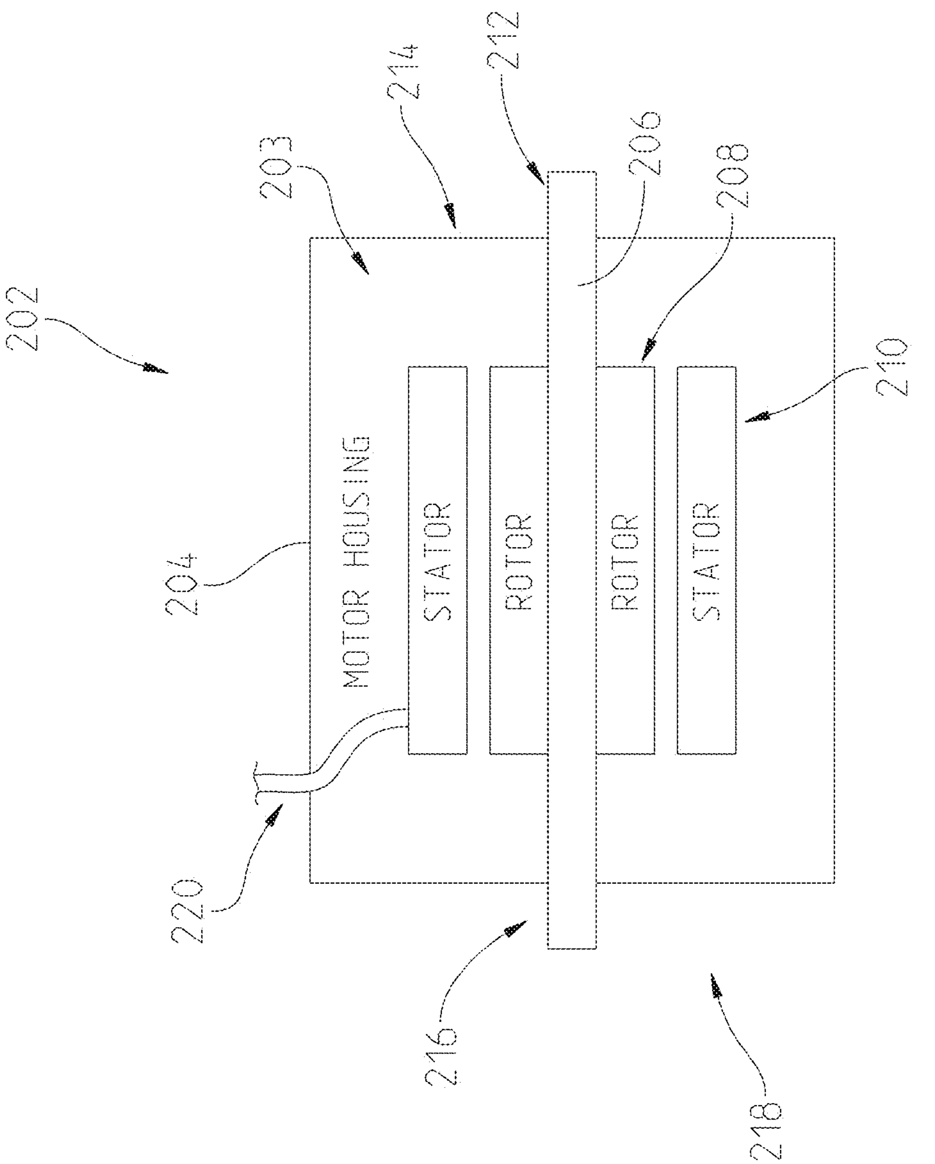
BATTERY HOUSING
CONTROLLER
THERMAL MANAGEMENT SYSTEM
BATTERY CELL
SENSORS

Fig. 11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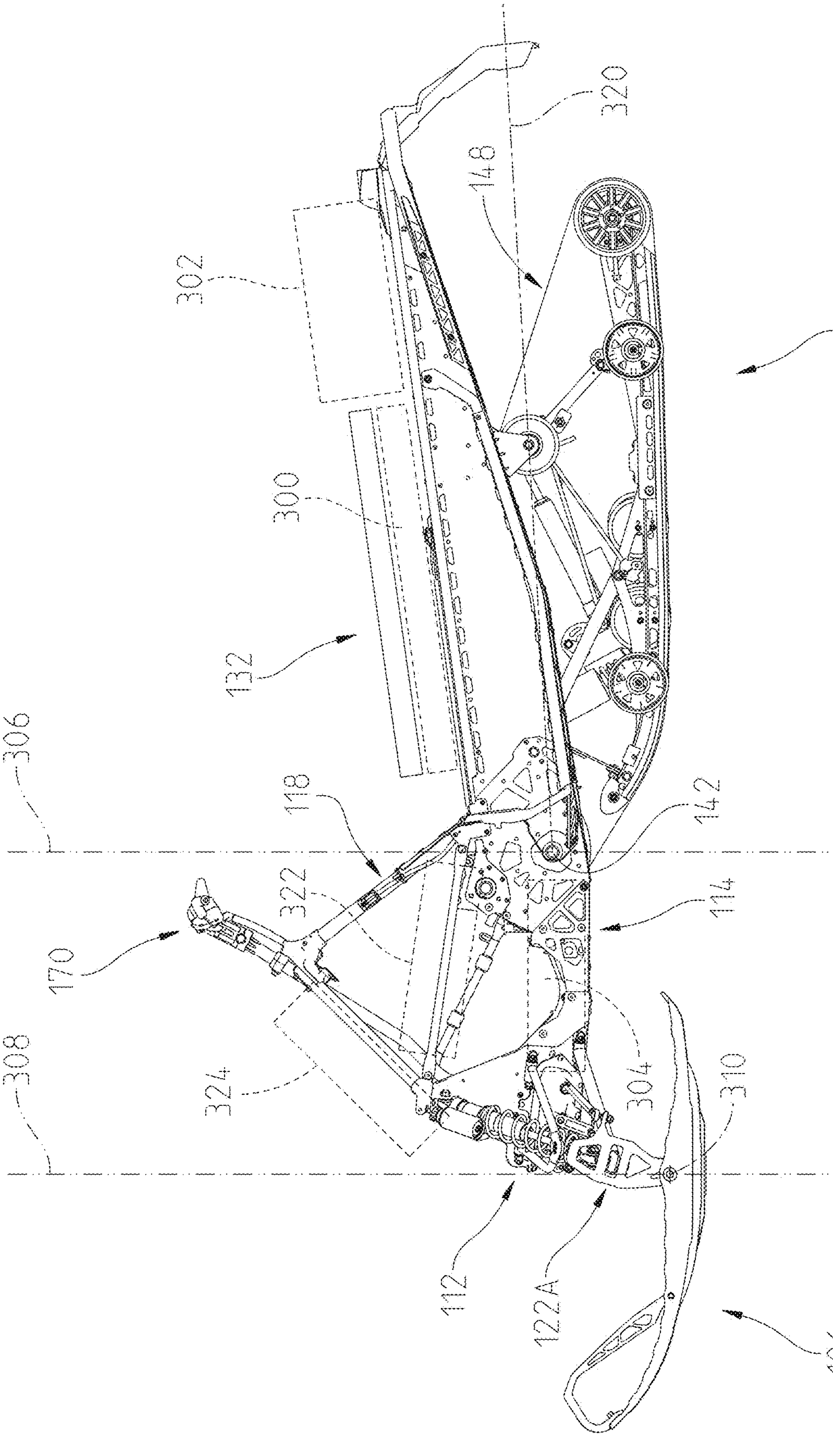
MOTOR HOUSING
STATOR
ROTOR
ROTOR
STATOR

Fig. 12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122A
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Fig. 13

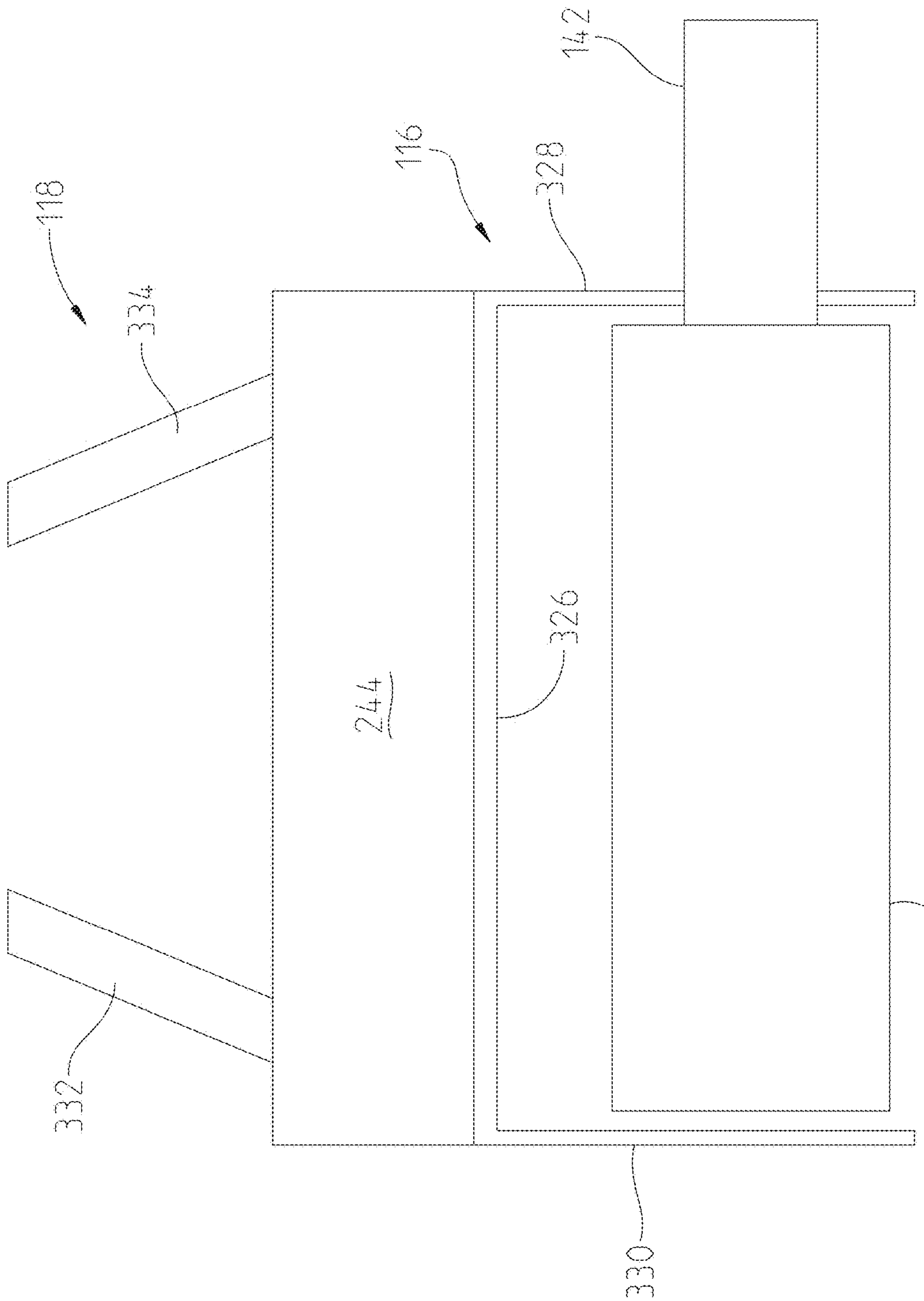
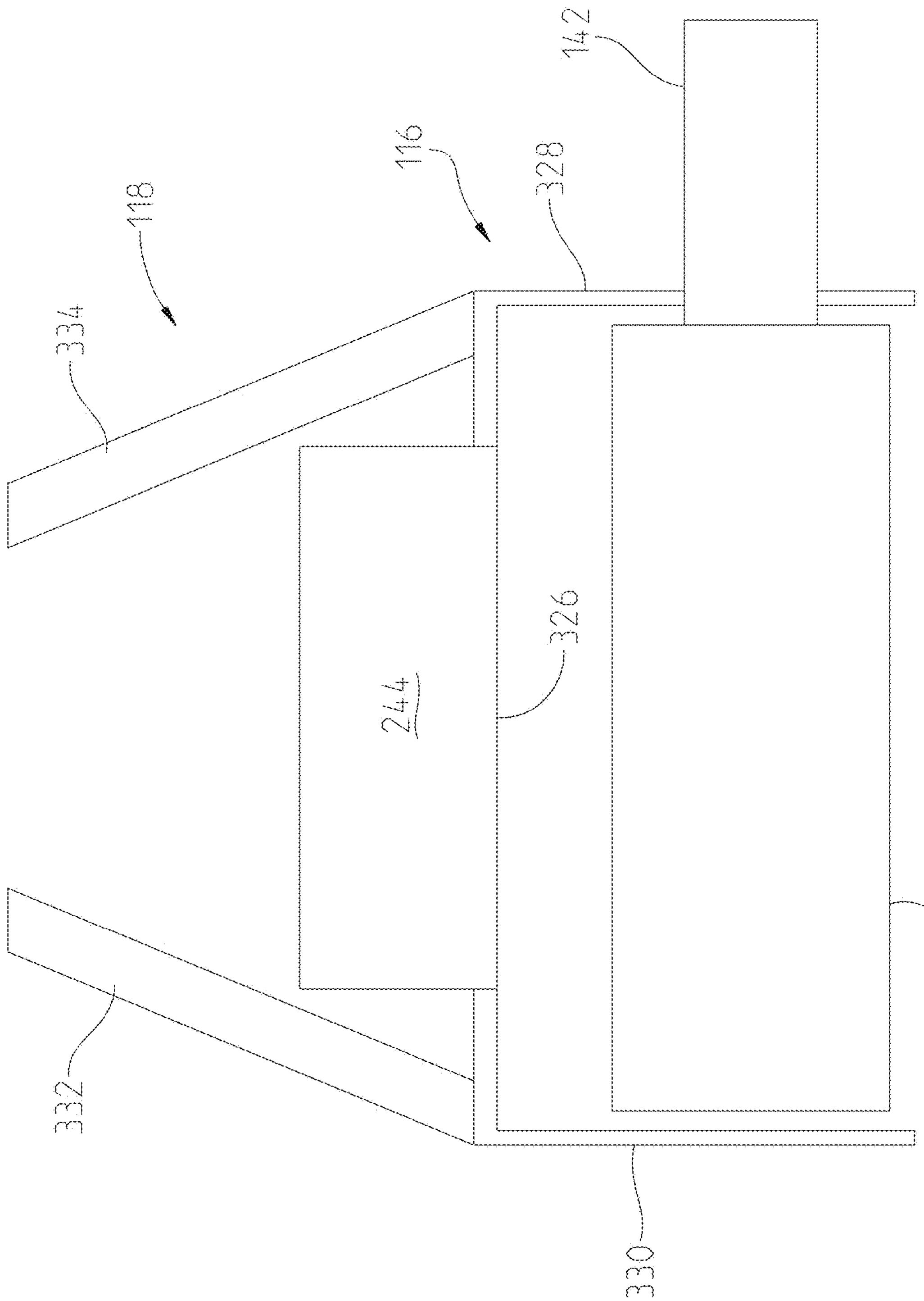


Fig. 14



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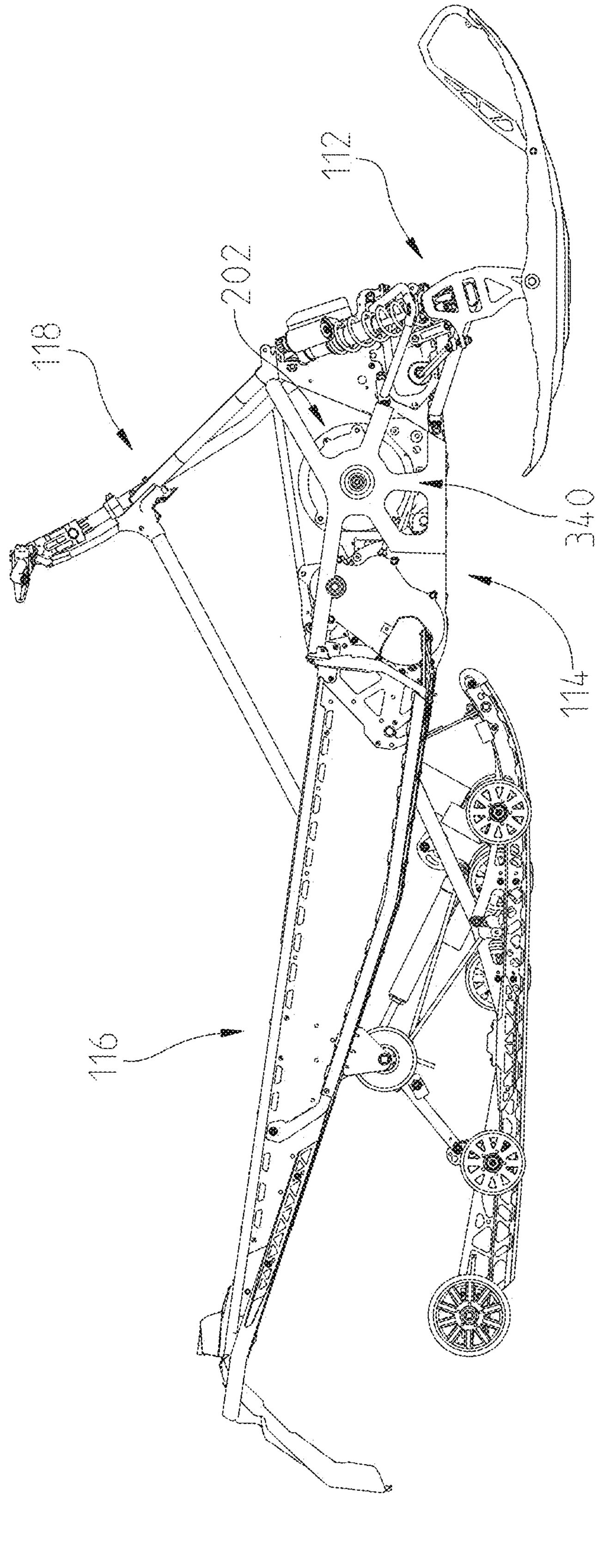

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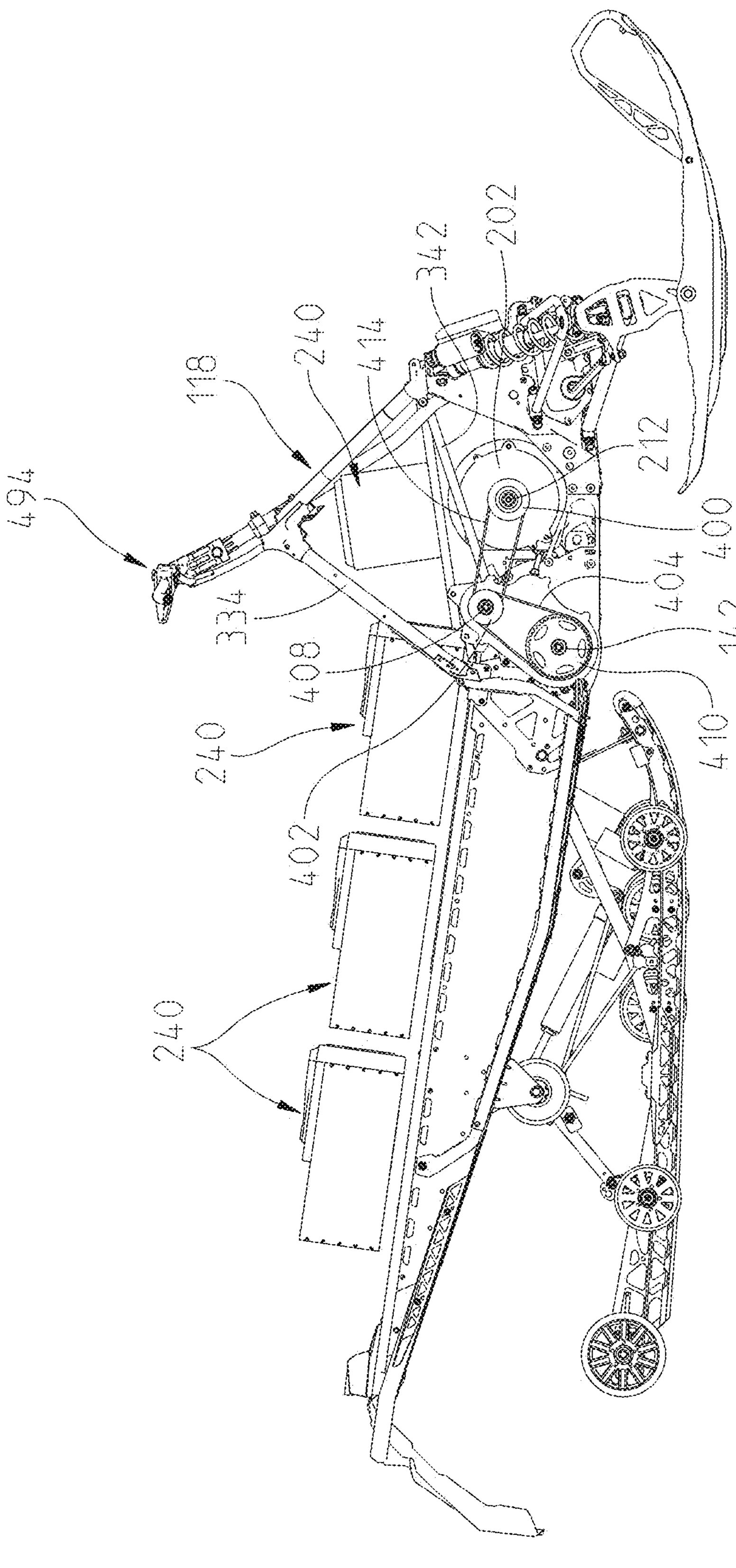

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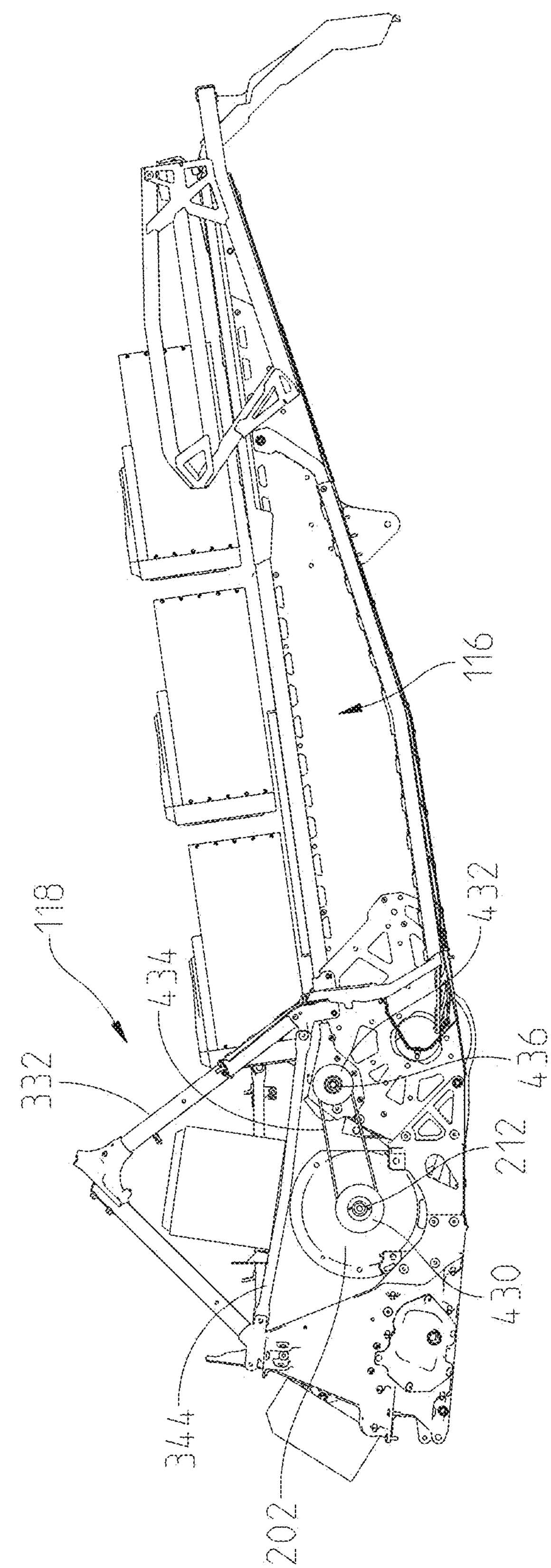

