US 20210009235A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0009235 A1**

OKADA et al. (43) **Pub. Date: Jan. 14, 2021**

(54) **SNOW VEHICLE**

(71) Applicant: **YAMAHA HATSUDOKI KABUSHIKI KAISHA**, Iwata (JP)

(72) Inventors: **Hiroyuki OKADA**, Minocqua, WI (US); **Lucas Matthew FUREY**, Woodruff, WI (US); **Gerard John KARPIK**, Eveleth, MN (US); **James Christopher VIZANKO**, Arbor Vitae, WI (US)

(21) Appl. No.: **16/508,506**

(22) Filed: **Jul. 11, 2019**

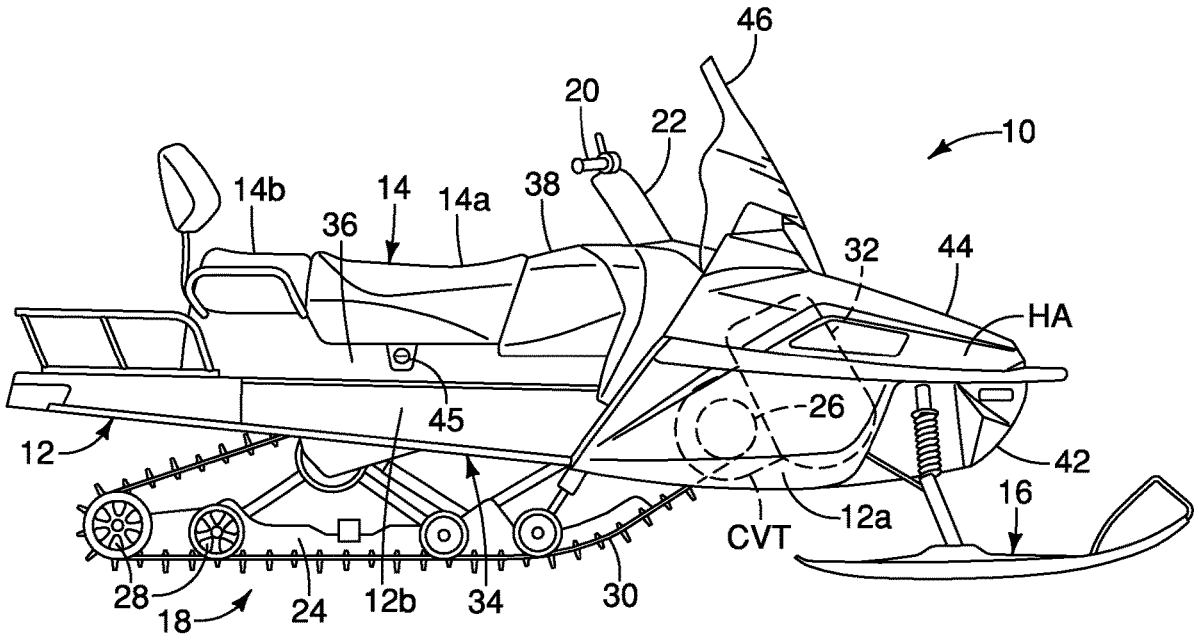
Publication Classification

(51) **Int. Cl.**
B62M 27/02 (2006.01)

(52) **U.S. Cl.**
CPC ***B62M 27/02*** (2013.01); *B62M 2027/028* (2013.01); *B62M 2027/025* (2013.01)

(57) **ABSTRACT**

A snow vehicle basically includes a vehicle body, a saddle seat, at least one ski, an engine, a starter motor and a lithium power module. The engine is attached to the vehicle body. The starter motor is operatively coupled to the engine and electrically coupled to a first electrical connection. The lithium power module has a lithium battery with a second electrical connection that is configured to be toollessly connected and disconnected to the first electrical connection.



