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(54) **FUEL SYSTEMS FOR SNOWMOBILES**

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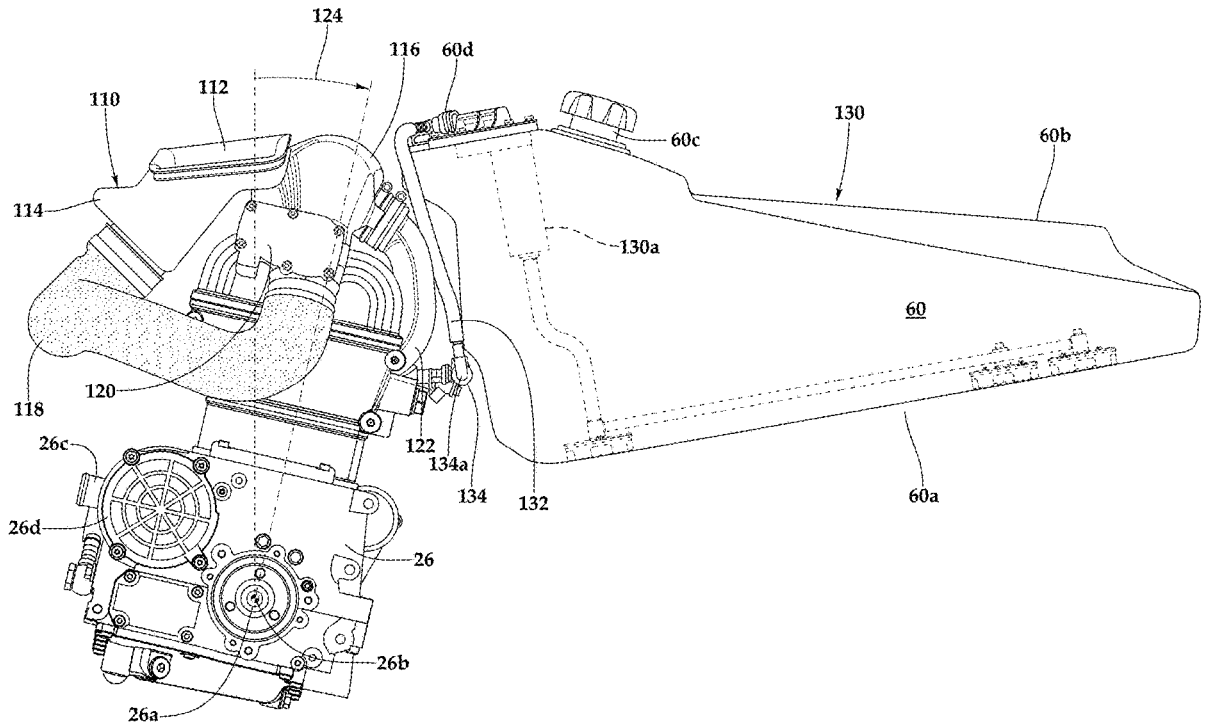
(57) **ABSTRACT**

A fuel system for a snowmobile having a chassis defining an engine bay and an engine positioned within the engine bay. The fuel system includes a fuel tank that is coupled to the chassis and is positioned aft of the engine. The fuel tank has a forward face that includes a lower contour and an upper contour. A fuel rail is in fluid communication with the fuel tank and the engine. The fuel rail is positioned between the engine and the lower contour of the forward face of the fuel tank.