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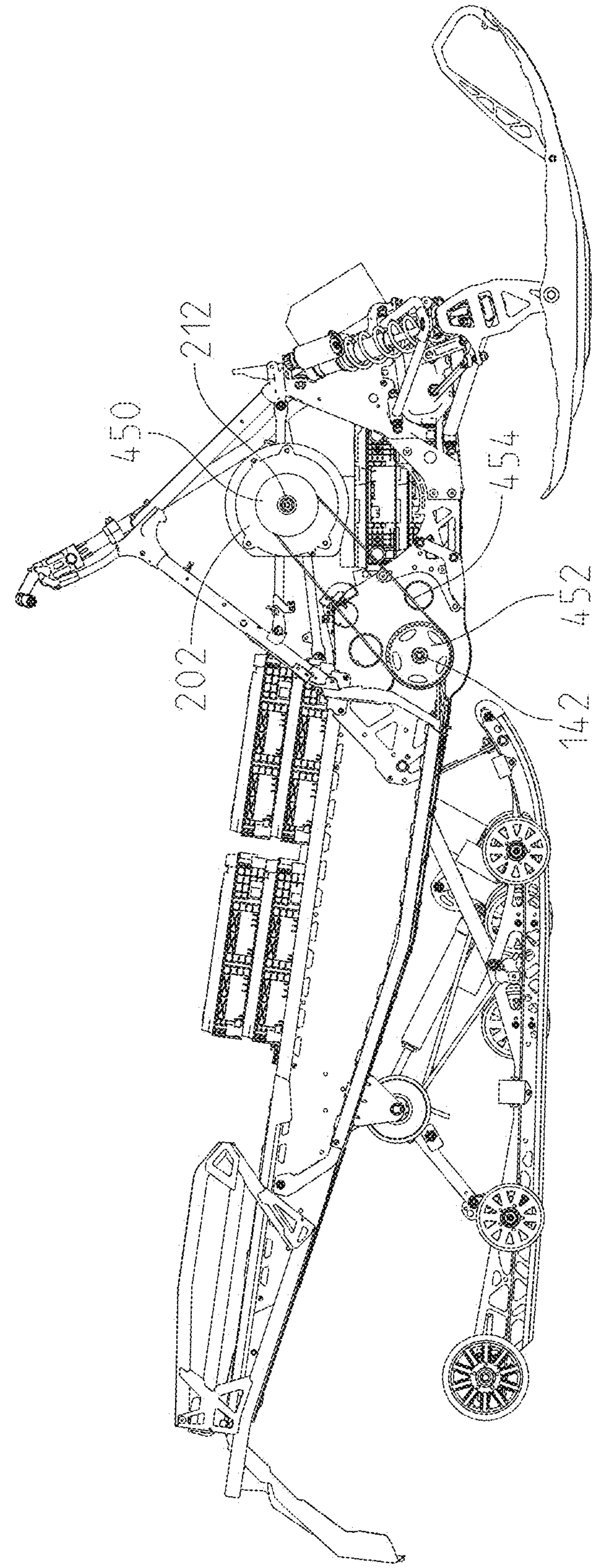

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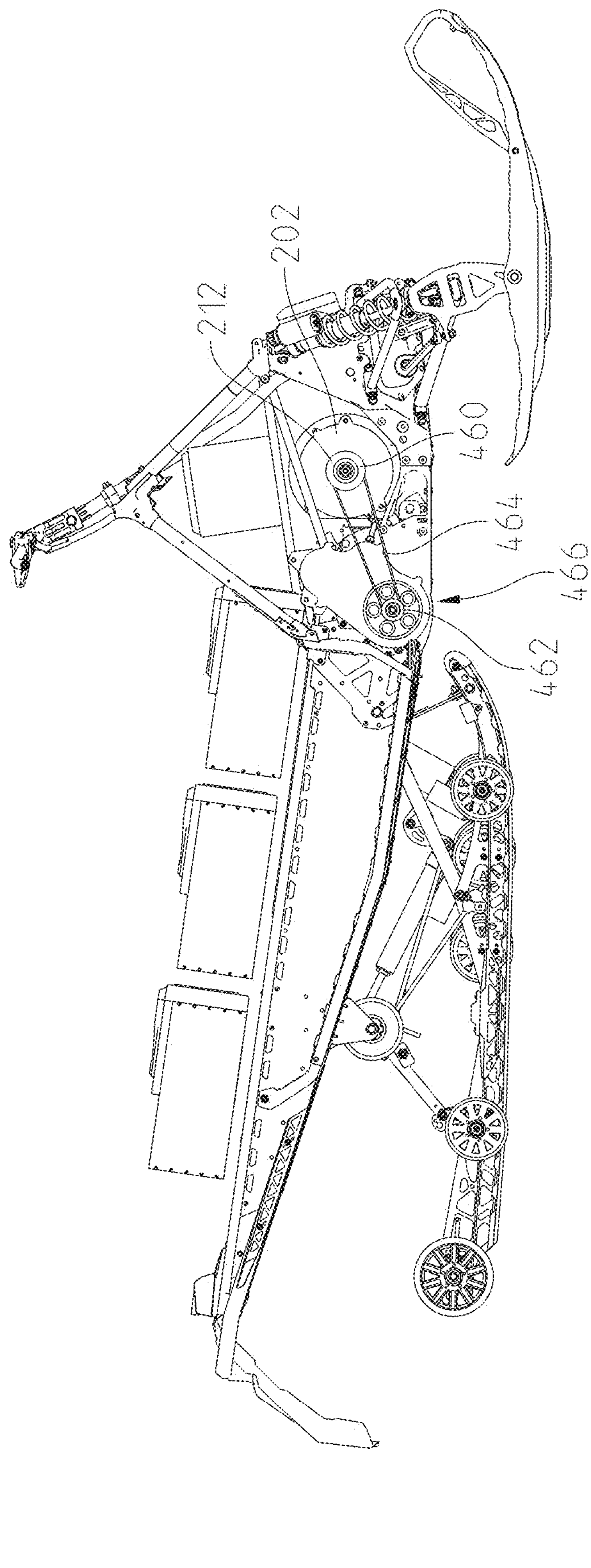

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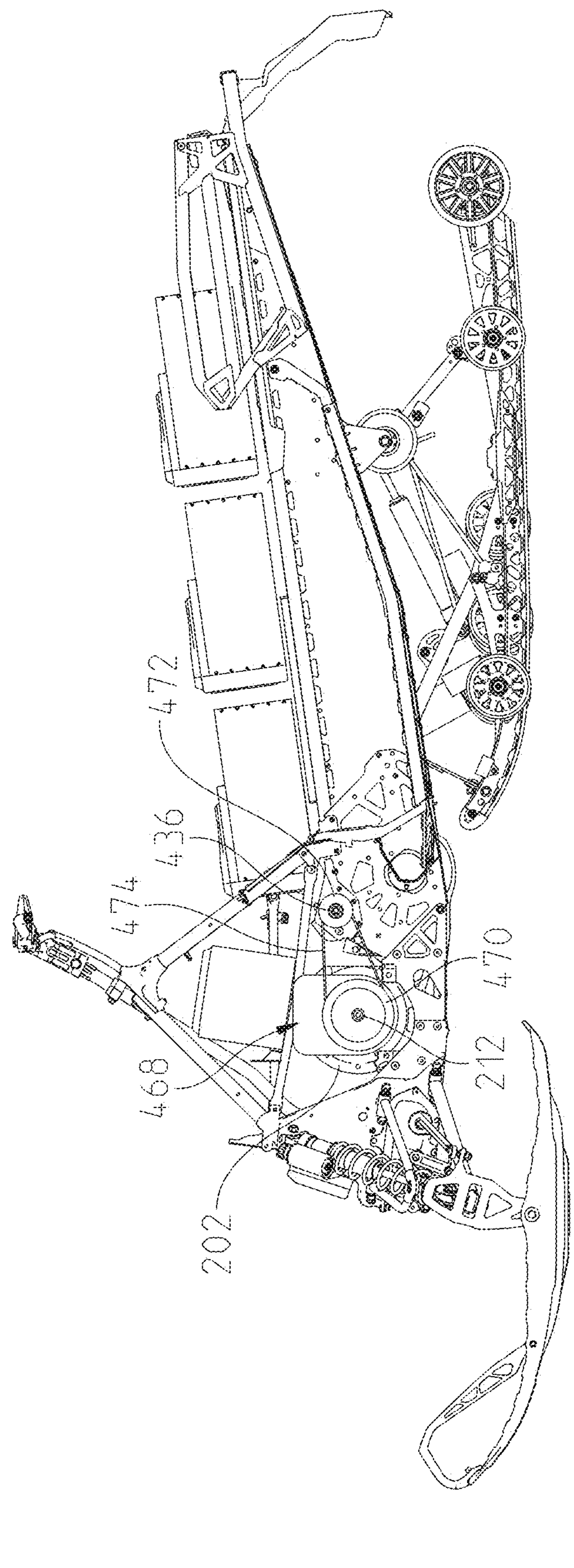

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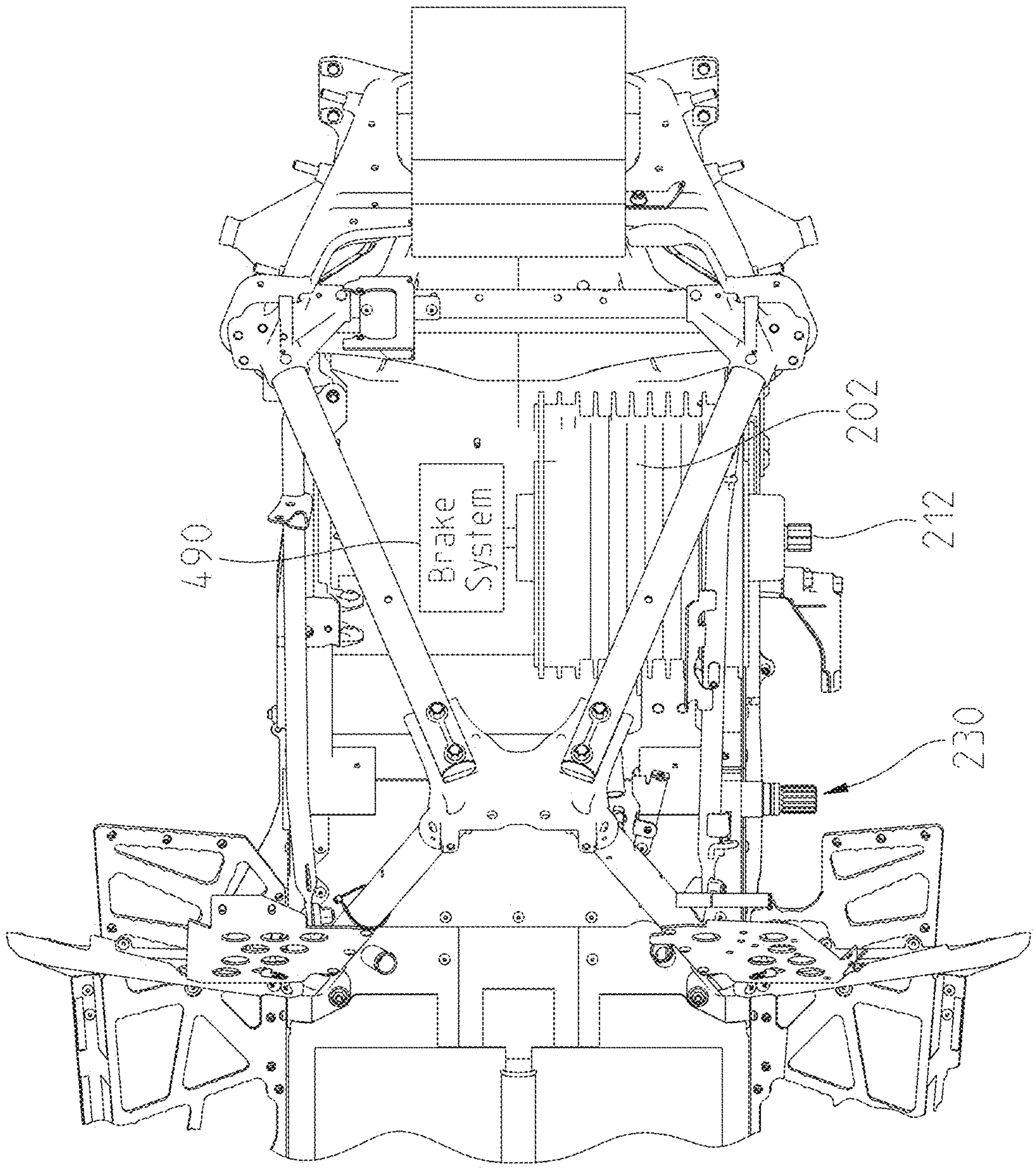

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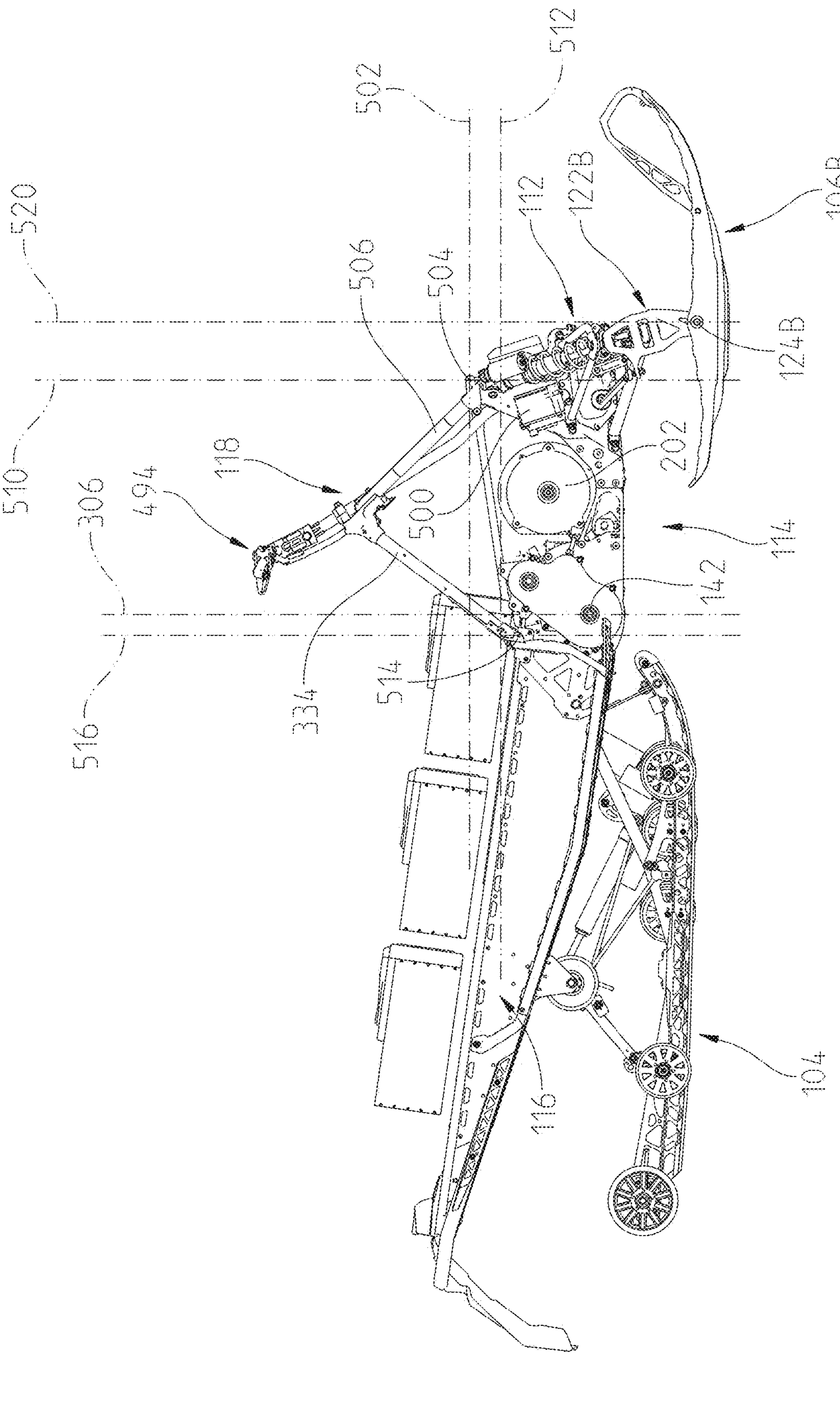
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Fig. 23

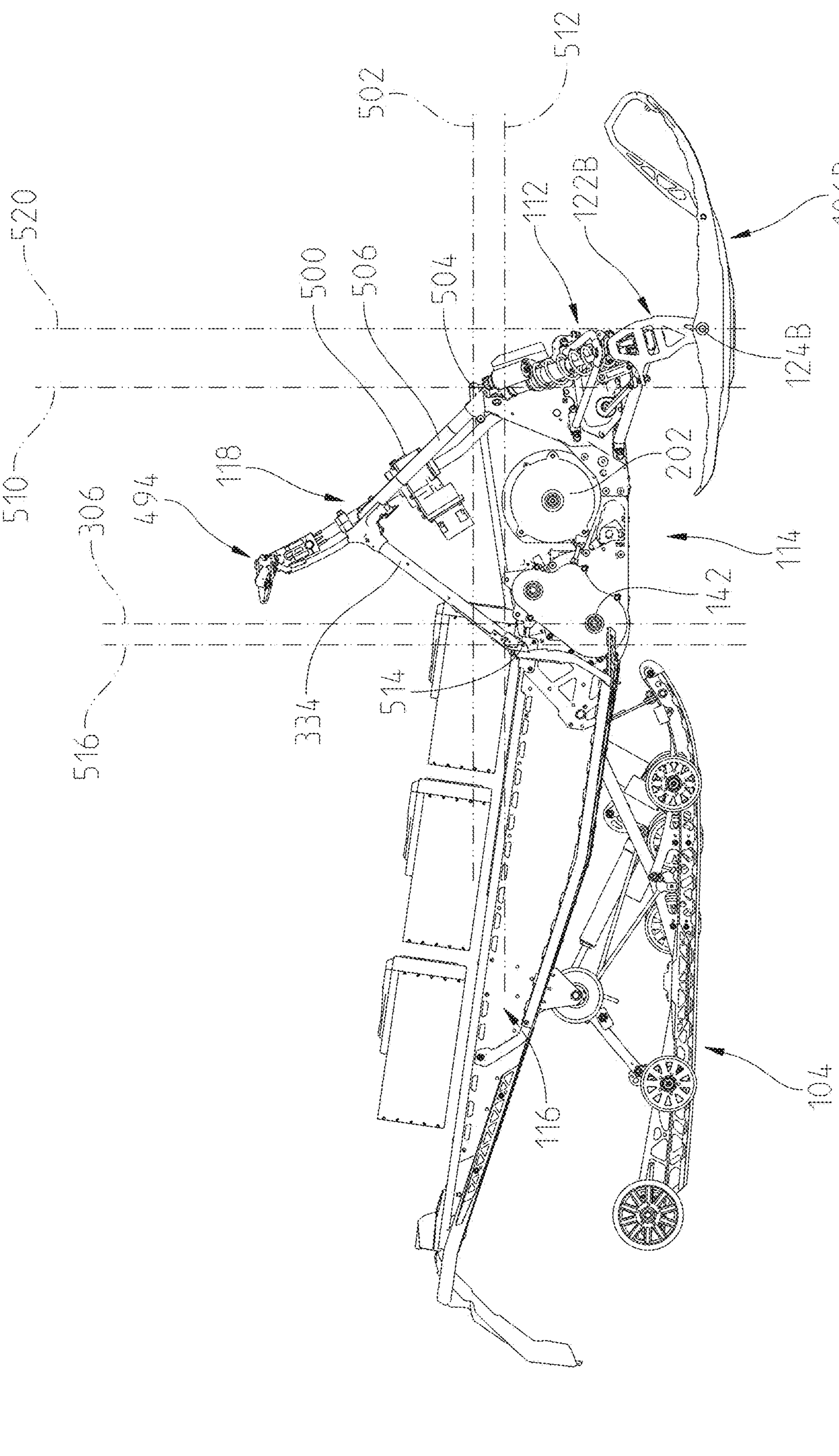
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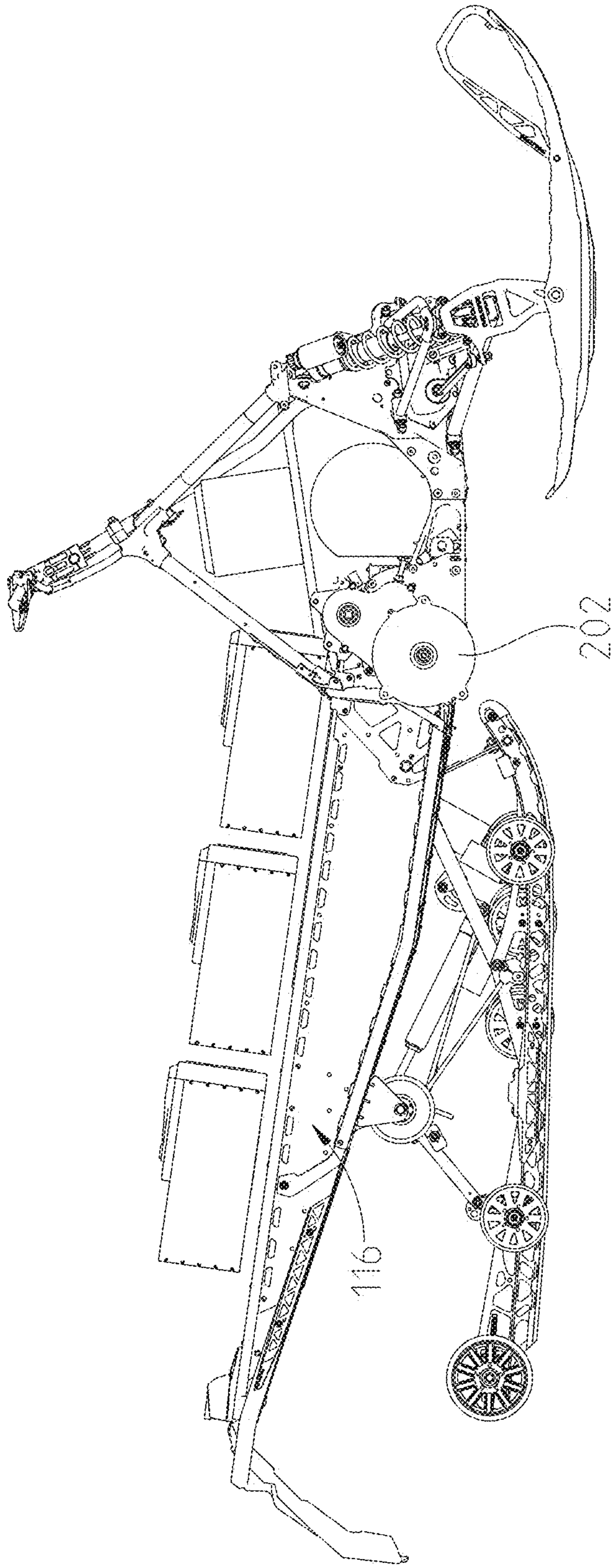
Fig. 24