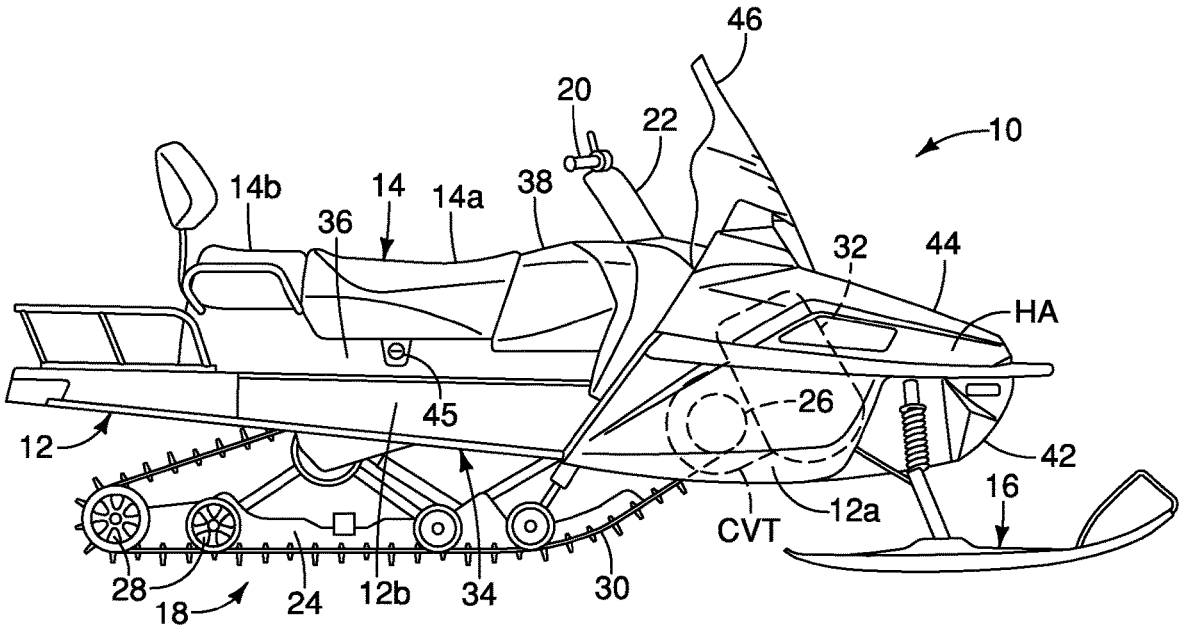

46
20
22
10
14b
14
14a
38
36
32
44
HA
45
26
12
42
16
CVT
12a
28
18
24
12b
34
30

FIG. 1

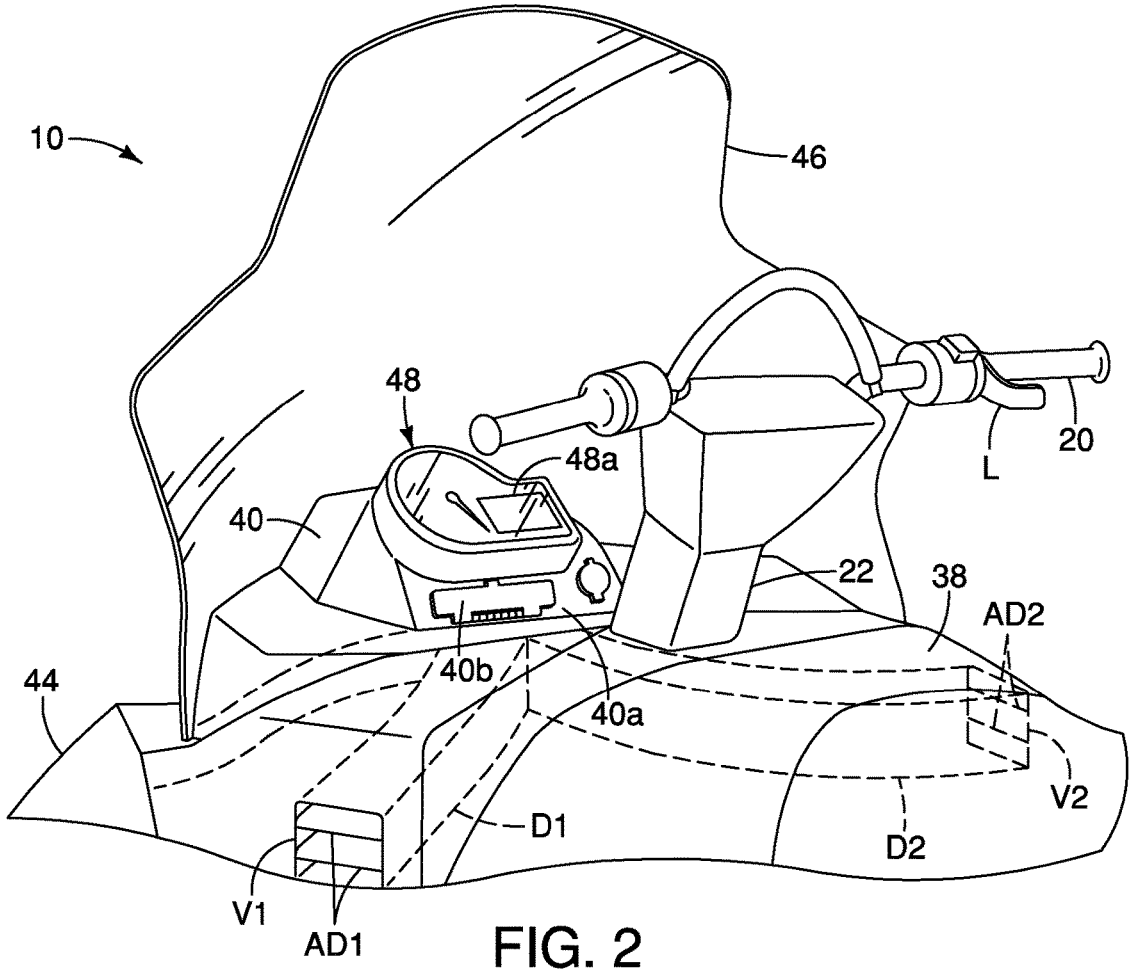

10
46
48
48a
20
L
40
22
38
AD2
40b
40a
44
V2
D1
D2
V1
AD1

FIG. 2

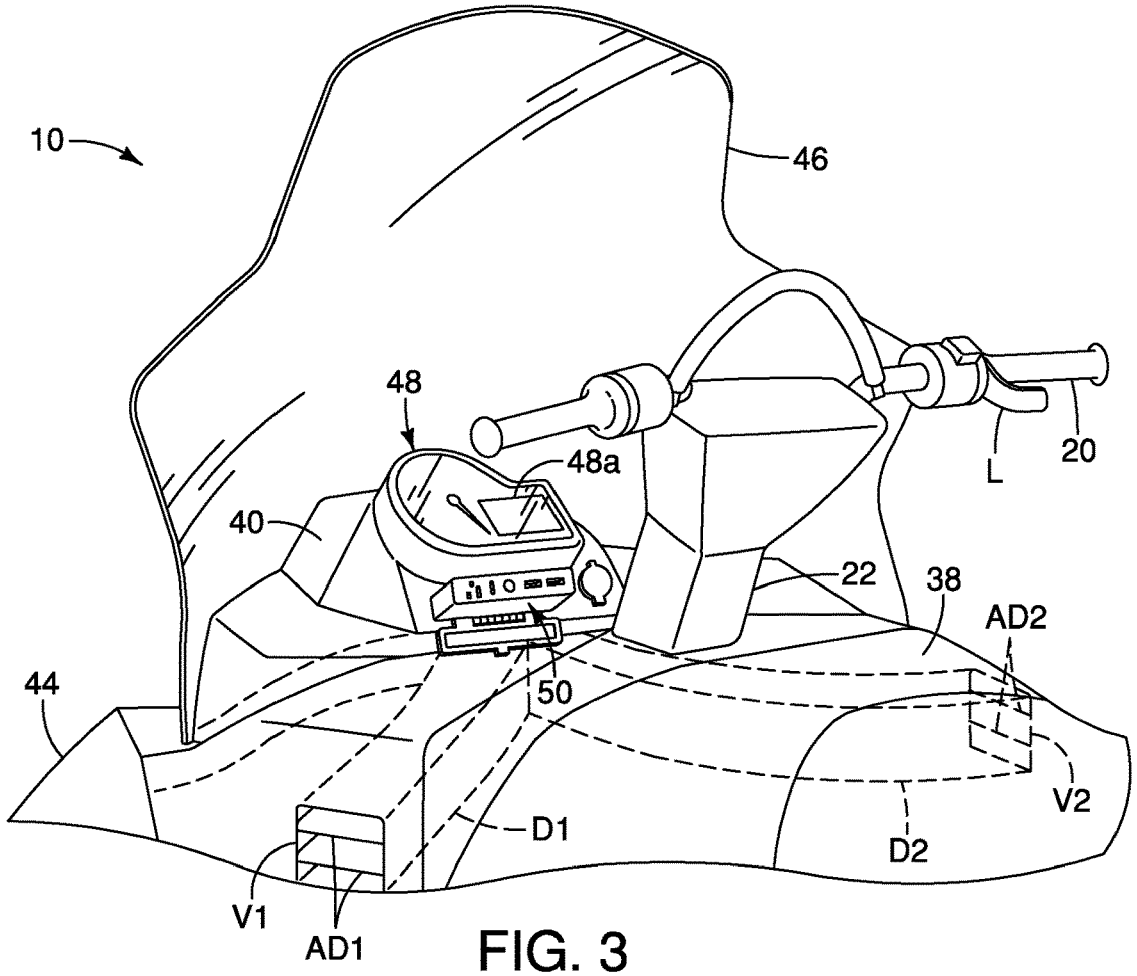

10
46
48
48a
40
L
20
22
38
AD2
44
50
V2
D1
D2
V1
AD1

FIG. 3

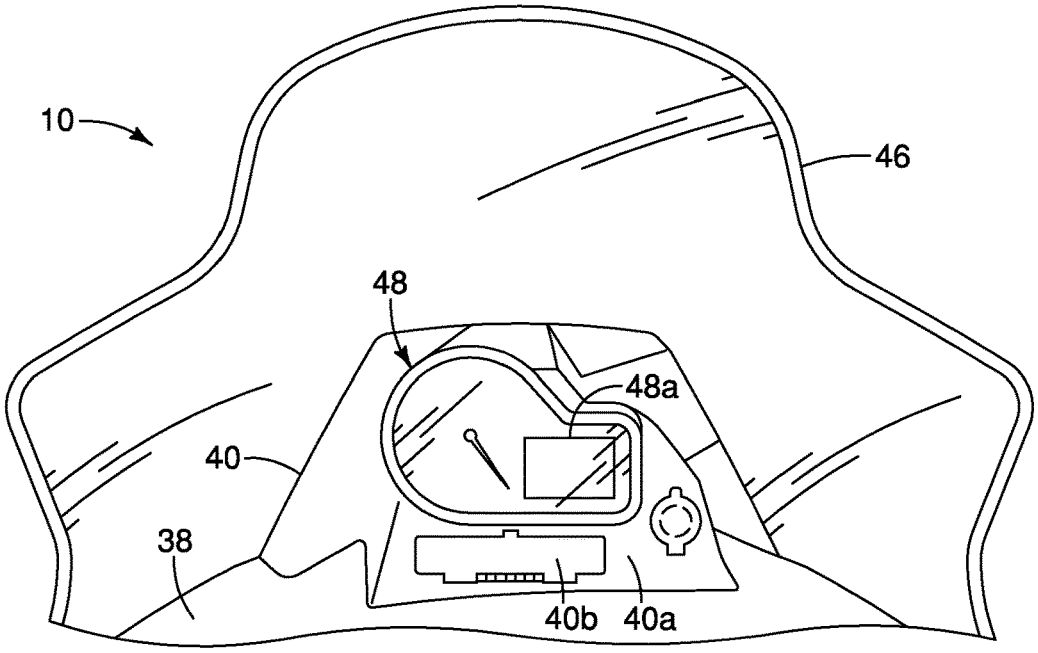

10
46
48
48a
40
38
40b
40a

FIG. 4

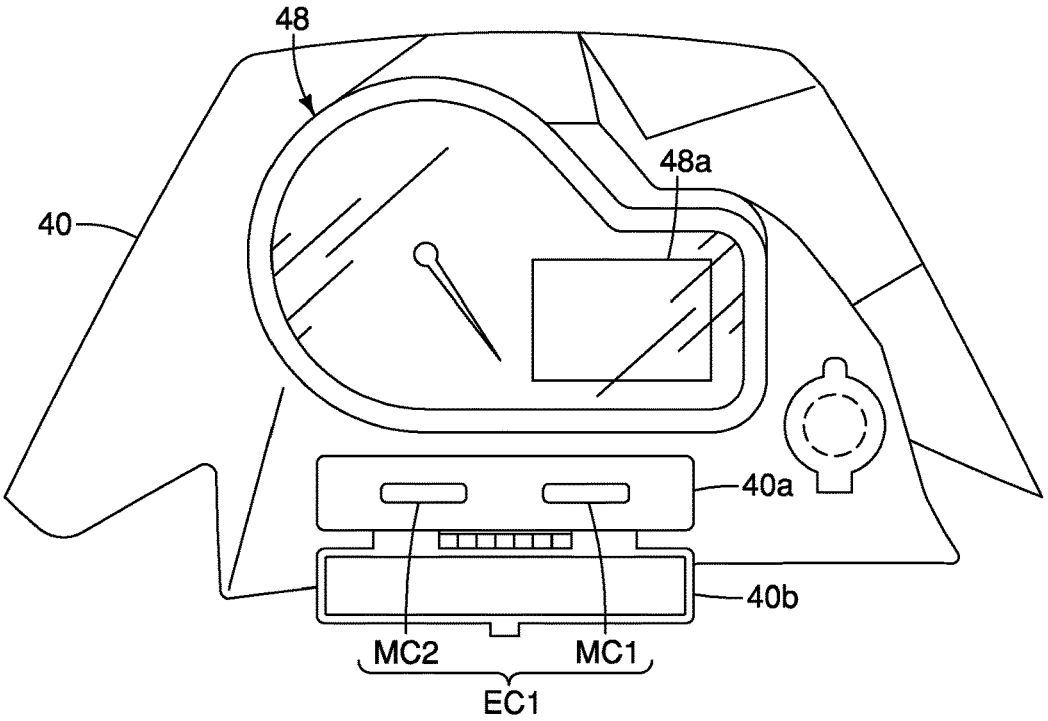


FIG. 5

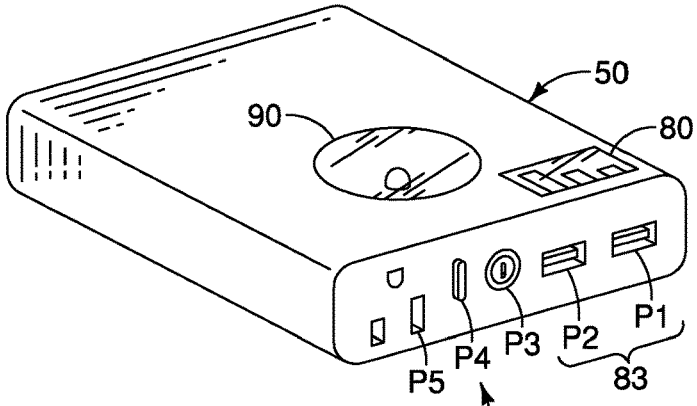


FIG. 6

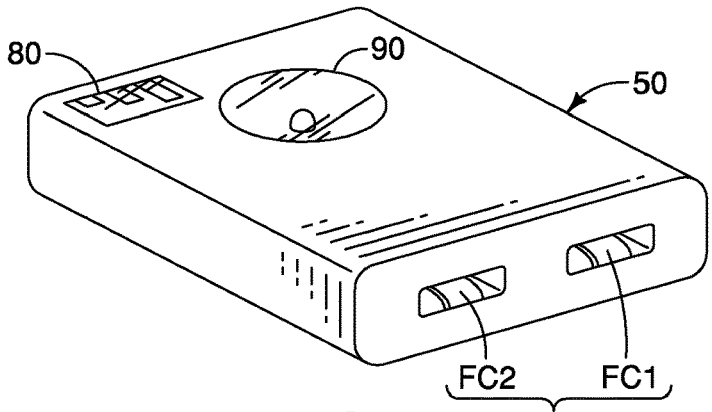


FIG. 7

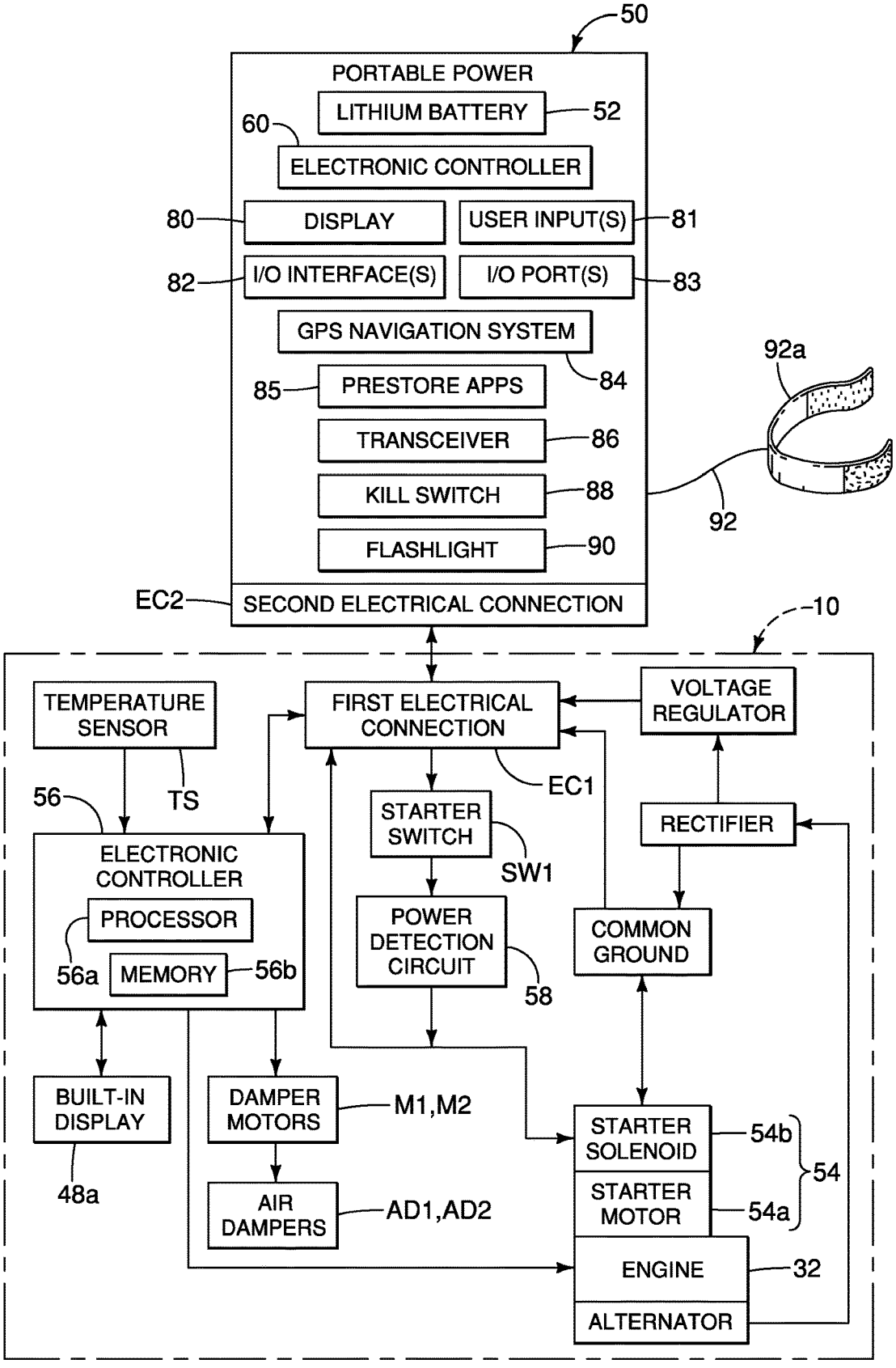

50
PORTABLE POWER
LITHIUM BATTERY
52
60
ELECTRONIC CONTROLLER
80
DISPLAY
USER INPUT(S)
81
82
I/O INTERFACE(S)
I/O PORT(S)
83
GPS NAVIGATION SYSTEM
84
85
PRESTORE APPS
TRANSCEIVER
86
KILL SWITCH
88
FLASHLIGHT
90
92a
92
EC2
SECOND ELECTRICAL CONNECTION
10
TEMPERATURE SENSOR
TS
FIRST ELECTRICAL CONNECTION
VOLTAGE REGULATOR
EC1
56
STARTER SWITCH
SW1
RECTIFIER
ELECTRONIC CONTROLLER
PROCESSOR
56a
MEMORY
56b
POWER DETECTION CIRCUIT
58
COMMON GROUND
BUILT-IN DISPLAY
48a
DAMPER MOTORS
M1,M2
STARTER SOLENOID
54b
54
STARTER MOTOR
54a
AIR DAMPERS
AD1,AD2
ENGINE
32
ALTERNATOR

FIG. 8

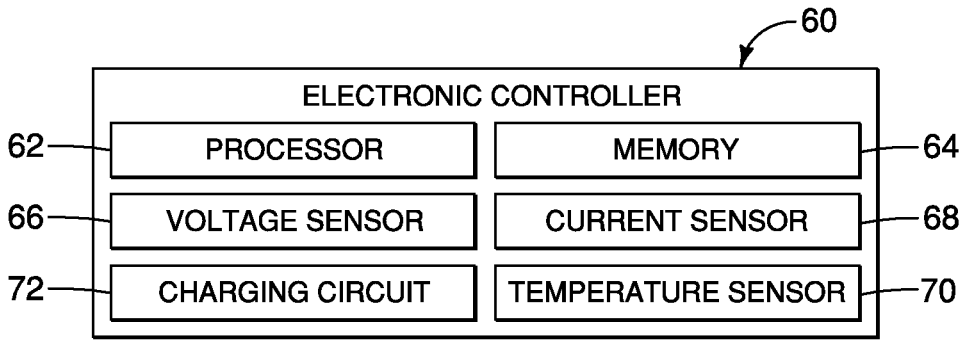

60
ELECTRONIC CONTROLLER
62
PROCESSOR
MEMORY
64
66
VOLTAGE SENSOR
CURRENT SENSOR
68
72
CHARGING CIRCUIT
TEMPERATURE SENSOR
70

FIG. 9

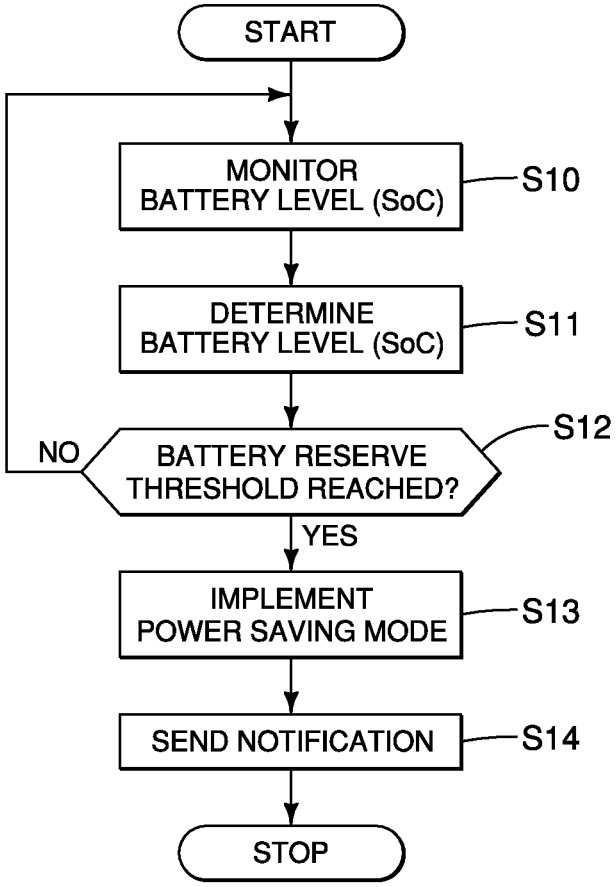

START
MONITOR BATTERY LEVEL (SoC)
S10
DETERMINE BATTERY LEVEL (SoC)
S11
S12
NO
BATTERY RESERVE THRESHOLD REACHED?
YES
IMPLEMENT POWER SAVING MODE
S13
SEND NOTIFICATION
S14
STOP