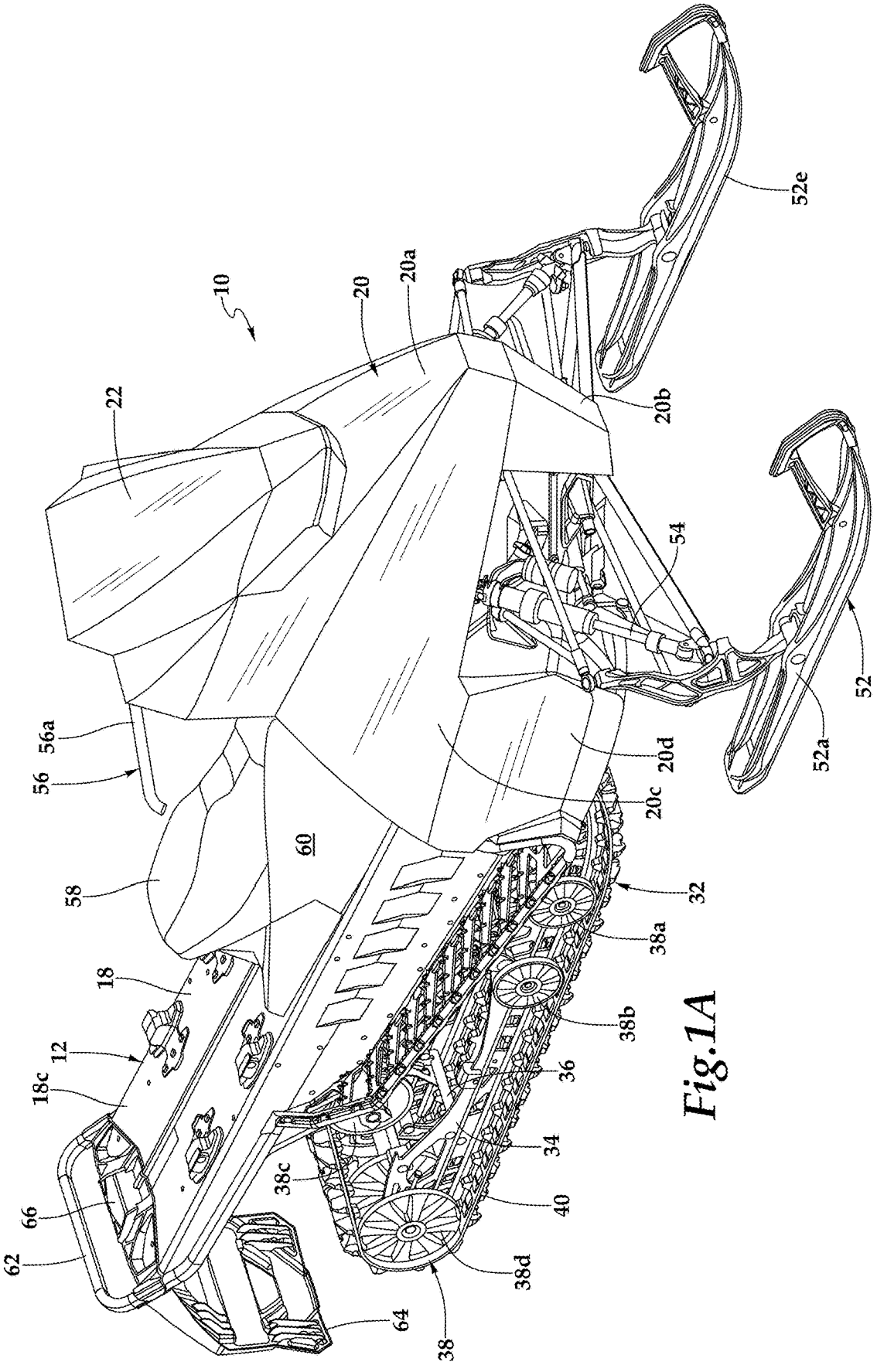

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Fig.1A

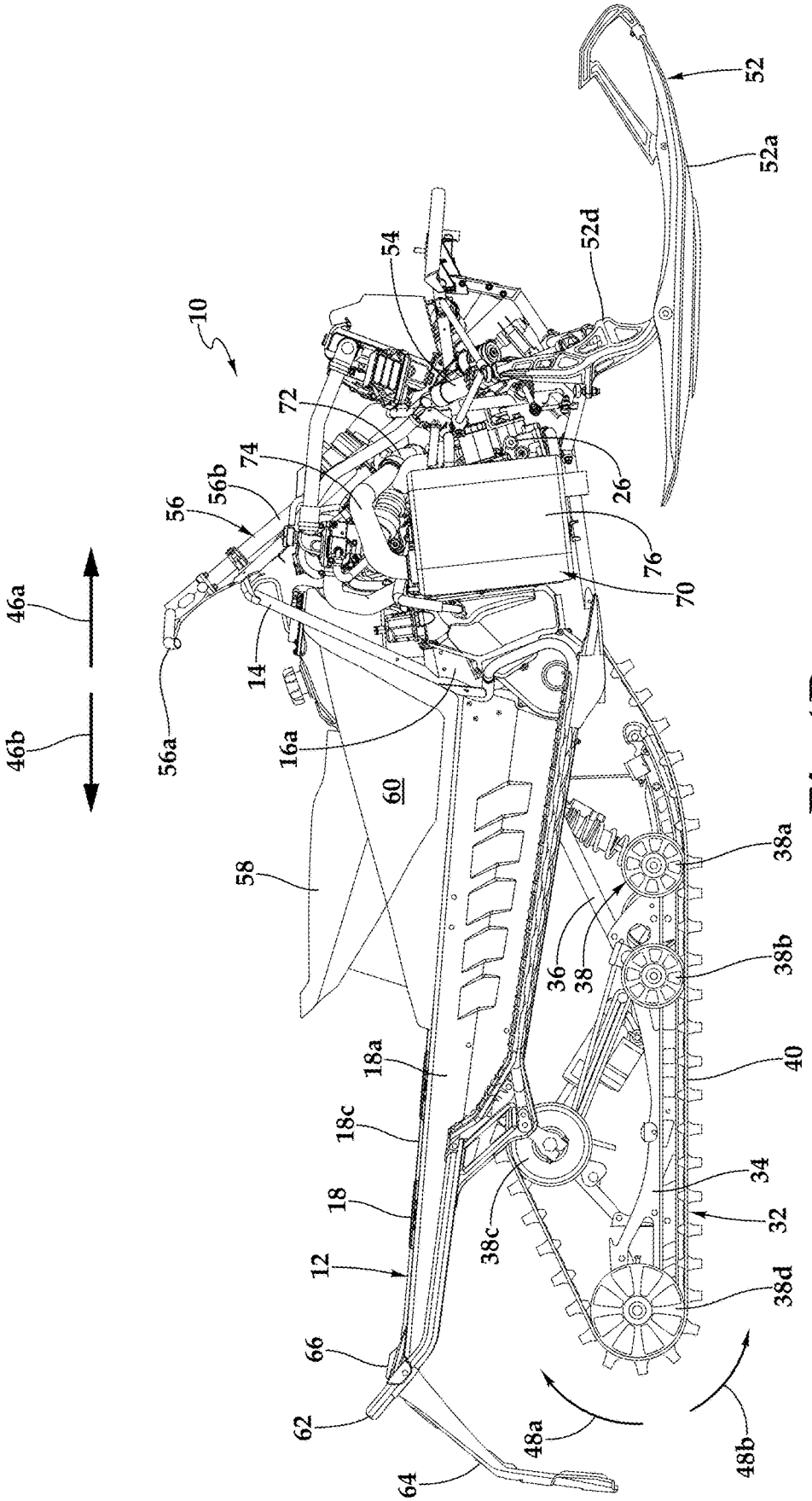
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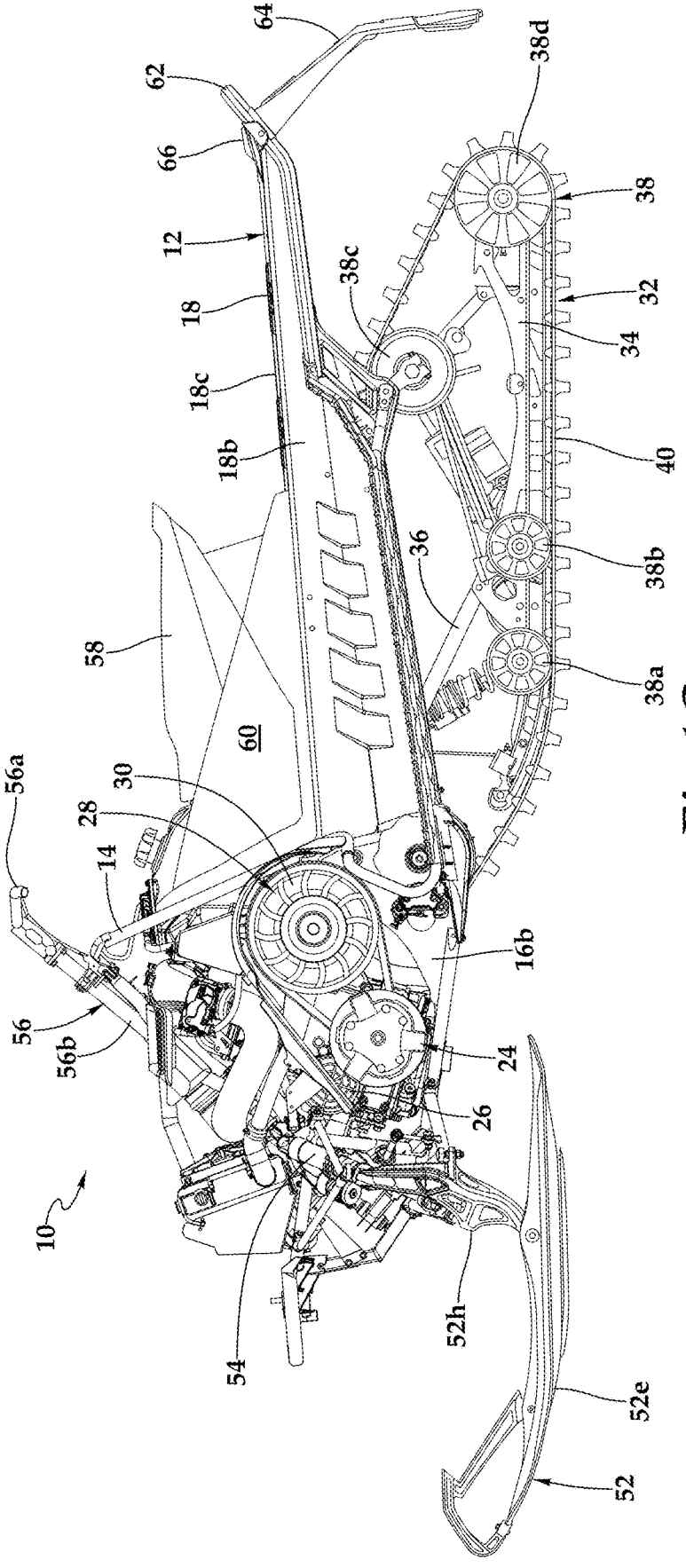
Fig.1B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52h
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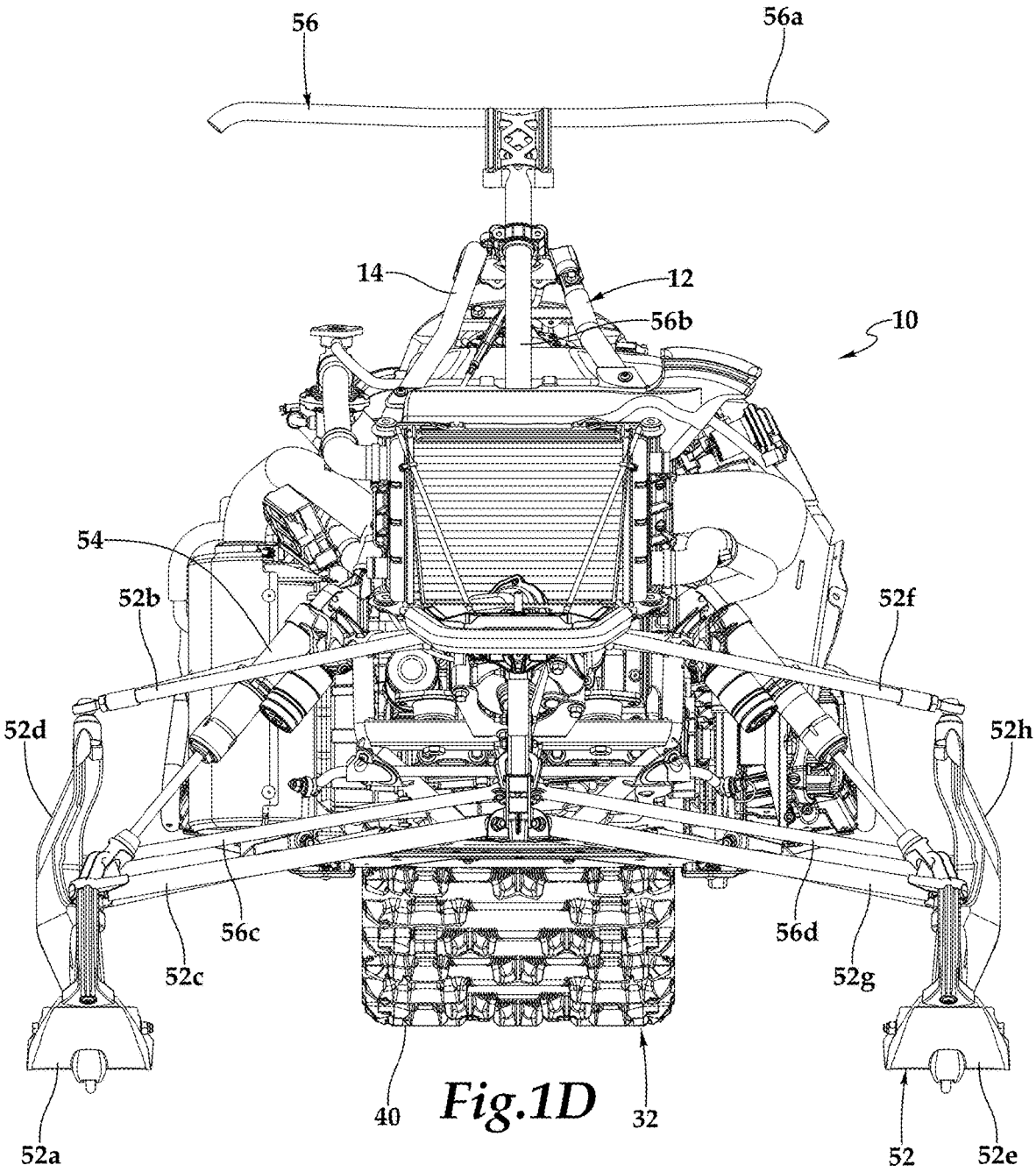
Fig.1C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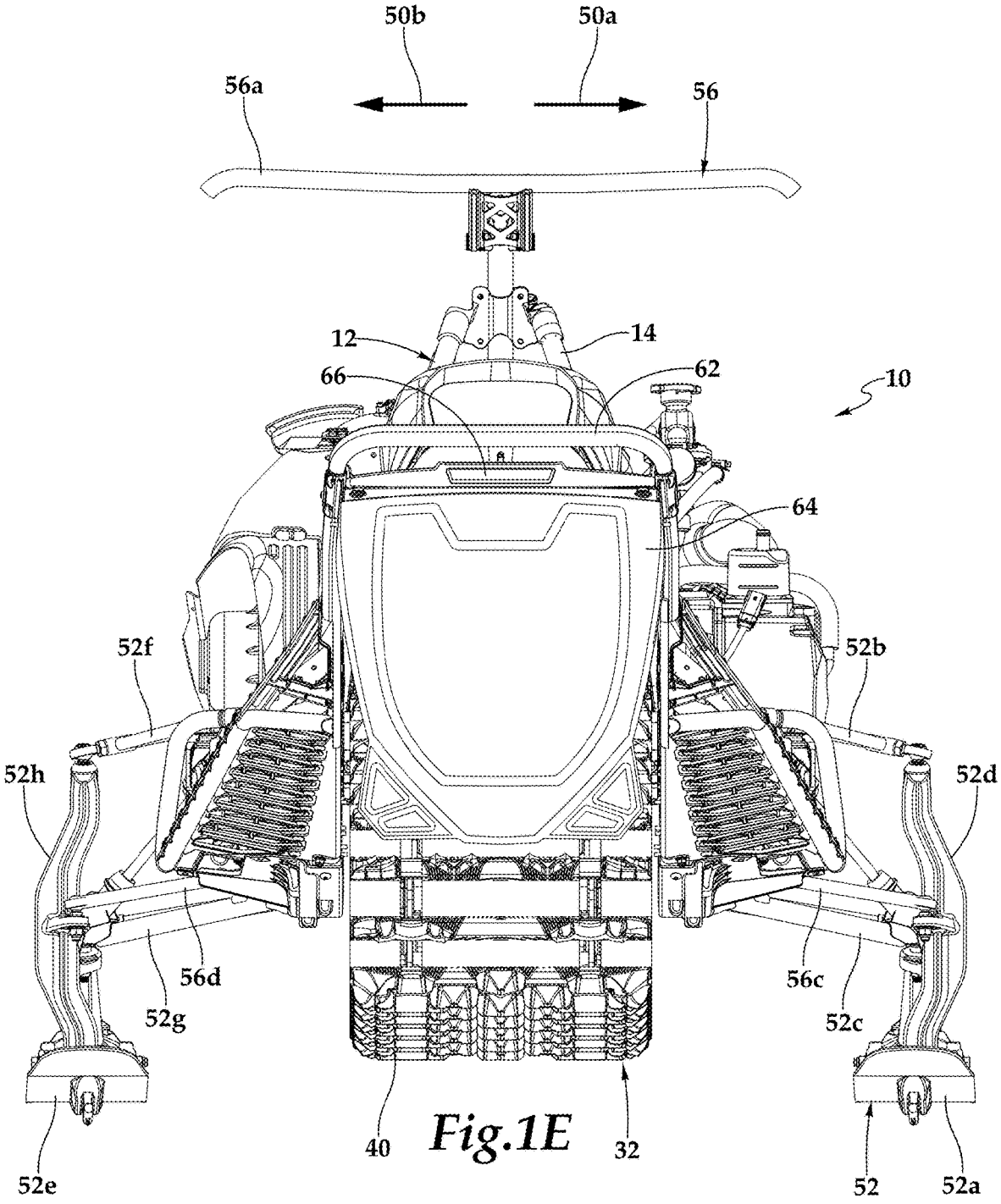
52e