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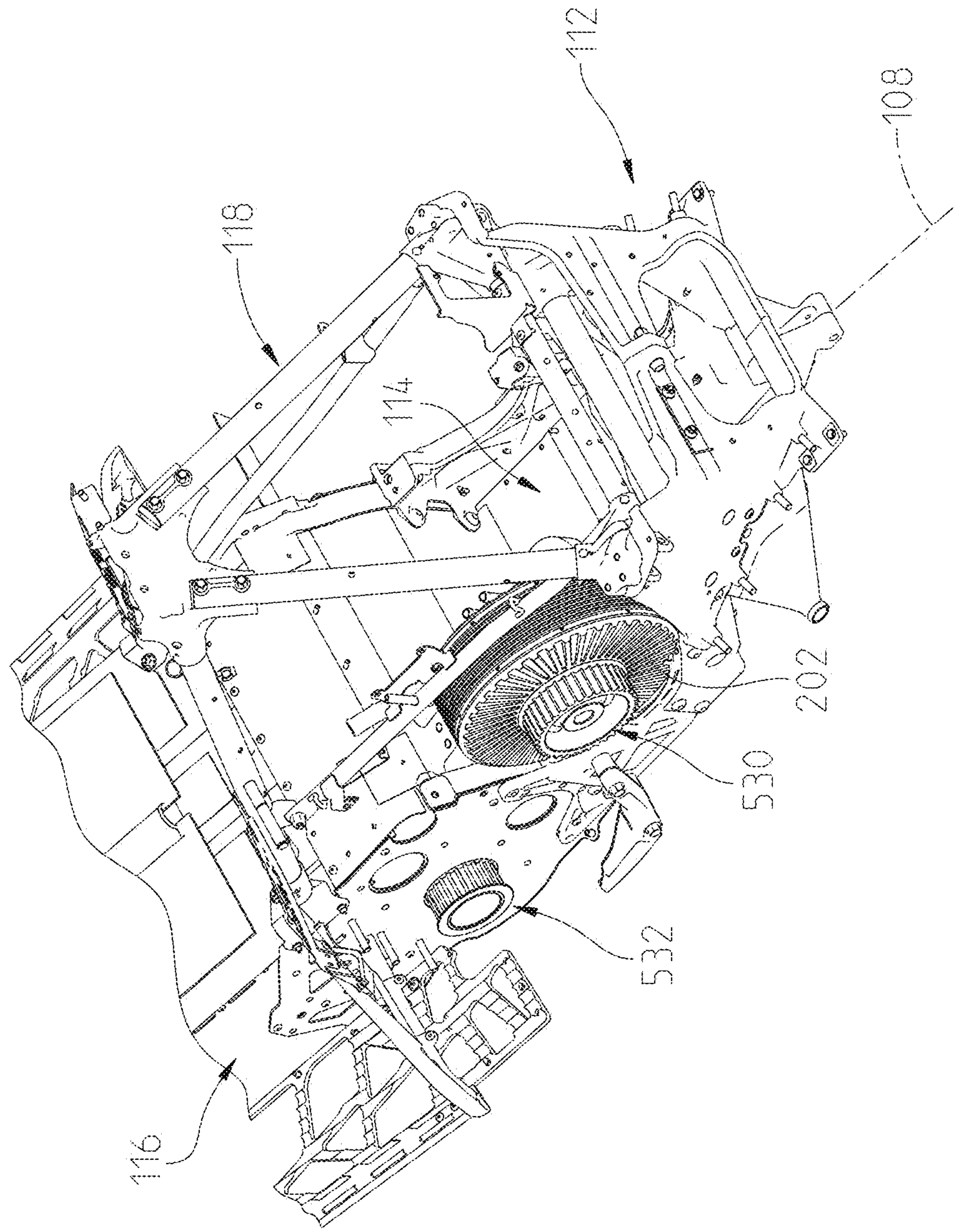
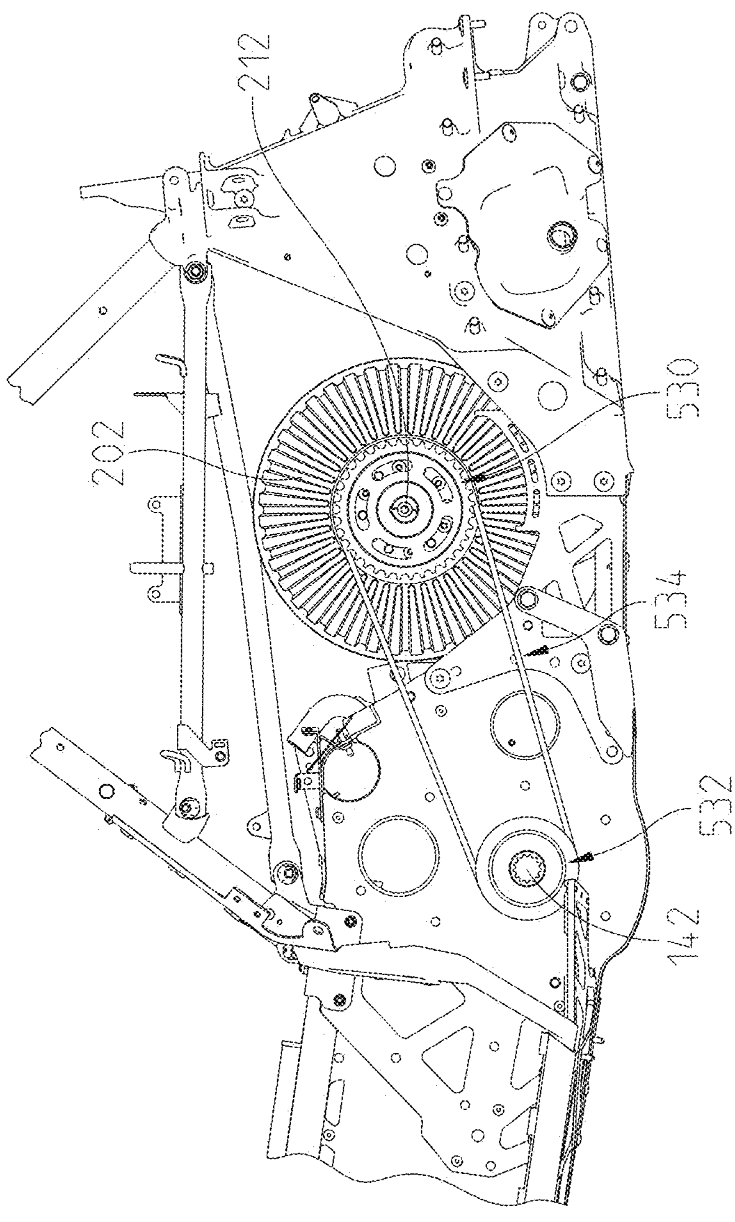


Fig. 26



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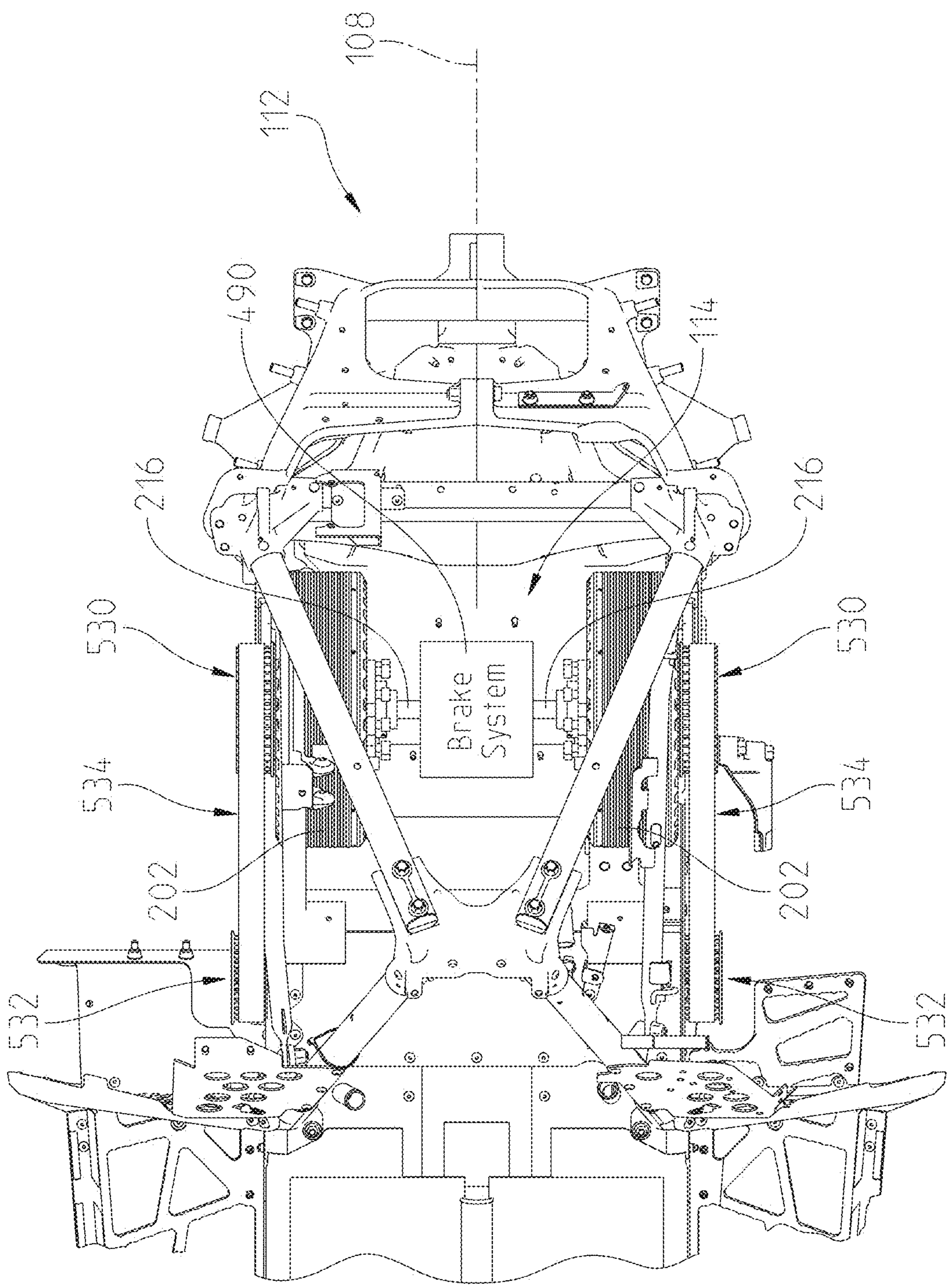
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112
490
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216
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530
530
Brake System
534
534
202
202
532
532

Fig. 28

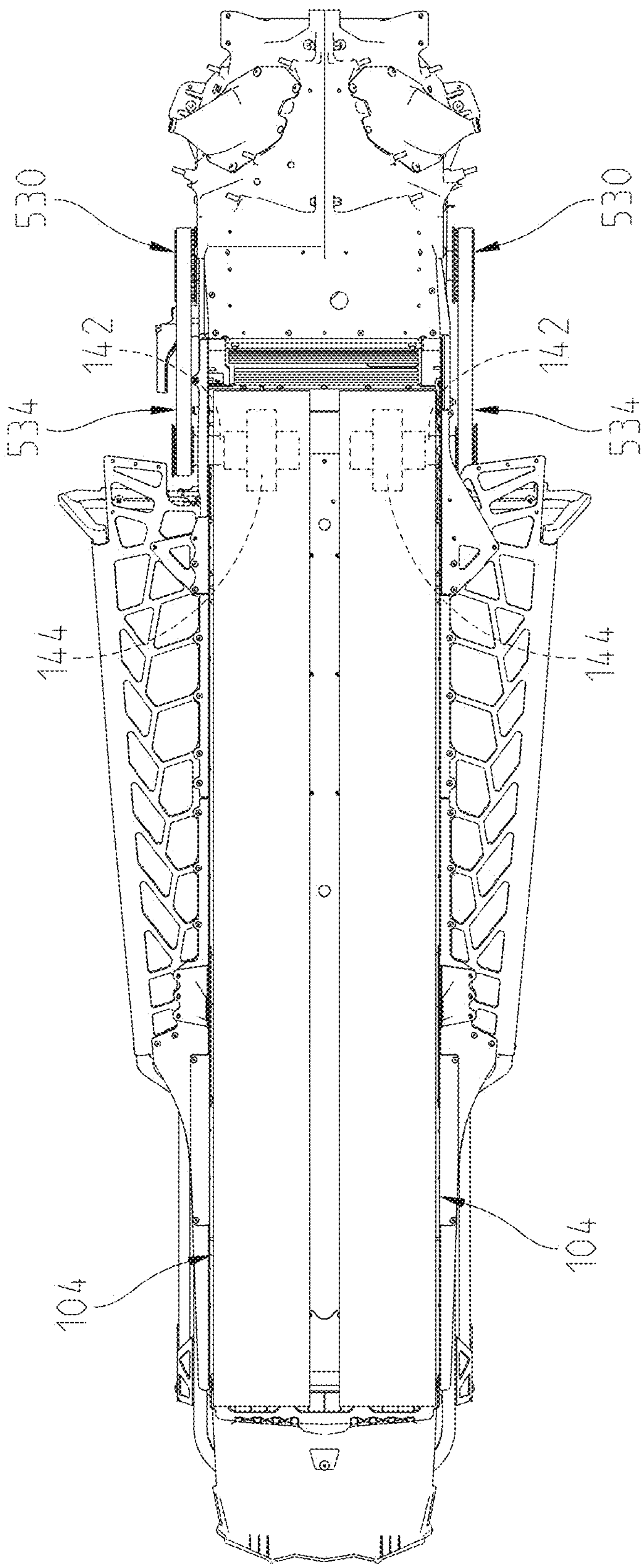


Fig. 29

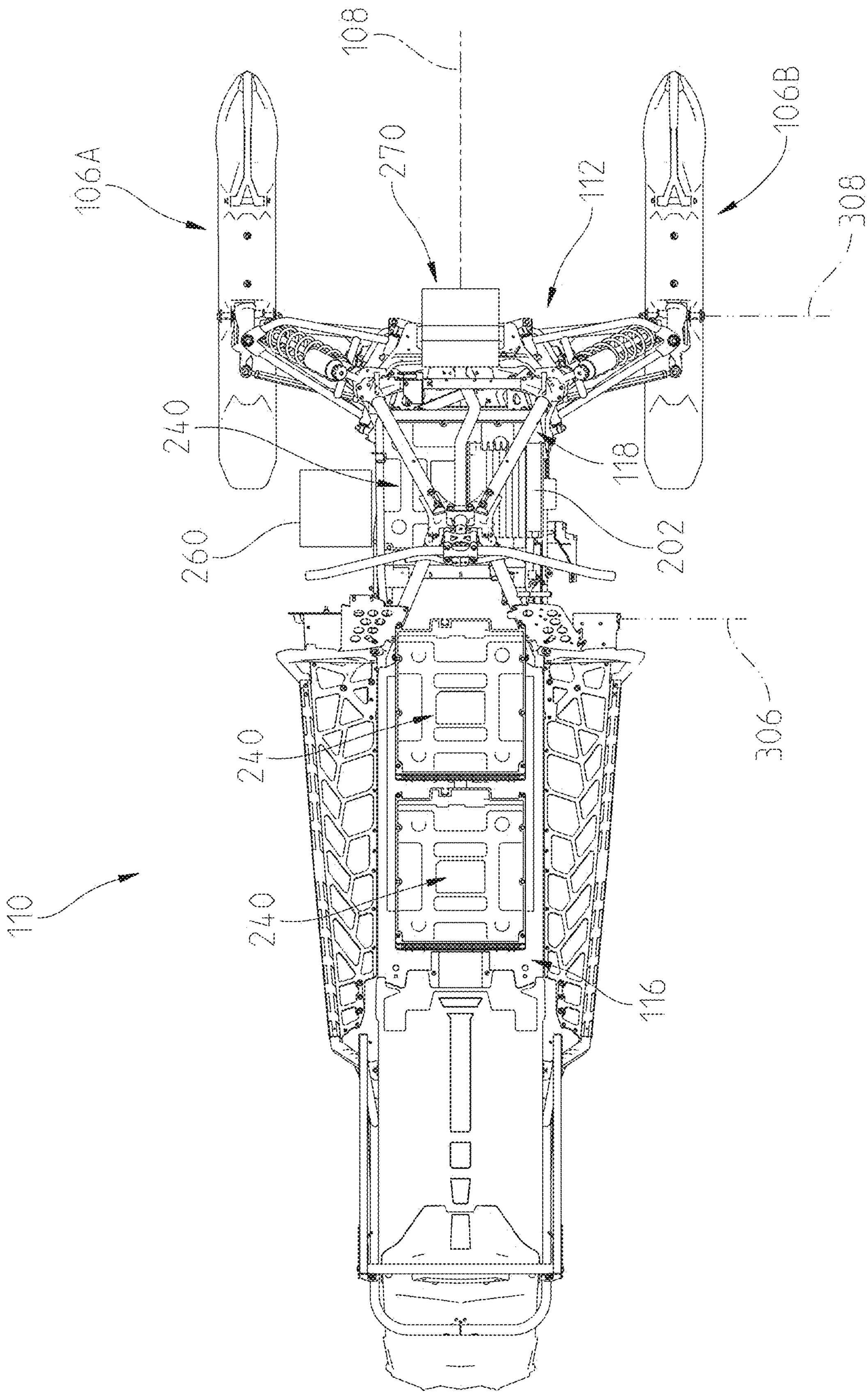


Fig. 30

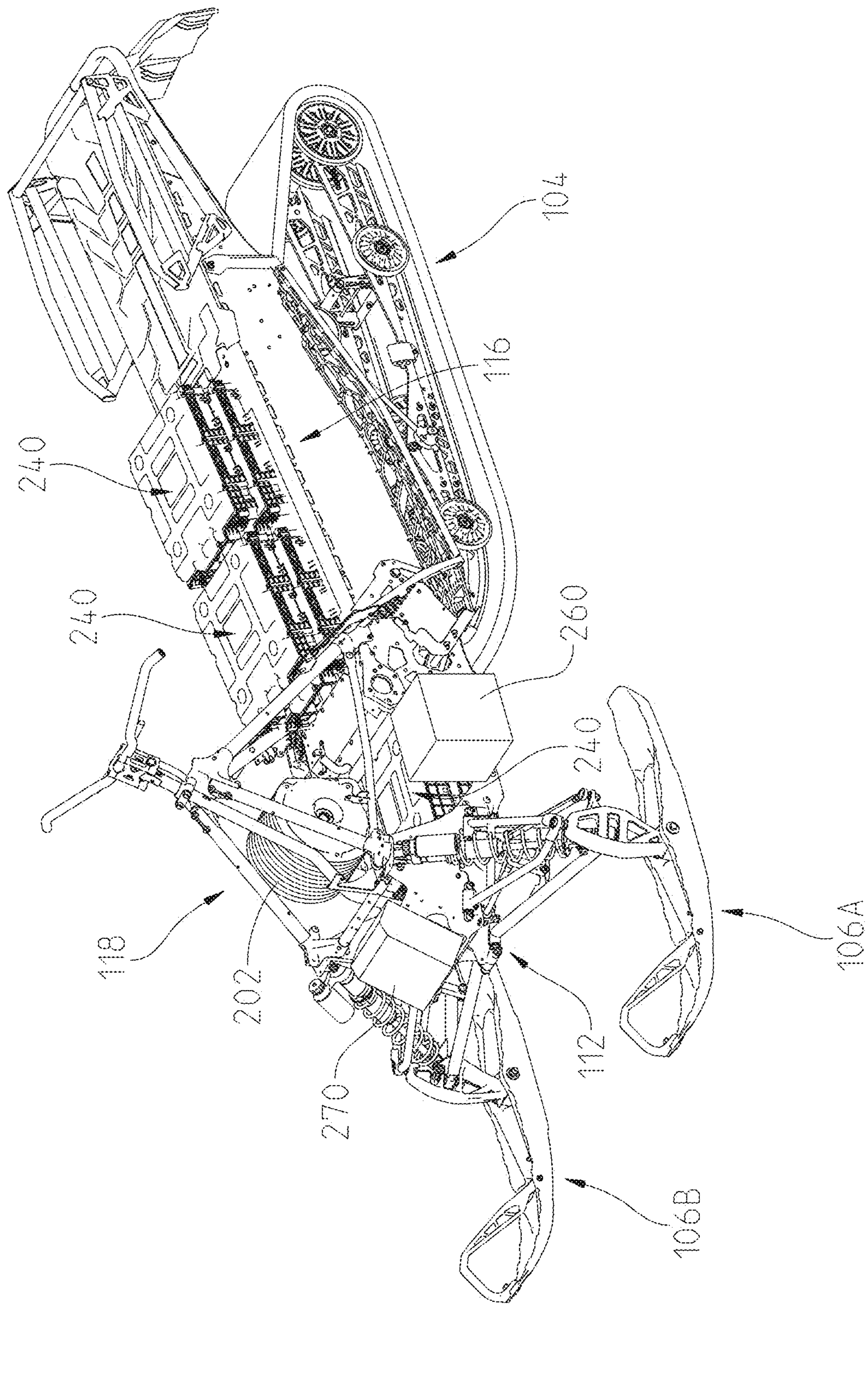
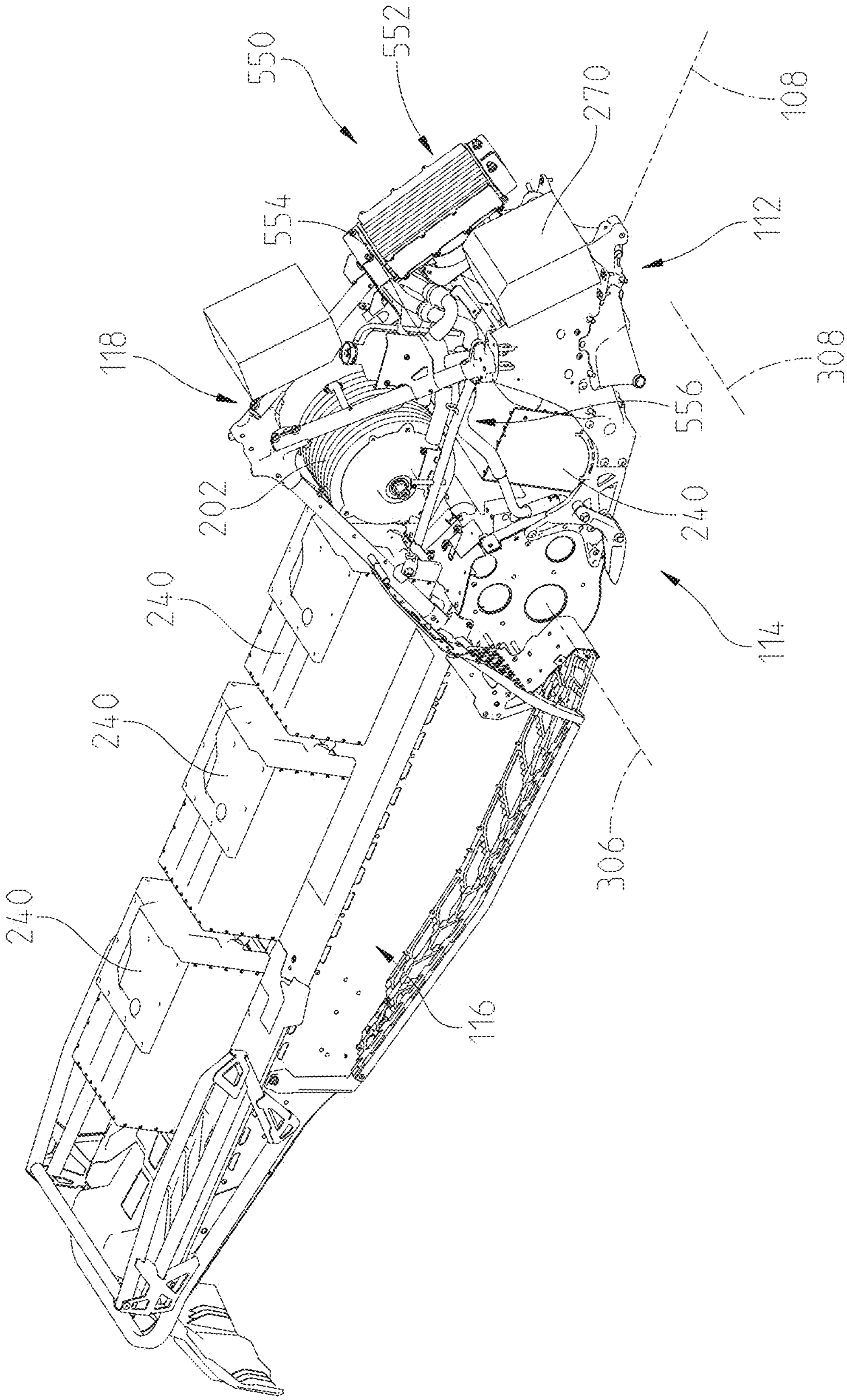