FIG. 10

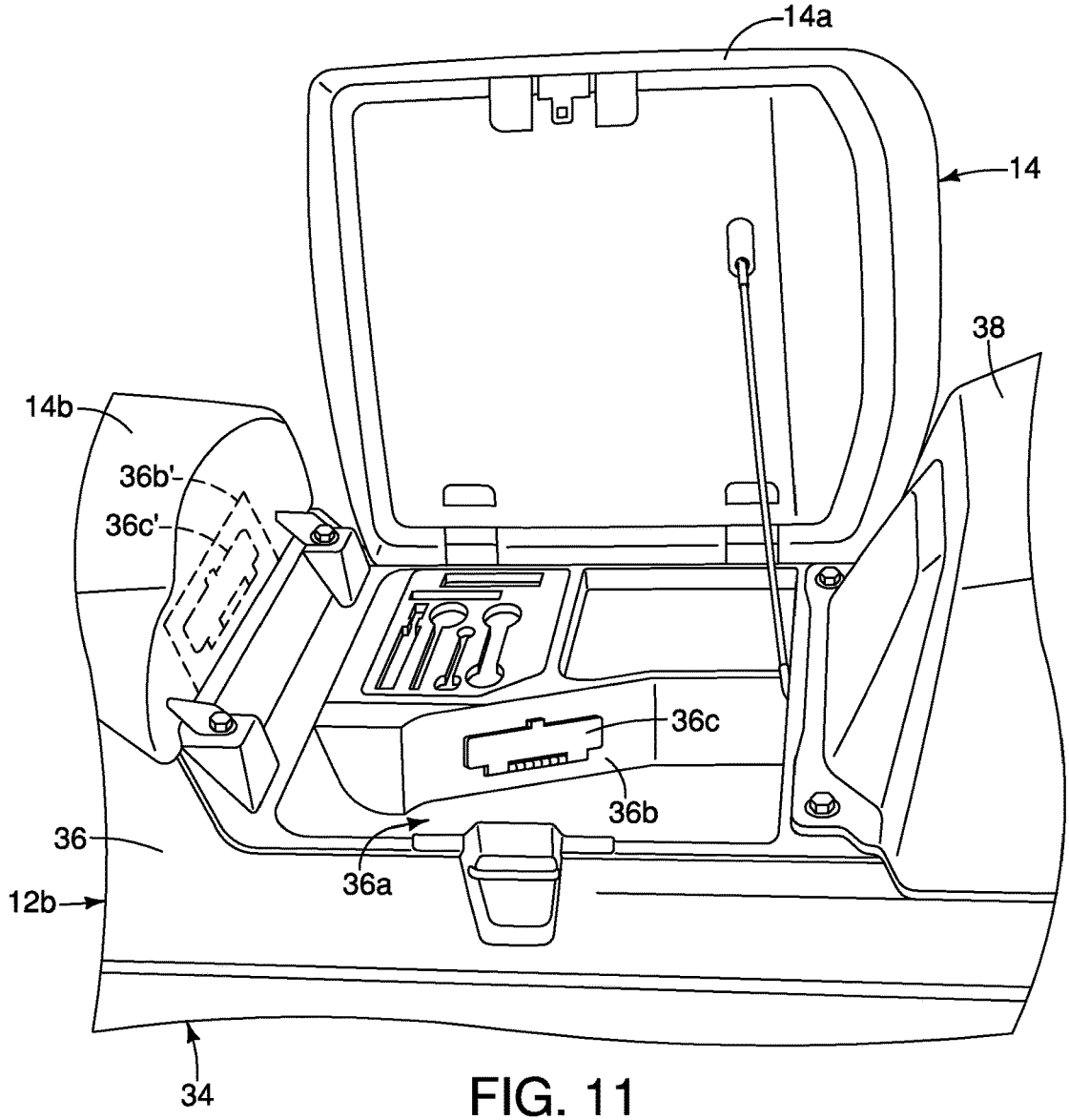

14a
14
38
14b
36b'
36c'
36c
36b
36
36a
12b
34

FIG. 11

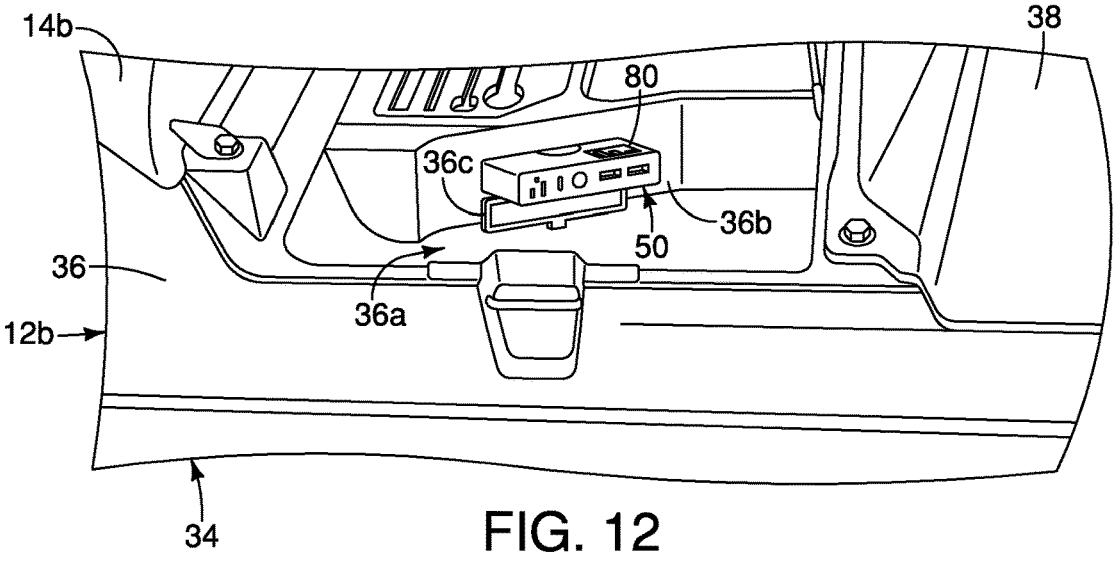

14b
38
80
36c
36b
50
36
36a
12b
34

FIG. 12

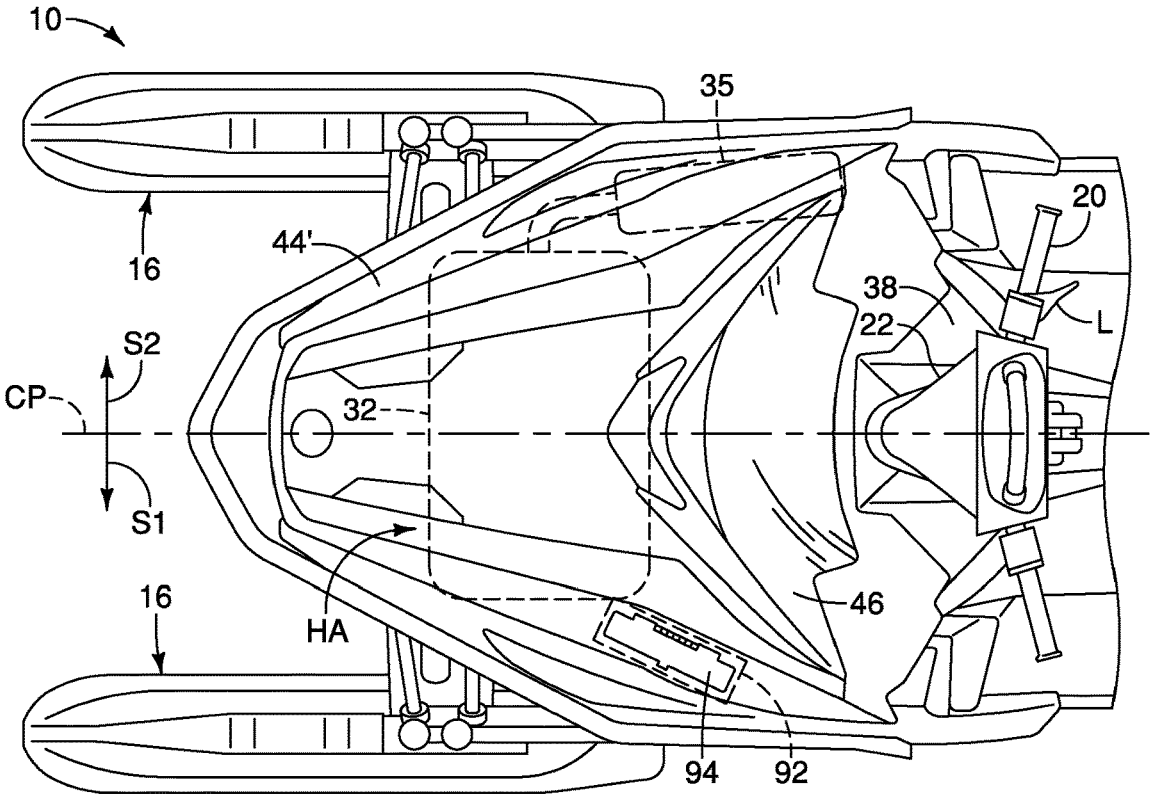

10
35
20
16
44'
38
22
L
S2
CP
32
S1
16
HA
46
94
92

FIG. 13

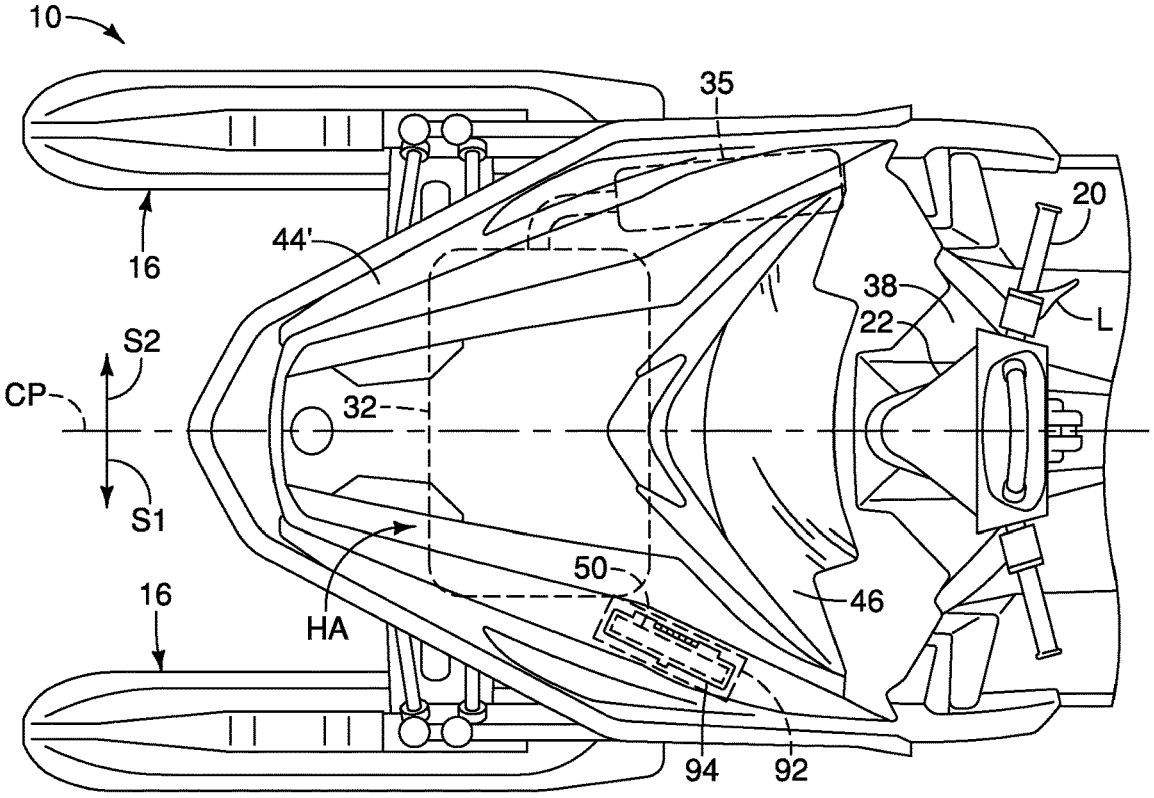

10
35
20
16
44'
38
22
L
S2
CP
32
S1
50
16
HA
46
94
92

FIG. 14

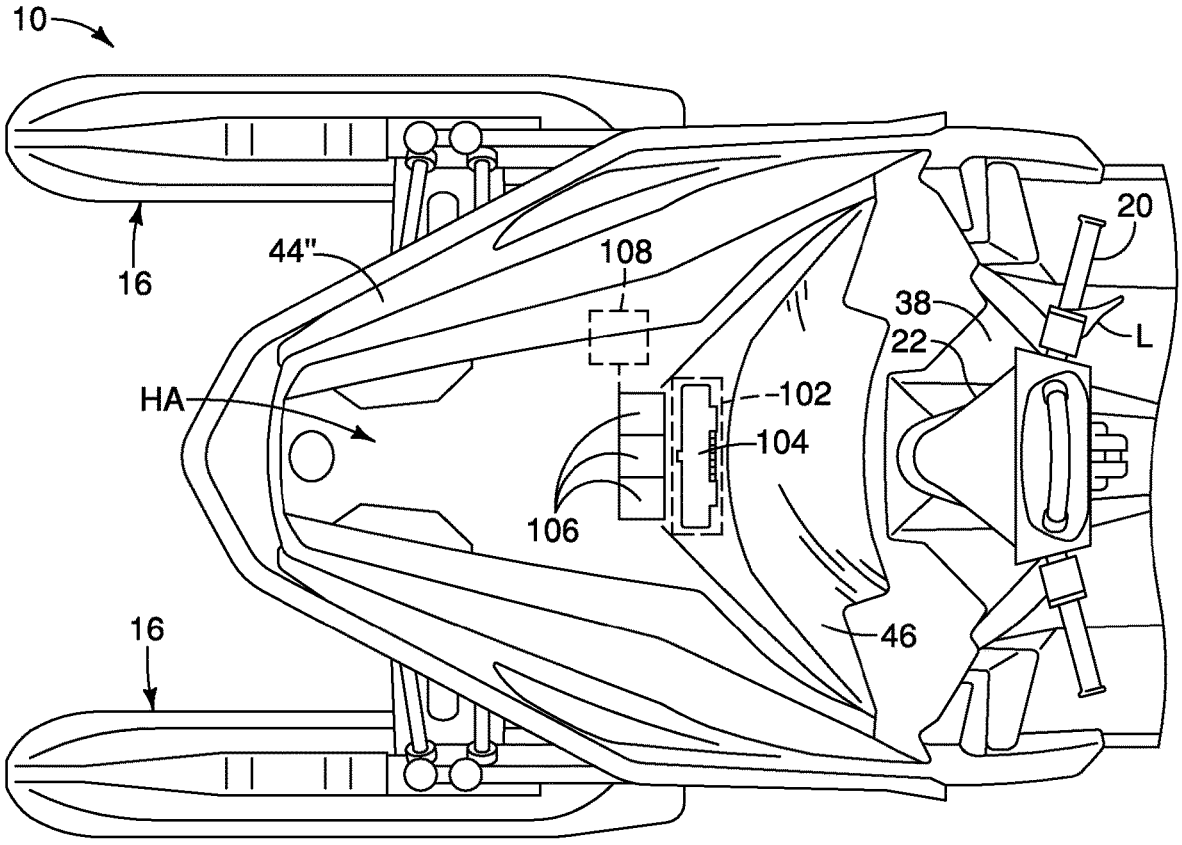


FIG. 15

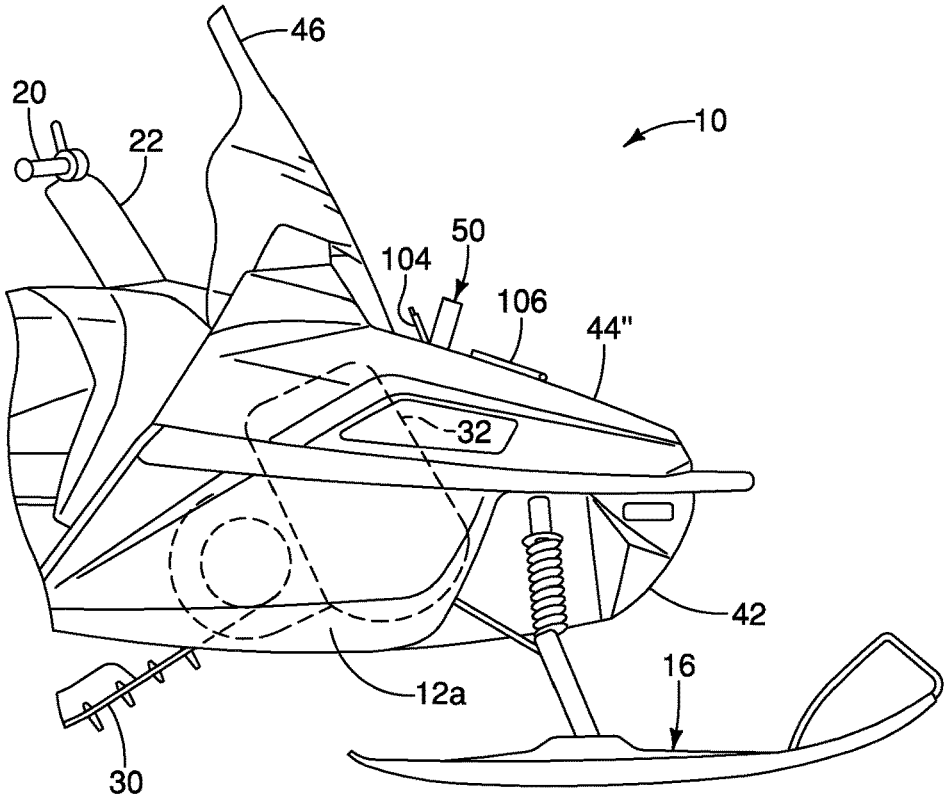

46
20
22
10
50
104
106
44"
32
42
16
12a
30

FIG. 16

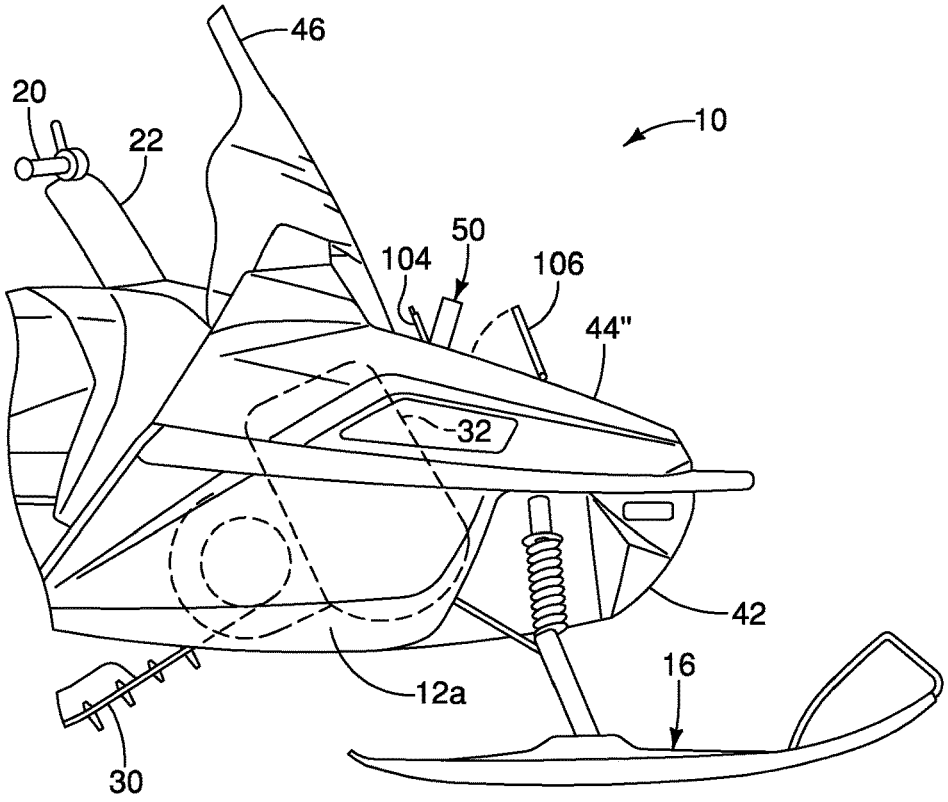

46
20
22
10
50
104
106
44"
32
42
16
12a
30

FIG. 17

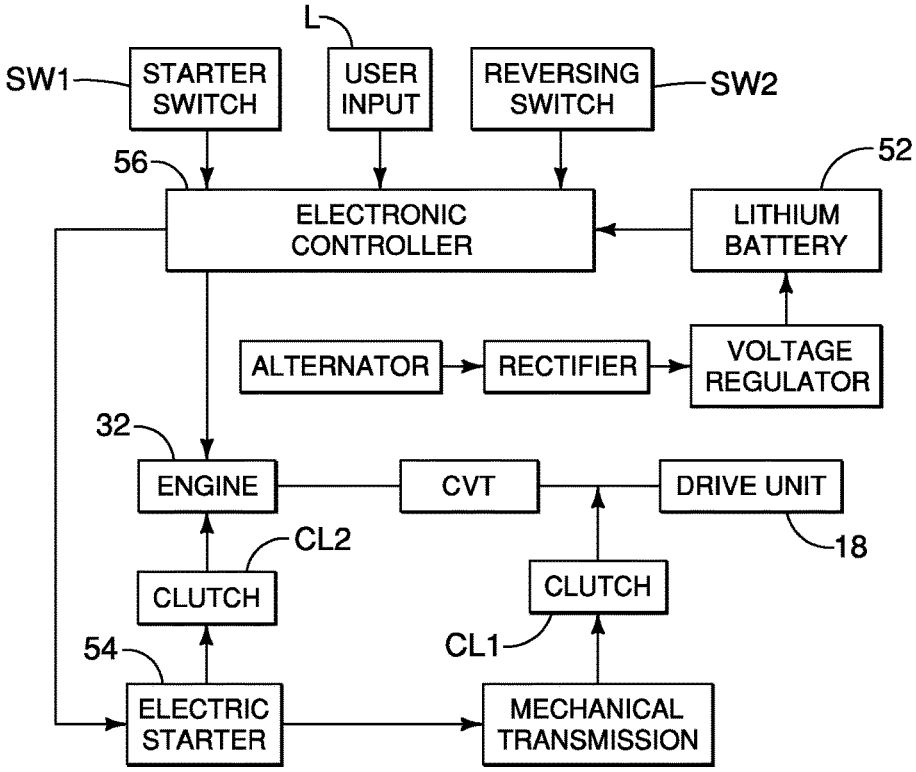

L
SW1
STARTER SWITCH
USER INPUT
REVERSING SWITCH
SW2
56
52
ELECTRONIC CONTROLLER
LITHIUM BATTERY
ALTERNATOR
RECTIFIER
VOLTAGE REGULATOR
32
ENGINE
CVT
DRIVE UNIT
18
CL2
CLUTCH
CLUTCH
CL1
54
ELECTRIC STARTER
MECHANICAL TRANSMISSION