Fig.1D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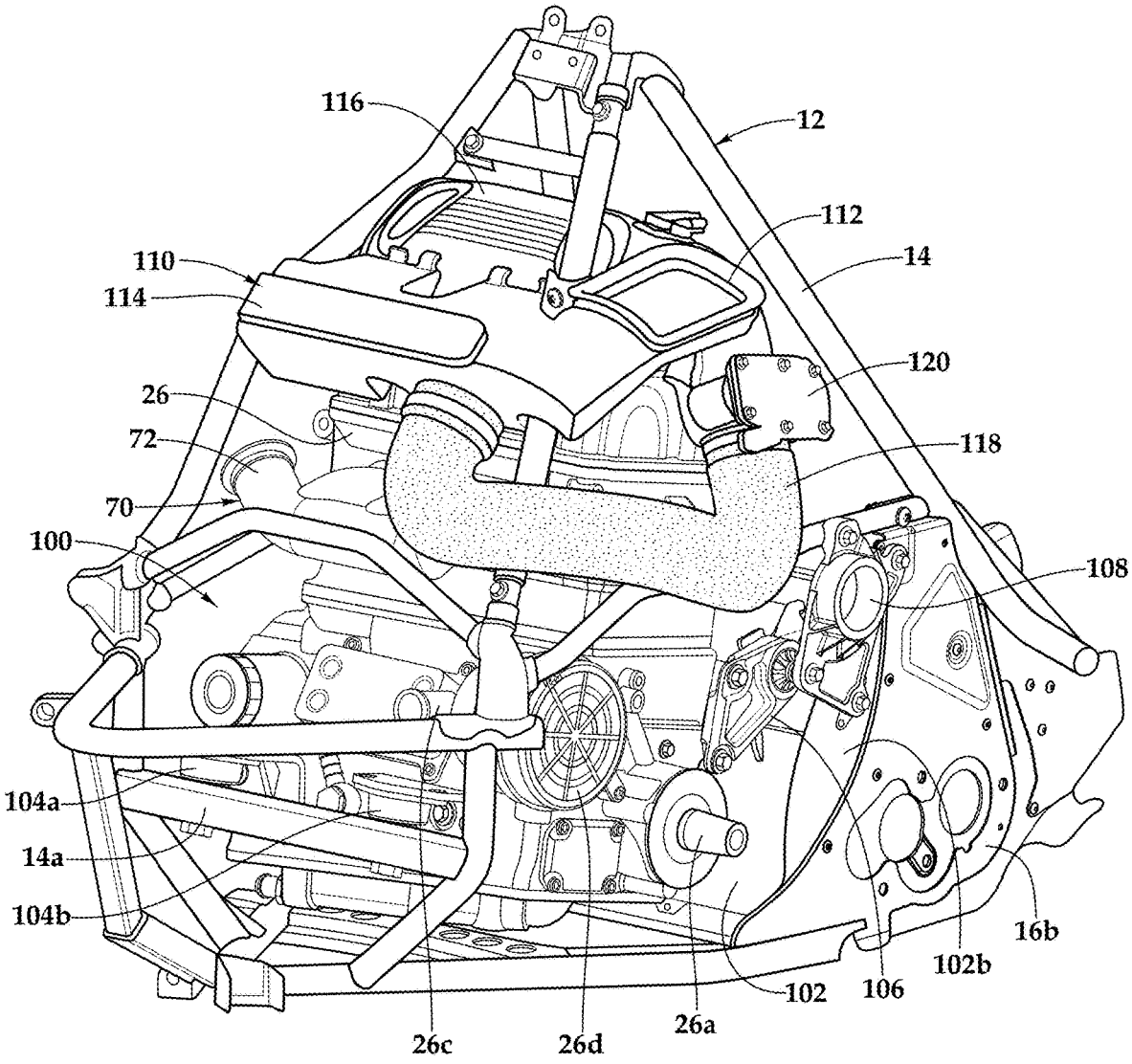
52a

Fig.1E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26c
26d

Fig.2

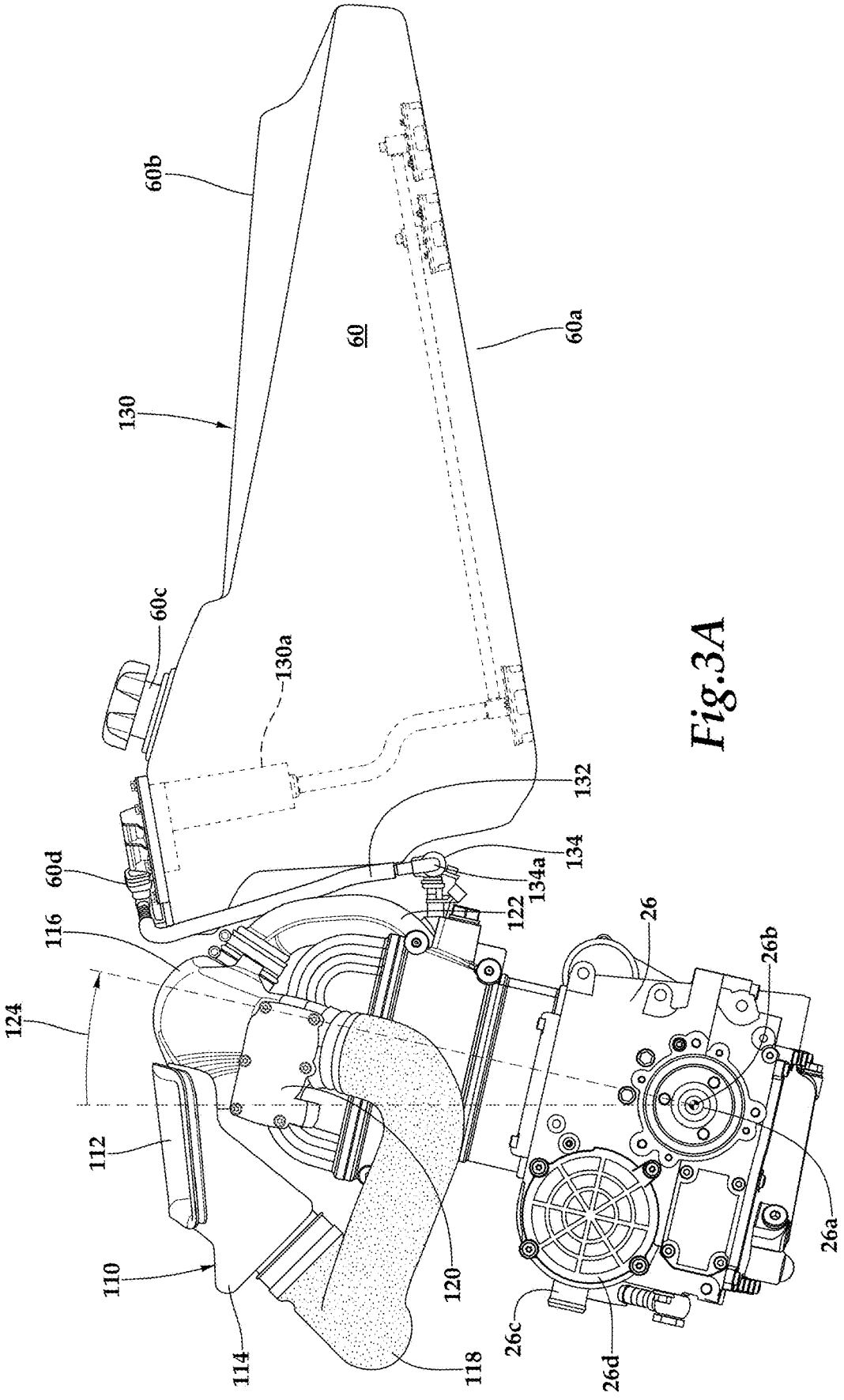
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Fig.3A