Fig. 31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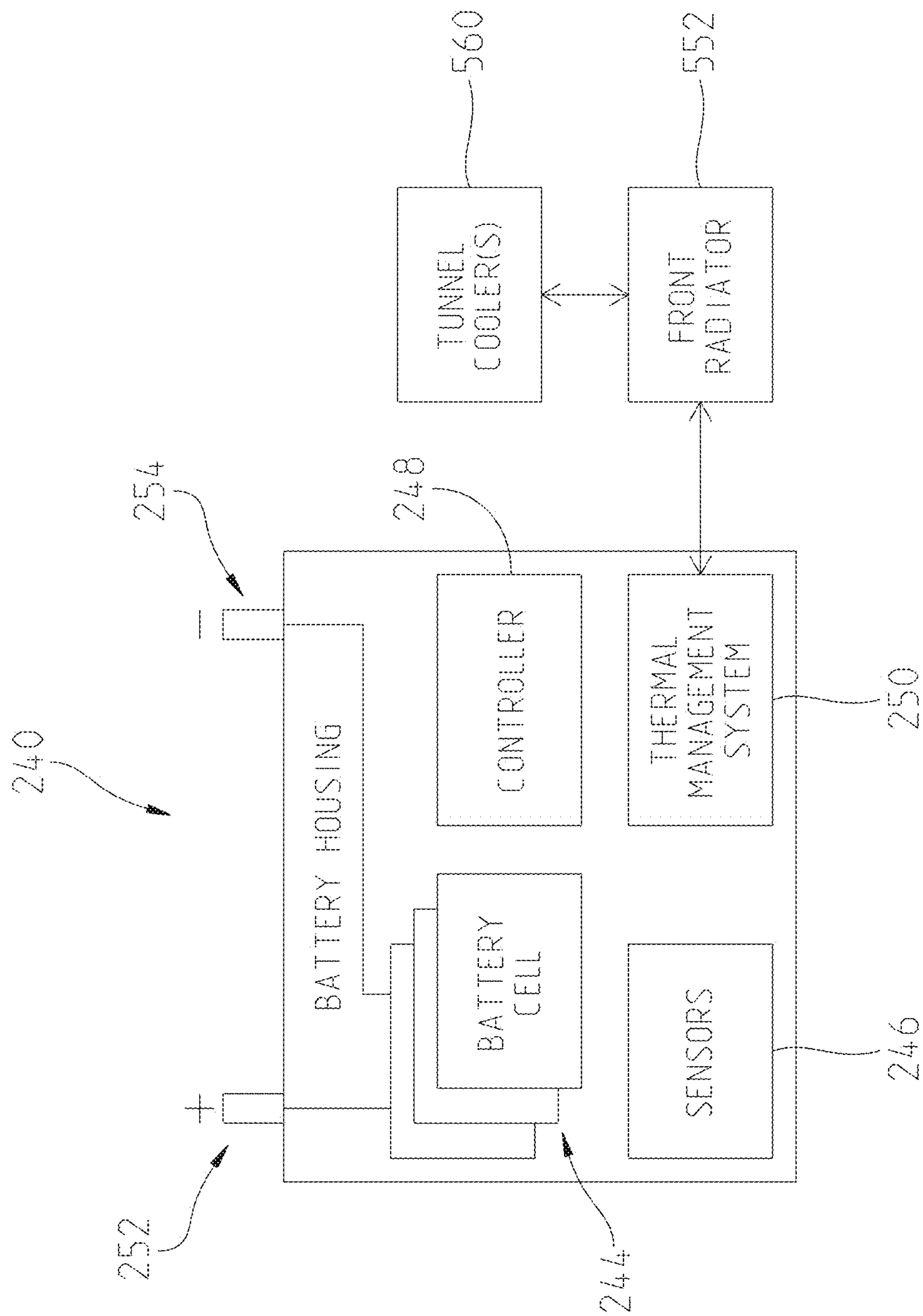
240
116

Fig. 32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254
252
BATTERY HOUSING
BATTERY CELL
244
CONTROLLER
248
THERMAL MANAGEMENT SYSTEM
250
SENSORS
246
TUNNEL COOLER(S)
560
FRONT RADIATOR
552
+
−

Fig. 33

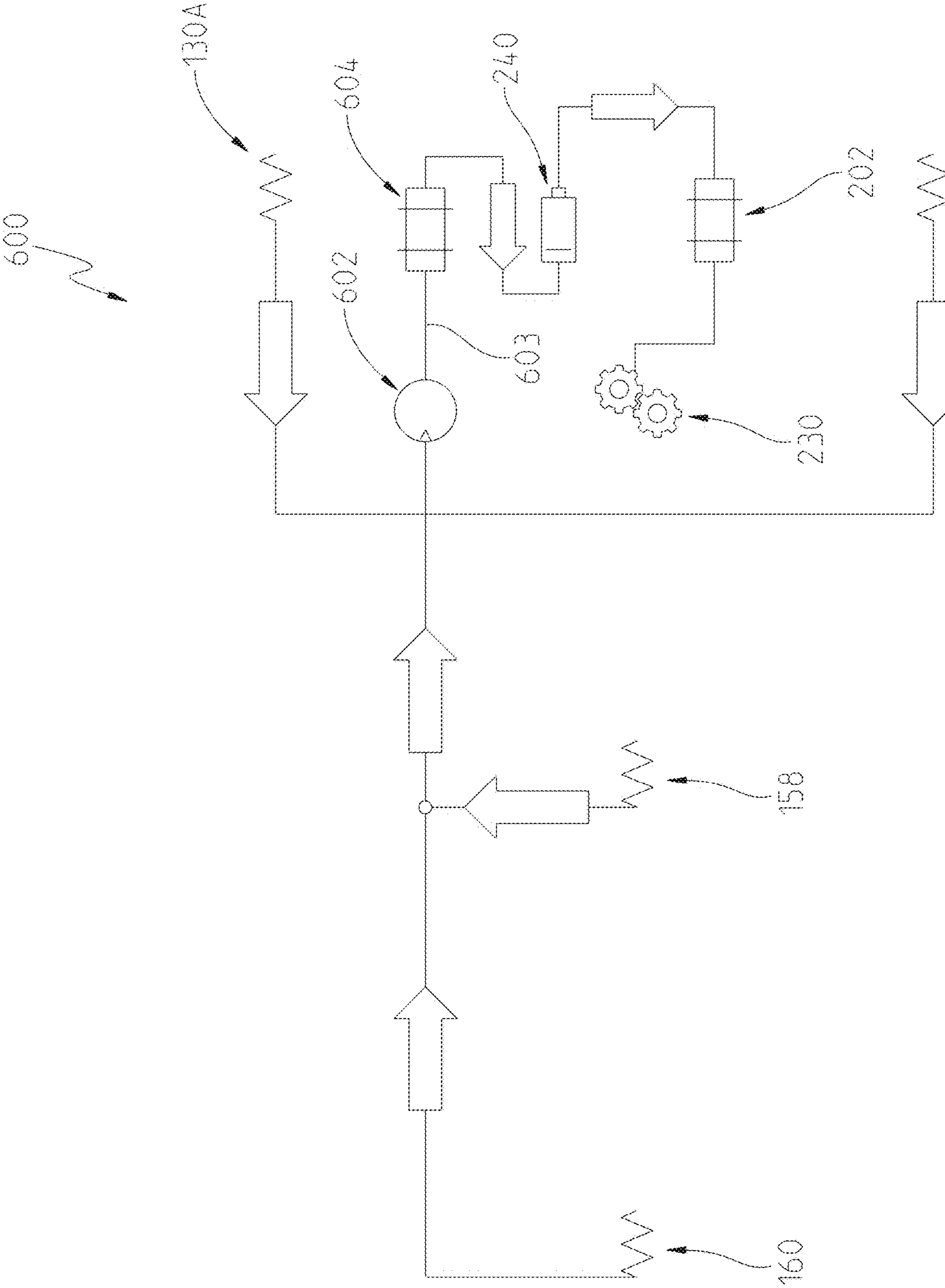


Fig. 34

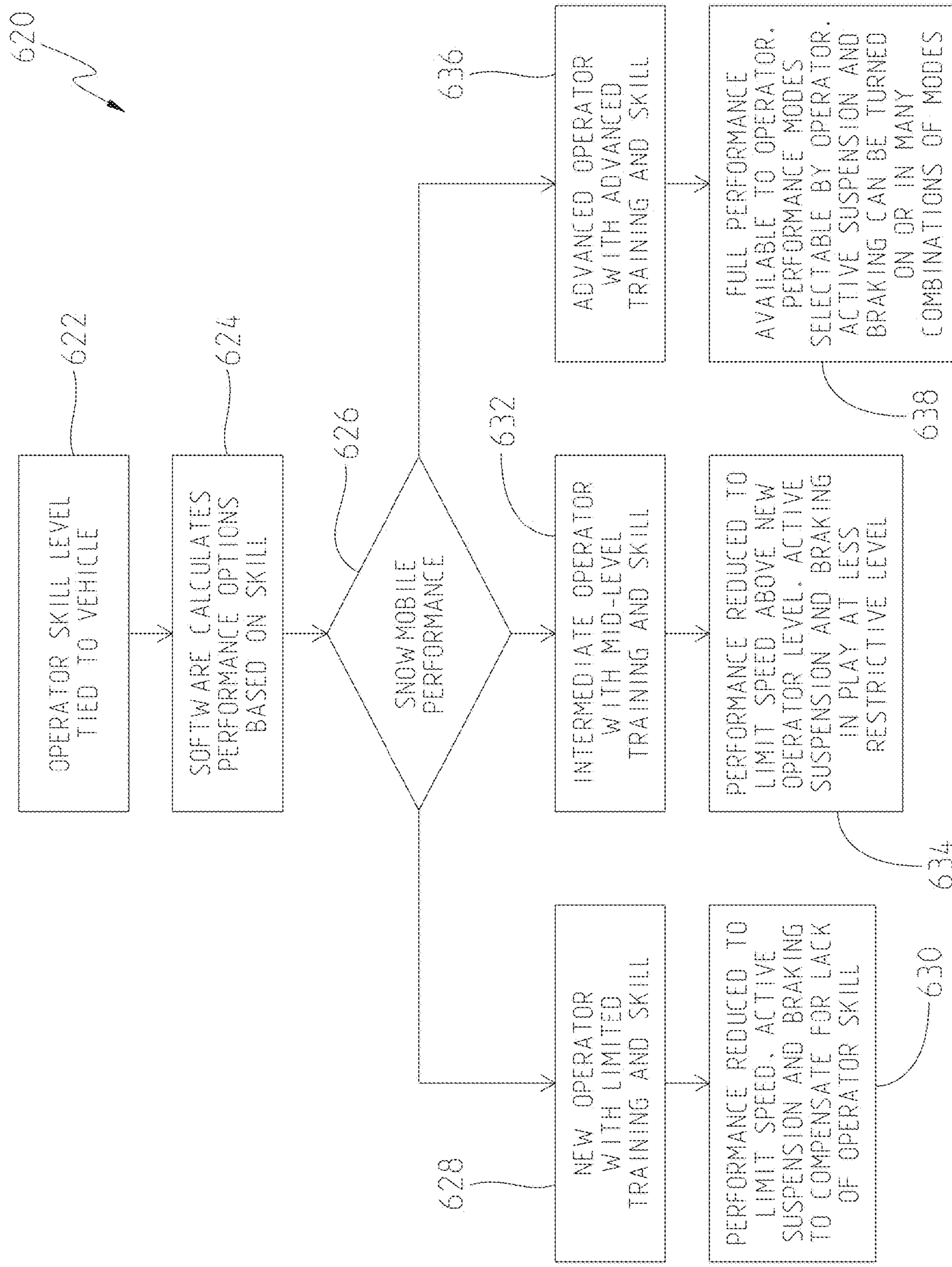

620
622
OPERATOR SKILL LEVEL TIED TO VEHICLE
624
SOFTWARE CALCULATES PERFORMANCE OPTIONS BASED ON SKILL
626
SNOWMOBILE PERFORMANCE
628
NEW OPERATOR WITH LIMITED TRAINING AND SKILL
630
PERFORMANCE REDUCED TO LIMIT SPEED. ACTIVE SUSPENSION AND BRAKING TO COMPENSATE FOR LACK OF OPERATOR SKILL
632
INTERMEDIATE OPERATOR WITH MID-LEVEL TRAINING AND SKILL
634
PERFORMANCE REDUCED TO LIMIT SPEED ABOVE NEW OPERATOR LEVEL. ACTIVE SUSPENSION AND BRAKING IN PLAY AT LESS RESTRICTIVE LEVEL
636
ADVANCED OPERATOR WITH ADVANCED TRAINING AND SKILL
638
FULL PERFORMANCE AVAILABLE TO OPERATOR. PERFORMANCE MODES SELECTABLE BY OPERATOR. ACTIVE SUSPENSION AND BRAKING CAN BE TURNED ON OR IN MANY COMBINATIONS OF MODES

Fig. 35

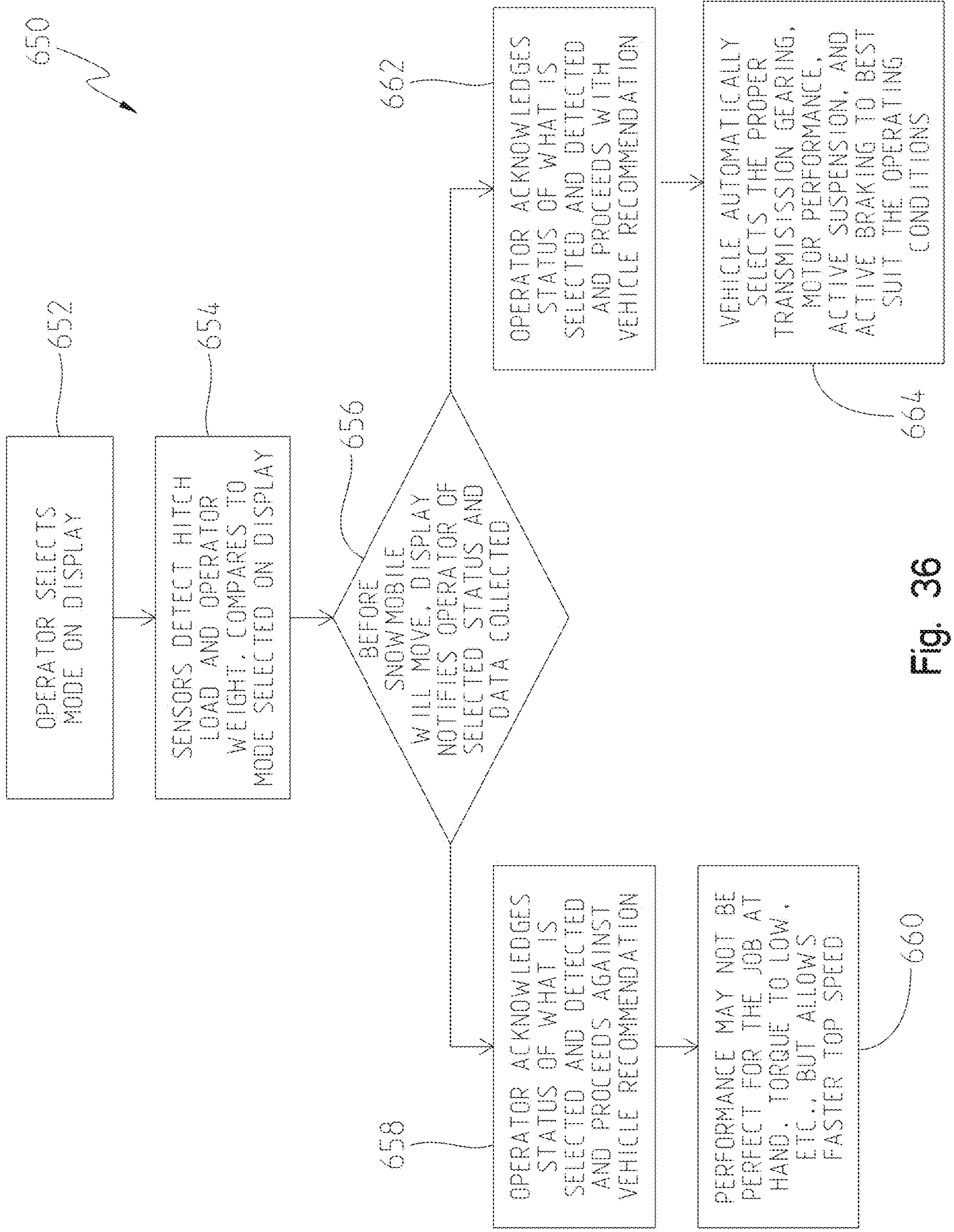
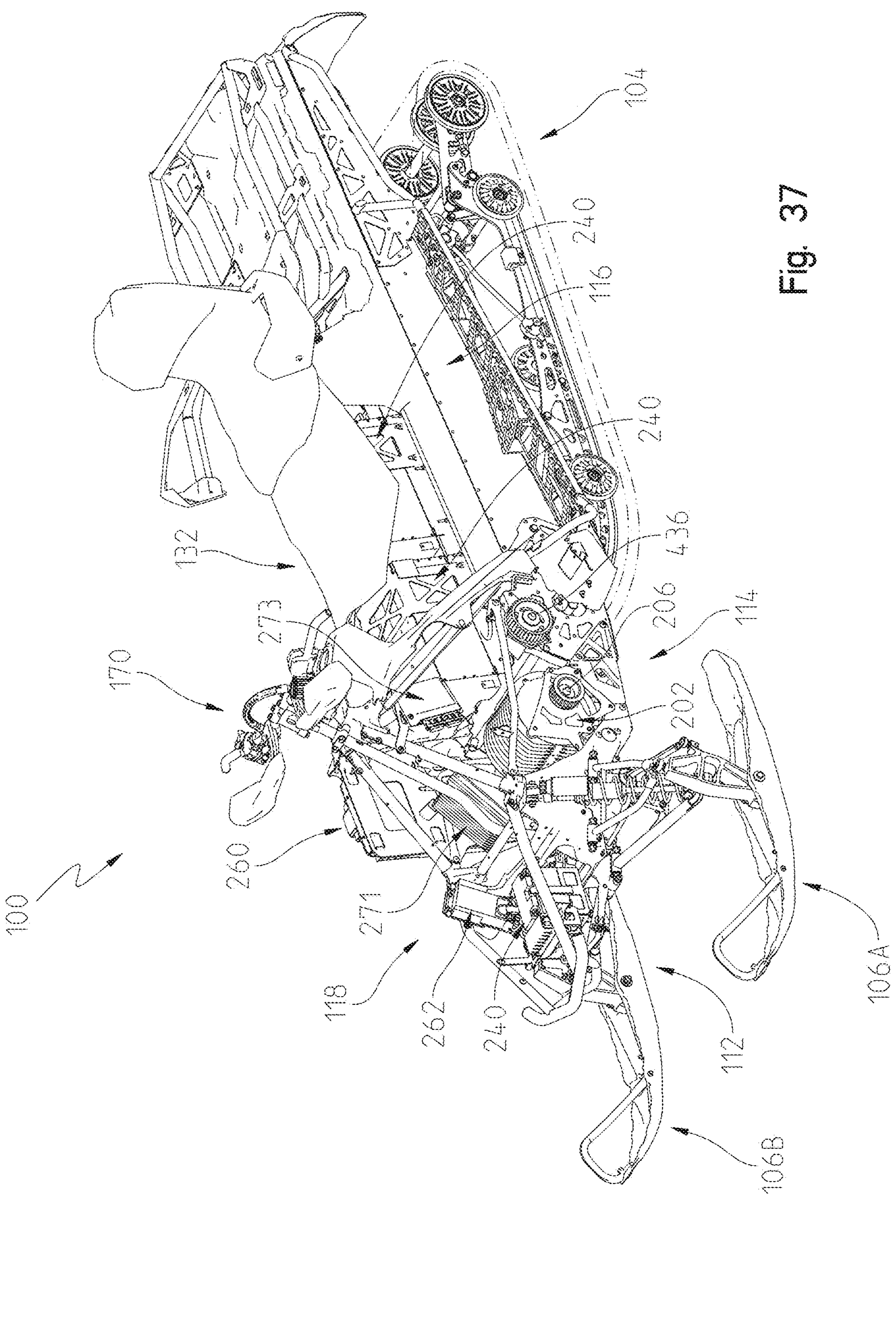

650
OPERATOR SELECTS MODE ON DISPLAY
652
SENSORS DETECT HITCH LOAD AND OPERATOR WEIGHT, COMPARES TO MODE SELECTED ON DISPLAY
654
BEFORE SNOWMOBILE WILL MOVE, DISPLAY NOTIFIES OPERATOR OF SELECTED STATUS AND DATA COLLECTED
656
OPERATOR ACKNOWLEDGES STATUS OF WHAT IS SELECTED AND DETECTED AND PROCEEDS AGAINST VEHICLE RECOMMENDATION
658
PERFORMANCE MAY NOT BE PERFECT FOR THE JOB AT HAND. TORQUE TO LOW, ETC., BUT ALLOWS FASTER TOP SPEED
660
OPERATOR ACKNOWLEDGES STATUS OF WHAT IS SELECTED AND DETECTED AND PROCEEDS WITH VEHICLE RECOMMENDATION
662
VEHICLE AUTOMATICALLY SELECTS THE PROPER TRANSMISSION GEARING, MOTOR PERFORMANCE, ACTIVE SUSPENSION, AND ACTIVE BRAKING TO BEST SUIT THE OPERATING CONDITIONS
664