FIG. 18

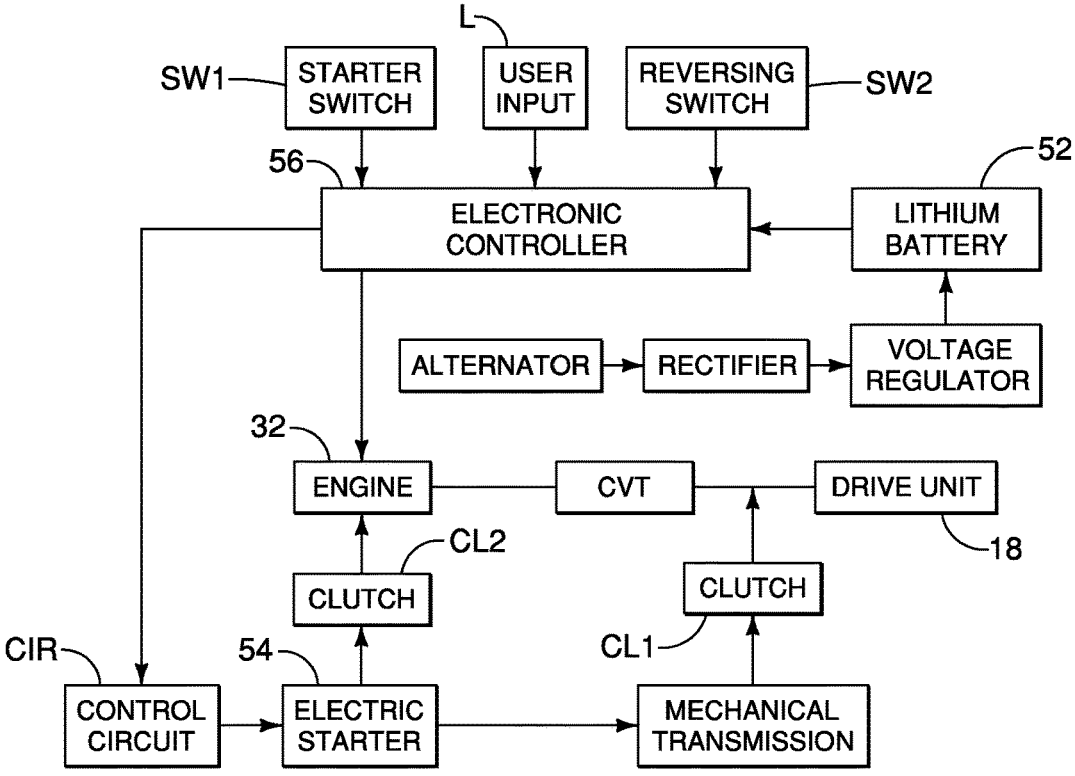

L
SW1
STARTER SWITCH
USER INPUT
REVERSING SWITCH
SW2
56
52
ELECTRONIC CONTROLLER
LITHIUM BATTERY
ALTERNATOR
RECTIFIER
VOLTAGE REGULATOR
32
ENGINE
CVT
DRIVE UNIT
18
CL2
CLUTCH
CLUTCH
CL1
CIR
54
CONTROL CIRCUIT
ELECTRIC STARTER
MECHANICAL TRANSMISSION