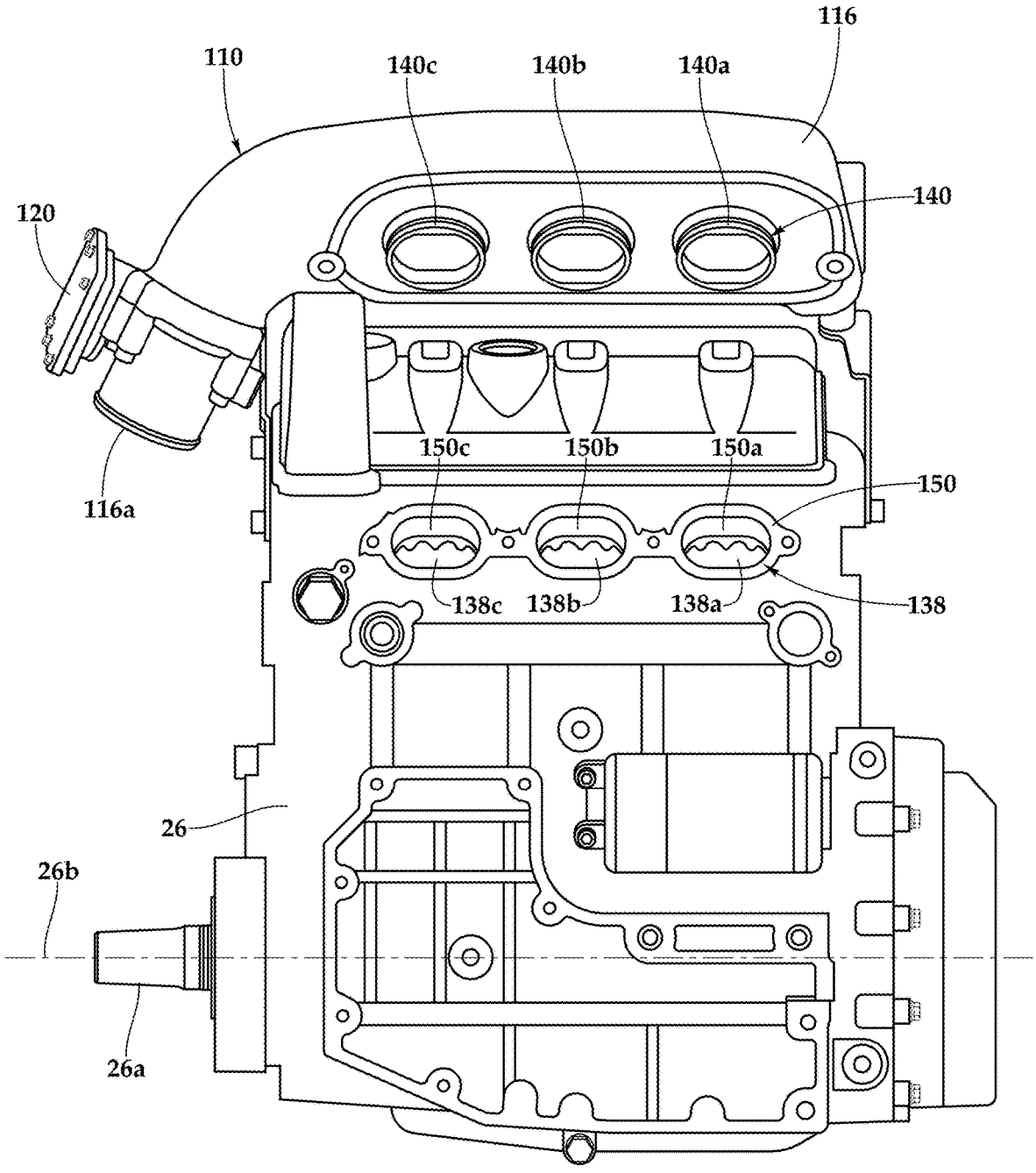
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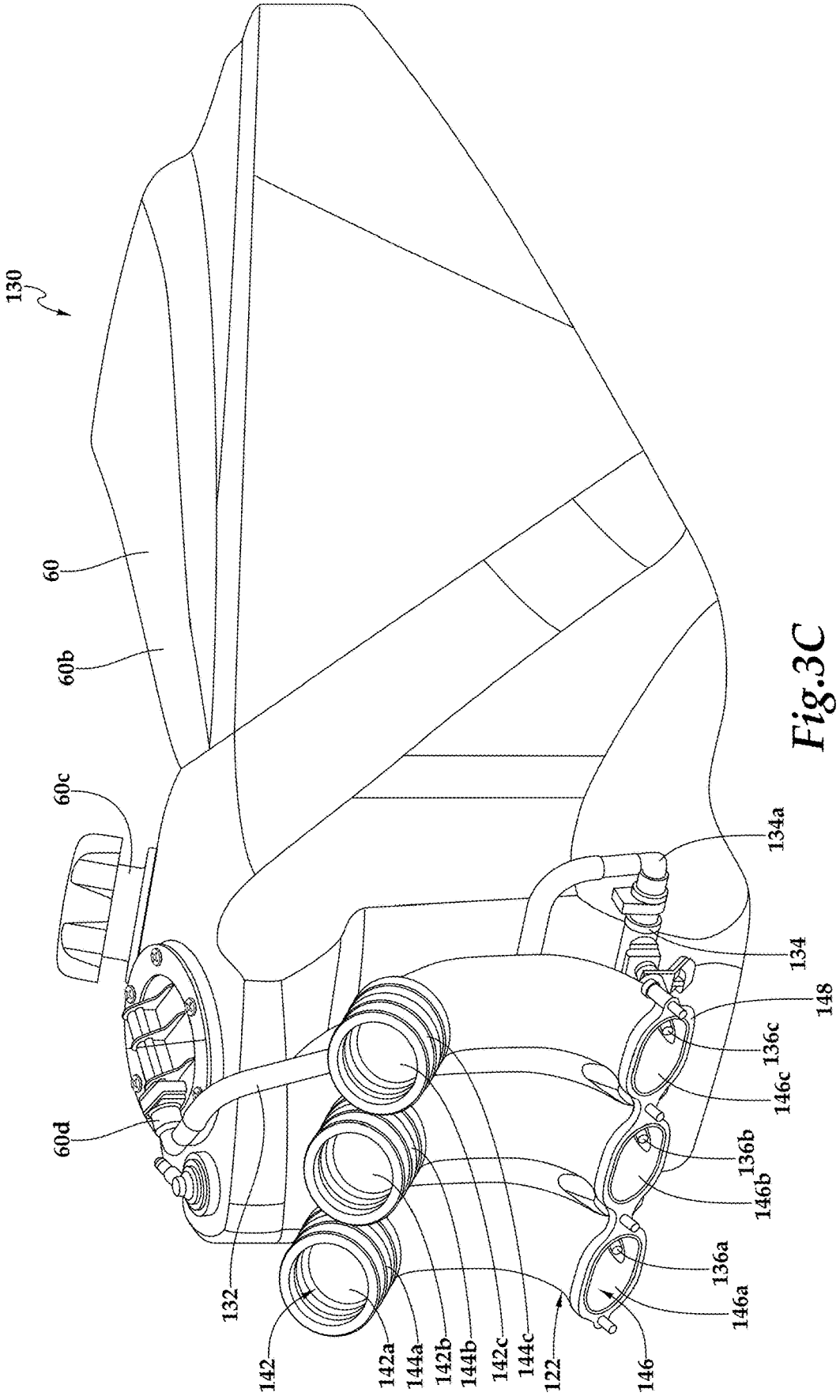
Fig.3B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134a

Fig.3C

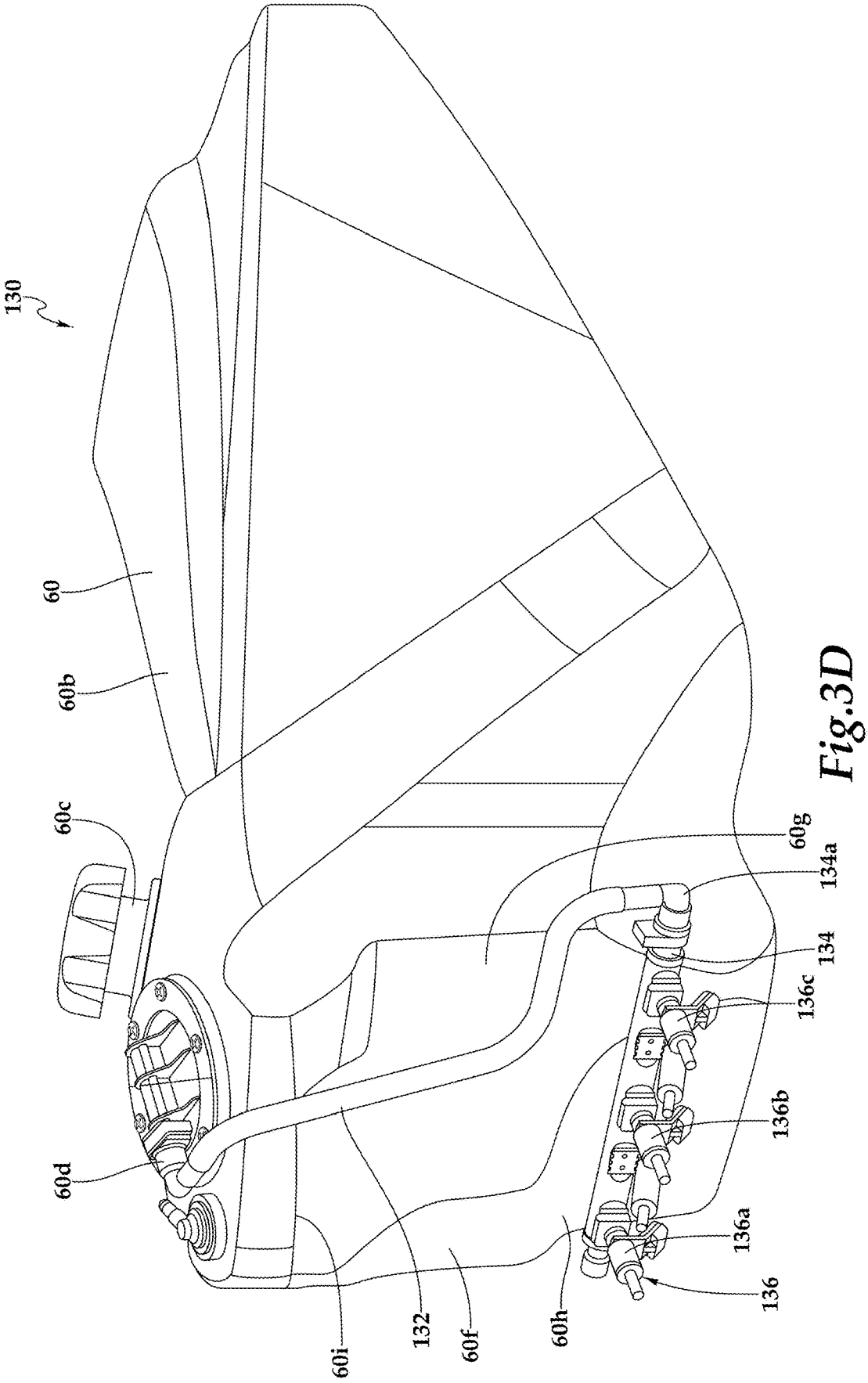
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Fig.3D

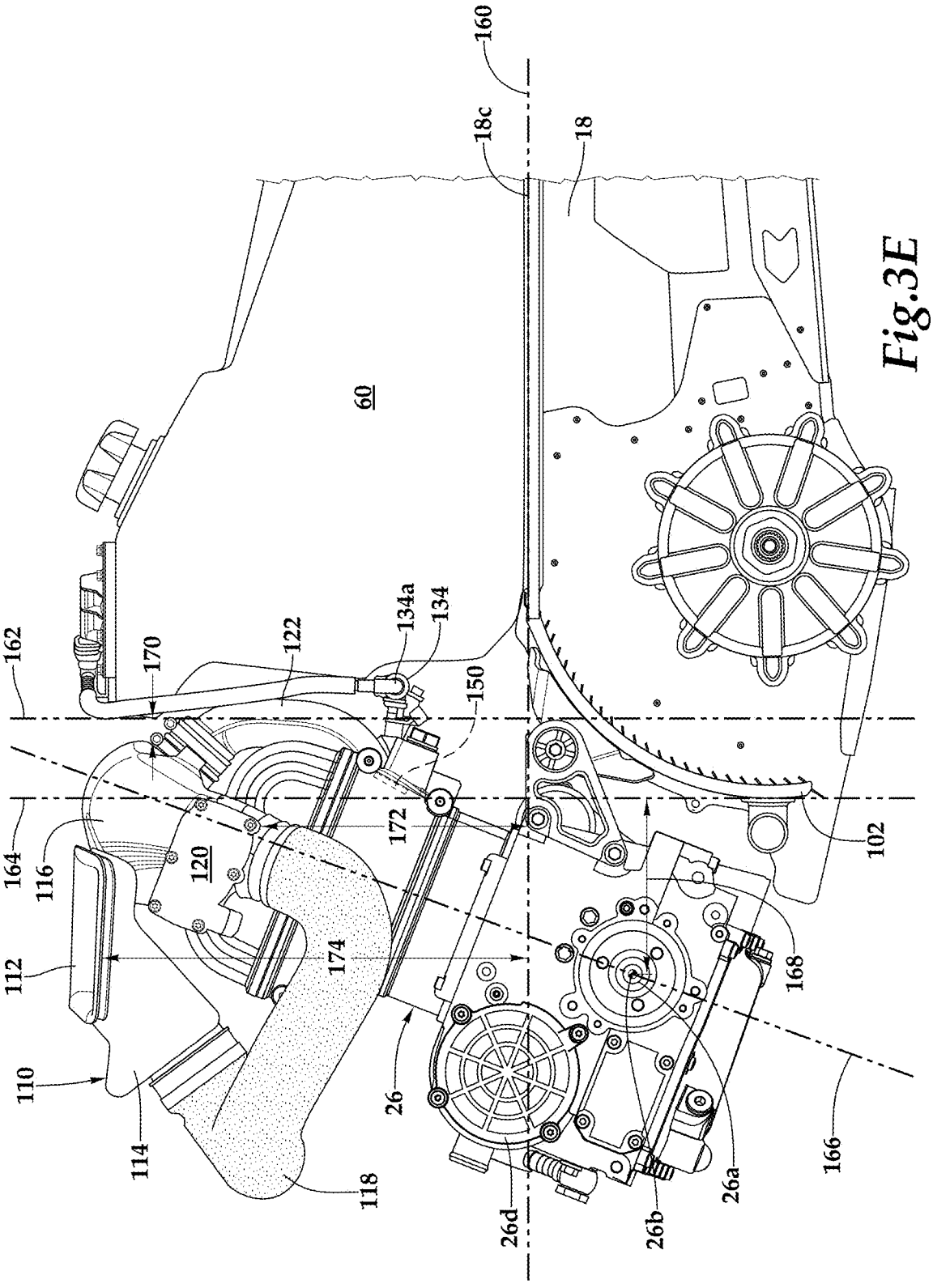
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Fig.3E