Fig. 36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106A
106B

Fig. 37

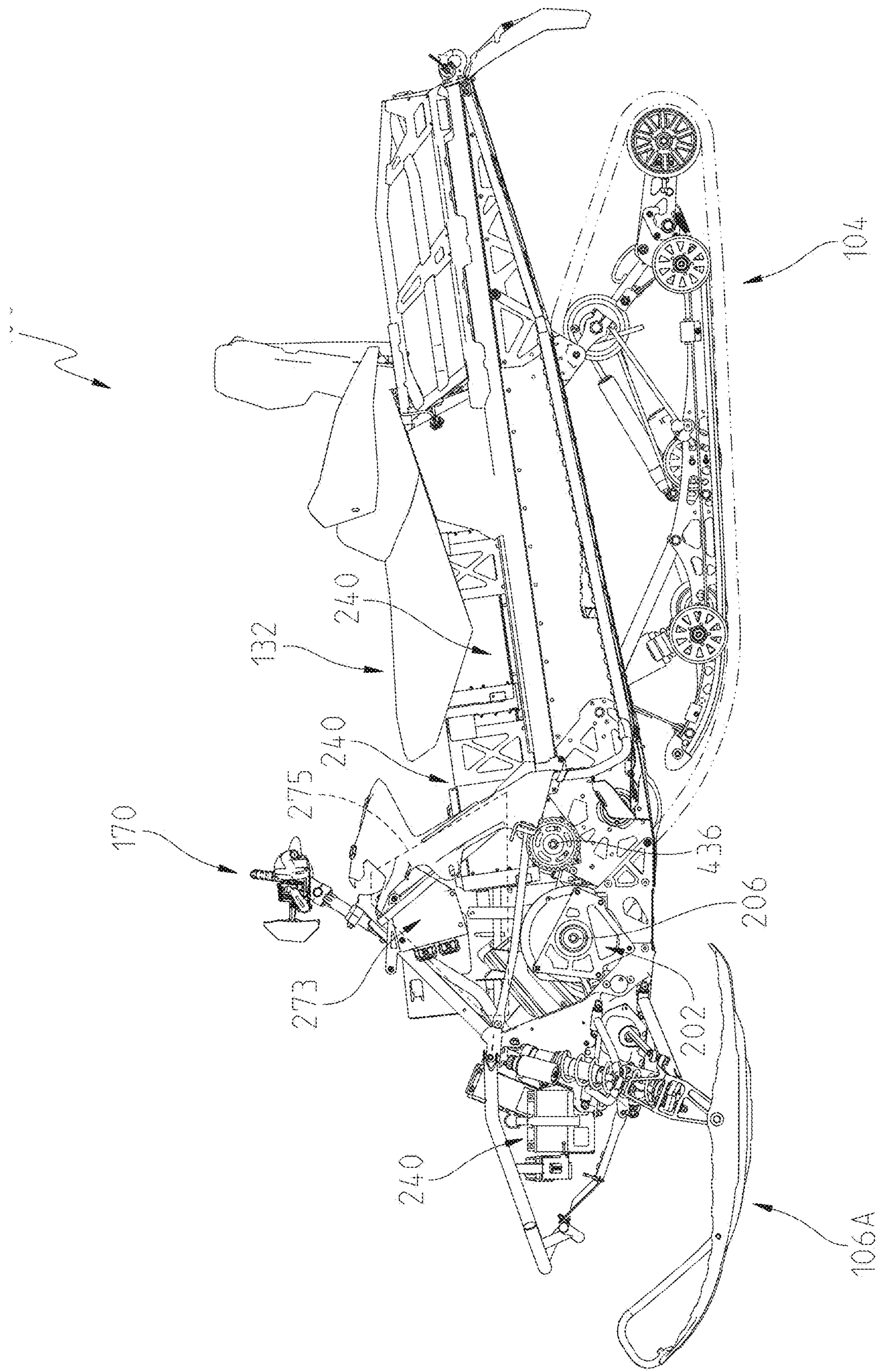


Fig. 38

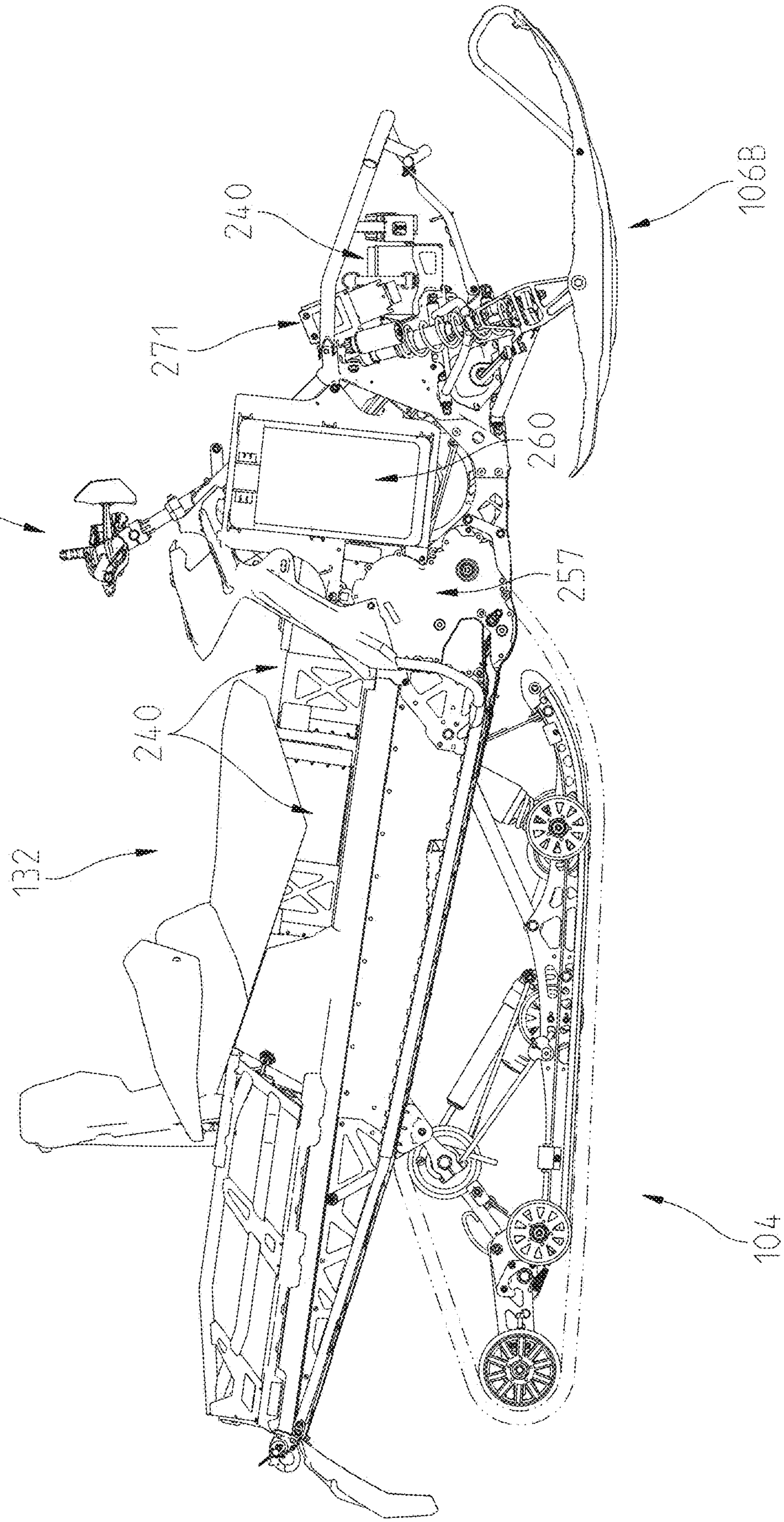


Fig. 39

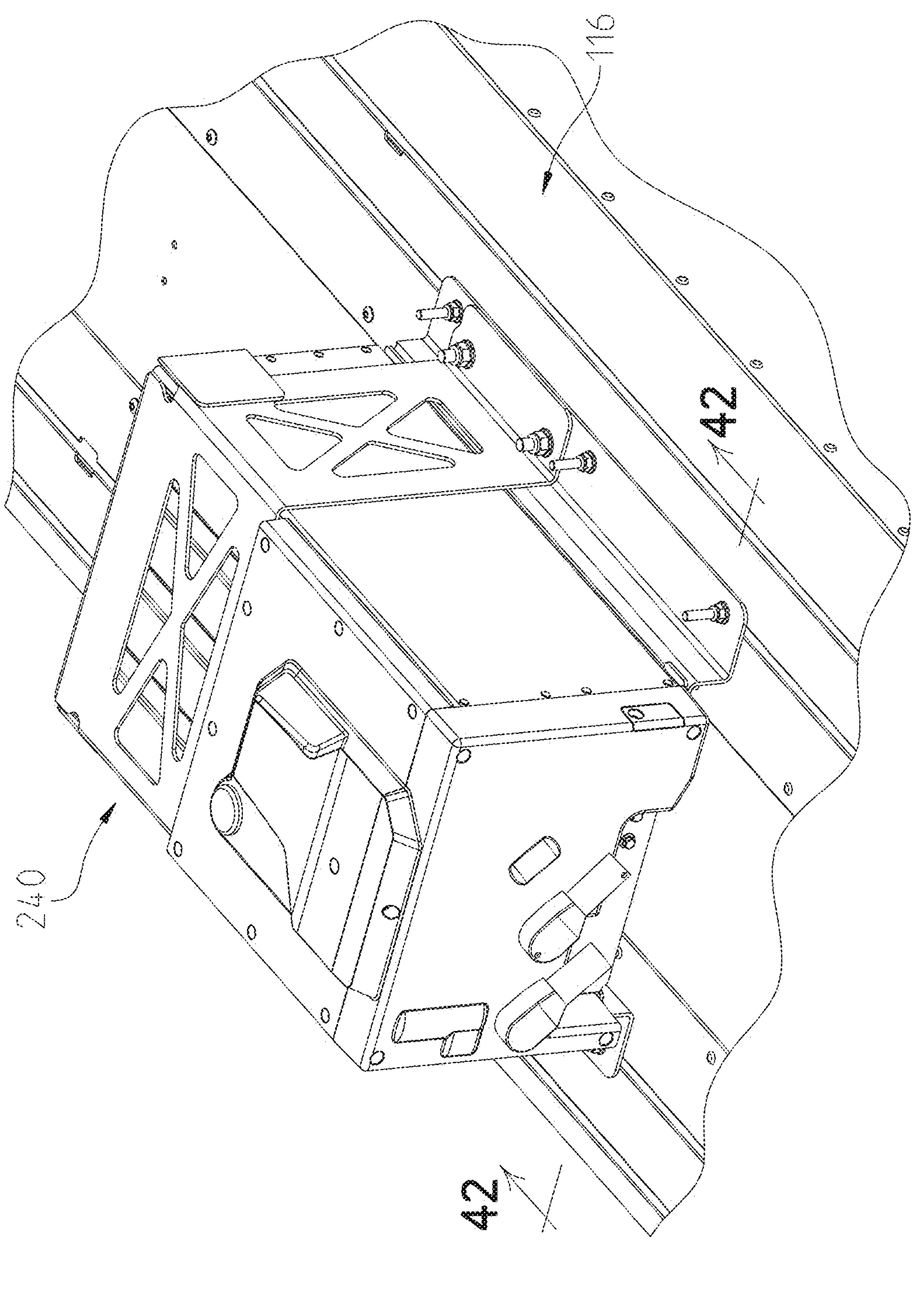
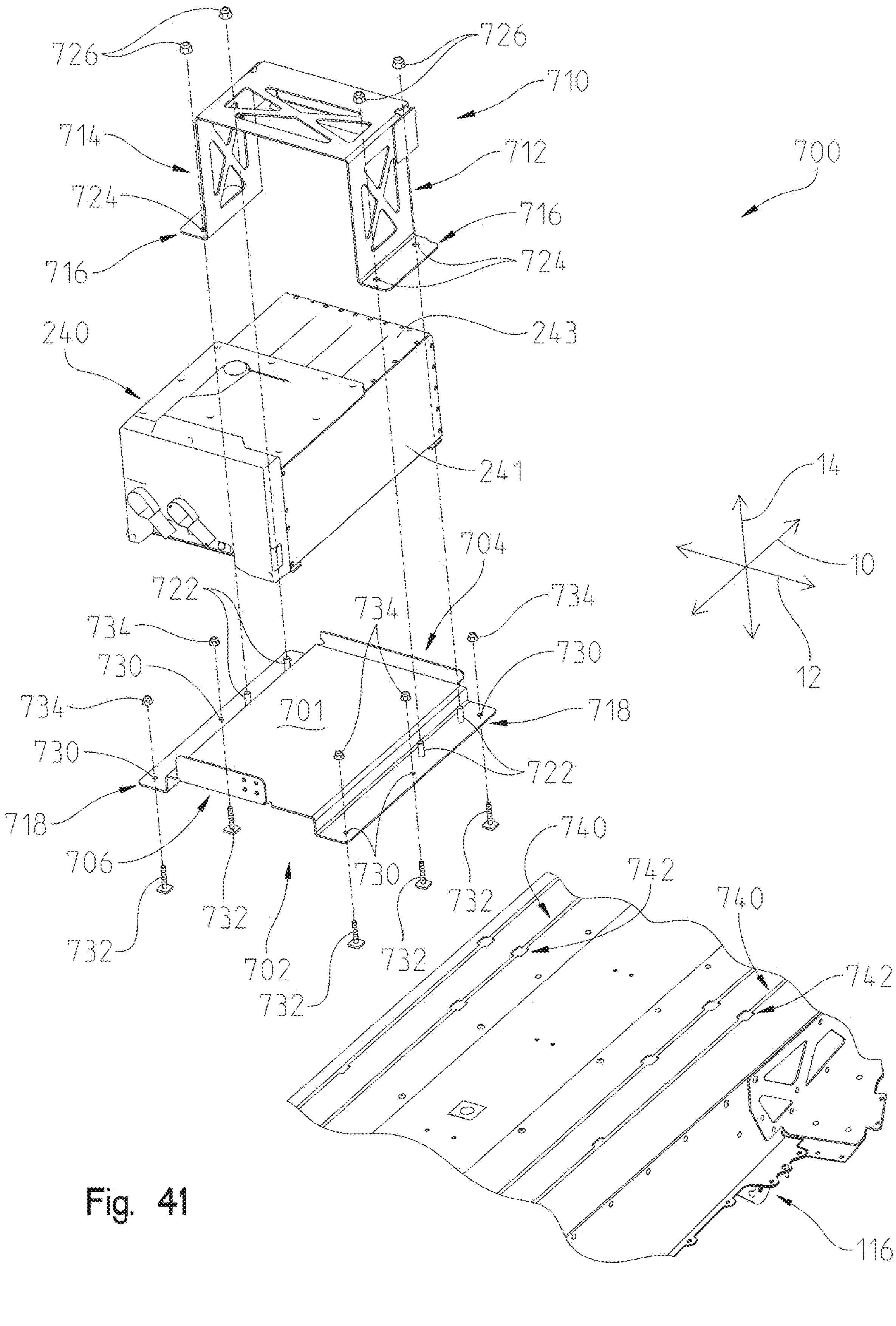


Fig. 40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116

Fig. 41

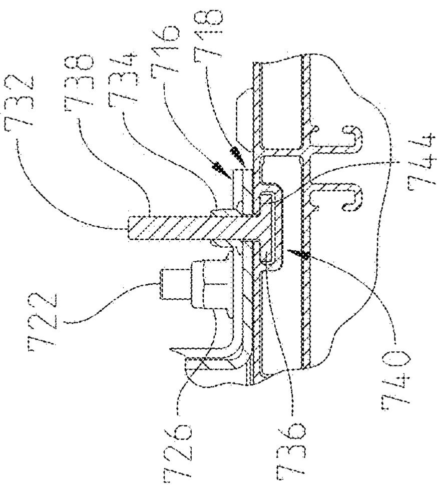

Fig. 42A

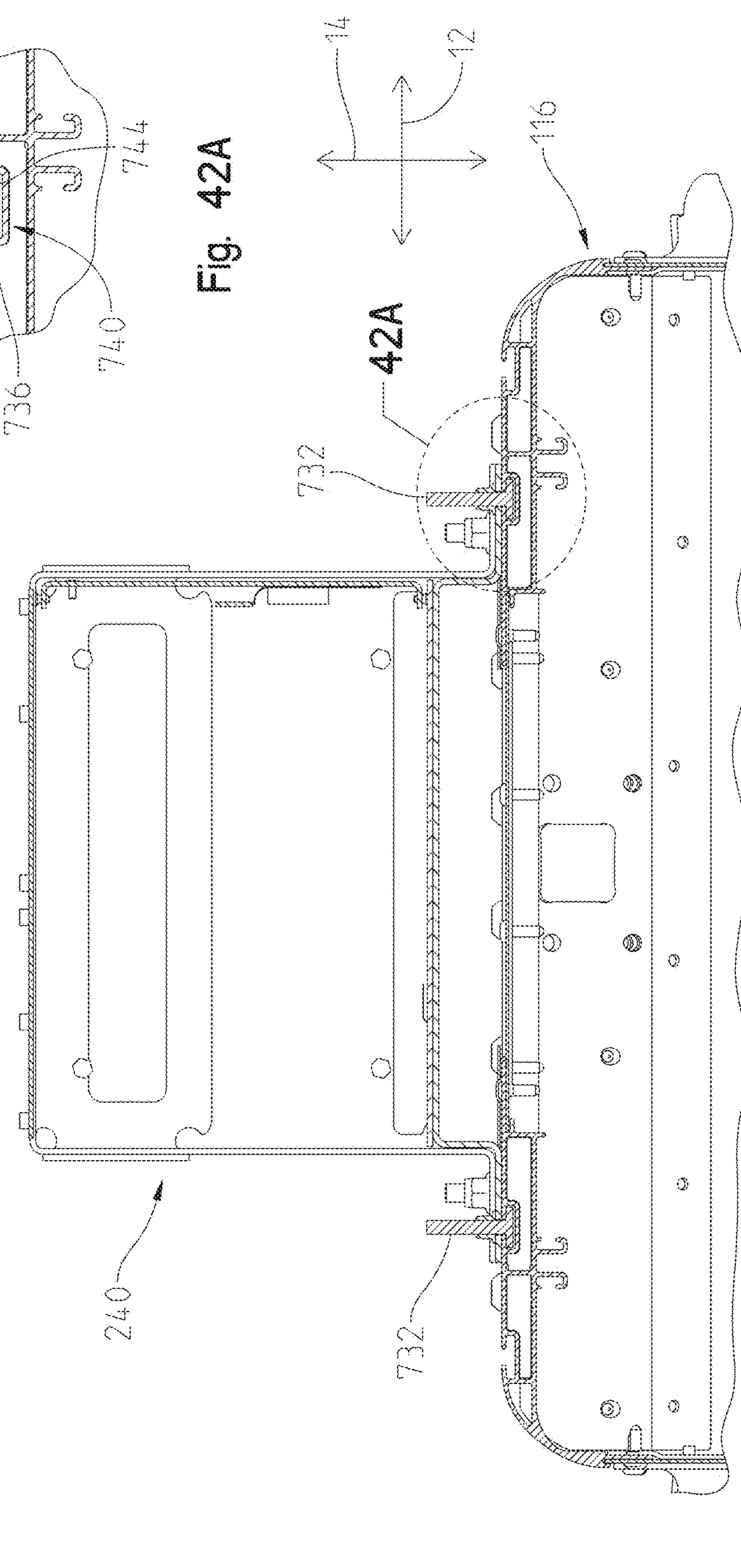

Fig. 42

ELECTRIC SNOWMOBILE

RELATED APPLICATIONS

[0001] The present disclosure relates to U.S. Provisional Application No. 63/295,560, filed Dec. 31, 2021, titled ELECTRIC SNOWMOBILE, the entire disclosure of which is expressly incorporated by reference herein.

FIELD

[0002] The present disclosure relates to electric vehicles and in particular to electric vehicles with an endless track ground engaging member.

BACKGROUND

[0003] Endless track vehicles include snowmobiles having an endless track rear ground engaging members and front skis.

SUMMARY

[0004] In an exemplary embodiment of the present disclosure, a snowmobile is provided. The snowmobile comprising: a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising an electric powertrain operatively coupled to the endless track to power movement of the endless track; a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile and includes a first component of the electric powertrain; a rear suspension positioned in an interior of the endless track and movably coupled to the structural frame; a left front suspension movably coupled to the structural frame and to the left front ski; a right front suspension movably coupled to the structural frame and to the right front ski; a steering assembly supported by the structural frame and operatively coupled to the left front ski and the right front ski to steer the snowmobile, the steering assembly including an operator steering input and a steering post; and a straddle seat positioned along the vertical centerline plane of the snowmobile over the endless track and positioned longitudinally rearward of the steering post of the steering assembly.

[0005] In an example thereof, the structural frame includes a rear portion including a tunnel, a front portion positioned forward of the tunnel, and an overstructure which supports the steering assembly and extends over the front portion, the front portion being movably coupled to the left front suspension and the right front suspension.

[0006] In another example thereof, the first component is part of a battery assembly.

[0007] In a further example thereof, the battery assembly includes a battery housing and at least one battery and the first component is the battery housing of the battery assembly, the battery housing including an interior to receive the at least one battery.

[0008] In a further still example thereof, the first component is part of a motor assembly.

[0009] In yet a further example thereof, the motor assembly includes a motor housing and at least one output shaft and the first component is the motor housing.

[0010] In yet still a further example thereof, the first component forms part of the tunnel of the structural frame.

[0011] In still a further example thereof, the first component forms part of the front portion of the structural frame.

[0012] In yet another example thereof, the first component forms part of the overstructure of the structural frame.

[0013] In still another example thereof, the structural frame includes a middle portion longitudinally between the front portion and the tunnel and the first component forms part of the middle portion of the structural frame.

[0014] In another exemplary embodiment of the present disclosure, a snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising an electric powertrain operatively coupled to the endless track to power movement of the endless track, the electric powertrain including at least one planetary gearset; a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile; a rear suspension positioned in an interior of the endless track and movably coupled to the structural frame; a left front suspension movably coupled to the structural frame and to the left front ski; a right front suspension movably coupled to the structural frame and to the right front ski; a steering assembly supported by the structural frame and operatively coupled to the left front ski and the right front ski to steer the snowmobile, the steering assembly including an operator steering input and a steering post; and a straddle seat positioned along the vertical centerline plane of the snowmobile over the endless track and positioned longitudinally rearward of the steering post of the steering assembly.

[0015] In a further exemplary embodiment of the present disclosure, a snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel having a forwardmost extent and an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including an electric motor operatively coupled to the endless track and a plurality of battery assemblies operatively coupled to the electric motor, the plurality of battery assemblies including a first battery assembly supported by the tunnel and extending forward of the forwardmost extent of the tunnel.

[0016] In an example thereof, the electric powertrain further includes a continuously variable transmission, the continuously variable transmission having a drive clutch and a driven clutch operatively coupled to the drive clutch, the drive clutch being driven by the electric motor and the endless track being driven by the driven clutch.

[0017] In another example thereof, the electric powertrain further includes an electronically controlled continuously variable transmission, the electronically controlled continuously variable transmission having a drive clutch and a driven clutch operatively coupled to the drive clutch, the drive clutch being driven by the electric motor and the endless track being driven by the driven clutch.

[0018] In a further example thereof, the electric powertrain further includes a chain drive which operatively couples the electric motor to the endless track.

[0019] In yet another example thereof, the electric motor is operatively coupled to the endless track through a portion of the electric powertrain positioned laterally outboard of the first endless track.

[0020] In still another example thereof, the first battery assembly is moveable relative to the tunnel.

[0021] In yet still another example thereof, the snowmobile further comprising a mounting assembly to couple the first battery assembly to the tunnel. In a variation thereof, the mounting assembly permits a movement of the first battery assembly relative to tunnel in a longitudinal direction along the tunnel. In another variation thereof, the tunnel includes at least one track and the mounting assembly cooperates with the at least one track to limit movement of the first battery assembly in the longitudinal direction along the tunnel. In a further variation thereof, the mounting assembly includes a locked state wherein a longitudinal position of the first battery assembly is locked relative to the tunnel.

[0022] In a further yet exemplary embodiment of the present disclosure, a snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel having a forwardmost extent; and an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including an electric motor operatively coupled to the endless track; and a plurality of battery assemblies operatively coupled to the electric motor. The plurality of battery assemblies including a first battery assembly supported by the tunnel and moveable along a longitudinal direction of the tunnel while coupled to the tunnel.

[0023] In an example thereof, the snowmobile further comprising a mounting assembly to couple the first battery assembly to the tunnel. In a variation thereof, the tunnel includes at least one track and the mounting assembly cooperates with the at least one track to limit movement of the first battery assembly in the longitudinal direction along the tunnel. In another variation thereof, the mounting assembly includes a locked state wherein a longitudinal position of the first battery assembly is locked relative to the tunnel.

[0024] In a still another exemplary embodiment of the present disclosure, a snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including a first endless track, a second endless track, a left front ski, and a right front ski. The first endless track and the second endless track are both positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel; and an electric powertrain operatively coupled to the first endless track and the second endless track to power movement of the first endless track and the second endless track. The electric powertrain including a first electric motor operatively coupled to the first endless track; a second electric motor operatively coupled to the second endless track; and a plurality of battery assemblies operatively coupled to at least one of the first electric motor and the second electric motor. The plurality of battery assemblies including a first portion and a second portion. The first portion being supported by the tunnel and the second portion being positioned forward of the tunnel.

[0025] In a yet still another exemplary embodiment of the present disclosure, a snowmobile having a longitudinal vertical centerline plane is provided. The snowmobile comprising a plurality of ground engaging members including a first endless track, a second endless track, a left front ski, and a right front ski, the first endless track and the second endless track are both positioned rearward of the left front ski and the right front ski. The first endless track having a first lateral outer extent positioned on a first side of the longitudinal vertical centerline plane. The second endless track having a second lateral outer extent positioned on a second side of the longitudinal vertical centerline plane, the second side being opposite the first side. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel; and an electric powertrain operatively coupled to the first endless track and the second endless track to power movement of the first endless track and the second endless track. The electric powertrain including a first electric motor operatively coupled to the first endless track laterally outboard of the first lateral outer extent of the first endless track; a second electric motor operatively coupled to the second endless track laterally outboard of the second lateral outer extent of the second endless track; and a plurality of battery assemblies operatively coupled to at least one of the first electric motor and the second electric motor.

[0026] In an example thereof, the plurality of battery assemblies include a first portion and a second portion, the first portion being supported by the tunnel and the second portion being positioned forward of the tunnel.

[0027] In a still further exemplary embodiment of the present disclosure, a snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile; and an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including a first electric motor operatively coupled to the endless track; a second electric motor operatively coupled to the endless track; and a plurality of battery assemblies operatively coupled to the first electric motor and the second electric motor.

[0028] In an example thereof, the plurality of battery assemblies include a first portion and a second portion, the first portion being supported by the tunnel and the second portion being positioned forward of the tunnel.

[0029] In another example thereof, an output of the first electric motor operatively coupled to the endless track is positioned on a first side of the vertical centerline longitudinal plane and an output the second electric motor operatively coupled to the endless track is positioned on a second side of the vertical centerline longitudinal plane, the second side being opposite the first side.

[0030] In a further still exemplary embodiment of the present disclosure, a method of adjusting a center of mass of a snowmobile is provided. The method comprising the steps of: supporting a first battery assembly of an electric powertrain to drive an endless track of the snowmobile to a tunnel of the snowmobile; restraining a movement of the first battery assembly relative to the tunnel to a longitudinal direction of the tunnel; moving the first battery assembly along the longitudinal direction relative to the tunnel from a first position to a second position; and locking the first battery assembly in the second position relative to the tunnel.

[0031] In yet a further still exemplary embodiment of the present disclosure, a method of selecting an operational mode from a plurality of operational modes for an electric powertrain of a snowmobile is provided. The method comprising: monitoring at least one vehicle characteristic; receiving a selected first operational mode of the plurality of operational modes; comparing the monitored vehicle characteristic to an acceptable range for the first selected mode; and if the monitored vehicle characteristic is outside of the acceptable range for the first selected mode, suggesting a second operational mode of the plurality of operational modes.