FIG. 19

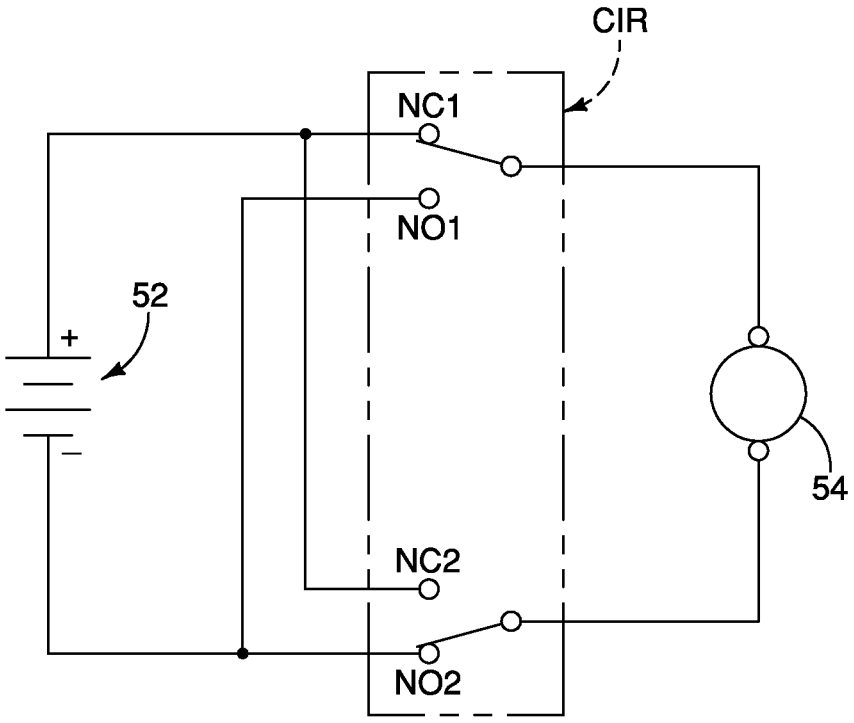


FIG. 20

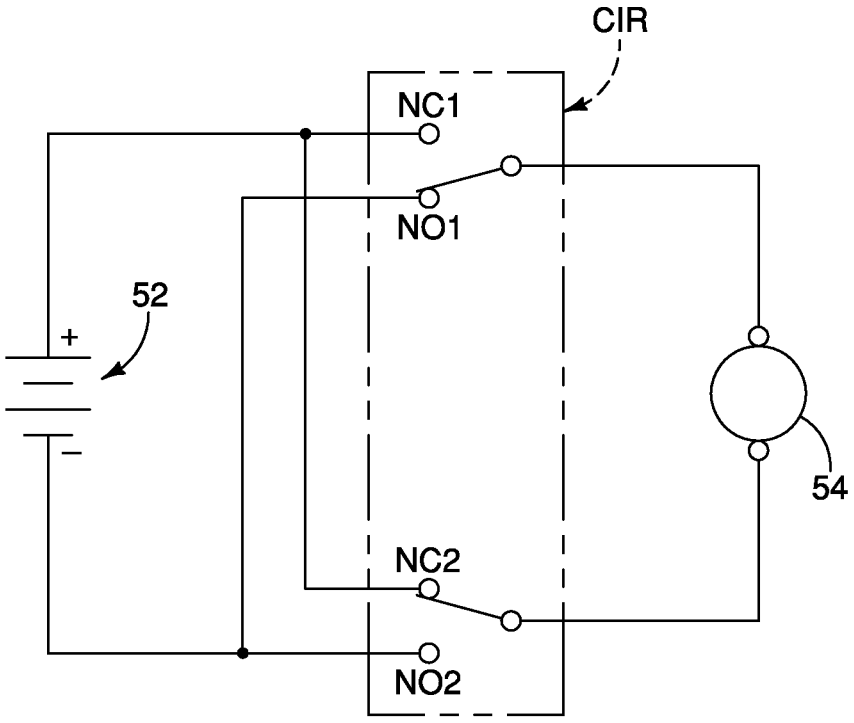


FIG. 21

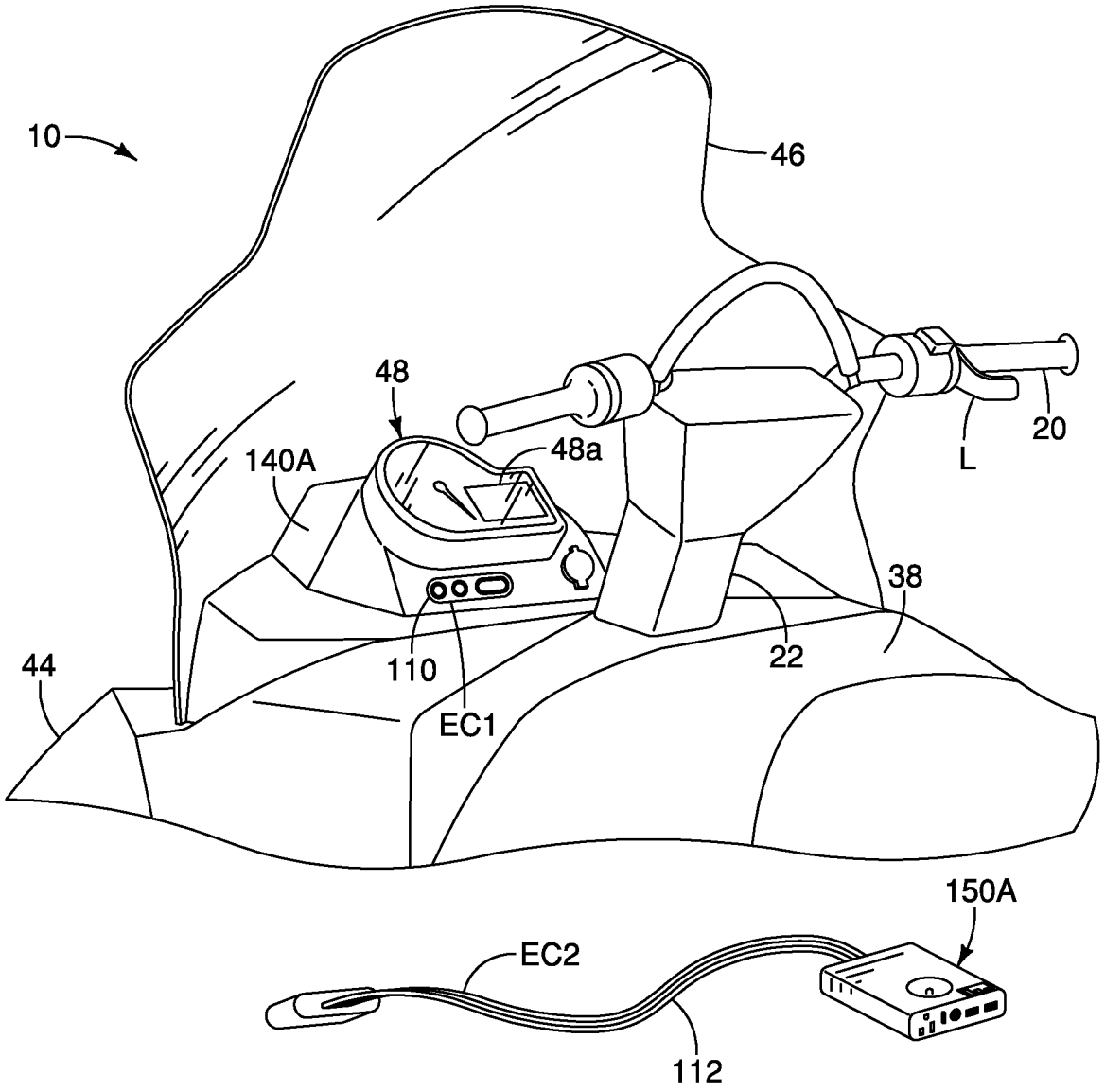


FIG. 22

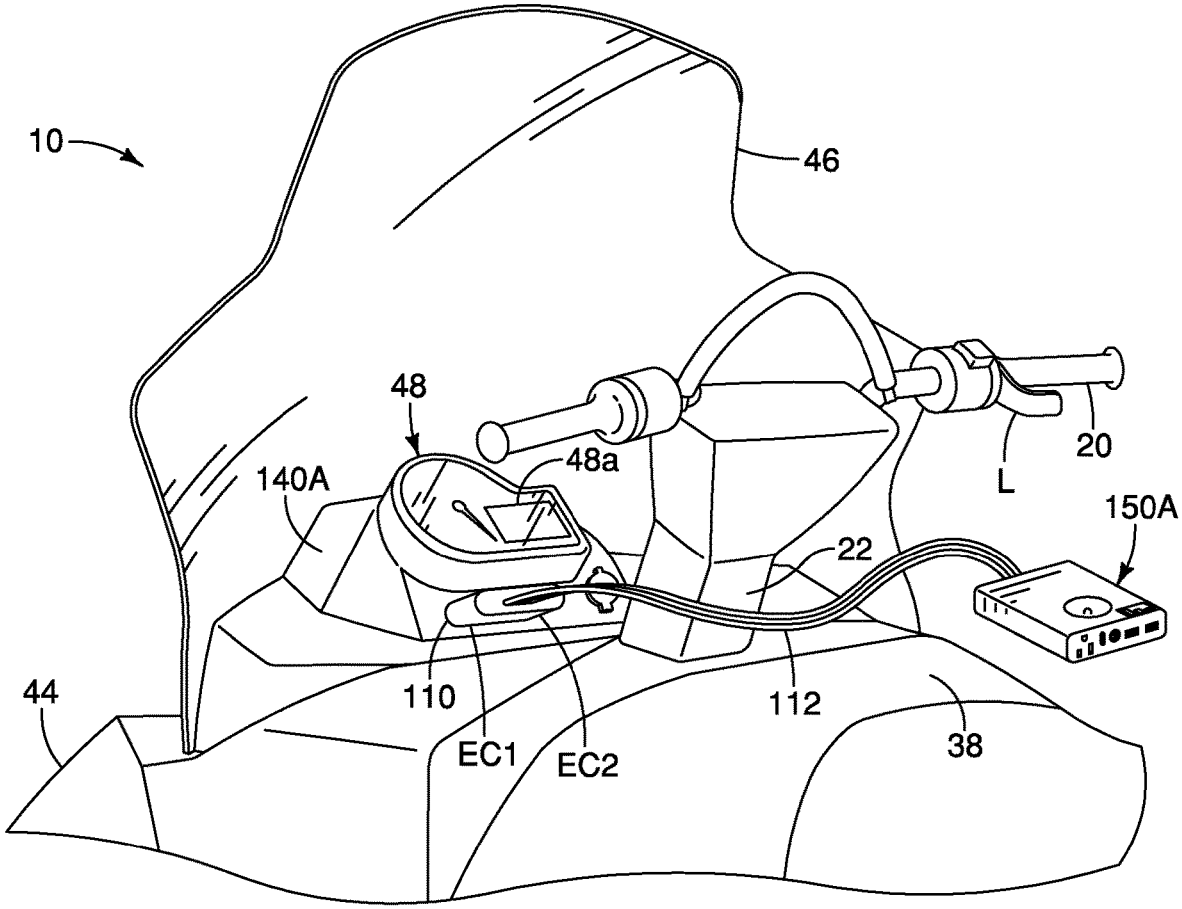


FIG. 23

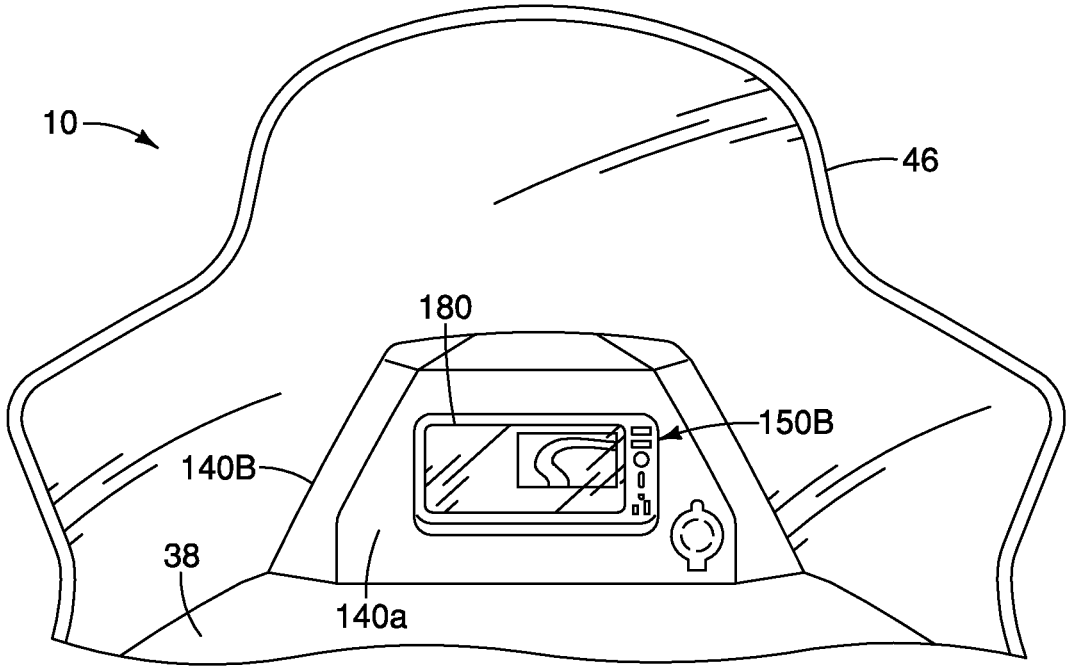

10
46
180
150B
140B
38
140a

FIG. 24

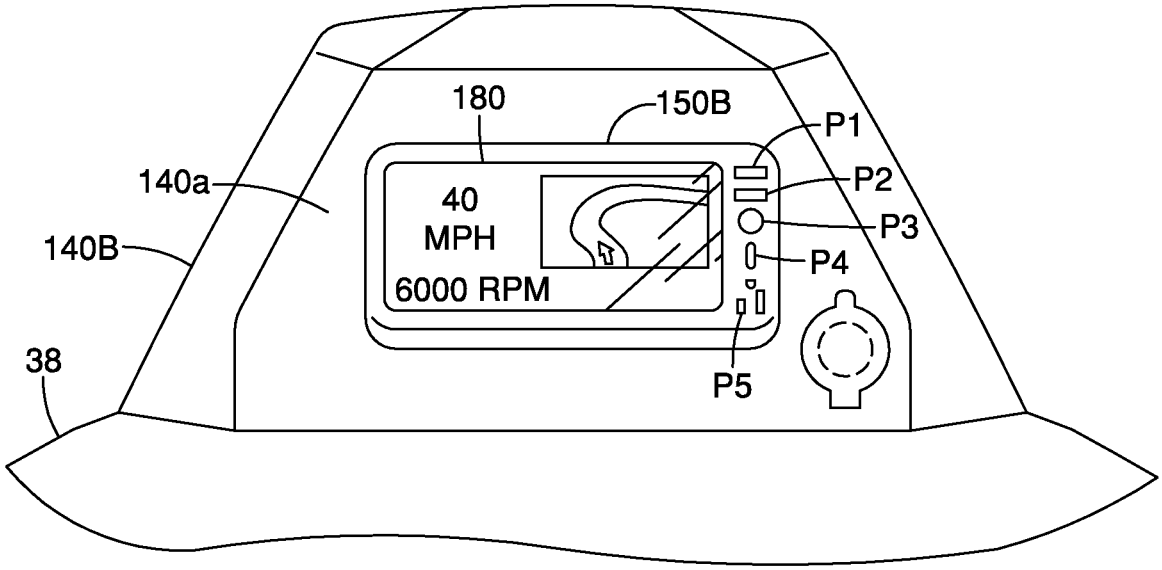

180
150B
P1
P2
P3
P4
140a
40
MPH
6000 RPM
140B
38
P5

FIG. 25

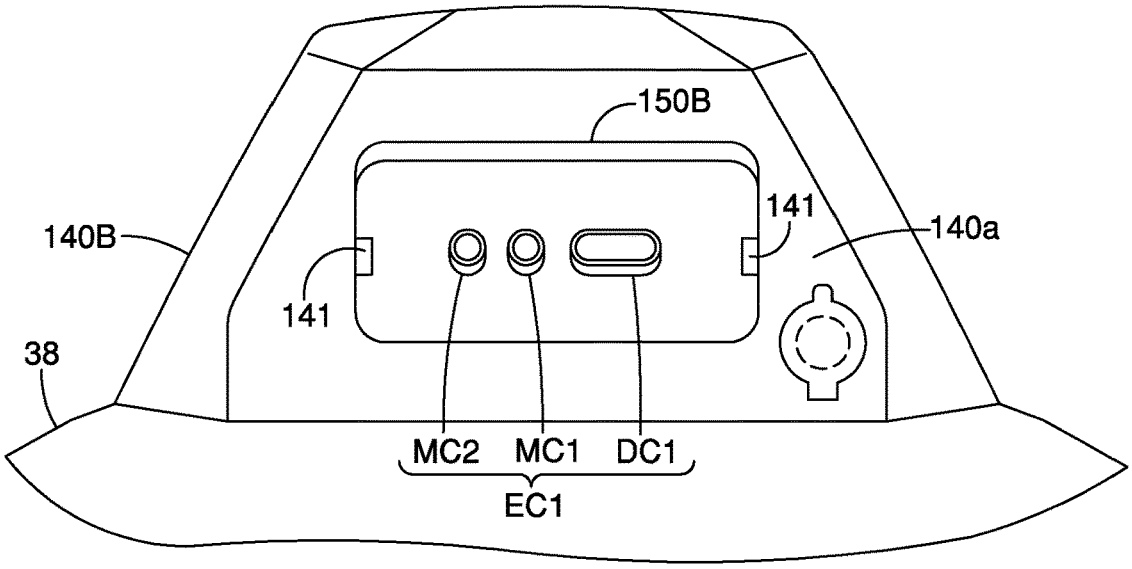


FIG. 26

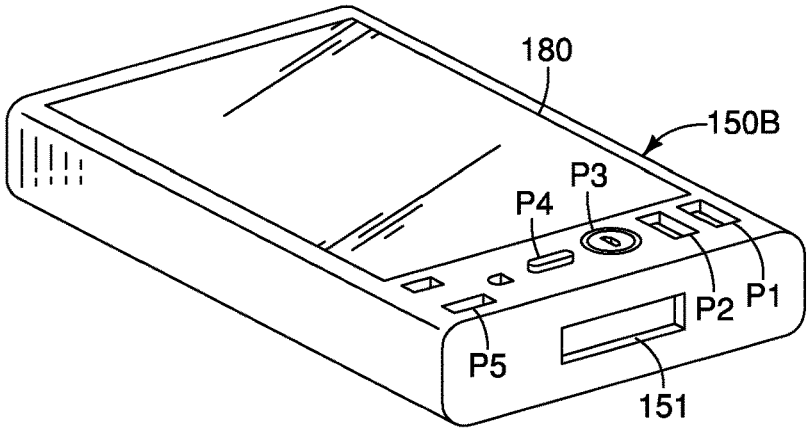


FIG. 27

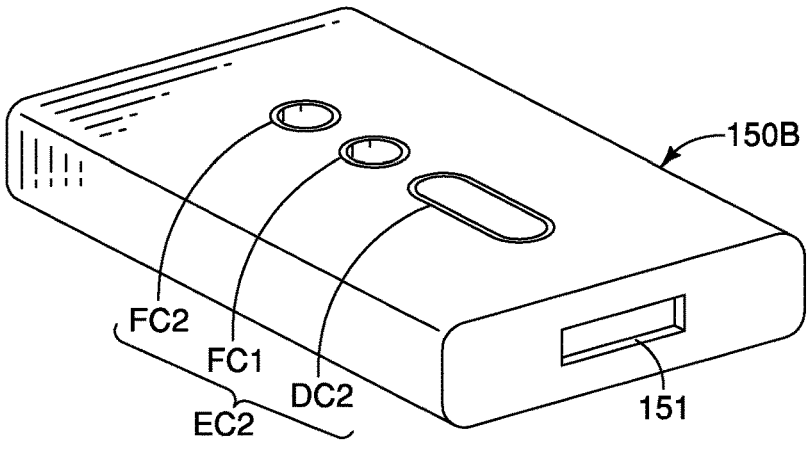


FIG. 28

SNOW VEHICLE

BACKGROUND

Technical Field

[0001] The present invention generally relates to snow vehicles. More specially, the present invention relates to a snow vehicle that has a battery and travels over snow or ice covered ground in cold weather.

Background Information

[0002] Generally, snow vehicles such as snowmobiles and snow bikes are land vehicles that are used for transportation, recreation, or utility in cold and snowy conditions. Typically, a snow vehicle includes a vehicle body supported by a track belt unit with an endless track belt and at least one steerable skis positioned in a forward direction of the track belt unit. The vehicle body has a saddle seat, an engine that drives the endless track belt, and a handlebar that is coupled to the skis. A rider can turn the handlebar to steer the skis to the left and right.

[0003] Traditionally, snowmobiles used two-stroke engines to generate power to turn the endless track belt. Two-stroke engines generally provide relatively high power-to-weight and power-to-size ratios. However, two-stroke engines have higher exhaust emissions than four-stroke engines, and require the rider to use a mixture of gasoline and oil as fuel. Also, in view of environmental concerns, there has been a trend to decrease exhaust emissions from internal combustion engines.

[0004] Accordingly, some of the snowmobile manufacturers have developed snowmobiles that used a four-stroke engine. Often, a four-stroke engine for a snowmobile uses an electric starter motor to start the engine, which is typically not used for starting a two-stroke engine in a snowmobile. Thus, a snowmobile with a four-stroke engine typically needs a battery for the electric starter motor. One example of a snowmobile having a battery for supplying electrical power to an electric starter motor is disclosed in U.S. Patent Application Publication No. 2019/0136818.

SUMMARY

[0005] Generally, the present disclosure is directed to various features of a snow vehicle provided with a portable power module that can used to supply electrical power to an electric starter.

[0006] In view of the state of the known technology and in accordance with one aspect of the present disclosure, a snow vehicle is provided that basically comprises a vehicle body, a saddle seat, at least one skis, an engine, a starter motor and a lithium power module. The saddle seat is provided on the vehicle body. The at least one skis is steerably arranged with respect to the vehicle body. The engine is attached to the vehicle body. The starter motor is operatively coupled to the engine and electrically coupled to a first electrical connection. The lithium power module has a lithium battery with a second electrical connection that is configured to be toollessly connected and disconnected to the first electrical connection.

[0007] With the snow vehicle according to this aspect, it is possible to easily install and remove the lithium power module without using tools.

[0008] In accordance with another aspect of the present disclosure, a snow vehicle is provided that basically comprises a vehicle body, a saddle seat, at least one skis, an engine and a lithium power module. The saddle seat is provided on the vehicle body. The at least one skis is steerably arranged with respect to the vehicle body. The vehicle body has a longitudinal center plane dividing the snow vehicle into first and second lateral sides. The engine is attached to the vehicle body and has an exhaust system that is primarily disposed on one of the first and second lateral sides. The lithium power module has a lithium battery, and is disposed on the other of the first and second lateral sides adjacent to the engine.

[0009] With the snow vehicle according to this aspect, it is possible keep the lithium battery while avoiding excess heating of the lithium battery from the exhaust system.

[0010] In accordance with another aspect of the present disclosure, a snow vehicle is provided that basically comprises a vehicle body, a windshield, a saddle seat, at least one skis and a lithium power module. The windshield is provided on the vehicle body. The saddle seat is provided on the vehicle body. The at least one skis is steerably arranged with respect to the vehicle body. The lithium power module has a lithium battery, and is disposed in an area defined between the windshield and the saddle seat.

[0011] With the snow vehicle according to this aspect, it is possible to easily install and remove the lithium power module while in the seated position.

[0012] In accordance with another aspect of the present disclosure, a snow vehicle is provided that basically comprises a vehicle body, a saddle seat, at least one skis and a lithium power module. The vehicle body has a saddle seat section. The saddle seat is provided on the saddle seat section of the vehicle body. The at least one skis is steerably arranged with respect to the vehicle body. The lithium power module has a lithium battery, and is disposed in one of the saddle seat section of the vehicle body and the saddle seat.

[0013] With the snow vehicle according to this aspect, it is possible to position the lithium power module in a protected and secure location.

[0014] In accordance with another aspect of the present disclosure, a snow vehicle is provided that basically comprises a vehicle body, a saddle seat, at least one skis, a drive unit, an engine, a starter motor, a battery and at least one user operated switch. The vehicle body has a saddle seat section. The saddle seat is provided on the saddle seat section of the vehicle body. The at least one skis is steerably arranged with respect to the vehicle body. The drive unit is supported by the saddle seat section of the vehicle body. The drive unit includes a track belt. The engine is attached to the vehicle body and is operatively coupled to the drive unit to drive the drive unit in a forward direction. The starter motor is operatively coupled to the engine and operatively coupled to the drive unit. The battery is electrically coupled to the starter motor. The user operated switch operates the starter motor to start the engine in a first vehicle condition, and operates the starter motor to drive the drive unit in a reverse direction in a second vehicle condition.

[0015] Also, other objects, features, aspects and advantages of the disclosed snow vehicle will become apparent to those skilled in the snow vehicle field from the following detailed description, which, taken in conjunction with the annexed drawings, discloses preferred embodiments of the snow vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Referring now to the attached drawings which form a part of this original disclosure.

[0017] FIG. **1** is a side elevational view of a snowmobile (a snow vehicle) in accordance with the illustrative embodiments.

[0018] FIG. **2** is a perspective view of a portion of the snowmobile illustrated in FIG. **1** having a battery receiving port or socket located in a dash panel area between a windshield and a steering column of the snowmobile.

[0019] FIG. **3** is a perspective view, similar to FIG. **2**, of a portion of the snowmobile illustrated in FIG. **1** but having a portable power source (a lithium power module) inserted into the battery receiving port.

[0020] FIG. **4** is an oblique view of the dash panel area of the snowmobile illustrated in FIG. **1** with the portable power source removed from the battery receiving port.

[0021] FIG. **5** is an oblique view, similar to FIG. **4**, of the dash panel area of the snowmobile illustrated in FIG. **1** with a port cover pivoted to an open position to expose the first electrical terminals of the battery receiving port.

[0022] FIG. **6** is a first end perspective view of the portable power source that is configured to be plugged into the battery receiving port.

[0023] FIG. **7** is a second end perspective view of the portable power source showing the second electrical terminals that are configured to be toollessly connected and disconnected to the first electrical terminals of the battery receiving port.

[0024] FIG. **8** is a functional block diagram of the electrical system of the snowmobile illustrated in FIG. **1** receiving power from the portable power source (the lithium power module) illustrated in FIGS. **6** and **7**.

[0025] FIG. **9** is a functional block diagram of the electronic controller of the portable power source (the lithium power module) illustrated in FIGS. **6** and **7**.

[0026] FIG. **10** is a flowchart depicting operational steps of a program executed by the electronic controller of the portable power source (the lithium power module) that functions to ensure a sufficient battery reserve for using the portable power source to start the engine of the snowmobile a predetermined number of times;

[0027] FIG. **11** is a perspective view of a saddle seat section of a vehicle body of the snowmobile illustrated in FIG. **1** having a battery receiving port or socket located in one of the saddle seat section of the vehicle body and the saddle seat.

[0028] FIG. **12** is a perspective view, similar to FIG. **12**, of the saddle seat section of the vehicle body of the snowmobile but having a portable power source (a lithium power module) inserted into the battery receiving port.

[0029] FIG. **13** is a top plan view of a front section of a vehicle body of the snowmobile illustrated in FIG. **1** having a battery receiving port or socket located in the engine compartment.

[0030] FIG. **14** is a top plan view, similar to FIG. **13**, of the front section of a vehicle body of the snowmobile but having a portable power source (a lithium power module) inserted into the battery receiving port.