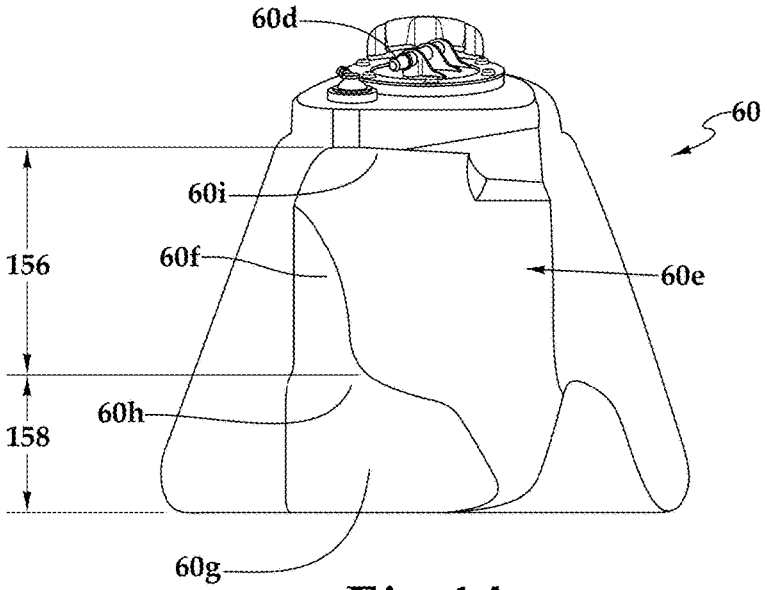
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Fig.4A

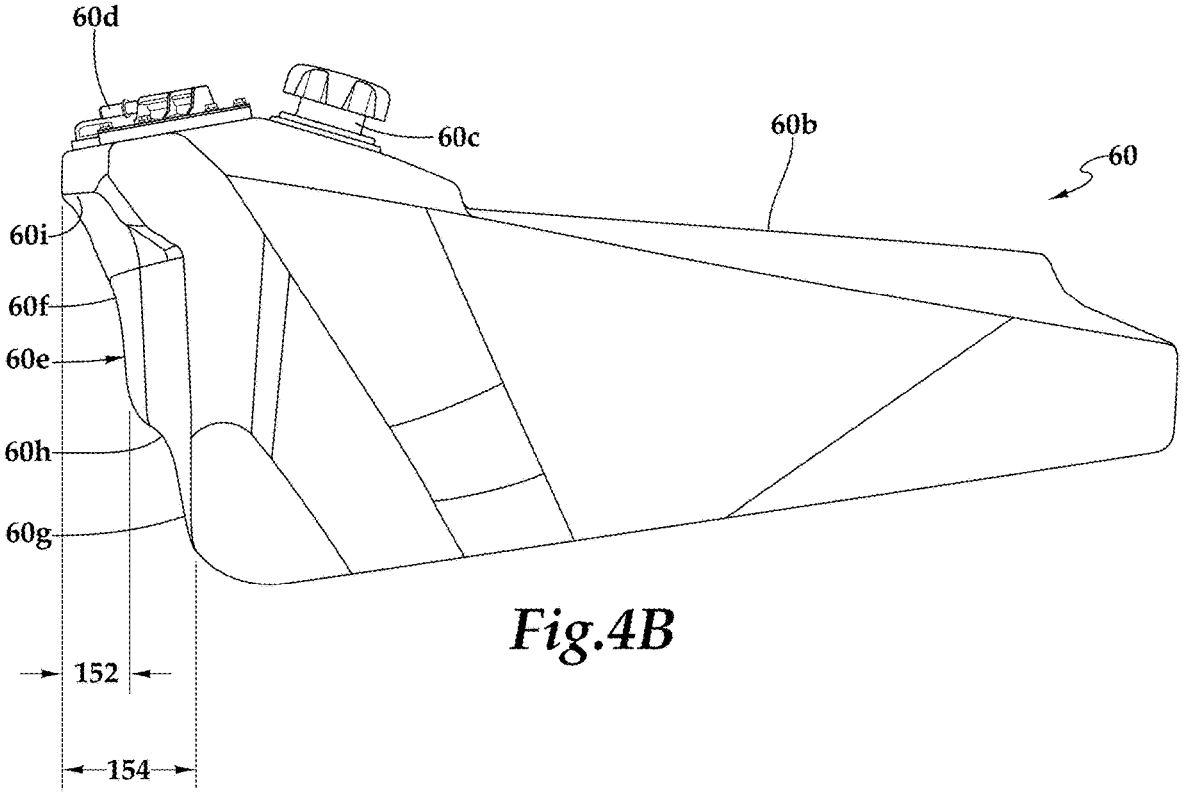
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Fig.4B

FUEL SYSTEMS FOR SNOWMOBILES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Application No. 63/528,774, filed Jul. 25, 2023 the entire contents of which is incorporated by reference herein for all purposes.

TECHNICAL FIELD OF THE DISCLOSURE

[0002] The present disclosure relates, in general, to fuel systems for use on land vehicles and, in particular, to fuel systems for use on snowmobiles that include a fuel tank having a contoured forward face that accommodates air intake components and fuel delivery components for compact positioned between an aftward side of the engine and the fuel tank.

BACKGROUND

[0003] Snowmobiles are popular land vehicles used for transportation and recreation in cold and snowy conditions. Certain snowmobiles are designed for specific applications such as trail, utility, mountain, race and crossover, to name a few. Snowmobiles typically include a chassis that supports various components of the snowmobile such as a ground-engaging endless drive track disposed in a longitudinally extending tunnel. The drive track is powered by an engine that enables the drive track to provide ground propulsion for the snowmobile. One or more skis serve to facilitate steering as well as to provide flotation of the front of the snowmobile over the snow. A handlebar assembly is positioned forward of a seat and is operatively linked to the skis for controlling the snowmobile.

[0004] The exhaust system of a snowmobile directs high-temperature exhaust gases away from the engine and the rider of the snowmobile. The exhaust system typically includes an exhaust manifold, an exhaust duct and a muffler, each of which is prone to high operating temperatures as a result of the high-temperature exhaust gases flowing therethrough. For many snowmobiles, it is desirable to densely pack systems such as the air intake system, the engine, the exhaust system, the drivetrain and the fuel system to reduce the overall size and improve the aerodynamics and handling of the snowmobile. It has been found, however, that temperature-sensitive components near the exhaust system, such as the fuel system components, may be negatively impacted by close proximity to the hot temperatures of the exhaust system. Accordingly, a need has arisen for densely packing snowmobile systems while also spacing the temperature-sensitive components, such as the fuel system components, thermally distant from the exhaust system components.

SUMMARY

[0005] In a first aspect, the present disclosure is directed to a fuel system for a snowmobile having a chassis defining an engine bay and an engine positioned within the engine bay. The fuel system includes a fuel tank that is coupled to the chassis and is positioned aft of the engine. The fuel tank has a forward face that includes a lower contour and an upper contour. A fuel rail is in fluid communication with the fuel tank and the engine. The fuel rail is positioned between the engine and the lower contour of the forward face of the fuel tank.

[0006] In certain embodiments, the fuel rail may extend laterally between the engine and the lower contour of the forward face of the fuel tank. In some embodiments, the fuel rail may be positioned below the upper contour of the forward face of the fuel tank. In certain embodiments, the fuel rail may be positioned aft of the engine. In some embodiments, the fuel rail may be positioned beneath at least a portion of the fuel tank and forward of at least a portion of the fuel tank. In certain embodiments, the snowmobile may include an air intake system that has a plurality of air outlets with the upper contour of the forward face of the fuel tank being configured to accommodate at least a portion of the air intake system between the engine and the fuel tank. In some embodiments, the fuel rail may extend laterally between a lower portion of the air intake system and the lower contour of the forward face of the fuel tank. In certain embodiments, the air intake system may include an air plenum that is positioned on top of the engine and air intake runners that are positioned at least partially between the engine and the upper contour of the forward face of the fuel tank with the fuel rail coupled to the air intake runners.

[0007] In a second aspect, the present disclosure is directed to a snowmobile that includes a chassis having a forward frame assembly that defines an engine bay and a tunnel that is coupled to the forward frame assembly. An engine is positioned within the engine bay and has a plurality of cylinders. An air intake system has at least one air inlet and a plurality of air outlets. Each of the air outlets is coupled to the engine and is configured to provide air to one of the cylinders. A fuel system includes a fuel tank that is coupled to the tunnel and is positioned aft of the engine and a fuel rail that is in fluid communication with the fuel tank and the engine. The fuel tank has a forward face that includes a lower contour and an upper contour. The fuel rail is positioned between the engine and the lower contour of the forward face of the fuel tank. At least a portion of the air intake system is positioned between the engine and the upper contour of the forward face of the fuel tank.

[0008] In some embodiments, the engine may be a four-stroke engine. In certain embodiments, the air intake system may include an airbox that includes the air inlet and air intake runners each including one of the air outlets. The air intake runners may be positioned at least partially between the engine and the upper contour of the forward face of the fuel tank. In some embodiments, the air intake runners may be positioned below at least a portion of the fuel tank. In certain embodiments, the air intake runners may be positioned at least partially beneath at least a portion of the fuel tank. In some embodiments, the air intake system may include an air plenum positioned on top of the engine with the air intake runners extending aftwardly and downwardly from the air plenum to the engine. In some embodiments, the fuel rail may be positioned below the upper contour of the forward face of the fuel tank. In certain embodiments, the fuel rail may be positioned beneath at least a portion of the fuel tank. In some embodiments, the fuel rail may extend laterally between the engine and the lower contour of the forward face of the fuel tank. In certain embodiments, the fuel rail may be positioned aft of the engine. In some embodiments, an exhaust system may include an exhaust manifold that is coupled to the engine and a muffler that is in fluid communication with the exhaust manifold. In certain embodiments, the exhaust manifold may be coupled to a

forward side of the engine and the air outlets of the air intake system may be coupled to an aft side of the engine.