[0032] In an example thereof, the step of suggesting the second operational mode of the plurality of operational modes occurs prior to permitting the snowmobile to move by the electric powertrain. In a variation thereof, the method further comprising the steps of: displaying on a display of the snowmobile the second operational mode of the plurality of operational modes; receiving an input resulting in selecting the second operational mode of the plurality of operational modes for operation of the snowmobile; and permitting movement of the snowmobile in the second operational mode of the plurality of operational modes. In another variation thereof, the method further comprising the steps of: displaying on a display of the snowmobile the second operational mode of the plurality of operational modes; receiving an input resulting in selecting the first operational mode of the plurality of operational modes for operation of the snowmobile; and permitting movement of the snowmobile in the first operational mode of the plurality of operational modes.

[0033] In yet still a further exemplary embodiment of the present disclosure, a method of controlling a position of a tensioning wheel of an endless track assembly of a snowmobile. The method comprising: determining an operating state of the snowmobile; if the operating state of the snowmobile is a first state the tensioning wheel is positioned in a first position by an actuator; otherwise, the tensioning wheel is positioned in a second position by the actuator.

[0034] In an example thereof, the first position is a raised position relative to the second position. In a variation thereof, the operating state is a direction of travel of the snowmobile. In another variation thereof, the operating state is a direction selection of the snowmobile with an operator input.

[0035] In another still exemplary embodiment of the present disclosure, a method of controlling a position of a tensioning wheel of an endless track assembly of a snowmobile is provided. The method comprising: receive an operator request to move the tensioning wheel; determining an operating state of the snowmobile; and moving the tensioning wheel with an actuator.

[0036] In an example thereof, the actuator changes a vertical location of the tensioning wheel.

[0037] In yet another still exemplary embodiment of the present disclosure, a snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski, the endless track being positioned rearward of the left front ski and the right front ski. The endless track including a tensioning wheel and an actuator which positions the tensioning wheel. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile; an operator input supported by the structural frame; and an electronic controller operatively coupled to the operator input and the actuator, the electronic controller altering a position of the tensioning wheel with the actuator based on the operator input.

[0038] In an example thereof, the electronic controller alters a height of the tensioning wheel with the actuator based on the operator input.

[0039] In another example thereof, the snowmobile further comprising an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including an electric motor operatively coupled to the endless track and a plurality of battery assemblies operatively coupled to the electric motor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0040] FIG. **1** illustrates a left side view of an exemplary snowmobile;

[0041] FIG. **2** illustrates a left side view of a structural frame of the snowmobile of FIG. **1**;

[0042] FIG. **3** illustrates a right side view of the exemplary snowmobile of FIG. **1**;

[0043] FIG. **4** illustrates a top view of the exemplary snowmobile of FIG. **1**;

[0044] FIG. **5** illustrates a top view of the exemplary frame of FIG. **2**;

[0045] FIG. **6** illustrates a right side view of a portion of an exemplary endless track ground engaging member with a tensioning wheel in a first position;

[0046] FIG. **7** illustrates a right side view of a portion of an exemplary endless track ground engaging member with a tensioning wheel in a second position;

[0047] FIG. **8** illustrates an exemplary processing sequence of the exemplary snowmobile of FIG. **1**;

[0048] FIG. **9** illustrates another exemplary processing sequence of the exemplary snowmobile of FIG. **1**;

[0049] FIG. **10** illustrates an exemplary electric powertrain assembly of the exemplary snowmobile of FIG. **1**;

[0050] FIG. **11** illustrates an exemplary battery assembly of the exemplary electric powertrain assembly of FIG. **10**;

[0051] FIG. **12** illustrates an exemplary motor assembly of the exemplary electric powertrain assembly of FIG. **10**;

[0052] FIG. **13** illustrates exemplary placement of exemplary battery assemblies on the exemplary frame of FIG. **2**;

[0053] FIG. **14** illustrates a battery assembly as part of the structural frame of the exemplary snowmobile of FIG. **1**;

[0054] FIG. **15** illustrates a battery assembly as part of the structural frame of the exemplary snowmobile of FIG. **1**;

[0055] FIG. **16** illustrates a motor assembly as part of the structural frame of the exemplary snowmobile of FIG. **1**;

[0056] FIG. **17** illustrates an exemplary driveline of the exemplary snowmobile of FIG. **1**;

[0057] FIG. **18** illustrates another exemplary driveline of the exemplary snowmobile of FIG. **1**;

[0058] FIG. **19** illustrates a further exemplary driveline of the exemplary snowmobile of FIG. **1**;

[0059] FIG. **20** illustrates yet another exemplary driveline of the exemplary snowmobile of FIG. **1**;

[0060] FIG. **21** illustrates still a further exemplary driveline of the exemplary snowmobile of FIG. **1**;

[0061] FIG. **22** illustrates an exemplary brake system of the exemplary snowmobile of FIG. **1**;

[0062] FIG. **23** illustrates an exemplary placement of a power steering unit of the exemplary snowmobile of FIG. **1**;

[0063] FIG. **24** illustrates another exemplary placement of a power steering unit of the exemplary snowmobile of FIG. **1**;

[0064] FIG. **25** illustrates an exemplary placement of components of the exemplary snowmobile of FIG. **1**;

[0065] FIG. **26** illustrates an exemplary placement of components of the exemplary snowmobile of FIG. **1** including an axial flux motor;

[0066] FIG. **27** illustrates the exemplary placement of components in FIG. **26** of the exemplary snowmobile of FIG. **1** including the axial flux motor;

[0067] FIG. **28** illustrates an exemplary placement of components of the exemplary snowmobile of FIG. **1** including a plurality of axial flux motors;

[0068] FIG. **29** illustrates an exemplary embodiment of a snowmobile including a plurality of endless tracks and a plurality of electric motors;

[0069] FIG. **30** illustrates an exemplary placement of components of the exemplary snowmobile of FIG. **1**;

[0070] FIG. **31** illustrates an exemplary placement of components of the exemplary snowmobile of FIG. **1**;

[0071] FIG. **32** illustrates an exemplary placement of components of an active cooling system of the exemplary snowmobile of FIG. **1**;

[0072] FIG. **33** illustrates an exemplary coupling of the active cooling system of FIG. **32** with an exemplary battery assembly;

[0073] FIG. **34** illustrates an exemplary placement of components of a kinetic energy recovery system of the exemplary snowmobile of FIG. **1**;

[0074] FIG. **35** illustrates a further exemplary processing sequence of the exemplary snowmobile of FIG. **1**;

[0075] FIG. **36** illustrates yet another exemplary processing sequence of the exemplary snowmobile of FIG. **1**;

[0076] FIG. **37** illustrates a left, front, perspective view of an exemplary layout of portions of an exemplary snowmobile;

[0077] FIG. **38** illustrates a left side view of the exemplary layout of FIG. **37**;

[0078] FIG. **39** illustrates a right side view of the exemplary layout of FIG. **37**;

[0079] FIG. **40** illustrates an exemplary battery assembly mounted to a tunnel of a snowmobile with a mounting assembly;

[0080] FIG. **41** is an exploded view of the mounting assembly of FIG. **40**;

[0081] FIG. **42** is a cross-sectional view along lines **42-42** in FIG. **40**; and

[0082] FIG. **42**A is a detail view of a portion of FIG. **42**.

[0083] Corresponding reference characters indicate corresponding parts throughout the several views. Unless stated otherwise the drawings are proportional with the exception of the flowcharts and block representations.

DETAILED DESCRIPTION OF THE DRAWINGS

[0084] The embodiments disclosed below are not intended to be exhaustive or to limit the invention to the precise forms disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. While the present disclosure is primarily directed to a snowmobile, it should be understood that the features disclosed herein may have application to other types of vehicles such as snow bikes.

[0085] Referring to FIG. **1**, an illustrated embodiment of snowmobile **100** is shown. Snowmobile **100** as illustrated includes a plurality of ground engaging members **102**. Illustratively, ground engaging members **102** include an endless track assembly **104** and a pair of front skis **106**A and **106**B (see FIG. **4**). Endless track assembly **104** supports a rear portion of snowmobile **100** while skis **106** support a front portion of snowmobile **100**. Further, endless track assembly **104** is operatively coupled to an electric powertrain assembly **200** (see FIG. **8**).

[0086] Referring to FIG. **2**, snowmobile **100** includes a structural frame **110**. Structural frame **110** includes a front frame portion **112** which is generally supported by skis **106**. Structural frame **110** further includes a tunnel **116** which is generally supported by endless track assembly **104** and a middle frame portion **114** connecting front frame portion **112** and tunnel **116**. Additionally, structural frame **110** may include an overstructure **118** which supports a steering assembly **170** of snowmobile **100**. In the illustrated embodiment, front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118** are coupled together with fasteners, weldments, adhesives, or other suitable couplers. In embodiments, one or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118** are integrally formed with another of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**. Exemplary frames are disclosed in U.S. Pat. No. 8,490,731 titled SNOWMOBILE, the entire disclosure of which is expressly incorporated by reference herein.

[0087] Each of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118** is apart of structural frame **110**. Structural frame **110** provides structural rigidity for snowmobile **100**. As explained herein each of front frame portion **112**, middle frame portion **114**, tunnel **116**, overstructure **118** may support one or more portions of electric powertrain assembly **200**. Further, as explained herein, one or more portions of electric powertrain assembly **200** may be part of the structural frame of snowmobile **100**. For example, one or more portions of electric powertrain assembly **200** may replace a component of one or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**, be interposed between the components of one or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**, be interposed between two or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**, and/or being integrally formed as part of one or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**.

[0088] Structural frame **110** supports an operator seat **132**. Operator seat **132** has a front end **134** and a rear end **136**, front end **134** being positioned closer to skis **106** than rear end **136**. Further, operator seat **132** is positioned rearward of a steering assembly **170** of snowmobile **100**.

[0089] Front frame portion **112** is coupled to skis **106**A and **106**B through respective front suspensions **120**A and **120**B (see FIG. **4**). Front suspensions **120**A and **120**B permits the relative movement of structural frame **110** relative to skis **106**. In general, front suspension **120**B is a mirror image of front suspension **120**A.

[0090] Referring to FIG. **1**, front suspension **120**A includes a spindle **122**A which is rotatably coupled to front skis **106**A at a lower end. Spindle **122**A is further rotatably coupled to a lower control arm **126**A and an upper control arm **128**A. Lower control arm **126**A and upper control arm **128**A are each rotatably coupled to front frame portion **112** of structural frame **110** (see FIG. **2**). A shock absorber **130**A is rotatably coupled to one of lower control arm **126**A and upper control arm **128**A and to front frame portion **112** of structural frame **110**. Shock absorbers **130**, in embodiments, may be electronically controlled shock absorber having adjustable compression and/or rebound damping characteristics. Additional details regarding exemplary electronically controlled shock absorber systems are described in U.S. patent application Ser. No. 17/325,062, filed May 19, 2021, titled SYSTEMS AND METHODS OF ADJUSTABLE SUSPENSIONS FOR OFF-ROAD RECREATIONAL VEHICLES, the entire disclosure of which is expressly incorporated by reference herein.

[0091] Referring to FIG. **3**, structural frame **110** is supported by endless track assembly **104** through a rear suspension **140** and a drive shaft **142** (see FIG. **10**). Drive shaft **142** includes at least one drive sprocket **144** which has a plurality of engagement features, such as teeth, to engage and move endless track belt **148** of endless track assembly **104**. Drive shaft **142** is rotatably coupled to structural frame **110** and couples endless track assembly **104** to structural frame **110**.

[0092] In the illustrated embodiment, rear suspension **140** of endless track assembly **104** includes a plurality of slide rails **150**, a plurality of control arms **152** rotatably coupled to the plurality of slide rails **150** and rotatably coupled to tunnel **116** of structural frame **110**, a plurality of idler wheels **154** coupled to the plurality of slide rails **150**, and at least one shock absorber **156**, illustratively front shock absorber **158** and rear shock absorber **160**. One or both of front shock absorber **158** and rear shock absorber **160**, in embodiments, may be an electronically controlled shock absorber having adjustable compression and/or rebound damping characteristics. Additional details regarding exemplary electronically controlled shock absorber systems are described in U.S. patent application Ser. No. 17/325,062, filed May 19, 2021, titled SYSTEMS AND METHODS OF ADJUSTABLE SUSPENSIONS FOR OFF-ROAD RECREATIONAL VEHICLES, the entire disclosure of which is expressly incorporated by reference herein.

[0093] Rear suspension **140** further includes tensioning wheels **162** which are positioned at a rear portion of endless track assembly **104** and engage endless track belt **148** to control the tension on endless track belt **148**. Referring to FIGS. **6** and **7**, in embodiments, tensioning wheels **162** is coupled to a tensioning rail **164**. Tensioning rail **164** is rotatably coupled to a rear portion **166** of endless track assembly **104** at location **167**. An actuator **168** is coupled to rear portion **166** and tensioning rail **164** to control a rotation position of tensioning rail **164** relative to rear portion **166**. Exemplary actuators include linear actuators, linkages, and other suitable actuators. In embodiments, actuator **168** is an electronically controlled actuator which is controlled by an electronic controller, such as controller **270** of electric powertrain assembly **200** described herein. As shown in FIG. **6**, tensioning wheels **162** is shown in a lowered position. As shown in FIG. **7**, tensioning wheels **162** is shown in a raised position. In embodiments, tensioning wheels **162** is placed in the lowered position when snowmobile **100** is moving relative to the ground in a forward direction wherein skis **106** are leading endless track belt **148** in the movement of snowmobile **100** and in the raised position when snowmobile **100** is moving relative to the ground in a reverse direction wherein endless track belt **148** is leading the skis **106** in the movement of snowmobile **100**.

[0094] Referring to FIG. **8**, an exemplary processing sequence **180** of electronic controller **270** for controlling the position of tensioning wheels **162** is shown. Electronic controller **270** determines an operating state of snowmobile **100**, as represented by block **182**. Exemplary operating states include a direction of travel of snowmobile **100**; a direction selection of snowmobile **100** (forward or reverse) with an operator input; a speed of snowmobile **100**; a selected mode of operation of snowmobile **100** (such as comfort or sport), the selected mode adjusting the characteristics of endless track assembly **104** and front suspensions **120**; and other suitable states of snowmobile **100**. If the operating state of snowmobile **100** is a first state then the tensioning wheel **162** is positioned in a first position, as represented by blocks **184** and **186**. Otherwise, the tensioning wheel **162** is positioned in a second position, as represented by blocks **184** and **188**. In embodiments, the first position of tensioning wheels **162** is the raised position of FIG. **7** and the second position of tensioning wheels **162** is the lowered position of FIG. **6**.

[0095] Referring to FIG. **9**, an exemplary processing sequence **190** of electronic controller **270** for controlling the position of tensioning wheels **162** is shown. Electronic controller **270** receives an operator request for tensioning wheel position, as represented by block **192**. Exemplary requests may be received through an input device **282**. Exemplary input devices may be specifically for tensioning wheel position or may be for other vehicle characteristic which effects the tensioning wheel position, such as forward or reverse selection. If a requested position is received, electronic controller **270** positions tensioning wheels **162** in the requested position, as represented by blocks **194** and **196**.

[0096] In embodiments, snowmobile **100** is powered for movement relative to the ground with an electric powertrain assembly. Referring to FIG. **10**, an exemplary electric powertrain assembly **200** is shown. Electric powertrain assembly **200** includes at least one electric motor assembly **202** including an electric motor **203**. Referring to FIG. **12**, electric motor assembly **202** includes a motor housing **204** in which are positioned a drive shaft **206** supporting a rotor **208** and a stator **210**. Drive shaft **206** includes a first end **212**

which extends beyond a first end **214** of motor housing **204** and optionally a second end **216** which extends beyond a second end **218** of motor housing **204**, second end **218** is opposite of first end **214**. In embodiments, electric motor assembly **202** further includes an electronic controller that controls the operation of electric motor **203**. Electric motor **203** receives electrical power through electrical connectors **220**.

[0097] Returning to FIG. **10**, electric motor assembly **202** is operatively coupled to drive sprocket **144** of endless track assembly **104** through a driveline **230**. In embodiments, electric motor assembly **202** is positioned within the interior of endless track belt **148**. In embodiments, electric motor assembly **202** is supported by structural frame **110** and coupled to drive shaft **142** through one or more of a gearset, a continuously variable transmission, a chain drive, other suitable coupling devices which transfer mechanical power, and/or combinations thereof.

[0098] Electric motor assembly **202** receives electrical energy from at least one battery assembly **240**. In embodiments, a plurality of battery assemblies **240** are provided. Referring to FIG. **11**, battery assembly **240** includes a battery housing **242** in which are positioned a plurality of battery cells **244**. Exemplary battery cells may be prismatic, cylindrical, or other suitable shapes. Exemplary battery cells include lithium-ion cells, nickel-cadmium cells, and other suitable cell chemistries. Battery assembly **240** may optionally include one or more of sensors **246**, an electronic controller **248**, and/or a thermal management system **250**.

[0099] Sensors **246** may monitor characteristics associated with one or more of battery cells **244**. Exemplary characteristics include temperature, charge, current, voltage, resistance, and other suitable characteristics. Electronic controller **248** controls the operation of battery cells **244** including charging and discharging. In embodiments, battery assembly **240** includes one or more switches which electronic controller **248** controls to selectively charge at least a portion of battery cells **244** and/or selectively discharge at least a portion of battery cells **244**.

[0100] Thermal management system **250** controls the temperature of battery cells **244**. In embodiments, thermal management system **250** removes heat from proximate battery cells **244** to lower or reduce a rate of increase in a temperature of battery cells **244**. In embodiments, thermal management system **250** provides heat to proximate battery cells **244** to raise the temperature of battery cells **244**, such as during cold weather operation. Exemplary thermal management system **250** include passive systems, such as plates, heat sinks, and active systems including fluid systems to enhance removal and/or supply of heat. Exemplary active systems include air systems wherein air is directed over plates, heat sinks, or fluid conduits positioned proximate to battery cells **244** and liquid systems wherein a liquid fluid is directed through fluid conduits proximate to battery cells **244**.

[0101] Plurality of battery cells **244** are electrically coupled together in series, in parallel, or in a combination of portions in series and portions in parallel. Plurality of battery cells **244** are electrically coupled to a positive terminal **252** of battery assembly **240** and a negative terminal **254** of battery assembly **240** both of which are accessible from an exterior of battery housing **242**.

[0102] Battery assembly **240** may be operatively coupled to a charger **260** to charge battery cells **244**. An exemplary charge port **245** (see FIG. **1**) may be positioned where a gas cap would be on a gas-powered snowmobile or other suitable locations. Further, battery assembly **240** may be operatively coupled to a DC-DC converter **262** which controls the power level provided to electric motor assembly **202**. In embodiments, electric motor **203** of electric motor assembly **202** is a DC motor. In embodiments, electric motor **203** of electric motor assembly **202** is an AC motor and an inverter is provided in addition to or in place of DC-DC converter **262**.

[0103] In embodiments, either DC-DC converter **262** or a second DC-DC converter receives power from battery assembly **240** and is converted to either AC accessory power or DC accessory power. In embodiments, at least one plug is provided to connect accessories, such as ice augers, stereos, heaters, cooling devices, computer, and a heater for battery assembly **240**.

[0104] Electric powertrain assembly **200** further includes an electronic controller **270**. Electronic controller **270** includes at least one processor **272** and at least one non-transitory computer readable medium, memory **274**. In embodiments, electronic controller **270** is a single unit that controls the operation of various systems of electric powertrain assembly **200** and optionally snowmobile **100**. In embodiments, electronic controller **270** is a distributed system comprised of multiple controllers each of which control one or more systems of electric powertrain assembly **200** and optionally snowmobile **100** and may communicate with each other over one or more wired and/or wireless networks.

[0105] Electronic controller **270** includes logic, such as processing sequences **180**, **190**, **620**, and **650** of FIGS. **8**, **9**, **35**, and **36**, which controls the operation of snowmobile **100**. Further, memory **274** may include one or more configuration settings for electronic controller **270**. The configuration settings may be used by the logic in the control of electric powertrain assembly **200** or other components and systems of snowmobile **100**, such as shock absorbers **130**, **158**, and/or **160**.

[0106] The term "logic" as used herein includes software and/or firmware executing on one or more programmable processors, application-specific integrated circuits, field-programmable gate arrays, digital signal processors, hardwired logic, or combinations thereof. Therefore, in accordance with the embodiments, various logic may be implemented in any appropriate fashion and would remain in accordance with the embodiments herein disclosed. The non-transitory machine-readable medium comprising logic can additionally be considered to be embodied within any tangible form of a computer-readable carrier, such as solid-state memory, magnetic disk, and optical disk containing an appropriate set of computer instructions and data structures that would cause a processor to carry out the techniques described herein. This disclosure contemplates other embodiments in which electronic controller **270** is not microprocessor-based, but rather is configured to control operation of propulsion system **200** based on one or more sets of hardwired instructions.

[0107] Electric powertrain assembly **200** further includes an operator interface **280** which includes a plurality of input devices **282** and a plurality of output devices **284**. Exemplary input devices **282** include levers, buttons, switches, soft keys, touch screens, and other suitable input devices. Exemplary output devices **284** include lights, displays, audio devices, tactile devices, and other suitable output devices. In embodiments, operator interface **280** includes a display, such as a touch screen display, and electronic controller **270** interprets various types of touches to the touch screen display as inputs and controls the content displayed on touch screen display. In embodiments, input devices **282** includes a mode input. Mode input provides an indication to electronic controller **270** of limits, setups, and other characteristics for electric powertrain assembly **200** of snowmobile **100** and/or other components and systems of snowmobile **100**

[0108] In exemplary modes, values for forward movement torque and speed performance, rearward movement torque and speed performance, and regenerative shock and/or braking performance. In one exemplary forward mode used for towing, climbing, or getting out of stuck situations, torque is maximized. In another exemplary forward mode, top speed (high endless track speed) is the focus. In a further exemplary forward economy mode, battery range is maximized. In an exemplary reverse mode, torque is maximized, and speed is limited over normal operation. An operator input may be provided, such as a button on the handlebars, to override limited speed. In a first exemplary regeneration mode, a level of regenerative braking in increased for situations like descending a hill. In this mode motor **202** provides much of the braking and capture of energy and the physical brakes would be used to supplement the motor regenerative braking. In a second exemplary regeneration mode, motor **202** provides very little freewheeling resistance and slowing snowmobile **100** down would rely solely on the physical brakes on snowmobile **100**. In a third exemplary mode, a level of motor **202** regenerative braking is between the first exemplary mode and the second exemplary mode. In a fourth exemplary mode, a level of motor **202** regenerative braking is variable depending on one or more of brake lever position, brake system fluid pressure, and/or endless track speed.

[0109] In embodiments, driveline **230** includes a peak torque limiter (not shown). The peak torque limiter may be integrated as part of drive shaft **142** of endless track assembly **104**, within a chaincase or transmission if included, or mounted directly to the electric motor.

[0110] Referring to FIG. **13**, exemplary layouts of battery assembly **240** on snowmobile **100** is illustrated. In embodiments, battery assembly **240** and/or other components of electric powertrain assembly **200** are placed to balance the mass of snowmobile **100** about a pitch center of snowmobile **100**. In a first position **300**, one or more battery assembly **240** are placed on top of tunnel **116** under operator seat **132**. In a second position **302**, one or more of battery assembly **240** are placed longitudinally offset from operator seat **132** and on top of tunnel **116**, such as rearward of operator seat **132** as shown in FIG. **13**. In a third position **304**, one or more of battery assembly **240** are supported by middle frame portion **114** of structural frame **110** longitudinally forward of a vertical lateral plane **306** aligned with drive shaft **142**, and optionally rearward of a vertical lateral plane **308** aligned with a pivot axis **310** between skis **106** and shock absorbers **122**, and at least partially lower than a horizontal plane passing through drive shaft **142**. In a fourth position **322**, one or more of battery assembly **240** are supported by middle frame portion **114** of structural frame **110** longitudinally forward of vertical lateral plane **306**, and optionally rearward of vertical lateral plane **308**, and completely above a horizontal plane passing through drive shaft **142**. In a fifth position **324**, one or more of battery assembly **240** are supported by overstructure **118** of structural frame **110**. In the illustrated embodiment of FIG. **13**, fifth position **324** of one or more of battery assembly **240** is on a front of overstructure **118**. In other embodiments, one or more of battery assembly **240** may be place on a front of overstructure **118**, a back of overstructure **118**, a left side of overstructure **118**, a right side of overstructure **118**, or a combination thereof.

[0111] In embodiments, a portion of battery assembly **240** are positioned below operator seat **132** and a heat exchanger is positioned under operator seat **132** to pull heat from the portion of battery assembly **240** to warm operator seat **132**. An exemplary heat exchanger may be a cooling plate in contact with the portion of battery assembly **240** and/or other portions of electric powertrain assembly **200**, such as an inverter as mentioned herein for an AC version of electric motor assembly **202**.