[0031] FIG. **15** is a top plan view of a front section of a vehicle body of the snowmobile illustrated in FIG. **1** having a battery receiving port located in the engine compartment and thermostatically controlled air dampers.

[0032] FIG. **16** is a side elevational view of a front portion of the snowmobile illustrated in FIG. **15** having the thermostatically controlled air dampers in a retracted position to permit air to flow towards the lithium battery.

[0033] FIG. **17** is a side elevational view of a front portion of the snowmobile illustrated in FIGS. **15** and **16** having the thermostatically controlled air dampers in an extended position to block air from flowing towards the lithium battery.

[0034] FIG. **18** is a functional block diagram of the snowmobile of the illustrated embodiments for reversing the drive unit of the snowmobile using the starter motor.

[0035] FIG. **19** is an alternate functional block diagram of the snowmobile of the illustrated embodiments for reversing the drive unit of the snowmobile using the starter motor.

[0036] FIG. **20** is a simplified circuit diagram of the control circuit of FIG. **19** used for suppling current to the starter motor in an engine starting state (i.e., a first polarity for starting the engine).

[0037] FIG. **21** is a simplified circuit diagram of the control circuit of FIG. **19** used for suppling current to the starter motor in a reverse drive state (i.e., a second polarity for driving the drive unit in reverse).

[0038] FIG. **22** is a perspective view of modified dash panel area of the snowmobile illustrated in FIG. **1** having a first electrical connection with a pluggable power and signal outlet in a dash panel area between a windshield and a steering column of the snowmobile for receiving a second electrical connection formed on one end of an electrical cord that has its other end connected to a modified portable power source (a lithium power module).

[0039] FIG. **23** is a perspective view of the front portion of the snowmobile illustrated in FIG. **22** in which the modified portable power source is connected to the first electrical connection of the snowmobile via the second electrical connection of the electrical cord.

[0040] FIG. **24** is an oblique view of a modified dash panel area for the snowmobile illustrated in FIG. **1** having a first electrical connection with a power and signal socket in a dash panel area between a windshield and a steering column of the snowmobile for receiving a modified portable power source (a lithium power module).

[0041] FIG. **25** is an enlarged oblique view of the modified dash panel area and the modified portable power source illustrated in FIG. **24**.

[0042] FIG. **26** is an enlarged oblique view, similar to FIG. **25**, of the modified dash panel area but with the modified portable power source removed.

[0043] FIG. **27** is a first side perspective view of the modified portable power source that is configured to be plugged into the power and signal socket of the modified dash panel shown in FIGS. **24** to **26**.

[0044] FIG. **28** is a second side perspective view of the modified portable power source that is configured to be plugged into the power and signal socket of the modified dash panel shown in FIGS. **24** to **26**.

[0045] It should be noted that these figures are intended to illustrate the general characteristics of methods, structure and/or materials utilized in certain illustrative embodiment and to supplement the written description provided below. These figures are to reduce scale of the actual snowmobile but may not precisely reflect the precise structural or performance characteristics of any given embodiment. However, the dimensional relationships and the arrangement of

the parts of the snowmobile are accurately depicted, except for the functional block diagrams.

DETAILED DESCRIPTION OF EMBODIMENTS

[0046] Selected embodiments will now be explained with reference to the drawings. It will be apparent to those skilled in the snowmobile field from this disclosure that the following descriptions of the embodiments are provided for illustration only and not for the purpose of limiting the invention as defined by the appended claims and their equivalents. Like reference numerals in the drawings denote like similar or identical elements or features, and thus the descriptions of the similar or identical elements or features may be omitted in later embodiments.

[0047] Referring initially to FIGS. **1** to **5**, a snowmobile **10** is illustrated that is configured in accordance with the illustrative embodiments. The snowmobile **10** is a saddle-riding type vehicle that basically includes a vehicle body **12**, a saddle seat **14**, a pair of skis **16** and a drive unit **18**. The skis **16** are supported by a front section **12***a* of the vehicle body **12**, which can also be referred to as a snowmobile body. The skis **16** are turnable in conventional manner by a handlebar **20** that is attached to an upper end of a steering column **22**. The vehicle body **12** has a saddle seat section **12***b*. The saddle seat **14** is provided on the saddle seat section **12***b* of the vehicle body **12**. The saddle seat **14** includes a movable seat **14***a* and a stationary seat **14***b* as seen in FIG. **11**. It will be apparent from this disclosure that the present invention can also be used in snow bikes.

[0048] The drive unit **18** is supported by the saddle seat section **12***b* of the vehicle body **12**. The drive unit **18** includes at least one beam **24** (only one shown), at least one driving wheel **26** (only one shown), a plurality of driven wheels **28** and a track belt **30**. The track belt **30** is wound around the driving wheels **26** and the driven wheels **28**. The driving wheels **26** are rotated by driving power supplied from an internal combustion engine **32** via a continuously variable transmission CVT in conventional manner. The driven wheels **28** are driven with a circulatory rotation of the track belt **30**.

[0049] The vehicle body **12** includes a frame **34** and various body panels such has a seat panel **36**, a center console panel **38**, a dash panel **40**, a hull **42** and a front engine cover **44**. The frame **34** is typically made of a metal, while the body panels are typically made of a non-metallic material such as reinforced plastic. The saddle seat **14** is mounted on the seat panel **36**. Here, the seat panel **36** includes a storage area or compartment **36***a* as seen in FIG. **11**. The movable seat **14***a* is hinged to the seat panel **36** between a closed position overlying the storage area **36***a* to conceal the storage area **36***a* and an open position exposing the storage area **36***a* to provide access to the storage area **36***a*. The movable seat **14***a* preferably has a lock **45** as seen in FIG. **1**. The hull **42** and the front engine cover **44** define an engine compartment for receiving the engine **32**. As seen in FIGS. **2** and **3**, two ducts D**1** and D**2** are provided for directing heated air from the engine compartment that is defined by the hull **42** and the front engine cover **44** to vent outlets V**1** and V**2**.

[0050] The engine **32** is a four-stroke engine that is attached to the vehicle body **12**. More specifically, the engine **32** is supported by the frame **34** and covered by the front engine cover **44**. A user input L (e.g., the throttle lever) is provided on the handlebar **20** for regulating the throttle of the engine **32**. Here, the snowmobile **10** further comprises a windshield **46** that is attached to the vehicle body **12**. The windshield **46** is located in an area between the dash panel **40** and the front engine cover **44**. Since snowmobiles are well known, the construction of the vehicle body **12** can be any conventional or unconventional snowmobile body. Thus, the vehicle body **12** will not be discussed in further detail herein.

[0051] As seen in FIGS. **2** to **5**, the snowmobile **10** further comprises an instrument cluster **48** provided in the dash panel **40**. The instrument cluster **48** includes a built-in display **48***a* (hereinafter the "display **48***a*") among other things. The display **48***a* can be any conventional display such as an LCD display. The display **48***a* notifies the rider of various operating conditions of the snowmobile **10** or other information. Here, in the first embodiment, the dash panel **40** also includes a battery support **40***a* that is located below the instrument cluster **48**. A lid **40***b* is pivotally attached to the battery support **40***a* to cover a first electrical connection EC**1**, which is electrically connected to an electrical system of the snowmobile **10** as shown in FIG. **8**. Here, the battery support **40***a* defines a battery receiving port or socket formed in the dash panel **40**. However, the battery support **40***a* is not limited to this configuration.

[0052] Referring now to FIGS. **3** and **6** to **8**, the snowmobile **10** further comprises a portable lithium power module **50**, which preferably includes a lithium battery **52** (FIG. **8**). The lithium battery **52** can be any suitable lithium-ion battery (e.g., Li-ion battery with lithium cobalt dioxide ($LiCoO_2$), lithium manganese oxide ($LiMn_2O_4$), or lithium iron phosphate ($LiFePO_4$) as a cathode material. Preferably, the lithium battery **52** is a lithium-iron battery (e.g., Li—Fe battery with lithium iron phosphate ($LiFePO_4$) as a cathode material). The lithium battery **52** is a rechargeable battery. For example, the lithium battery **52** has at least a 600 peak Amp with a capacity of approximately 29.6 watt hours so as to provide approximately seventy-eight (78) engine starts on a single charge. More preferably, the lithium battery **52** has at least an 800 peak Amp with a capacity of approximately 37 watt hours, and even more preferably, the lithium battery **52** has at least a 1000 peak Amp with a capacity of approximately 144 watt hours. Of course, it will be apparent to from this disclosure that the lithium battery **52** is not limited to the above-mentioned amperages and watt hour capacities.

[0053] Here, the portable lithium power module **50** has several functions and/or features in addition to supplying electrical power to an electrical system (12 to 48 Volt DC-BUS) of the snowmobile **10**. However, in its simplest form, the portable lithium power module **50** can be merely a pluggable battery without any addition functions and/or features. In any case, the portable lithium power module **50** is configured to be electrically connected and electrically disconnected from the electrical system (12 to 48 Volt DC-BUS) of the snowmobile **10** without using any tools. The portable lithium power module **50** is provided with a second electrical connection EC**2** that is electrically connected to the lithium battery **52**. The second electrical connection EC**2** is configured to electrically mate with the first electrical connection EC**1** of the electrical system of the snowmobile **10**. Thus, the lithium power module **50** is removably supported to the battery support **40***a* while the first and second connections E**1** and E**2** are electrically connected. Here, the first electrical connection EC) includes

a pair of male electrical contacts MC1 and MC2, while the second electrical connection EC2 includes a pair of female electrical contacts FC1 and FC2. However, the first and second electrical connections EC1 and EC2 can be any suitable electrical connections for transferring electrical power from the lithium battery **52** to the electrical system of the snowmobile **10**. In the illustrated embodiment, the portable lithium power module **50** can communicate data with the components of the snowmobile **10** using Power Line Communication (PLC), which is a communication technology that enables sending data over existing power cables. Alternatively, one or more dedicated data connections can be used for communicating data between the portable lithium power module **50** and the components of the snowmobile **10**.

[0054] A primary function of the portable lithium power module **50** is to provide electrical power to an electric starter **54** (FIG. **8**). In the illustrated embodiment, for example, the electric starter **54** includes a starter motor **54***a* and a starter solenoid **54***b*. The starter motor **54***a* of the electric starter **54** is electrically coupled to a first electrical connection E1 via the starter solenoid **54***b*. Here, since the electrical system is preferably a 12 to 48 Volt electrical system, the starter motor **54***a* is a 12 to 48 Volt starter motor, and the starter solenoid **54***b* is a 12 to 48 Volt starter solenoid. The starter solenoid **54***b* is electrically connected to the lithium battery **52** of the portable lithium power module **50** when the portable lithium power module **50** is plugged into the snowmobile. Namely, the lithium power module **50** has the second electrical connection EC2 that is configured to be toollessly connected and disconnected to the first electrical connection EC1 that is electrically connected to the starter solenoid **54***b* of the snowmobile **10**. The engine **32** is started by depressing an ignition switch SW1 (e.g., a button, a lever or other suitable user operated input device) which is shown in FIG. **8**.

[0055] The starter motor **54***a* is used to start the engine **32** using the electrical power from the lithium battery **52** in a conventional manner. The starter motor **54***a* can also be used to drive the drive unit **18** in reverse as explained below.

[0056] A secondary function of the portable lithium power module **50** is to display information (e.g., battery voltage, battery level, battery current, etc.) of the lithium battery **52** to a rider using the display **48***a* of the snowmobile **10**. Also, depending on the configuration (e.g., stored applications, features, etc.) of the portable lithium power module **50**, the portable lithium power module **50** can display other information (e.g., map (trail) data, GPS data, navigation, emergency alerts, maintenance logging data, weather, text messages, vehicle status, suspension settings, etc.) as needed and/or desired on the display **48***a* of the snowmobile **10**. Moreover, the battery support **40***a* can include an electric battery heater (not shown) for heating the battery support **40***a*, which in turn will heat the lithium battery **52**. In such a case, the electric battery heater receives electrical power from the lithium battery **52** based on the internal temperature. Alternatively, the lithium battery **52** can include an electric battery heater (not shown) for heating the lithium battery **52**.

[0057] In the embodiment shown in FIGS. **2** to **5**, the lithium power module **50** is disposed in an area defined between the windshield **46** and the saddle seat **14**. More particularly, as seen in FIGS. **2** to **5**, the lithium power module **50** is disposed in the battery support **40***a* formed in the dash panel **40** between the windshield **46** and the steering column **22**. In this way, the lithium power module **50** is can be easily installed and removed by the rider. Also, as seen in FIG. **3**, in this embodiment, the lithium power module **50** is partially exteriorly disposed and partially interiorly disposed while the first and second electrical connections EC1 and EC2 are connected.

[0058] As previously mentioned, the lithium power module **50** is toollessly connected to the battery support **40***a* for electrically connecting the lithium battery **52** to the electrical system of the snowmobile **10**. Here, the lithium power module **50** is merely pushed into the battery receiving port defined by the battery support **40***a* with the lithium power module **50** being frictionally retained. However, the battery support **40***a* can be provided with one or more hand operated latches for more securely retaining the lithium power module **50** in the battery receiving port defined by the battery support **40***a*. Alternatively, a push type latching system such as used for computer memory cards could be used. In any case, the lithium power module **50** is preferably a quick-connect configuration in which the lithium battery **52** is electrically connected to the electrical system of the snowmobile **10** without using a tool and the lithium battery **52** is electrically disconnected from the electrical system of the snowmobile **10** without using a tool in a repeatable manner.

[0059] Here, as seen in FIG. **8**, the snowmobile **10** further comprises an electronic controller **56** that is an engine control unit (ECU) for controlling the operation of the engine **32**. The term "electronic controller" as used herein refers to hardware that executes a software program, and does not include a human. The electronic controller **56** is preferably a microcomputer that includes one or more processors and one or more computer storage devices (i.e., computer memory). For example, the electronic controller **56** includes a processor **56***a* and memory **56***b*. The electronic controller **56** is formed of one or more semiconductor chips that are mounted on one or more circuit boards. Also, the electronic controller **56** may be separate of the engine control unit (ECU). Although illustrated as separate elements, those of skill in the art will recognize that the processor **56***a* and the memory **56***b* can be mounted on a single circuit boards. The processor **56***a* can be a conventional central processing unit (CPU) or any other type of device, or multiple devices, capable of manipulating or processing information such as program code stored in the memory **56***b* in order to allow the electronic controller **56** to perform the functionality described herein. Processors and memory are extremely well known in the computer field and often used in the snowmobile field, therefore no further description will be provided. Moreover, the control of an engine using an engine control unit is well known in the snowmobile field, therefore no further description will be provided with respect to the control of the engine **32** using the electronic controller **56**.

[0060] In the illustrated embodiments, the snowmobile **10** further comprises a power detection circuit **58**. The power detection circuit **58** is electrically connected to an electrical path between the lithium battery **52** and the starter solenoid **54***b*. The electronic controller **56** is operatively coupled to the power detection circuit **58** and the engine **32**. The electronic controller **56** is programmed to shut off the engine **32** in response to the power detection circuit **58** detecting the lithium battery **52** is no longer connected to the electrical system of the snowmobile **10**. The power detection circuit **58** acts as a kill switch in the situation in which the portable

lithium power module **50** is connected to the snowmobile **10** using a power cord and the portable lithium power module **50** is carried on the rider. While the power detection circuit **58** is indicated as a separate part from the electronic controller **56**, it will be apparent from this disclosure that the power detection circuit **58** can be integrated with the electronic controller **56**.

[0061] As seen in FIGS. **8** and **9**, in the illustrated embodiments, the portable lithium power module **50** further includes an electronic controller **60**. The electronic controller **60** is configured to communicate with the electronic controller **56** of the snowmobile **10**. Here, the electronic controller **60** communicates with the electronic controller **56** using power-line communication. DC-BUS is one of several protocols for power-line communication. Alternatively, one or more data connections can be provided between the electronic controller **56** and the electronic controller **60** to allow for communication therebetwen. Likewise, the electronic controller **56** and the electronic controller **60** can communicate with other electrical components of the snowmobile **10** using one or more data connections.

[0062] The electronic controller **60** is preferably a microcomputer that includes one or more processors and one or more computer storage devices (i.e., computer memory devices). For example, the electronic controller **60** includes a processor **62** and memory **64** as illustrated in FIG. **9**. The electronic controller **60** is formed of one or more semiconductor chips that are mounted on one or more circuit boards. Although illustrated as separate elements, those of skill in the art will recognize that the processor **62** and the memory **64** can be mounted on separate circuit boards. The processor **62** can be a conventional central processing unit (CPU) or any other type of device, or multiple devices, capable of manipulating or processing information such as program code stored in the memory **64** in order to allow the electronic controller **60** to perform the functionality described herein. Likewise, a timer module can be provided as a function of the processor, and can function to accurately measure the passage of time. Processors, memory and timers are extremely well known in the computer field and often used in the snowmobile field, therefore no further description will be provided.