[0009] In a third aspect, the present disclosure is directed to a snowmobile having a chassis that includes a tunnel having an upper surface. An engine is coupled to the chassis. The engine includes one or more cylinders and a crankshaft having an axis of rotation. A fuel tank is positioned on the upper surface of the tunnel aft of the engine. The fuel tank has a forward face defining a first contour. A fuel rail is in fluid communication with the fuel tank and the engine. The fuel rail is received in the first contour between the fuel tank and the engine.

[0010] In certain embodiments, an air plenum may be positioned on top of the engine and a heat exchanger may be positioned at a forward end of the tunnel. In such embodiments, the crankshaft may be positioned a first distance from the heat exchanger and the air plenum may be positioned a second distance from the fuel tank with the first distance being greater than the second distance. In some embodiments, the heat exchanger may include a forward portion that defines a forward end of the tunnel. In such embodiments, a first plane may extend along the upper surface of the tunnel and a second plane may extends from the forward portion of the heat exchanger perpendicular to the first plane such that when the first plane is horizonal, the crankshaft is positioned below the first plane and forward of the second plane, and the fuel rail is positioned above the first plane and aftward of the second plane. Also, when the first plane is horizonal, at least a portion of the air plenum may be positioned aftward of the second plane. In certain embodiments, the engine may include one or more air intake inlets on an aftward side of the engine such that when the first plane is horizonal, the one or more air intake inlets are positioned aftward of the second plane. In addition, when the first plane is horizonal, the one or more engine air inlets may be positioned above the first plane. In some embodiments, the air plenum may include an air inlet such that when the first plane is horizonal, the air inlet of the air plenum may be positioned above the first plane and forward of the second plane. In certain embodiments, a throttle valve assembly may be in fluid communication with the air inlet of the air plenum such that when the first plane is horizonal, the throttle valve assembly is positioned above the first plane and forward of the second plane. In addition, the throttle valve assembly may be positioned outboard of a forward frame assembly of the chassis and/or may include a single throttle valve. In some embodiments, an air intake system may be in fluid communication with the throttle valve assembly with an air inlet positioned outboard of the forward frame assembly.

[0011] In certain embodiments, a third plane may extend through the axis of rotation of the crankshaft and the centerline of the one or more cylinders such that when the first plane is horizonal, the air inlet of the air intake system may be positioned above the first plane and forward of the second and the third planes and/or at least a portion of the throttle valve assembly and at least a portion of the air inlet of the air plenum may be positioned forward of the third plane. In some embodiments, when the first plane is horizonal, the throttle valve assembly may be positioned a first distance from the first plane and the air inlet of the air intake system may be positioned a second distance from the first plane that is greater than the first distance. In certain embodiments, the engine may include a water pump such that when the first plane is horizonal, the water pump may be positioned forward of the third plane and at least partially below the first plane. In some embodiments, when the first plane is horizonal, the second plane and the third plane may intersect at the air plenum. In certain embodiment, the engine may be a four-stroke, three cylinder engine.

[0012] In some embodiments, a first plane may extend along the upper surface of the tunnel and a second plane may extend from a forward portion of the fuel tank perpendicular to the first plane such that when the first plane is horizonal, the fuel rail may be positioned above the first plane and at least partially positioned aftward of the second plane. In certain embodiments, the fuel rail may be positioned entirely aftward of the second plane. In some embodiments, the fuel rail may include an inlet that is in fluid communication with the fuel tank such that when the first plane is horizonal, the fuel rail inlet may be positioned aftward of the second plane. In certain embodiments, an air plenum may be positioned on top of the engine with one or more air intake runners extending therefrom to one or more air intake inlets on an aftward side of the engine such that when the first plane is horizonal, at least a portion of the one or more air intake runners may be positioned aftward of the second plane. In such embodiments, when the first plane is horizonal, the one or more engine air inlets may be positioned above the first plane and forward of the second plane.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] For a more complete understanding of the features and advantages of the present disclosure, reference is now made to the detailed description along with the accompanying figures in which corresponding numerals in the different figures refer to corresponding parts and in which:

[0014] FIGS. **1**A-**1**E are schematic illustrations of a snowmobile having a fuel system in accordance with embodiments of the present disclosure;

[0015] FIG. **2** is an isometric view of an engine including an air intake system coupled to a forward frame assembly of a snowmobile in accordance with embodiments of the present disclosure;

[0016] FIGS. **3**A-**3**E are various views of an engine including an air intake system and a fuel system for a snowmobile in accordance with embodiments of the present disclosure; and

[0017] FIGS. **4**A-**4**B are front and side views of a fuel tank for use in a fuel system of a snowmobile in accordance with embodiments of the present disclosure.

DETAILED DESCRIPTION

[0018] While the making and using of various embodiments of the present disclosure are discussed in detail below, it should be appreciated that the present disclosure provides many applicable inventive concepts, which can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative and do not delimit the scope of the present disclosure. In the interest of clarity, all features of an actual implementation may not be described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developer's specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. More-

over, it will be appreciated that such a development effort might be complex and time-consuming but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

[0019] In the specification, reference may be made to the spatial relationships between various components and to the spatial orientation of various aspects of components as the devices are depicted in the attached drawings. However, as will be recognized by those skilled in the art after a complete reading of the present disclosure, the devices, members, apparatuses, and the like described herein may be positioned in any desired orientation. Thus, the use of terms such as "above," "below," "upper," "lower" or other like terms to describe a spatial relationship between various components or to describe the spatial orientation of aspects of such components should be understood to describe a relative relationship between the components or a spatial orientation of aspects of such components, respectively, as the devices described herein may be oriented in any desired direction. As used herein, the term "coupled" may include direct or indirect coupling by any means, including by mere contact or by moving and/or non-moving mechanical connections.

[0020] Referring to FIGS. **1**A-**1**E in the drawings, a land vehicle depicted as a snowmobile is schematically illustrated and generally designated **10**. Structural support for snowmobile **10** is provided by a chassis **12** that includes a forward frame assembly **14**, a right side plate member **16***a*, a left side plate member **16***b* and a longitudinally extending tunnel **18**. Forward frame assembly **14** (see also FIG. **2**) is formed from interconnected tubular members such as round and hollow tubular members comprised of metal, metal alloy, polymeric materials, fiber reinforced polymer composites and/or combinations thereof that are coupled together by welds, bolts, pins or other suitable fastening means. Plate members **16***a*, **16***b* are coupled to and preferably welded to forward frame assembly **14** such that forward frame assembly **14** and plate members **16***a*, **16***b* form a welded frame assembly. Tunnel **18** is coupled to forward frame assembly **14** and/or plate members **16***a*, **16***b* with welds, bolts, rivets or other suitable means. In the illustrated embodiment, tunnel **18** includes a right sidewall **18***a*, a left sidewall **18***b* and a top panel **18***c* having a substantially planar upper surface. Tunnel **18** may be integrally formed or may consist of multiple members that are coupled together with welds, bolts, rivets or other suitable means. Plate members **16***a*, **16***b* and tunnel **18** may be formed from sheet metal, metal alloy, fiber reinforced polymer or other suitable material or combination of materials.

[0021] Various components of snowmobile **10** are assembled on or around forward frame assembly **14**. One or more body panels **20** cover and protect the various components of snowmobile **10** including parts of forward frame assembly **14**. For example, a hood panel **20***a*, a nose panel **20***b*, an upper right side panel **20***c* and a lower right side panel **20***d* shield underlying componentry from the snow and terrain. Similarly, an upper left side panel and a lower left side panel (not visible) also shield underlying componentry from the snow and terrain. In the illustrated embodiment, snowmobile **10** has a windshield **22** that shields the rider of snowmobile **10** from snow, terrain and frigid air during operation. Even through snowmobile **10** has been described and depicted as including specific body panels **20**, it should be understood by those having ordinary skill in the art that a snowmobile of the present disclosure may include any number of body panels in any configuration to provide the shielding functionality. In addition, it should be understood by those having ordinary skill in the art that the right side and the left side of snowmobile **10** will be with reference to a rider of snowmobile **10** with the right side of snowmobile **10** corresponding to the right side of the rider and the left side of snowmobile **10** corresponding to the left side of the rider.

[0022] Body panels **20** have been removed from snowmobile **10** in FIGS. **1**B-**1**E to reveal the underlying components of snowmobile **10**. For example, snowmobile **10** has a powertrain **24** that includes an engine **26** and a drivetrain **28** both of which are coupled to forward frame assembly **14**. Engine **26** resides in an engine bay formed within forward frame assembly **14**. In the illustrated embodiment, engine **26** is a four-stroke, three cylinder engine that is aftwardly tilted and has air intake inlets on the aftward side of engine **26** and exhaust outlets on the forward side of engine **26**. In other embodiments, an engine of the present disclosure may be a two-stroke engine, an electric motor, a hybrid engine or other prime mover. In addition, an engine of the present disclosure may have more than or less than three cylinders, may be vertically mounted or mounted with a forward tilt and/or may have air intake inlets or exhaust outlets in other locations. In the illustrated embodiment, engine **26** is an internal combustion engine such as a naturally aspirated internal combustion engine, a supercharged internal combustion engine or a turbo charged internal combustion engine. Engine **26** may be an interchangeable engine of the type disclosed in commonly owned U.S. patent application Ser. No. 18/649,993, filed Apr. 29, 2024, the entire contents of which are incorporated by reference herein for all purposes. Engine **26** includes a crankshaft **26***a* that has an axis of rotation **26***b* (see also FIGS. **2**, **3**B). Crankshaft **26***a* is coupled to drivetrain **28** and specifically to a transmission **30** of drivetrain **28** such as a continuously variable transmission, an electrically variable transmission or other suitable transmission type for varying the ratio of the engine output speed to the drive track input speed. Engine **26** includes a fluid inlet port **26***c* on the forward side of engine **26**. Fluid inlet port **26***c* is in fluid communication with a water pump **26***d* that circulates a fluid through engine **26** and a cooling circuit including, for example, a radiator and one or more heat exchangers, such that heat extracted from the engine by the fluid is removed from the fluid in the cooling circuit as the fluid circulates therethrough.