[0112] In embodiments, at least a portion of battery assembly **240** are supported by tunnel **116** and under operator seat **132** and/or behind operator seat **132**. The portion of battery assembly **240** may be swapped out or expanded to including additional battery assembly **240** to enhance the power and/or range of snowmobile **100**.

[0113] In addition to being supported by structural frame **110**, in embodiments, one or more of battery assembly **240** forms part of the structural frame of snowmobile **100**. Referring to FIG. **14**, a battery assembly **240** is interposed between tunnel **116** and overstructure **118** and each of tunnel **116** and overstructure **118** are connected thereto. Tunnel **116** includes an inverted U-shape having a top **326**, a right side wall **328**, and a left side wall **330**. Drive sprocket **144** extends between left side wall **330** and right side wall **328** and drive shaft **142** extends from inside tunnel **116** to outside of tunnel **116**. Battery assembly **240** is mounted to top **326** of tunnel **116** and a left rear support **332** and a right rear support **334** of overstructure **118** are mounted to battery assembly **240**. In embodiments, one or more of battery cells **244** may be interposed between any two of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**. In embodiments, one or more battery cells **244** replace one or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**.

[0114] In embodiments, battery assembly **240** forms part of the structural frame of snowmobile **100**. A battery assembly **240** forms part of one or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**. For example, referring to FIG. **15**, a battery assembly **240** forms part of top **326** of tunnel **116** and overstructure **118** connects to tunnel **116** independent of battery assembly **240**. In embodiments, overstructure **118** connects to tunnel **116** through battery assembly **240** and battery assembly **240** both forms part of tunnel **116**, and optionally part of overstructure **118**, and is interposed between tunnel **116** and overstructure **118**. In embodiments, battery assembly **240** replaces middle frame portion **114** and front frame portion **112** as part of the structural frame **110**. The front suspensions **120** may be bolted or otherwise fastened to a front portion of battery assembly **240** and the front of tunnel **116** may be fastened to a rear portion of battery assembly **240**. In embodiments, suspension components, such as lower control arms **126**, upper control arms **128**, shock absorbers **130**, and sway bars may be coupled to the front portion of battery assembly **240**. One or more additional battery assemblies **240** may for part of the structural frame of the tunnel **116** such as the top portion of the tunnel and the sides, front, and/or rear of the tunnel **116** may be fastened to the battery assembly **240** forming the top of tunnel **116**. Additionally portions of overstructure **118** may be formed by one or more battery assemblies **240**. The steering post, mounts for the hood, and other components could be mounted to the one or more battery assemblies, such as to bosses or recesses provided on the one or more battery assemblies. In embodiments, both the upper and lower steering shafts may be the one or more battery assemblies. The one or more battery assemblies may be positioned to provide proper clearance for the drag link connecting the upper and lower steering shafts to provide full range of steering motion. An advantage, among others, of having at least one or more battery assemblies form part of the structural frame is a reduction in the weight of vehicle **100**.

[0115] Similar to battery assembly **240**, electric motor assembly **202** may be part of structural frame **110**. Electric motor assembly **202** may be interposed between any two of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**, forms part of at least one of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**, and both is interposed between any two of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118** and forms part of at least one of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**. Referring to FIG. **16**, a bracket **340** of electric motor assembly **202** is coupled to motor housing **204** and electric motor assembly **202** forms a right side part of middle frame portion **114** of structural frame **110**.

[0116] Further, similar to battery assembly **240**, the placement of electric motor assembly **202** on snowmobile **100** supported by one or more of front frame portion **112**, middle frame portion **114**, tunnel **116**, and overstructure **118**. In embodiments, electric motor assembly **202** is placed forward of vertical lateral plane **306**. In embodiments, electric motor assembly **202** is placed forward of vertical lateral plane **306** and predominantly to one side, left or right, of a longitudinal vertical plane **108** (see FIG. **5**) of snowmobile **100**, and optionally completely to one side, left or right of longitudinal vertical plane **108** of snowmobile **100**. In embodiments, electric motor assembly **202** is placed forward of vertical lateral plane **306** and is centered relative to longitudinal vertical plane **108** of snowmobile **100**. In embodiments, a first electric motor assembly **202** is placed forward of vertical lateral plane **306** and predominantly to one side, left or right, of longitudinal vertical plane **108** of snowmobile **100**, and optionally completely to one side, left or right of longitudinal vertical plane **108** of snowmobile **100** and a second electric motor assembly **202** is placed forward of vertical lateral plane **306** and predominantly to the other side, left or right, of longitudinal vertical plane **108** of snowmobile **100**, and optionally completely to one side, left or right of longitudinal vertical plane **108** of snowmobile **100**. An advantage, among others, of having at least one of electric motor assembly **202** and/or at least one of battery assembly **240** be part of structural frame **110** is the reduction in weight of snowmobile **100**.

[0117] Referring to FIG. **17**, an exemplary embodiment of driveline **230** is shown. In FIG. **17**, electric motor assembly **202** is positioned so that output shaft **212** of electric motor assembly **202** or a rotatable shaft operatively coupled to output shaft **212** extends outboard of tunnel **116** and overstructure **118** of structural frame **110**, in particular support **342** of overstructure **118**. Driveline **230** includes a drive wheel **400** coupled to first end **212** of drive shaft **206** of electric motor assembly **202**, a driven wheel **402**, and an endless connector **404** operatively coupling driven wheel **402** to drive wheel **400**. In embodiments, endless connector **404** is a belt and each of drive wheel **400** and driven wheel **402** are pulleys adapted for use with a belt. In embodiments, endless connector **404** is a chain and each of drive wheel **400** and driven wheel **402** are sprockets adapted for use with a chain.

[0118] Driven wheel **402** is carried by a rotatable shaft **408** on which a second drive wheel (not shown) is also carried and rotates with driven wheel **402**. The second drive wheel, or another rotatable element operatively coupled to the second drive wheel, is operatively coupled to a second driven wheel **410** through a second endless connector **414**. Second driven wheel **410** is carried by drive shaft **142**. In embodiments, second endless connector **414** is a belt and each of second drive wheel and second driven wheel **410** are pulleys adapted for use with a belt. In embodiments, second endless connector **414** is a chain and each of second drive wheel and second driven wheel **410** are sprockets adapted for use with a chain.

[0119] A rotation of first end **212** of drive shaft **206** causes a corresponding rotation of drive wheel **400** which rotates driven wheel **402** through endless connector **404**. Driven wheel **402** in turn causes a rotation of drive shaft **142** through the second drive wheel, second endless connector **414**, and second driven wheel **410**. In embodiments, the second drive wheel, second driven wheel **410**, and second endless connector **414** are provided in a chaincase having fluid to lubricate second endless connector **414** and the rotatable shaft connected to the second drive wheel and driven wheel **402** extends outward from the chaincase to support driven wheel **402**.

[0120] Referring to FIG. **18**, another exemplary embodiment of driveline **230** is shown. In FIG. **18**, electric motor assembly **202** is positioned so that output shaft **212** of electric motor assembly **202** or a rotatable shaft operatively coupled to output shaft **212** extends outboard of tunnel **116**, and optionally of overstructure **118**, in particular support **344** of overstructure **118**. Driveline **230** includes a drive wheel **430** coupled to first end **212** of drive shaft **206** of electric motor assembly **202**, a driven wheel **432**, and an endless connector **434** operatively coupling driven wheel **432** to drive wheel **430**. In embodiments, endless connector **434** is a belt and each of drive wheel **430** and driven wheel **432** are pulleys adapted for use with a belt. In embodiments, endless connector **434** is a chain and each of drive wheel **430** and driven wheel **432** are sprockets adapted for use with a chain.

[0121] Driven wheel **402** is carried by a rotatable jackshaft **436** on a left side of tunnel **116**. Jackshaft **436** extends across longitudinal vertical plane **108** and extends beyond tunnel **116** on a right side of snowmobile **100**. Jackshaft **436** is received on the right side of tunnel **116** in a chaincase (not shown) which transfer the rotation of rotatable jackshaft **436** to drive shaft **142**.

[0122] A rotation of first end **212** of drive shaft **206** causes a corresponding rotation of drive wheel **430** which rotates driven wheel **432** through endless connector **434**. Driven wheel **432** in turn causes a rotation of rotatable jackshaft **436** which, in turn, causes a rotation of drive shaft **142** through the chaincase.

[0123] Referring to FIG. **19**, yet another exemplary embodiment of driveline **230** is shown. In FIG. **19**, electric motor assembly **202** is positioned so that output shaft **212** of electric motor assembly **202** or a rotatable shaft operatively coupled to output shaft **212** extends outboard of tunnel **116**, and optionally of overstructure **118**. Driveline **230** includes a drive wheel **450** coupled to first end **212** of drive shaft **206** of electric motor assembly **202**, a driven wheel **452**, and an endless connector **454** operatively coupling driven wheel **452** to drive wheel **450**. In embodiments, endless connector **454** is a belt and each of drive wheel **450** and driven wheel **452** are pulleys adapted for use with a belt. In embodiments, endless connector **454** is a chain and each of drive wheel **450** and driven wheel **452** are sprockets adapted for use with a chain. Driven wheel **402** is carried by drive shaft **142**.

[0124] A rotation of first end **212** of drive shaft **206** causes a corresponding rotation of drive wheel **450** which rotates driven wheel **452** through endless connector **454**. Driven wheel **452** in turn causes a rotation of drive shaft **142**.

[0125] Referring to FIG. **20**, a further exemplary embodiment of driveline **230** is shown. In FIG. **20**, electric motor assembly **202** is positioned so that output shaft **212** of electric motor assembly **202** or a rotatable shaft operatively coupled to output shaft **212** extends outboard of tunnel **116** and overstructure **118** of structural frame **110**. Driveline **230** includes a drive wheel **460** coupled to first end **212** of drive shaft **206** of electric motor assembly **202**, a driven wheel **462**, and an endless connector **464** operatively coupling driven wheel **462** to drive wheel **460**. In embodiments, endless connector **464** is a belt and each of drive wheel **460** and driven wheel **462** are pulleys adapted for use with a belt. In embodiments, endless connector **464** is a chain and each of drive wheel **460** and driven wheel **462** are sprockets adapted for use with a chain.

[0126] Driven wheel **462** is coupled to an input gear (not shown) of a gearset **466** and is operatively coupled to drive shaft **142** through gearset **466**. Exemplary gearsets **466** include planetary gearsets **408**. In embodiments, driven wheel **402** is coupled to one of a sun gear, a planet carrier, and/or a ring gear of gearset **466**. In embodiments, gearset **466** includes multiple planetary gearsets and one or more of selective couplers, brakes or clutches, which may be selectively activated by electronic controller **270** to select a gear ratio between drive shaft **142** and the input gear coupled to driven wheel **462**.

[0127] A rotation of first end **212** of drive shaft **206** causes a corresponding rotation of drive wheel **460** which rotates driven wheel **462** through endless connector **464**. Driven wheel **462** in turn causes a rotation of drive shaft **142** through gearset **466**.

[0128] Referring to FIG. **21**, a yet further exemplary embodiment of driveline **230** is shown. In FIG. **21**, electric motor assembly **202** is positioned so that output shaft **212** of electric motor assembly **202** or a rotatable shaft operatively coupled to output shaft **212** extends outboard of tunnel **116**, and optionally of overstructure **118**. Driveline **230** includes a continuously variable transmission (CVT) **468** which includes a drive clutch **470** coupled to first end **212** of drive shaft **206** of electric motor assembly **202**, a driven clutch **472**, and an endless connector **474** operatively coupling driven clutch **472** to drive clutch **470**. In embodiments, endless connector **474** is a belt and each of drive clutch **470** and driven clutch **472** includes two sheaves whose spacing controls the gear ratio of CVT **468**. In embodiments, CVT **468** is solely mechanically controlled. In embodiments, CVT **468** is at least partially electronically controlled by electronic controller **270**. Exemplary CVT arrangements are disclosed in U.S. Pat. No. 8,490,731 titled SNOWMOBILE; U.S. Pat. No. 8,534,413 titled PRIMARY CLUTCH ELECTRONIC CVT; U.S. Pat. No. 9,540,072 titled SNOWMOBILE; and U.S. Pat. No. 10,648,554 titled SNOWMOBILE, the entire disclosures of which are expressly incorporated by reference herein.

[0129] Driven clutch **472** is carried by a rotatable jackshaft **436** on a left side of tunnel **116**. Jackshaft **436** extends across longitudinal vertical plane **108** and extends beyond tunnel **116** on a right side of snowmobile **100**. Jackshaft **436** is received on the right side of tunnel **116** in a chaincase (not shown) which transfer the rotation of rotatable jackshaft **436** to drive shaft **142**.

[0130] A rotation of first end **212** of drive shaft **206** causes a corresponding rotation of drive clutch **470** which rotates driven clutch **472** through endless connector **474**. Driven clutch **472** in turn causes a rotation of rotatable jackshaft **436** which, in turn, causes a rotation of drive shaft **142** through the chaincase.

[0131] Referring to FIG. **22**, an exemplary brake system **490** is shown. Brake system **490** is coupled to second end **216** on side **218** of motor housing **204** opposite first end **212** of drive shaft **206** which is coupled to driveline **230**. Brake system **490** may include a brake disk coupled to second end **216** of drive shaft **206** and a brake caliper which is actuated to apply braking force to the brake disk and thereby to endless track assembly **104** through driveline **230** and electric motor assembly **202**. In embodiments, the actuation of the brake caliper is controlled by electronic controller **270**. In embodiments, the actuation of the brake caliper is controlled with a fluid system. In either case, the actuation is initiated by the operator actuating a brake input, such as a brake lever on handlebars **494**.

[0132] Referring to FIGS. **23** and **24**, exemplary placements of a power steering unit **500** are illustrated. Referring to FIG. **23**, a first horizontal plane **502** passes through a connection **504** between a front support **506** of overstructure **118** of structural frame **110** and front frame portion **112** of structural frame **110** and a first lateral vertical plane **510** also passes through connection **504**. A second horizontal plane **512** passes through a connection **514** between rear support **334** of overstructure **118** of structural frame **110** and tunnel **116** of structural frame **110** and a second lateral vertical plane **516** also passes through connection **514**. A third lateral vertical plane **520** passes through a connection **124** between ski **106** and spindle **122**. As shown in FIG. **23**, a first placement of power steering unit **500** is positioned between third lateral vertical plane **520** and second lateral vertical plane **516** along a longitudinal length of snowmobile **100**. Power steering unit **500** is also shown being positioned within overstructure **118** and lower than first horizontal plane **502**. As shown in FIG. **24**, a second placement of power steering unit **500** is positioned between third lateral vertical plane **520** and second lateral vertical plane **516** along a longitudinal length of snowmobile **100**. Power steering unit **500** is also shown being positioned higher than second horizontal plane **512** and optionally higher than **502**. Power steering unit **500** is also shown being positioned completely higher than electric motor assembly **202**. In embodiments, power steering unit **500** straddles one of first horizontal plane **502** and second horizontal plane **512**.

[0133] Referring to FIG. **25**, in embodiments, electric motor assembly **202** may be positioned within tunnel **116** or longitudinally adjacent to tunnel **116**. An advantage, among others of this placement of electric motor assembly **202** includes the provision of additional space below overstructure **118** for battery assembly **240** or storage.

[0134] Referring to FIGS. **26** and **27**, electric motor assembly **202** is shown positioned completely to the right side of longitudinal vertical plane **108** (see FIG. **26**). In the illustrated embodiment, electric motor assembly **202** includes an axial flux motor which has a narrow lateral extent. Other exemplary motors sized and/or mounted to be positioned completely to the right side of longitudinal vertical plane **108** may be used. Advantages, among others, for using an axial flux motor are space savings, additional space for batteries and/or storage, and power density capabilities. As shown in FIG. **27**, first end **212** of drive shaft **206** carries a first wheel **530**. First wheel **530** is operatively coupled to drive shaft **142** through a second wheel **532** carried by drive shaft **142** through an endless connector **534**. In embodiments, endless connector **534** is a belt and each of drive wheel **530** and driven wheel **532** are pulleys adapted for use with a belt. In embodiments, endless connector **534** is a chain and each of drive wheel **530** and driven wheel **532** are sprockets adapted for use with a chain.

[0135] A rotation of first end **212** of drive shaft **206** causes a corresponding rotation of drive wheel **530** which rotates driven wheel **532** through endless connector **534**. Driven wheel **532** in turn causes a rotation of drive shaft **142**. In embodiments, the axial flux motor may be used with any of the embodiments of driveline **230** disclosed herein.

[0136] Referring to FIG. **28**, an exemplary layout having two electric motor assemblies **202** is illustrated. Each of the electric motor assemblies **202** are axial flux motors and are coupled independently to drive shaft **142** through respective first wheel **530**, second wheel **532**, and endless connector **534**. Each electric motor assembly is positioned completely to a respective side of longitudinal vertical plane **108**. Brake system **490** is coupled to second end **216** of each of the electric motor assemblies. In embodiments, exemplary brake system **490** includes separate brake disks and calipers for each respective second end **216** of drive shaft **206**. In embodiments, the brake system **490** may be on first end **212** of driveshaft **206** or on the shaft supporting second wheel **532**.

[0137] Referring to FIG. **29**, the arrangement of FIG. **28** is illustrated except each of electric motor assemblies **202** drives an independent drive shaft **142** and an independent endless track assembly **104**. By having multiple endless tracks, the track speed and direction of each may be individually controlled by electronic controller **270**. In embodiments, electronic controller **270** may differentiate the track speeds to assist in turning of snowmobile **100** based in part on a sensed turn angle of handlebars by the operator. In embodiments, electronic controller **270** may cause snowmobile **100** to spin in place by rotating the respective tracks **104** in opposite directions.

[0138] Referring to FIGS. **30** and **31**, an exemplary layout of some components of electric powertrain assembly **200** for snowmobile **100** are shown. As shown in FIG. **30**, battery assemblies **240** have a first portion positioned longitudinally between vertical lateral plane **306** and vertical lateral plane **308** and a second portion positioned longitudinally rearward of vertical lateral plane **306**.

[0139] A single electric motor assembly **202** is positioned longitudinally between vertical lateral plane **306** and vertical lateral plane **308** and above the first portion of battery assemblies **240**. As illustrated electric motor assembly **202** is positioned on both sides of longitudinal vertical plane **108**. In embodiments, electric motor assembly **202** is centered about longitudinal vertical plane **108**. In embodiments, electric motor assembly **202** is completely to one side of longitudinal vertical plane **108**.

[0140] In embodiments, the first portion of battery assemblies **240** is positioned completely above electric motor assembly **202**. In embodiments, the first portion of battery assemblies **240** is positioned both above electric motor assembly **202** and below electric motor assembly **202**. In embodiments, the first portion of battery assemblies **240** may be positioned laterally offset from electric motor assembly **202** such that electric motor assembly **202** is completely to one side laterally of the first portion of battery assemblies **240**.

[0141] Charger **260** is positioned longitudinally between vertical lateral plane **306** and vertical lateral plane **308**. Further, charger **260** is positioned on a first side of longitudinal vertical plane **108** and at least a majority of electric motor assembly **202** is positioned on a second side of longitudinal vertical plane **108** opposite the first side. In embodiments, charger **260** is positioned completely to a first side of longitudinal vertical plane **108** and electric motor assembly **202** is positioned completely to a second side of longitudinal vertical plane **108**. In embodiments, charger **260** is mounted to overstructure **118**. Charger **260** is illustrated on a left side of longitudinal vertical centerline plane **108**. In embodiments, charger **260** is positioned longitudinally between vertical lateral plane **306** and vertical lateral plane **308** and on a right side of longitudinal vertical centerline plane **108**. In embodiment, charger **260** is positioned on tunnel **116** and may be positioned forward of operator seat **132** and/or above one or more of battery assembly **240** which may also be supported on tunnel **116**.

[0142] Electronic controller **270** is shown mounted to front frame portion **112** of structural frame **110** and centered along longitudinal vertical plane **108**. In embodiments, wherein electronic controller **270** is a distributed controller, the electronic controller **270** shown in FIG. **30** is a motor controller for electric motor assembly **202**. An advantage, among others of positioning electronic controller **270** on a leading edge of front frame portion **112** is that electronic controller **270** receives ambient air to cool electronic controller **270**. In embodiments, electronic controller **270** is mounted to one of middle frame portion **114**, tunnel **116**, or overstructure **118**. In embodiments, electronic controller **270** or at least a motor controller of electronic controller **270** is positioned adjacent to electric motor assembly **202**, such as in middle frame portion **114** under overstructure **118** in FIG. **37**. Advantages, among others, of this placement of the motor controller and electric motor assembly **202** is to reduce the length of high voltage wire needed to couple electric motor assembly **202** and the motor controller and to improve cooling performance be directing air flow from a hood **105** (see FIG. **1**) or other body work **103** (see FIG. **1**) of snowmobile **100** towards the motor controller and electric motor assembly **202**.

[0143] Referring to FIG. **32**, another exemplary layout of some components of electric powertrain assembly **200** for snowmobile **100** are shown. As shown in FIG. **32**, battery assemblies **240** have a first portion positioned longitudinally between vertical lateral plane **306** and vertical lateral plane **308** and a second portion positioned longitudinally rearward of vertical lateral plane **306**.

[0144] A single electric motor assembly **202** is positioned longitudinally between vertical lateral plane **306** and vertical lateral plane **308** and above the first portion of battery assemblies **240**. As illustrated electric motor assembly **202** is centered about longitudinal vertical plane **108**. In embodiments, electric motor assembly **202** is completely to one side of longitudinal vertical plane **108**.

[0145] In embodiments, the first portion of battery assemblies **240** is positioned completely above electric motor assembly **202**. In embodiments, the first portion of battery assemblies **240** is positioned both above electric motor assembly **202** and below electric motor assembly **202**. In embodiments, the first portion of battery assemblies **240** may be positioned laterally offset from electric motor assembly **202** such that electric motor assembly **202** is completely to one side laterally of the first portion of battery assemblies **240**.

[0146] Electronic controller **270** is shown mounted to front frame portion **112** of structural frame **110** and centered along longitudinal vertical plane **108**. In embodiments, wherein electronic controller **270** is a distributed controller, the electronic controller **270** shown in FIG. **32** is a motor controller for electric motor assembly **202**. An advantage, among others of positioning electronic controller **270** on a leading edge of front frame portion **112** is that electronic controller **270** receives ambient air to cool electronic controller **270**. In embodiments, electronic controller **270** is mounted to one of middle frame portion **114**, tunnel **116**, or overstructure **118**.

[0147] FIG. **32** also includes an active cooling system **550**. Active cooling system **550** includes a front radiator **552** coupled to front frame portion **112**, a fluid pump **554**, and fluid transport conduits **556**. Cooling fluid provided by **550** is circulated to thermal management system **250** of battery assembly **240** (see FIG. **33**), a thermal management system of a motor controller of electronic controller **270**, and/or a similar thermal management system of electric motor assembly **202**. In embodiments, active cooling system **550** also includes at least one tunnel cooler **560**. Exemplary tunnel coolers and cooling systems are disclosed in U.S. Pat. No. 11,142,286, titled SNOWMOBILE; U.S. Pat. No. 8,567,546 titled VEHICLE COOLING SYSTEM; and U.S. Pat. No. 8,490,731 titled SNOWMOBILE, the entire disclosures of which are expressly incorporated by reference herein. In embodiments, active cooling system **550** provides cooling fluid to a thermal management system of a motor controller of electronic controller **270**. In embodiments, active cooling system **550** provides cooling fluid to a thermal management system of a motor controller of electronic controller **270** and a thermal management system **250** of battery assemblies **240**. In embodiments, active cooling system **550** provides cooling fluid to a thermal management system of a motor controller of electronic controller **270**, a thermal management system **250** of battery assemblies **240**, and a thermal management system of electric motor assembly **202**.

[0148] Further, as illustrated in FIG. **32** and FIG. **19**, electric motor assembly **202** is positioned such that at least the drive shaft is higher than the front edge of the tunnel **116** and optionally all of electric motor assembly **202** is positioned higher than the front edge of the tunnel **116**. An advantage, among others, of this placement of the electric motor assembly **202** is to permit at least a portion of battery assemblies **240** to be positioned lower in middle frame portion **114** to lower the center of mass of vehicle **100** in situations wherein the portion of the battery assemblies weighs more than electric motor assembly **202**. Additionally or alternatively, electric motor assembly is positioned longitudinally proximate the front of tunnel **116**. Advantages, among others, of this placement of electric motor assembly **202** is to reduce the length of conduit needed to transport fluid from tunnel coolers **560** to electric motor assembly **202**. Advantages, among others, of this placement of the electric motor assembly **202** are to reduce the fluid circuit length and to reduce the weight of vehicle **100**.