[0063] Here, optionally, the electronic controller **60** further includes a voltage sensor **66**, a current sensor **68**, a temperature sensor **70** and a charging circuit **72**. In this way, a variety of devices can be connected to the portable lithium power module **50** for receiving electrical power and/or for communicating with the electronic controller **60**. The voltage sensor **66** is configured to detect the voltage of the lithium battery **52**, while the current sensor **68** is configured to detect the current of the lithium battery **52**. The voltage sensor **66** can be a voltage detection circuit that measures voltage between two points of the electrical circuit between the lithium battery **52** and the starter solenoid **54***b*. The voltage sensor **66** generates a voltage signal that is proportional to that voltage, and sends the voltage signal to the processor **62** which stores a voltage value in the memory **64**. The current sensor **68** can be a current detection circuit that detects electric current in the electrical circuit between the lithium battery **52** and the starter solenoid **54***b*. The current sensor **68** generates a current signal that is proportional to that current, and sends the current signal to the processor **62** which stores a current value in the memory **64**. The temperature sensor **70** is configured to detect the temperature of the lithium battery **52**. The temperature sensor **70** generates a temperature signal that is indicative of the current temperature of the lithium battery **52**. The temperature signal, the voltage signal and/or the current signal can be used by the processor **62** to calculate a battery level or state of charge (SoC) of the lithium battery **52** using conventional techniques. Charging circuits are extremely well known in the computer field, therefore no further description will be provided of the charging circuit **72**. The charging circuit **72** is preferably configured to charge the lithium battery **52** using electrical power generated by the alternator and electrical power from an external source (e.g., a residential power supply).

[0064] As mentioned above, an electric battery heater (not shown) can be provided to heat the lithium battery **52** in very cold conditions when the engine **32** is not running. However, when the engine is running, air heated by the engine can be used to keep the lithium battery **52** warm. For example, the battery receiving port or socket of the battery support **40***a* is at least partially disposed in one or both of the ducts D**1** and D**2** so that the warm air from the engine compartment warms the lithium battery **52**. Here, both of the ducts D**1** and D**2** are configured to direct air to the lithium battery **52**. However, depending on the outside temperature where the snowmobile **10** is being used, the lithium battery **52** may become overheated if warm air from the engine compartment is continuously flow to the lithium battery **52**. Thus, in one embodiment, to regulate the airflow to the lithium battery **52** from the engine compartment, the snowmobile **10** further comprises two air dampers AD**1** and AD**2**, two electric damper motors M**1** and M**2** and an outside temperature sensor TS. Alternatively, any other mechanical thermostat (e.g., bimetal thermostats, wax pellet thermostats, and pneumatic thermostats) which both sense and control temperature can be used as needed and/or desired. The air dampers AD**1** and AD**2** are either disposed in the ducts D**1** and D**2** or located at the vent outlets V**1** and V**2** for regulating the air flow in the ducts D**1** and D**2**. In particular, the electronic controller **56** selectively controls the damper motors M**1** and M**2** to operate the air dampers AD**1** and AD**2**. Preferably, the air dampers AD**1** and AD**2** are thermostatically controlled between a first position increasing airflow to the lithium battery **52** and a second position decreasing airflow to the lithium battery **52**. More specifically, the electronic controller **56** operates one or both of the damper motors M**1** and M**2** to selectively increases airflow to the lithium battery **52** and decrease airflow to the lithium battery **52** based on a detected temperature. The detected temperature can be a detected temperature of the lithium battery **52** or an outside air temperature detected by the temperature sensor TS. By closing the air dampers AD**1** and AD**2**, the heated air from the engine compartment would stop flowing towards the lithium battery **52**. The temperature sensor TS can also be used to control the electric battery heater (not shown) so that the electric battery heater is turned on in very cold conditions when the engine **32** is not running.

[0065] Optionally, as seen in FIG. **8**, the lithium power module **50** further comprises a display **80** for displaying various battery related information, one or more user inputs **81**, one or more I/O interfaces **82** and the I/O ports **83**. Here, as seen in FIGS. **6** and **7**, the lithium power module **50** includes two USB ports P**1** and P**2** as one example of the I/O ports **83** and a push button P**4** for setting modes of operation as one example of the user input **81**. Of course, it will be

apparent from this disclosure that the lithium power module **50** can include other types of the I/O ports and user inputs as needed and/or desired. Also, optional, as seen in FIG. **8**, the lithium power module **50** further comprises a GPS Navigation system **84** for providing navigation information, a plurality of prestored applications **85** stored in the memory **64**, a transceiver **86** for receiving and transmitting wireless signals such as remote assistance, a kill switch **88** and a flashlight **90**. Of course, it will be apparent from this disclosure that the lithium power module **50** does not need to include all of the features. Rather, the lithium power module **50** can include some or none of these features, or can include other features not mentioned herein. For example, the lithium power module **50** can be configured to include a headlight for the snowmobile **10** when the lithium power module **50** is installed on the snowmobile **10**. This headlight would also work as a flashlight when the lithium power module **50** is removed from the snowmobile **10**.

[0066] As seen in FIG. **8**, in the illustrated embodiments, the portable lithium power module **50** further one or more user inputs **81**, one or more I/O interfaces **82** and one or more I/O ports **83**. Charging circuits, user inputs, I/O interfaces and I/O ports are extremely well known in the computer field, therefore no further description will be provided. In this way, a variety of devices can be connected to the portable lithium power module **50** for receiving electrical power and/or for communicating with the electronic controller **60**.

[0067] In the illustrated embodiments, as seen in FIG. **6**, the portable lithium power module **50** has a tether connection port P**3** for operating the kill switch **88** and a standard three prong electrical outlet P**5**. Thus, the lithium power module **50** includes a pluggable power port, namely, the USB ports P**1** and P**2** and the electrical outlet P**5**. The portable lithium power module **50** can be recharged by plugging in a charger into one of the USB ports and then plugging the charger into a household electrical outlet, similar to charging a cell phone. Thus, the USB ports are power and signal outlets. Preferably, the portable lithium power module **50** can also be charged from the snowmobile stator via the charging circuit **72**.

[0068] The USB ports P**1** and P**2** can be used to plug other devices into the portable lithium power module **50** for either receiving power from the lithium battery **52** or communicating with the electronic controller **60**. Examples of other devices include, but not limited to, smart phones, tablets, laptops, heated riding gear, etc.

[0069] The tether connection port P**3** is configured to connect a tether line **92** to the portable lithium power module **50**. Specifically, one end of the tether line **92** has a rider attachment **92***a* (e.g., a wrist strap) that is attached to the rider, while the other end of the tether line **92** is plugged into the tether connection port P**3**. When the tether line **92** is plugged into the tether connection port P**3**, the kill switch **88** is closed and the electronic controller **60** permits the engine **32** of the snowmobile **10** to continue to run. However, when the tether line **92** is unplugged from the tether connection port P**3**, the kill switch **88** is open and the electronic controller **60** shuts off the engine **32** of the snowmobile **10**. In this way, if the rider falls off the snowmobile **10**, then the electronic controller **60** will shut off the engine **32**.

[0070] The electrical outlet P**5** is configured to connect higher voltage devices to the lithium battery **52**. For examples, higher voltage devices include, but not limited to, chainsaws, power tools, heated jacket, ice auger, sonar flasher system, blue tooth communication devices, etc. Also, when the portable lithium power module **50** is removed from the snowmobile **10**, the second electrical connection EC**2** of the portable lithium power module **50** can be connected to a jumper cable for jump starting other vehicles.

[0071] As seen in FIG. **10**, the processor **62** of the electronic controller **60** executes a control process for reserving a predetermined amount of battery level to start the engine **32** of the snowmobile. The control process of the flow chart in FIG. **10** is executed at predetermined intervals after the portable lithium power module **50** is plugged into the battery support **40***a* and the first and second electrical connections EC**1** and EC**2** are engaged.

[0072] In step S**10** of the control process, the processor **62** monitors the battery level (SoC) of the lithium battery **52** by receiving and storing the voltage value and/or the current value in the memory **64**. Next, the control process proceeds to step S**11**.

[0073] In step S**11** of the control process, the processor **62** determines the battery level (SoC) of the lithium battery **52**. The battery level (SoC) of the lithium battery **52** can also be referred to as the remaining capacity of the lithium battery **52**. The battery level (SoC) of the lithium battery **52** can be determined in many ways. For example, the remaining capacity of the lithium battery **52** can be estimated using the voltage values from the voltage sensor **66** and the current values from the current sensor **68**. Preferably, the estimated battery level (SoC) of the lithium battery **52** is also base on a temperature reading using the temperature sensor TS provided on the snowmobile or the temperature sensor **70** in the portable lithium power module **50**. Since estimating a battery level (SoC) of a lithium battery is well known, a detailed discussion of the many different estimation methods will not present herein for the sake of brevity. After estimating the battery level (SoC) of the lithium battery **52**, the control process proceeds to step S**12**.

[0074] In step S**12** of the control process, the processor **62** compares the battery level (SoC) of the lithium battery **52** with a predetermined battery reserve threshold stored in the memory **64**. The predetermined battery reserve threshold can be adjusted by the rider as needed and/or desired from a default or factory threshold setting. If the battery level (SoC) of the lithium battery **52** is above the predetermined battery reserve threshold, then the control process proceeds back to step S**10**. On the other hand, if the battery level (SoC) of the lithium battery **52** is below the predetermined battery reserve threshold, then the control process proceeds to step S**13**.

[0075] In step S**13** of the control process, the processor **62** implements a power saving mode in which selected various applications and/or features that consume electrical power from the lithium battery **52** will be shut down and/or disabled until the lithium battery **52** is recharged above the predetermined battery reserve threshold. After entering the power saving mode, the control process proceeds to step S**14**.

[0076] In step S**14** of the control process, the processor **62** notifies the rider of the lithium battery **52** falling below the predetermined battery reserve threshold. The low battery notification can be accomplished in one or more ways. For example, a low battery notification can be displayed on the display **48***a*. Alternatively, a low battery notification can be sent to the rider's phone, which can ring or vibrate as well

as display the low battery notification. After the low battery notification has been sent, the control process ends until the lithium battery **52** is recharged above the predetermined battery reserve threshold.

[0077] Referring now to FIGS. **11** and **12**, an alternative placement of the lithium power module **50** is illustrated. Here, the seat panel **36** is provide a battery support **36***b* that defines a battery receiving port located inside the storage area **36***a*. The battery receiving port of the battery support **36***b* is configured to toollessly connect and disconnect the lithium power module **50** to the electrical system of the snowmobile **10**. In this way, the lithium power module **50** can be locked within the storage area **36***a* while electrically connected to the electrical system of the snowmobile **10**. In particular, the battery support **36***b* also includes an electrical connection, which is electrically connected to the electrical system of the snowmobile **10**. A lid **36***c* is pivotally attached to the battery support **36***b* to cover the electrical connection inside the recess defined by the battery support **36***b*. The electrical connection inside the battery support **36***b* is the same as the first electrical connection EC**1** shown in FIG. **5**. Thus, the battery support **36***b* receives the lithium power module **50** in the same way as the battery support **40***a*. Alternatively, the stationary seat **14***b* can be provided with a battery support **36***b*' that defines a battery receiving port for receiving the lithium power module **50**. Here, like the other battery supports, a lid **36***c*' is pivotally mounted to the battery support **36***b*'. Thus, the lithium power module **50** can be disposed in either the saddle seat section **12***b* of the vehicle body **12** or the saddle seat **14** (e.g., the stationary seat **14***b*).

[0078] Referring now to FIGS. **13** and **14**, an alternative placement of the lithium power module **50** is illustrated. Here, the lithium power module **50** is disposed in a vehicle heat generated area HA of the snowmobile **10**. In this way, the lithium power module **50** can be warmed by the heat generated from the engine **32** during the operation of the snowmobile **10**. For example, in this embodiment, the vehicle heat generated area HA includes an engine heat generated area. More specifically, in this embodiment, the vehicle heat generated area HA corresponds to the engine compartment defined by the hull **42** and a front engine cover **44**'.

[0079] The vehicle body **12** has a longitudinal center plane CP dividing the snowmobile **10** into first and second lateral sides S**1** and S**2**. The engine **32** has an exhaust system **35** that is primarily disposed on one of the first and second lateral sides S**1** and S**2**. The exhaust system **35** includes a header, a muffler, a mid-pipe (optionally), and a turbo charger (optionally). Preferably, the lithium power module **50** is disposed on the other of the first and second lateral sides S**1** and S**2** adjacent to the engine **32**. Here, the exhaust system **35** is disposed primarily on the first lateral side S**1** of the snowmobile **10**, which corresponds to the right side of the snowmobile **10** as viewed from a rider seated in a normal riding position on the saddle seat **14**. Thus, the lithium power module **50** is disposed on the second lateral side S**2** of the snowmobile **10**, which corresponds to the left side of the snowmobile **10** as viewed from a rider seated in a normal riding position on the saddle seat **14**. However, the lithium power module **50** can be disposed on the first lateral side S**1** of the snowmobile **10** when the exhaust system **35** is disposed on the second lateral side S**2** of the snowmobile **10**. In other words, based on the snowmobile design, the exhaust system **35** and the lithium power module **50** are disposed on opposite sides of the longitudinal center plane CP of the snowmobile **10**. In this way, the lithium power module **50** is kept warm by the heat from the engine **32** while the engine **32** is running. However, the lithium power module **50** is protected from overheating due to the heat from the exhaust system **35**.

[0080] Here, in this embodiment, the hull **42** is provided with a battery support **92** that defines a battery receiving port located inside the vehicle heat generated area HA. The front engine cover **44**' is provided with a lid **94** that covers the battery receiving port of the battery support **92**. The battery receiving port formed by the battery support **92** is configured to toollessly connect and disconnect the lithium power module **50** to the electrical system of the snowmobile **10**. In particular, the battery support **92** also includes the first electrical connection EC**1** (see FIGS. **5** and **8**), which is electrically connected to the electrical system of the snowmobile **10**. The lid **94** is pivotally attached to the front engine cover **44**' to cover the electrical connection inside the recess defined by the battery support **92**. The first electrical connection EC**1** inside the battery support **92** is the same as the first electrical connection EC shown in FIGS. **5** and **8**. Thus, the battery support **92** receives the lithium power module **50** in the same way as the battery support **40***a*. Here, the battery receiving port of the battery support **92** is deeper than the other battery supports such that the lithium power module **50** is completely covered with the lid **94** while the first and second electrical connections are connected.

[0081] Referring now to FIGS. **15** to **16**, an alternative placement of the lithium power module **50** is illustrated. Here, the lithium power module **50** is disposed in the vehicle heat generated area HA of the snowmobile **10** so that the lithium power module **50** can be warmed by the heat generated from the engine **32** during the operation of the snowmobile **10**. However, in this position, the lithium battery **52** in the lithium power module **50** may become overheated depending on the weather conditions.

[0082] In this embodiment, the front engine cover **44"** is provided with a battery support **102** that defines a battery receiving port located inside the vehicle heat generated area HA. The front engine cover **44"** is provided with a lid **104** that covers the battery receiving port of the battery support **102** when the lithium power module **50** is not installed. Here, when the lithium power module **50** is installed in the battery receiving port of battery support **102**, about one-quarter of the lithium power module **50** is located above the front engine cover **44"**. The same as the other embodiments, the battery receiving port formed by the battery support **102** is configured to toollessly connect and disconnect the lithium power module **50** to the electrical system of the snowmobile **10**.

[0083] To regulate the airflow against the lithium power module **50**, the front engine cover **44"** is provided with at least one air damper **106**. Here, the front engine cover **44** has three air dampers **106** that can be individually controlled by the electronic controller **56** operating electric damper motors. Preferably, the air dampers **106** are automatically controlled based on a detected temperature of either the lithium battery **52** or an outside air temperature detected by the temperature sensor TS. Alternatively, any other mechanical thermostat (e.g., bimetal thermostats, wax pellet thermostats, and pneumatic thermostats) which both sense and control temperature can be used as needed and/or desired.