[0023] A drive track system **32** is at least partially disposed within and/or below tunnel **18** and is in contact with the ground to provide ground propulsion for snowmobile **10**. Torque and rotational energy are provided to drive track system **32** from engine **26** via drivetrain **28**. Drive track system **32** includes a track frame **34**, an internal suspension **36**, a plurality of idler wheels **38** such as idler wheels **38***a*, **38***b*, **38***c*, **38***d* and an endless track **40**. Track frame **34** may be coupled to forward frame assembly **14** via a swing arm having a coil spring, a rigid strut, a torsion spring, an elastomeric member or any other suitable coupling configuration. Endless track **40** is driven by a track drive sprocket via a track driveshaft (not visible) that is rotated responsive to torque provided from powertrain **24**. Endless track **40** rotates around track frame **34** and idler wheels **38** to propel snowmobile **10** in either the forward direction, as indicated by arrow **46***a*, or the backwards direction, as indicated by arrow **46***b* in FIG. **1**B. When viewed from the right side of

snowmobile **10**, endless track **40** rotates around track frame **34** and idler wheels **38** in the clockwise direction, as indicated by arrow **48***a*, to propel snowmobile **10** in the forward direction **46***a*. Endless track **40** rotates around track frame **34** and idler wheels **38** in the counterclockwise direction, as indicated by arrow **48***b*, to propel snowmobile **10** in the backward direction **46***b*. The forward and backward directions also represent the longitudinal direction of snowmobile **10** with the lateral direction of snowmobile **10** being normal thereto and represented by the rightward direction, as indicated by arrow **50***a*, and the leftward direction, as indicated by arrow **50***b* in FIG. **1**E. The backward direction may also be referred to herein as the aftward direction.

[0024] Snowmobile **10** has a ski system **52** and a front suspension assembly **54** that provide front end support for snowmobile **10**. Ski system **52** includes a right ski **52***a* that is coupled to forward frame assembly **14** by upper and lower A-arms **52***b*, **52***c* and right spindle **52***d*. Ski system **52** also includes a left ski **52***e* that is coupled to forward frame assembly **14** by upper and lower A-arms **52***f*, **52***g* and left spindle **52***h*. Skis **52***a*, **52***e* are interconnected to a steering system **56** including a handlebar assembly **56***a*, a steering column **56***b*, a right tie rod **56***c* and a left tie rod **56***d* that enable the rider to steer snowmobile **10**. For example, when handlebar assembly **56***a* is rotated, skis **52***a*, **52***e* responsively pivot to turn snowmobile **10**. The rider controls snowmobile **10** from a seat **58** that is position atop a fuel tank **60**, above tunnel **18**, aft of handlebar assembly **56***a* and aft of forward frame assembly **14**. Snowmobile **10** has a lift bumper **62** that is coupled to an aft end of tunnel **18** that enables a person to lift the rear end of snowmobile **10** in the event snowmobile **10** becomes stuck or needs to be repositioned when it is not moving. Snowmobile **10** has a snow flap **64** that deflects snow emitted by endless track **40**. In the illustrated embodiment, snow flap **64** is coupled to lift bumper **62**. In other embodiments, a snow flap may be coupled directly to tunnel **18**. A taillight housing **66** is also coupled to lift bumper **62** and houses a taillight of snowmobile **10**. Snowmobile **10** has an exhaust system **70** that includes an exhaust manifold **72** that is coupled to engine **26**, an exhaust duct **74** and a muffler **76**. Exhaust system **70** is configured to direct high-temperature exhaust gases away from engine **26** and the rider of snowmobile **10**.

[0025] It should be appreciated that snowmobile **10** is merely illustrative of a variety of vehicles that can implement the embodiments disclosed herein. Other vehicle implementations can include motorcycles, snow bikes, all-terrain vehicles (ATVs), utility vehicles, recreational vehicles, scooters, automobiles, mopeds, straddle-type vehicles and the like. As such, those skilled in the art will recognize that the embodiments disclosed herein can be integrated into a variety of vehicle configurations. It should be appreciated that even though ground-based vehicles are particularly well-suited to implement the embodiments of the present disclosure, airborne vehicles and devices such as aircraft can also implement the embodiments.

[0026] Referring additionally to FIG. **2** of the drawings, details relating to engine **26** of snowmobile **10** will now be discussed. Engine **26** is positioned within an engine bay **100** defined by forward frame assembly **14** and arcuate heat exchanger **102** that is positioned at the forward end of tunnel **18** such that the forward portion of arcuate heat exchanger **102** may be considered as the forward end of tunnel **18**. Arcuate heat exchanger **102** is coupled to forward frame assembly **14**, plate members **16***a*, **16***b* and/or tunnel **18**. Arcuate heat exchanger **102** is positioned aft of a lower portion of engine **26** and below fuel tank **60**. In the illustrated embodiment, engine **26** is resiliently secured within engine bay **100** by a pair of forward engine mounts **104***a*, **104***b* that are coupled to a cross member **14***a* of forward frame assembly **14** and a pair of rear engine mounts, only left-rear engine mount **106** being visible, that are coupled to a forward face of arcuate heat exchanger **102**. Left-rear engine mount **106** is also coupled to a driven shaft bearing hub **108** that is coupled to forward frame assembly **14**, plate member **16***b* and an end cap **102***b* of arcuate heat exchanger **102**. Engine **26** has an air intake system **110** that receives air from the atmosphere and distributes the air to each of the cylinders of engine **26**. More specifically, air intake system **110** includes an air inlet **112** that is positioned outboard of forward frame assembly **14** that feeds air into an airbox **114** that is positioned generally forward and generally above engine **26**. Air from airbox **114** is routed to an air intake manifold via an air duct **118**. The air intake manifold includes an air plenum **116** that is positioned on top of engine **26** and has an air inlet **116***a* (see also FIG. **3**B) that is positioned outboard of forward frame assembly **14**. The volume of air delivered to air plenum **116** from airbox **114** is controlled via a throttle valve assembly **120** that is positioned outboard of forward frame assembly **14** and has, for example, a single throttle valve disposed therein. The air intake manifold also includes air intake runners **122**. Air plenum **116** is configured to damp the air flow prior to distribution of the air to the cylinders of engine **26** via air intake runners **122** (see also FIG. **3**A). Engine **26** has exhaust system **70** (see also FIG. **1**B) that includes exhaust manifold **72** that is coupled to the forward side of engine **26**, which is also considered to be the hot side of engine **26** due to the hot temperatures associated with engine exhaust. The aft side of engine **26** is concomitantly considered the cool side of engine **26** as hot exhaust system components are located opposite and/or remote therefrom.

[0027] Referring additionally to FIGS. **3**A-**3**E of the drawings, addition details relating to the positioning of engine **26** and fuel tank **60** of snowmobile **10** will now be discussed. Engine **26** is aftwardly tilted relative to vertical as indicated by arrow **124**. In the illustrated embodiment, engine **26** is aftwardly tilted between five degrees and twenty degrees from vertical such as about ten degrees from vertical. It should be understood by those having ordinary skill in the art that engine **26** could have other aftwardly tilted angles both less than five degrees or greater than twenty degrees from vertical. Snowmobile **10** has a fuel system **130** that is positioned aft of engine **26** and more particularly, fuel system **130** is compactly positioned aft of engine **26**. Fuel system **130** includes fuel tank **60** that is positioned on tunnel **18** (see also FIG. **1**C). Fuel tank **60** has a lower surface **60***a* that is supported by the upper surface of top panel **18***c* of tunnel **18**. Fuel tank **60** also has an upper surface **60***b* that receives seat **58** on an aft portion thereof and has a fill port **60***c* and a discharge port **60***d* at a forward portion thereof. In the illustrated embodiment, discharge port **60***d* forms the uppermost part of fuel tank **60** with each of fill port **60***c* and discharge port **60***d* positioned above engine **26**. Fuel system **130** includes a fuel pump **130***a* that is positioned within fuel tank **60**. Fuel system **130** also includes a fuel conduit **132** that fluidically couples fuel tank **60** with an inlet **134***a* of a

fuel rail **134**. Fuel pump **130***a* provides high pressure fuel to fuel rail **134** via fuel conduit **132**. Fuel system **130** includes a multi-point fuel injector system **136** that is coupled to fuel rail **134** and is configured to inject fuel into the cylinders **138** of engine **26**. In the illustrated embodiment, fuel injector system **136** include a right fuel injector **136***a*, a center fuel injector **136***b* and a left fuel injector **136***c* wherein, right fuel injector **136***a* injects fuel into right cylinder **138***a* of engine **26**, center fuel injector **136***b* injects fuel into center cylinder **138***b* of engine **26** and left fuel injector **136***c* injects fuel into left cylinder **138***c* of engine **26**. As such, each of the fuel injectors **136***a*, **136***b*, **136***c* injects fuel into a respective one of the three cylinders **138***a*, **138***b*, **138***c* of engine **26**.

[0028] Referring specifically to FIGS. **3**B-**3**C, air plenum **116** is positioned on top of engine **26** and includes a plurality of air discharge ports **140**; namely, right air discharge port **140***a*, center air discharge port **140***b* and left air discharge port **140***c*. Air intake runners **122** include a plurality of air inlet ports **142**; namely, right air inlet port **142***a*, center air inlet port **142***b* and left air inlet port **142***c*. Right air discharge port **140***a* is in fluid communication with right air inlet port **142***a* via a right coupling **144***a*. Center air discharge port **140***b* is in fluid communication with center air inlet port **142***b* via a center coupling **144***b*. Left air discharge port **140***c* is in fluid communication with left air inlet port **142***b* via a left coupling **144***c*. Air intake runners **122** also include a plurality of air outlet ports **146**; namely, right air outlet port **146***a*, center air outlet port **146***b* and left air outlet port **146***c*. Air outlet ports **146** serve as the air outlets for air intake system **110**. Air intake runners **122** include a flange **148** that mates to an aft side of engine **26** at air intake inlets **150**, such that air intake runners **122** may be coupled to engine **26** using bolts or other suitable fasteners. In this position, right air outlet port **146***a* is aligned to provide air to right cylinder **138***a* through right air intake inlet **150***a*, center air outlet port **146***b* is aligned to provide air to center cylinder **138***b* through center air intake inlet **150***b* and left air outlet port **146***c* is aligned to provide air to left cylinder **138***c* through left air intake inlet **150***c*. In addition, right fuel injector **136***a* is coupled to air intake runners **122** proximate right air outlet port **146***a*, center fuel injector **136***b* is coupled to air intake runners **122** proximate center air outlet port **146***b* and left fuel injector **136***c* is coupled to air intake runners **122** proximate left air outlet port **146***c*. In this configuration, right fuel injector **136***a* is aligned to inject fuel into right cylinder **138***a*, center fuel injector **136***b* is aligned to inject fuel into center cylinder **138***b* and left fuel injector **136***c* is aligned to inject fuel into left cylinder **138***c*.