[0149] In embodiments, each of at least one battery assembly **240** and electric motor assembly **202** form part of structural frame **110**. In embodiments, battery assembly **240** and electric motor assembly **202** are directly fastened together. In embodiments, battery assembly **240** and electric motor assembly **202** are separated by another component of structural frame **110** and are thereby indirectly fastened together.

[0150] Referring to FIG. **34**, a kinetic energy recovery system **600** is illustrated. As shown in FIG. **34**, each of or optionally at least one of shock absorber **130**A, shock absorber **130**B, front shock absorber **158**, and rear shock absorber **160** are hydraulically coupled to a hydraulic pump **602** to cause a rotation of an output **603** of hydraulic pump **602**. Output **603** is operatively coupled to the output shaft of an electric motor **604** to generate electrical energy. The generated electrical energy is provided to battery assembly **240** to charge battery assembly **240**. In embodiments, kinetic energy recovery system **600** also includes energy capture from a brake system of snowmobile **100**.

[0151] Referring to FIG. **35**, an exemplary processing sequence **620** is shown. In processing sequence **620**, various performance characteristics of snowmobile **100** are set based on a characteristic of the intended operator. Some fleet operators (rental, ski-resort, etc.) may want to limit performance of snowmobile **100** based on characteristics, such as the skill level and the training of the operator. An indication of the characteristic of the intended operator, such as skill level, is received by electronic controller **270**, as represented by block **622**. In embodiments, this indication may be a value to indicate a level of skill of the operator, such as "1" for limited skill, "2" for intermediate skill, and "3" for advanced skill. The indication may be input through one of input device **282**. The indication may be received over a network, such as a wireless network, a wired network, or a combination thereof. The indication may be provided on a dongle which is plugged into snowmobile **100**.

[0152] Electronic controller **270** determines performance options of snowmobile **100** based on the indication of the skill level of the intended operator, as represented by blocks **624** and **626**. In the case of limited skill, the performance parameters are set to limit a speed of snowmobile **100** and both active suspension with one or more of shock absorber **130**A, shock absorber **130**B, front shock absorber **158**, and rear shock absorber **160** and active braking are activated, as represented by blocks **628** and **630**. In the case of intermediate skill, the performance parameters are set to limit a speed of snowmobile **100** which is higher than the speed limit of the limited skill setting and both active suspension with one or more of shock absorber **130**A, shock absorber **130**B, front shock absorber **158**, and rear shock absorber **160** and active braking are activated, as represented by blocks **632** and **634**. In the case of advanced skill, the performance parameters are set to not limit a speed of snowmobile **100**, to provide the operator to select between various performance modes, and to activate or deactivate one or more of active suspension with one or more of shock absorber **130**A, shock absorber **130**B, front shock absorber **158**, and rear shock absorber **160** and active braking, as represented by blocks **636** and **638**.

[0153] Referring to FIG. **36**, an exemplary processing sequence **650** is shown. In processing sequence **650**, an operator selects a mode for snowmobile **100** with input device **282**, such as a touch display, as represented by block **652**. Electronic controller **270** receives values from a plurality of sensors of snowmobile **100** to detect various vehicle characteristics, such as a hitch load, an operator weight, and compares those values to acceptable ranges for the selected mode, as represented by block **654**. If a value of the detected vehicle characteristics are outside of the acceptable ranges, then prior to permitting snowmobile **100** to move electronic controller **270** display on a display of output devices **284** of the selected mode and a recommendation of a different mode based on the detected vehicle values, as represented by block **656**. The operator through input device **282** may acknowledge and select the different mode and electronic controller **270** configures snowmobile **100** to operate in the different mode, as represented by blocks **662** and **664**. The operator through input device **282** may also decline to accept the different mode and to proceed with the current selected mode, as represented by blocks **658** and **660**.

[0154] Referring to FIGS. **37-39**, an exemplary layout for snowmobile **100** is shown. In the embodiment of FIGS. **37-39**, electric motor assembly **202** is positioned forward of tunnel **116** supported by middle frame portion **114** with drive shaft **206** extending laterally leftward. Driveshaft **206** is operatively coupled to rotatable jackshaft **436** through an endless coupler (not shown), such as a chain or belt. As mentioned herein, rotatable jackshaft **436** is operatively coupled to drive sprocket **144** through a gearcase **257** (FIG. **39**) or other coupling arrangement.

[0155] In embodiments, drive shaft **206** is operatively coupled to rotatable jackshaft **436** through a continuously variable transmission (CVT). Exemplary CVTs include standard CVTs wherein the effective gear ratio is controlled by weights which alter sheave separations and electronically controlled CVTs wherein sheave separations and hence the effective gear ratio are at least partially controlled by electronically controlled actuators. Exemplary CVTs are disclosed in U.S. Pat. Nos. 3,727,478; 4,023,635; 6,176,796; 7,070,527; and 11,085,528, the entire disclosures of which are expressly incorporated by reference herein.

[0156] Returning to FIG. **37**, charger **260** is positioned forward of tunnel **116** supported by middle frame portion **114** and laterally rightward. A motor controller **271** of electronic controller **270** is supported by middle frame portion **114**, or alternatively front frame portion **112**, and generally positioned between a leftward lateral extent of electric motor assembly **202** and a rightward lateral extent of charger **260**. Airflow through body work **103** of snowmobile **100**, such as hood **105**, may be directed to motor controller **271** of electronic controller **270** to cool motor controller **271** of electronic controller **270** and/or to electric motor assembly **202** and/or battery assembly **240** to cool electric motor assembly **202** and/or electric motor assembly **202**. A vehicle controller **273** of electronic controller **270** is supported by overstructure **118**. DC-DC converter **262** is supported by front frame portion **112**. A first battery assembly **240** is supported by front frame portion **112** and multiple battery assemblies **240** are supported by tunnel **116**.

[0157] Referring to FIG. **38**, due to the placement of electric motor assembly **202**, charger **260**, motor controller **271**, and battery assembly **240**, space **275** within overstructure **118** and middle frame portion **114** along longitudinal vertical centerline plane **108** is generally available for storage. In embodiments, bodywork **103** includes at least one door or removable portion providing access to a storage area within space **275**.

[0158] Referring to FIGS. **40-42**, an exemplary mounting assembly **700** for battery assemblies **240** on tunnel **116** is shown. Referring to FIG. **41**, mounting assembly **700** includes a support **702** which supports battery assembly **240** relative to tunnel **116**. Support **702** includes an upper surface which contacts battery assembly **240**. Support **702** further includes a rearward stop **704** and a forward stop **706** which captures battery assembly **240** in a longitudinal direction **10** when supported on upper surface **701** of support **702**.

[0159] Mounting assembly **700** further includes a cover **710** which is positioned over at least a part of battery assembly **240**. Cover **710** includes a left wall **712** and a right wall **714** which capture battery assembly **240** in a lateral direction **12**. Each of walls **712**, **714** have a respective wing **716** which is positioned adjacent respective wings **718** of support **702**. Studs **722** of support **702** are received in apertures **724** of wings **716** of cover **710**. Retainers **726** are threaded onto studs **722** to couple cover **710** to support **702** and capture battery assembly **240** in a vertical direction **14**.

[0160] Support **702** includes apertures **730** in wings **718**. Apertures **730** receive locators **732**. Referring to FIG. **42**A locators **732** include a head **736** received in a channel **740** of tunnel **116**. Channel **740** is sized to retain head **736** in lateral direction **12** and vertical direction **14**. In embodiments, head **736** has a polygonal shape, such as quadrilateral, which are sized to minimize spinning of locators **732** when placed in channel **740**. Head **736** may enter channel **740** through enlarged openings **742** in tunnel **116** (see FIG. **41**) and/or from a longitudinal end of tunnel **116**. A threaded stud **738** of locators **732** passes through respective ones of apertures **730** in wings **718**. Retainers **734** are threaded onto respective studs **738** of locators **732**. As retainers **734** are tightened, head **736** of locator **732** are drawn into contact with upper surface **744** of channel **740** to hold battery assembly **240** in longitudinal direction **10** along tunnel **116**. When the retainers **734** are tightened to hold battery assembly **240**, the mounting assembly is in a locked state and when retainers **734** are loosened so that battery assembly **240** may move in longitudinal direction **10**, the mounting assembly is in an unlocked state.

[0161] An advantage, among others, of coupling battery assembly **240** to tunnel **116** is that the longitudinal placement of battery assembly **240** along tunnel may be adjusted to alter the center of mass of snowmobile **100**. Although mounting assembly **700** is illustrated supporting a single battery assembly, a given mounting assembly may be sized and shaped to support multiple battery assemblies **240**.

Further, multiple mounting assemblies **700** may be provided to permit the mounting location of multiple battery assemblies to be individually adjusted.

[0162] For example, a battery assembly **240** may be cantilevered off a front of tunnel **116** (see FIGS. **37** and **38**). As such, the battery assembly **240** may both be supported by tunnel **116** and extend forward of endless track assembly **104**. In embodiments, battery assembly **240** may be further supported by other portions of structural frame **110**, such as middle frame portion **114** and/or overstructure **118**.

[0163] Example 1: A snowmobile is provided. The snowmobile comprising: a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising an electric powertrain operatively coupled to the endless track to power movement of the endless track; a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile and includes a first component of the electric powertrain; a rear suspension positioned in an interior of the endless track and movably coupled to the structural frame; a left front suspension movably coupled to the structural frame and to the left front ski; a right front suspension movably coupled to the structural frame and to the right front ski; a steering assembly supported by the structural frame and operatively coupled to the left front ski and the right front ski to steer the snowmobile, the steering assembly including an operator steering input and a steering post; and a straddle seat positioned along the vertical centerline plane of the snowmobile over the endless track and positioned longitudinally rearward of the steering post of the steering assembly.

[0164] Example 2: The snowmobile of Example 1, wherein the structural frame includes a rear portion including a tunnel, a front portion positioned forward of the tunnel, and an overstructure which supports the steering assembly and extends over the front portion, the front portion being movably coupled to the left front suspension and the right front suspension.

[0165] Example 3: The snowmobile of Example 2, wherein the first component is part of a battery assembly.

[0166] Example 4: The snowmobile of Example 3, wherein the battery assembly includes a battery housing and at least one battery and the first component is the battery housing of the battery assembly, the battery housing including an interior to receive the at least one battery.

[0167] Example 5: The snowmobile of Example 2, wherein the first component is part of a motor assembly.

[0168] Example 6: The snowmobile of Example 5, wherein the motor assembly includes a motor housing and at least one output shaft and the first component is the motor housing.

[0169] Example 7: The snowmobile of one of Examples 3-6, wherein the first component forms part of the tunnel of the structural frame.

[0170] Example 8: The snowmobile of one of Examples 3-6, wherein the first component forms part of the front portion of the structural frame.

[0171] Example 9: The snowmobile of one of Examples 3-6, wherein the first component forms part of the overstructure of the structural frame.

[0172] Example 10: The snowmobile of any one of Examples 3-6, wherein the structural frame includes a middle portion longitudinally between the front portion and the tunnel and the first component forms part of the middle portion of the structural frame.

[0173] Example 11: A snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising an electric powertrain operatively coupled to the endless track to power movement of the endless track, the electric powertrain including at least one planetary gearset; a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile; a rear suspension positioned in an interior of the endless track and movably coupled to the structural frame; a left front suspension movably coupled to the structural frame and to the left front ski; a right front suspension movably coupled to the structural frame and to the right front ski; a steering assembly supported by the structural frame and operatively coupled to the left front ski and the right front ski to steer the snowmobile, the steering assembly including an operator steering input and a steering post; and a straddle seat positioned along the vertical centerline plane of the snowmobile over the endless track and positioned longitudinally rearward of the steering post of the steering assembly.

[0174] Example 12: A snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel having a forwardmost extent and an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including an electric motor operatively coupled to the endless track and a plurality of battery assemblies operatively coupled to the electric motor, the plurality of battery assemblies including a first battery assembly supported by the tunnel and extending forward of the forwardmost extent of the tunnel.

[0175] Example 13: The snowmobile of Example 12, wherein the electric powertrain further includes a continuously variable transmission, the continuously variable transmission having a drive clutch and a driven clutch operatively coupled to the drive clutch, the drive clutch being driven by the electric motor and the endless track being driven by the driven clutch.

[0176] Example 14: The snowmobile of Example 12, wherein the electric powertrain further includes an electronically controlled continuously variable transmission, the electronically controlled continuously variable transmission having a drive clutch and a driven clutch operatively coupled to the drive clutch, the drive clutch being driven by the electric motor and the endless track being driven by the driven clutch.

[0177] Example 15: The snowmobile of Example 12, wherein the electric powertrain further includes a chain drive which operatively couples the electric motor to the endless track.

[0178] Example 16: The snowmobile of Example 12, wherein the electric motor is operatively coupled to the endless track through a portion of the electric powertrain positioned laterally outboard of the first endless track.

[0179] Example 17: The snowmobile of Example 12, wherein the first battery assembly is moveable relative to the tunnel.

[0180] Example 18: The snowmobile of Example 12, further comprising a mounting assembly to couple the first battery assembly to the tunnel.

[0181] Example 19: The snowmobile of Example 18, wherein the mounting assembly permits a movement of the first battery assembly relative to tunnel in a longitudinal direction along the tunnel.

[0182] Example 20: The snowmobile of Example 19, wherein the tunnel includes at least one track and the mounting assembly cooperates with the at least one track to limit movement of the first battery assembly in the longitudinal direction along the tunnel.

[0183] Example 21: The snowmobile of Example 20, wherein the mounting assembly includes a locked state wherein a longitudinal position of the first battery assembly is locked relative to the tunnel.

[0184] Example 22: A snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel having a forwardmost extent; and an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including an electric motor operatively coupled to the endless track; and a plurality of battery assemblies operatively coupled to the electric motor. The plurality of battery assemblies including a first battery assembly supported by the tunnel and moveable along a longitudinal direction of the tunnel while coupled to the tunnel.

[0185] Example 23: The snowmobile of Example 22, further comprising a mounting assembly to couple the first battery assembly to the tunnel.

[0186] Example 24: The snowmobile of Example 23, wherein the tunnel includes at least one track and the mounting assembly cooperates with the at least one track to limit movement of the first battery assembly in the longitudinal direction along the tunnel.

[0187] Example 25: The snowmobile of Example 23, wherein the mounting assembly includes a locked state wherein a longitudinal position of the first battery assembly is locked relative to the tunnel.

[0188] Example 26: A snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including a first endless track, a second endless track, a left front ski, and a right front ski. The first endless track and the second endless track are both positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel; and an electric powertrain operatively coupled to the first endless track and the second endless track to power movement of the first endless track and the second endless track. The electric powertrain including a first electric motor operatively coupled to the first endless track; a second electric motor operatively coupled to the second endless track; and a plurality of battery assemblies operatively coupled to at least one of the first electric motor and the second electric motor. The plurality of battery assemblies including a first portion and a second portion. The first portion being supported by the tunnel and the second portion being positioned forward of the tunnel.

[0189] Example 27: A snowmobile having a longitudinal vertical centerline plane is provided. The snowmobile comprising a plurality of ground engaging members including a first endless track, a second endless track, a left front ski, and a right front ski, the first endless track and the second endless track are both positioned rearward of the left front ski and the right front ski. The first endless track having a first lateral outer extent positioned on a first side of the longitudinal vertical centerline plane. The second endless track having a second lateral outer extent positioned on a second side of the longitudinal vertical centerline plane, the second side being opposite the first side. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel; and an electric powertrain operatively coupled to the first endless track and the second endless track to power movement of the first endless track and the second endless track. The electric powertrain including a first electric motor operatively coupled to the first endless track laterally outboard of the first lateral outer extent of the first endless track; a second electric motor operatively coupled to the second endless track laterally outboard of the second lateral outer extent of the second endless track; and a plurality of battery assemblies operatively coupled to at least one of the first electric motor and the second electric motor.

[0190] Example 28: The snowmobile of Example 27, wherein the plurality of battery assemblies include a first portion and a second portion, the first portion being supported by the tunnel and the second portion being positioned forward of the tunnel.

[0191] Example 29: A snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski. The endless track being positioned rearward of the left front ski and the right front ski. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile; and an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including a first electric motor operatively coupled to the endless track; a second electric motor operatively coupled to the endless track; and a plurality of battery assemblies operatively coupled to the first electric motor and the second electric motor.

[0192] Example 30. The snowmobile of Example 29, wherein the plurality of battery assemblies include a first portion and a second portion, the first portion being supported by the tunnel and the second portion being positioned forward of the tunnel.

[0193] Example 31. The snowmobile of Example 29, wherein an output of the first electric motor operatively coupled to the endless track is positioned on a first side of the vertical centerline longitudinal plane and an output the second electric motor operatively coupled to the endless track is positioned on a second side of the vertical centerline longitudinal plane, the second side being opposite the first side.

[0194] Example 32: A method of adjusting a center of mass of a snowmobile is provided. The method comprising the steps of: supporting a first battery assembly of an electric powertrain to drive an endless track of the snowmobile to a tunnel of the snowmobile; restraining a movement of the first battery assembly relative to the tunnel to a longitudinal direction of the tunnel; moving the first battery assembly along the longitudinal direction relative to the tunnel from a first position to a second position; and locking the first battery assembly in the second position relative to the tunnel.

[0195] Example 33: A method of selecting an operational mode from a plurality of operational modes for an electric powertrain of a snowmobile is provided. The method comprising: monitoring at least one vehicle characteristic; receiving a selected first operational mode of the plurality of operational modes; comparing the monitored vehicle characteristic to an acceptable range for the first selected mode; and if the monitored vehicle characteristic is outside of the acceptable range for the first selected mode, suggesting a second operational mode of the plurality of operational modes.

[0196] Example 34: The method of Example 33, wherein the step of suggesting the second operational mode of the plurality of operational modes occurs prior to permitting the snowmobile to move by the electric powertrain.

[0197] Example 35: The method of Example 34, further comprising the steps of: displaying on a display of the snowmobile the second operational mode of the plurality of operational modes; receiving an input resulting in selecting the second operational mode of the plurality of operational modes for operation of the snowmobile; and permitting movement of the snowmobile in the second operational mode of the plurality of operational modes.

[0198] Example 36: The method of Example 34, further comprising the steps of: displaying on a display of the snowmobile the second operational mode of the plurality of operational modes; receiving an input resulting in selecting the first operational mode of the plurality of operational modes for operation of the snowmobile; and permitting movement of the snowmobile in the first operational mode of the plurality of operational modes.

[0199] Example 37: A method of controlling a position of a tensioning wheel of an endless track assembly of a snowmobile. The method comprising: determining an operating state of the snowmobile; if the operating state of the snowmobile is a first state the tensioning wheel is positioned in a first position by an actuator; otherwise, the tensioning wheel is positioned in a second position by the actuator.

[0200] Example 38: The method of Example 37, wherein the first position is a raised position relative to the second position.

[0201] Example 39: The method of Example 38, wherein the operating state is a direction of travel of the snowmobile.

[0202] Example 40: The method of Example 38, wherein the operating state is a direction selection of the snowmobile with an operator input.

[0203] Example 41: A method of controlling a position of a tensioning wheel of an endless track assembly of a snowmobile is provided. The method comprising: receive an operator request to move the tensioning wheel; determining an operating state of the snowmobile; and moving the tensioning wheel with an actuator.

[0204] Example 42: The method of Example 41, wherein the actuator changes a vertical location of the tensioning wheel.

[0205] Example 43: A snowmobile is provided. The snowmobile comprising a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski, the endless track being positioned rearward of the left front ski and the right front ski. The endless track including a tensioning wheel and an actuator which positions the tensioning wheel. The snowmobile further comprising a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile; an operator input supported by the structural frame; and an electronic controller operatively coupled to the operator input and the actuator, the electronic controller altering a position of the tensioning wheel with the actuator based on the operator input.

[0206] Example 44: The snowmobile of Example 43, wherein the electronic controller alters a height of the tensioning wheel with the actuator based on the operator input.

[0207] Example 45: The snowmobile of Example 43, further comprising an electric powertrain operatively coupled to the endless track to power movement of the endless track. The electric powertrain including an electric motor operatively coupled to the endless track and a plurality of battery assemblies operatively coupled to the electric motor.

[0208] While this invention has been described as having an exemplary design, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

1. A snowmobile, comprising:

a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski, the endless track being positioned rearward of the left front ski and the right front ski;

an electric powertrain operatively coupled to the endless track to power movement of the endless track;

a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile and includes a first component of the electric powertrain;

a rear suspension positioned in an interior of the endless track and movably coupled to the structural frame;

a left front suspension movably coupled to the structural frame and to the left front ski;

a right front suspension movably coupled to the structural frame and to the right front ski;

a steering assembly supported by the structural frame and operatively coupled to the left front ski and the right front ski to steer the snowmobile, the steering assembly including an operator steering input and a steering post; and

a straddle seat positioned along the vertical centerline plane of the snowmobile over the endless track and positioned longitudinally rearward of the steering post of the steering assembly.

2. The snowmobile of claim **1**, wherein the structural frame includes a rear portion including a tunnel, a front portion positioned forward of the tunnel, and an overstructure which supports the steering assembly and extends over the front portion, the front portion being movably coupled to the left front suspension and the right front suspension.

3. The snowmobile of claim **2**, wherein the first component is part of a battery assembly.

4. The snowmobile of claim **3**, wherein the battery assembly includes a battery housing and at least one battery and the first component is the battery housing of the battery assembly, the battery housing including an interior to receive the at least one battery.

5. The snowmobile of claim **2**, wherein the first component is part of a motor assembly.

6. The snowmobile of claim **5**, wherein the motor assembly includes a motor housing and at least one output shaft and the first component is the motor housing.

7. The snowmobile of claim **3**, wherein the first component forms part of the tunnel of the structural frame.

8. The snowmobile of claim **3**, wherein the first component forms part of the front portion of the structural frame.

9. The snowmobile of claim **3**, wherein the first component forms part of the overstructure of the structural frame.

10. The snowmobile of claim **3**, wherein the structural frame includes a middle portion longitudinally between the front portion and the tunnel and the first component forms part of the middle portion of the structural frame.

11. (canceled)

12. A snowmobile comprising:

a plurality of ground engaging members including an endless track positioned along a vertical centerline plane of the snowmobile, a left front ski, and a right front ski, the endless track being positioned rearward of the left front ski and the right front ski;

a structural frame supported by the plurality of ground engaging members, the structural frame provides structural rigidity for the snowmobile, the structural frame including a tunnel having a forwardmost extent; and

an electric powertrain operatively coupled to the endless track to power movement of the endless track, the electric powertrain including

an electric motor operatively coupled to the endless track; and

a plurality of battery assemblies operatively coupled to the electric motor, the plurality of battery assemblies including a first battery assembly supported by the tunnel and extending forward of the forwardmost extent of the tunnel.

13. The snowmobile of claim **12**, wherein the electric powertrain further includes a continuously variable transmission, the continuously variable transmission having a drive clutch and a driven clutch operatively coupled to the drive clutch, the drive clutch being driven by the electric motor and the endless track being driven by the driven clutch.

14. The snowmobile of claim **12**, wherein the electric powertrain further includes an electronically controlled continuously variable transmission, the electronically controlled continuously variable transmission having a drive clutch and a driven clutch operatively coupled to the drive clutch, the drive clutch being driven by the electric motor and the endless track being driven by the driven clutch.

15. The snowmobile of claim **12**, wherein the electric powertrain further includes a chain drive which operatively couples the electric motor to the endless track.

16. The snowmobile of claim **12**, wherein the electric motor is operatively coupled to the endless track through a portion of the electric powertrain positioned laterally outboard of the first endless track.

17. The snowmobile of claim **12**, wherein the first battery assembly is moveable relative to the tunnel.

18. The snowmobile of claim **12**, further comprising a mounting assembly to couple the first battery assembly to the tunnel.

19. The snowmobile of claim **18**, wherein the mounting assembly permits a movement of the first battery assembly relative to tunnel in a longitudinal direction along the tunnel.

20. The snowmobile of claim **19**, wherein the tunnel includes at least one track and the mounting assembly cooperates with the at least one track to limit movement of the first battery assembly in the longitudinal direction along the tunnel.

21. The snowmobile of claim **20**, wherein the mounting assembly includes a locked state wherein a longitudinal position of the first battery assembly is locked relative to the tunnel.

22.-**45**. (canceled)

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