The air dampers **106** are movable through an infinite number of positions. As seen in FIG. **16**, the air dampers **106** are in a retracted position to permit air to flow towards the lithium battery. As seen in FIG. **17**, the air dampers **106** are in an extended position to block air from flowing towards the lithium battery **52** of the lithium power module **50**. Thus, in this situation, the air flow towards the lithium power module **50** is regulated to maintain the temperature of the lithium battery **52** within a predetermined temperature range.

[0084] Referring now to FIGS. **18** to **21**, two methods of driving the drive unit **18** in reverse using the starter motor **54***a* will now be discussed. The functional block diagram of the snowmobile **10** illustrate in FIGS. **18** and **19** applies to all of the embodiments disclosed herein. Basically, the snowmobile **10** is provided with a reversing switch SW**2**. While the reversing switch SW**2** is illustrated as being a separate and apart from the starter switch SW**1**, it will be apparent from this disclosure that the reversing switch SW**2** and the starter switch SW**1** can be a single integrated one user operated switch. For example, a single knob or lever can be provided in which movement of the knob or lever in a first direction starts the engine **32**, while movement of the knob or lever in a second direction (opposite to the first direction) drives the track belt **30** in the reverse direction using the starter motor **54***a*. While the lithium battery **52** of the lithium power module **50** is used for supplying the electrical power to the starter motor **54***a* for driving the track belt **30** in the reverse direction, a standard lead acid battery can be used. The lead acid battery can be provided on the snowmobile **10** in a conventional manner. Also, the engine **32** does not necessarily need to be running during the second vehicle condition. However, it may be advantageous for the engine **32** to be running so the battery power to the starter motor **54***a* can be supplemented with electrical power from the alternator, which is operated by the engine **32** in a conventional manner. The alternator also is used to charge the lithium battery **52** when the engine **32** is running.

[0085] In the case of the functional block diagram of the snowmobile **10** illustrate in FIG. **18**, the rider operates the starter switch SW**1** to start the engine **32** with the snowmobile **10** being in a first vehicle condition (e.g., the engine stopped). With the engine **32** running at idle, the engine **32** does not transmit power through the CVT so that the drive unit **18** is not being driven by the engine **32**. Basically, the CVT of the snowmobile **10** acts as a clutch. In this way, the CVT is driven by the engine **32**, but the CVT does not transmit significant amounts of power to the drive unit **18** when the engine **32** is at low rpm (idle). Also, with the engine **32** running and the drive unit **18** not being driven by the engine **32**, a first clutch CL prevents power from being transmitted between the electric starter **54** and the drive unit **18**, and a second clutch CL**2** (one-way clutch) prevents the starter motor **54***a* from being rotated by the operation of the engine **32**. In this way, so long as the engine **32** is running, the power of the electric starter **54** will not be transmitted through the engine **32** and the power of the engine **32** will not be transmitted to the electric starter **54**. While the second clutch CL**2** is shown as a separate unit, typically, the second clutch CL**2** is an integrated part of the engine **32**.

[0086] Now, when a rider wants to drive the snowmobile **10** in reverse with the snowmobile **10** being in a second vehicle condition (e.g., the engine running and CVT not transmitting power from the engine **32**), then the rider operates the reversing switch SW**2** to operate the electric starter **54** to drive the drive unit **18** in reverse. In other words, the rotation of an output shaft of the starter motor **54***a* is not transmitted through the engine **32** but is transmitted to the drive unit **18** to drive the drive unit **18** in reverse. A mechanical transmission OT (e.g., one or more of a gear train, a chain drive, a belt drive, etc.) operatively connects the output shaft of the starter motor **54***a* to the drive unit **18** such that the drive unit **18** is operated to turn the track belt **30** in the reverse direction. In this way, rider can back up the snowmobile **10** using the starter motor **54***a* to turn the track belt **30** in the reverse direction. By varying the operation of the throttle via the user input L or some other suitable user input, the rider can regulate the power to the track belt **30**. If the user input L (i.e., the throttle lever) is used for regulating the power to the track belt **30**, then the electronic controller **56** will need to limit the rpm of the engine **32** while in the second vehicle condition (the engine running and CVT not transmitting power from the engine **32**). The rider then operates the reversing switch SW**2** for a second time to resume a conventional operating mode. In this way, operation of the user input L causes the track belt **30** to move to drive the snowmobile **10** in a forward direction.

[0087] In the case of the functional block diagram of the snowmobile **10** illustrate in FIG. **19**, a control circuit CIR (electrical circuit) is provided for changing the polarity of electricity to the electric starter **54**. By reversing the polarity of the electricity from the lithium battery **52** to the electric starter **54**, the output shaft of the starter motor **54***a* is changed from rotating in a first rotational direction to start the engine **32** to rotating in a second rotational direction to drive the drive unit **18** in reverse. The control circuit CIR is controlled by the electronic controller **56** in response to operation of the reversing switch SW**2**. As seen in FIG. **20**, the control circuit CIR (the electrical circuit) has a first current flow path from the lithium battery **52** to a first terminal of the electric starter **54** to establish a first polarity of electricity to the electric starter **54** to operate the electric starter **54** in a first direction. As seen in FIG. **21**, the control circuit CIR (the electrical circuit) has a second current flow path from the lithium battery **52** to a second terminal of the electric starter **54** to establish a second polarity of electricity to the electric starter **54** that is opposite the first polarity to operate the electric starter **54** in a second direction. The electronic controller **56** connects the lithium battery **52** to the first terminal of the electric starter **54** to start the engine **32** by establishing the first current flow path when the reversing switch SW**2** has not been operated, and selectively connects the lithium battery **52** to the second terminal of the electric starter **54** to drive the drive unit **18** in a reverse direction by establishing the second current flow path in response to operation of the reversing switch SW**2**. Of course, other electromechanical arrangements can be used to drive the snowmobile **10** in reverse in which the first clutch CL**1** is preferably a one way clutch, but not limited to a one way clutch.

[0088] Referring now to FIGS. **22** and **23**, the snowmobile **10** has been modified to have a modified dash panel **140**A with a pluggable power and signal port **110** that includes the first electrical connection EC**1** (e.g., a female electrical receptacle having a pair of power contacts and a data contact). Here, a lithium power module **150**A includes an electrical cord **112** that has a second electrical connection (e.g., a male electrical connector having a pair of power contacts and a data contact) formed at its free end. The other

end of electrical cord **112** is electrically connected to the lithium battery **52** of the lithium power module **150**A. The lithium power module **150**A is identical to the lithium power module **50** except that instead of using Power Line Communication to send data, a dedicated data line is provided. The electrical cord **112** is configured to be detachably connected to the pluggable power and signal port **110** without tools just like in the prior embodiments. Here, the rider can keep the lithium power module **150**A in a pocket so that the lithium power module **50** remains warm while riding. Also, the electrical cord **112** in conjunction with the power detection circuit **58** can shut off the engine **32** in the event the rider falls off the snowmobile **10**. As mentioned above, the power detection circuit **58** is electrically connected to an electrical path between the lithium battery **52** and the starter solenoid **54***b*. The electronic controller **56** is operatively coupled to the power detection circuit **58** and the engine **32**. The electronic controller **56** is programmed to shut off the engine **32** in response to the power detection circuit **58** detecting the lithium battery **52** is no longer connected to the electrical system of the snowmobile **10**. The power detection circuit **58** acts as a kill switch in the situation in which the electrical cord **112** is disconnected from the pluggable power and signal port **110**.

[0089] Referring now to FIGS. **24** to **28**, the snowmobile **10** has been modified to have a modified dash panel **140**B with a display and battery support **140***a* for receiving a portable lithium power module **1501** that includes a display **180**. Here, the portable lithium power module **150**B is plugged into the display and battery support **140***a* of the modified dash panel **140**B. Thus, like all of the other embodiments, the portable lithium power module **150**B has a lithium battery is that is configured to be toollessly connected and disconnected to the electrical system of the snowmobile **10**.

[0090] Basically, the portable lithium power module **150**B is functionally identical to the portable lithium power module **50** except that (1) a dedicated data line is provided to send data instead of using Power Line Communication, (2) the flashlight **90** being omitted, and (3) the display **180** has been added that functions as the dash panel instrument display for the snowmobile **10**. Thus, the various operating conditions (vehicle speed, engine rpm's, etc.) of the snowmobile **10** and navigational information are displayed on the display **180** of the portable lithium power module **150**B. Here, the display and battery support **140***a* includes the first electrical connection EC**1** (e.g., a male electrical receptacle having a pair of power contacts MC**1** and MC**2** and a data contact DC**1**). Also, here, the lithium power module **150**B includes the second electrical connection EC**2** (e.g., a female electrical connector having a pair of power contacts FC**1** and FC**2** and a data contact DC**2**).

[0091] Also, here, the housing of the portable lithium power module **150**B has recesses **151** (only one shown) on opposite side edges that are engaged by spring biased detents **141** when the portable lithium power module **150**B is disposed in the display and battery receiving port defined by the display and battery support **140***a*. In this way, the portable lithium power module **150**B can be removably retained in the modified dash panel **140**B.

[0092] In understanding the scope of the present invention, the term "comprising" and its derivatives, as used herein, are intended to be open ended terms that specify the presence of the stated features, elements, components, groups, integers, and/or steps, but do not exclude the presence of other unstated features, elements, components, groups, integers and/or steps. The foregoing also applies to words having similar meanings such as the terms, "including", "having" and their derivatives. Thus, as used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. Also, the terms "part," "section," "portion," "member" or "element" when used in the singular can have the dual meaning of a single part or a plurality of parts. Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which illustrative embodiments of the inventive concepts belong. It will be further understood that terms, such as those defined in commonly-used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0093] It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled"" to another element, there are no intervening elements present. As used herein the term "and/or" includes any and all combinations of one or more of the associated listed items. Additionally, similar words used to describe the relationship between elements or layers should be interpreted in a like fashion (e.g., "between" versus "directly between", "above" versus "directly above", "below" versus "directly below", "adjacent" versus "directly adjacent," "on" versus "directly on"). Thus, components that are shown directly connected or contacting each other can have intermediate structures disposed between them unless specified otherwise.

[0094] The phrase "at least one of" as used in this disclosure means "one or more" of a desired choice. For one example, the phrase "at least one of" as used in this disclosure means "only one single choice" or "both of two choices" if the number of its choices is two. For another example, the phrase "at least one of" as used in this disclosure means "only one single choice" or "any combination of equal to or more than two choices" if the number of its choices is equal to or more than three.

[0095] Also, it will be understood that, although the terms "first", "second", etc. may be used herein to describe various elements, components, regions, positions and/or sections, these elements, components, regions, positions and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer, position or section from another element, component, region, layer, position or section. Thus, a first element, component, region, position or section discussed above could be termed a second element, component, region, position or section without departing from the teachings of illustrative embodiments.

[0096] Spatially relative terms, such as "forward", "rearward", "above", "below", "beneath", "downward" "vertical", "horizontal", and "transverse" as well as any other similar spatial terms may be used herein for the ease of description to describe one element or feature's relationship to another element(s) or feature(s) of the above embodi-

ments. These terms, as utilized to describe the present invention should be interpreted relative to a snowmobile on a flat horizontal surface and with to a direction in which a rider looks straight when seated on a rider's seat in a straight forward driving direction. Thus, front, rear, left and right shown in the description of the preferred embodiments indicate the front, rear, left and right, respectively, when viewed from a vehicle occupant seated on a seat. The terms of degree such as "substantially", "about" and "approximately" as used herein mean an amount of deviation of the modified term such that the end result is not significantly changed.

[0097] While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in this field from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. The structures and functions of one embodiment can be adopted in another embodiment. It is not necessary for all advantages to be present in a particular embodiment at the same time. Every feature which is unique from the prior art, alone or in combination with other features, also should be considered a separate description of further inventions by the applicant, including the structural and/or functional concepts embodied by such feature(s). Thus, the foregoing descriptions of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A snow vehicle comprising:
a vehicle body;
a saddle seat provided on the vehicle body;
at least one skis steerably arranged with respect to the vehicle body;
an engine attached to the vehicle body;
a starter motor operatively coupled to the engine and electrically coupled to a first electrical connection; and
a lithium power module having a lithium battery with a second electrical connection that is configured to be toollessly connected and disconnected to the first electrical connection.

2. The snow vehicle according to claim **1**, wherein
the lithium power module is disposed in a vehicle heat generated area of the snow vehicle.

3. The snow vehicle according to claim **2**, wherein
the vehicle heat generated area includes an engine heat generated area.

4. The snow vehicle according to claim **2**, wherein
the vehicle heat generated area includes an electric heat generated area.

5. The snow vehicle according to claim **1**, wherein
the lithium power module is partially exteriorly disposed and partially interiorly disposed while the first and second electrical connections are connected.

6. The snow vehicle according to claim **1**, wherein
the lithium power module is covered with a lid while the first and second electrical connections are connected.

7. The snow vehicle according to claim **1**, wherein
one of the first and second electrical connections includes an electrical cord that is configured to be detachably connected to the other of the first and second electrical connections.

8. The snow vehicle according to claim **7**, further comprising
a power detection circuit electrically connected to the one of the first and second electrical connections, and
an electronic controller operatively coupled to the power detection circuit and the engine, the electronic controller shutting off the engine in response to the power detection circuit detecting the first and second electrical connections being disconnected.

9. The snow vehicle according to claim **1**, wherein
the lithium power module includes a pluggable power port.

10. The snow vehicle according to claim **1**, wherein
the vehicle body has a battery support, and the lithium power module is removably supported to the battery support while the first and second connections are electrically connected.

11. The snow vehicle according to claim **1**, wherein
the vehicle body has a longitudinal center plane dividing the snow vehicle into first and second lateral sides,
the engine has an exhaust system that is primarily disposed on one of the first and second lateral sides, and
the lithium power module is disposed on the other of the first and second lateral sides adjacent to the engine.

12. The snow vehicle according to claim **1**, further comprising
a windshield provided on the vehicle body, and
the lithium power module being disposed in an area defined between the windshield and the saddle seat.

13. The snow vehicle according to claim **1**, wherein
the saddle seat is provided on a saddle seat section of the vehicle body, and
the lithium power module being disposed in one of the saddle seat section of the vehicle body and the saddle seat.

14. The snow vehicle according to claim **2**, further comprising
at least one air damper configured to regulate airflow with respect to the lithium battery.

15. The snow vehicle according to claim **14**, wherein
the air damper is thermostatically controlled to selectively increases airflow to the lithium battery and decrease airflow to the lithium battery based on a detected temperature.

16. A snow vehicle comprising:
a vehicle body having a longitudinal center plane dividing the snow vehicle into first and second lateral sides;
a saddle seat provided on the vehicle body;
at least one skis steerably arranged with respect to the vehicle body;
an engine attached to the vehicle body and having an exhaust system that is primarily disposed on one of the first and second lateral sides; and
a lithium power module having a lithium battery and disposed on the other of the first and second lateral sides adjacent to the engine.

17. The snow vehicle according to claim **16**, wherein
the lithium power module is partially exteriorly disposed and partially interiorly disposed while the first and second electrical connections are connected.

18. The snow vehicle according to claim **16**, wherein
the lithium power module is covered with a lid while the first and second electrical connections are connected.

19. The snow vehicle according to claim **16**, wherein the lithium power module includes a pluggable power port.

20. The snow vehicle according to claim **16**, wherein the vehicle body has a battery support, and the lithium power module is removably supported to the battery support while the first and second connections are electrically connected.

21. A snow vehicle comprising:

a vehicle body;

a windshield provided on the vehicle body;

a saddle seat provided on the vehicle body;

at least one skis steerably arranged with respect to the vehicle body; and

a lithium power module having a lithium battery and disposed in an area defined between the windshield and the saddle seat.

22. The snow vehicle according to claim **21**, wherein the lithium power module includes a pluggable power port.

23. A snow vehicle comprising:

a vehicle body having a saddle seat section;

a saddle seat provided on the saddle seat section of the vehicle body;

at least one skis steerably arranged with respect to the vehicle body; and

a lithium power module having a lithium battery and disposed in one of the saddle seat section of the vehicle body and the saddle seat.

24. A snow vehicle comprising:

a vehicle body having a saddle seat section;

a saddle seat provided on the saddle seat section of the vehicle body;

at least one skis steerably arranged with respect to the vehicle body;

a drive unit support by the saddle seat section of the vehicle body, the drive unit including a track belt;

an engine attached to the vehicle body and operatively coupled to the drive unit to drive the drive unit in a forward direction;

a starter motor operatively coupled to the engine and operatively coupled to the drive unit;

a battery electrically coupled to the starter motor; and

at least one user operated switch that operates the starter motor to start the engine in a first vehicle condition, and that operates the starter motor to drive the drive unit in a reverse direction in a second vehicle condition.

* * * * *