[0029] Referring specifically to FIG. **3**E of the drawings, engine **26** and fuel tank **60** are shown in their installed positions relative to tunnel **18**. In the illustrated orientation, the top surface of top panel **18***c* of tunnel **18** defines a tunnel plane **160** that is depicted as a horizontal plane. It is to be understood by those having ordinary skill in the art that a snowmobile of the present disclosure can be positioned in a variety of orientations. For example, in FIGS. **1**B-**1**E, snowmobile **10** is depicted as having skis **52***a*, **52***e* and track drive **40** on a horizonal surface such that a tunnel plane would have an angle relative to a horizontal place such as an angle between five degrees and ten degrees or an angle of about eight degrees. In FIG. **3**E, however, the orientation of tunnel plane **160** has been set to the horizontal to establish a convenient reference frame. In addition to tunnel plane **160**, FIG. **3**E illustrates a fuel tank plane **162** that is depicted as a vertical plane that touches the forwardmost point of fuel tank **60** and is perpendicular to tunnel plane **160**, an arcuate heat exchanger plane **164** that is depicted as a vertical plane that touches the forwardmost point of arcuate heat exchanger **102**, is perpendicular to tunnel plane **160** and is forward of arcuate heat exchanger plane **164**, and a crankshaft plane **166** that is depicted as a tilted plane that passes through axis of rotation **26***b* of crankshaft **26***a* and the centerline of the cylinders **138** of engine **26**.

[0030] Relationships between various snowmobile components and the identified planes will now be disclosed. Crankshaft **26***a* is positioned a first distance **168** from heat exchanger **102**, as represented by arcuate heat exchanger plane **164**, and air plenum **116** is positioned a second distance **170** from fuel tank **60**, a represented by fuel tank plane **162**, with the first distance **168** being greater than the second distance **170**. Crankshaft **26***a* is positioned below tunnel plane **160** and forward of arcuate heat exchanger plane **164**. Fuel rail **134** is positioned above tunnel plane **160** and aftward of arcuate heat exchanger plane **164**. At least a portion of air plenum **116** is positioned aftward of arcuate heat exchanger plane **164**. Air intake inlets **150** are positioned aftward of arcuate heat exchanger plane **164** and above tunnel plane **160**. Air inlet **116***a* (see also FIG. **3**B) of air plenum **116** is positioned above tunnel plane **160** and forward of arcuate heat exchanger plane **164**. Likewise, throttle valve assembly **120** is positioned above tunnel plane **160** and forward of arcuate heat exchanger plane **164**.

[0031] Air inlet **112** of air intake system **110** is positioned above tunnel plane **160** and forward of arcuate heat exchanger plane **164**. At least a portion of throttle valve assembly **120** and at least a portion of air inlet **116***a* of air plenum **116** is positioned forward of crankshaft plane **166**. Throttle valve assembly **120** is positioned a first distance **172** from tunnel plane **160** and air inlet **112** of air intake system **110** is positioned a second distance **174** from tunnel plane **160** that is greater than first distance **172**. Water pump **26***d* is positioned forward of crankshaft plane **166** and at least partially below tunnel plane **160**. Arcuate heat exchanger plane **164** and crankshaft plane **166** intersect at air plenum **116**. Fuel rail **134** is positioned above tunnel plane **160** and at least partially positioned aftward of fuel tank plane **162**. In the illustrated embodiment, fuel rail **134** is positioned entirely aftward of fuel tank plane **162**. Fuel rail inlet **134***a* is positioned aftward of fuel tank plane **162**. At least a portion of air intake runners **122** is positioned aftward of fuel tank plane **162**. Air intake inlets **150** are positioned above tunnel plane **160** and forward of fuel tank plane **162**.

[0032] Referring additionally to FIGS. **4**A-**4**B, addition features of fuel tank **60** will now be discussed. Fuel tank **60** is uniquely shaped to allow for compact positioning of fuel tank **60** relative to engine **26** and, in particular, relative to the cool side of engine **26** when engine **26** is oriented with an aftward tilt. For example, fuel tank **60** has a forward face **60***e* with a plurality of concave portions including an upper contour **60***f* and a lower contour **60***g*. A right section of upper contour **60***f* is configured to accommodate a downwardly extending portion of air intake runners **122** between engine **26** and fuel tank **60**. A left section of upper contour **60***f* is configured to accommodate a downwardly extending portion of air intake runners **122** and a downwardly extending portion of fuel conduit **132** between engine **26** and fuel tank **60**. Lower contour **60***g* is configured to accommodate a

downwardly extending portion of air intake runners **122** and the laterally extending fuel rail **134** between engine **26** and fuel tank **60**. In the illustrated embodiments, the right section of upper contour **60***f* has recess depth **152**. The left section of upper contour **60***f* and lower contour **60***g* have a recess depth **154** wherein, recess depth **152** is less than recess depth **154**. This configuration results in an overhang portion **60***h* above lower contour **60***g* which can also be describes as being between the right section of upper contour **60***f* and lower contour **60***g*. In addition, forward face **60***e* has an overhang portion **60***i* that is above upper contour **60***f* and thus above lower contour **60***g*. Upper contour **60***f* extends vertically between overhang portion **60***h* and overhang portion **60***i*, as indicated by arrow **156**. Lower contour **60***g* extends vertically between a lower end of forward face **60***e* and overhang portion **60***h*, as indicated by arrow **158**. The aftwardly tilted engine **26** together with the contoured forward face **60***e* of fuel tank **60** allow for a portion of air intake system **110** and a portion of fuel system **130** to be positioned between engine **26** and fuel tank **60**. In addition, air intake runners **122** are positioned below overhang portion **60***i* of fuel tank **60** and at least partially beneath overhang portion **60***i* of fuel tank **60**. Fuel rail **134** is positioned below overhang portion **60***i*, below upper contour **60***f* and below overhang portion **60***h* of fuel tank **60**. In addition, fuel rail **134** is positioned beneath overhang portion **60***i*, beneath upper contour **60***f* and beneath overhang portion **60***h* of fuel tank **60**. Fuel rail **134** is also positioned between a lower portion of air intake runners **122** and fuel tank **26**.

[0033] The compact positioning of fuel tank of the present disclosure relative to the engine enabled by the uniquely shaped fuel tank of the present disclosure provides numerous benefits to the disclosed snowmobile. For example, by compactly positioning the fuel tank relative to the engine, the fuel tank is positioned substantially forward relative to the rider of the snowmobile which improves the mass centralization of the disclosed snowmobile and maintains a low center of gravity for the disclosed snowmobile, which improves the handling of the disclosed snowmobile. In addition, by compactly positioning the fuel tank relative to the engine, the overall size of the disclosed snowmobile is reduced which improves the aerodynamics of the disclosed snowmobile. Further, by compactly positioning the fuel tank relative to the cool side of the engine, the fuel system components are positioned thermally distant from the exhaust system components and are thus protected from the hot temperatures of the exhaust system.

[0034] The foregoing description of embodiments of the disclosure has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the disclosure. The embodiments were chosen and described in order to explain the principals of the disclosure and its practical application to enable one skilled in the art to utilize the disclosure in various embodiments and with various modifications as are suited to the particular use contemplated. For example, numerous combinations of the features disclosed herein will be apparent to persons skilled in the art including the combining of features described in different and diverse embodiments, implementations, contexts, applications and/or figures. Other substitutions, modifications, changes and omissions may be made in the design, operating conditions and arrangement of the embodiments without departing from the scope of the present disclosure. Such modifications and combinations of the illustrative embodiments as well as other embodiments will be apparent to persons skilled in the art upon reference to the description. It is, therefore, intended that the appended claims encompass any such modifications or embodiments.

What is claimed is:

1. A fuel system for a snowmobile having a chassis defining an engine bay and an engine positioned within the engine bay, the fuel system comprising:

a fuel tank coupled to the chassis and positioned aft of the engine, the fuel tank having a forward face including a lower contour and an upper contour; and

a fuel rail in fluid communication with the fuel tank and the engine;

wherein, the fuel rail is positioned between the engine and the lower contour of the forward face of the fuel tank.

2. The fuel system as recited in claim **1** wherein, the fuel rail extends laterally between the engine and the lower contour of the forward face of the fuel tank.

3. The fuel system as recited in claim **1** wherein, the fuel rail is positioned below the upper contour of the forward face of the fuel tank.

4. The fuel system as recited in claim **1** wherein, the fuel rail is positioned aft of the engine.

5. The fuel system as recited in claim **1** wherein, the fuel rail is positioned beneath at least a portion of the fuel tank and forward of at least a portion of the fuel tank.

6. The fuel system as recited in claim **1** wherein, the snowmobile includes an air intake system having a plurality of air outlets; and

wherein, the upper contour of the forward face of the fuel tank is configured to accommodate at least a portion of the air intake system between the engine and the fuel tank.

7. The fuel system as recited in claim **6** wherein, the fuel rail extends laterally between a lower portion of the air intake system and the lower contour of the forward face of the fuel tank.

8. The fuel system as recited in claim **6** wherein, the air intake system includes an air plenum positioned on top of the engine and air intake runners positioned at least partially between the engine and the upper contour of the forward face of the fuel tank; and

wherein, the fuel rail is coupled to the air intake runners.

9. A snowmobile comprising:

a chassis including a forward frame assembly defining an engine bay and a tunnel coupled to the forward frame assembly;

an engine positioned within the engine bay and having a plurality of cylinders;

an air intake system having at least one air inlet and a plurality of air outlets, each of the air outlets coupled to the engine and configured to provide air to one of the cylinders; and

a fuel system including a fuel tank coupled to the tunnel and positioned aft of the engine and a fuel rail in fluid communication with the fuel tank and the engine;

wherein, the fuel tank has a forward face that includes a lower contour and an upper contour;

wherein, the fuel rail is positioned between the engine and the lower contour of the forward face of the fuel tank; and

wherein, at least a portion of the air intake system is positioned between the engine and the upper contour of the forward face of the fuel tank.

10. The snowmobile as recited in claim **9** wherein, the engine is a four-stroke engine.

11. The snowmobile as recited in claim **9** wherein, the air intake system further comprises an airbox including the at least one air inlet and air intake runners each including one of the air outlets; and

wherein, the air intake runners are positioned at least partially between the engine and the upper contour of the forward face of the fuel tank.

12. The snowmobile as recited in claim **11** wherein, the air intake runners are positioned below at least a portion of the fuel tank.

13. The snowmobile as recited in claim **11** wherein, the air intake runners are positioned at least partially beneath at least a portion of the fuel tank.

14. The snowmobile as recited in claim **11** wherein, the air intake system further comprises an air plenum positioned on top of the engine; and

wherein, the air intake runners extend aftwardly and downwardly from the air plenum to the engine.

15. The snowmobile as recited in claim **9** wherein, the fuel rail is positioned below the upper contour of the forward face of the fuel tank.

16. The snowmobile as recited in claim **9** wherein, the fuel rail is positioned beneath at least a portion of the fuel tank.

17. The snowmobile as recited in claim **9** wherein, the fuel rail extends laterally between the engine and the lower contour of the forward face of the fuel tank.

18. The snowmobile as recited in claim **9** wherein, the fuel rail is positioned aft of the engine.

19. The snowmobile as recited in claim **9** further comprising an exhaust system including an exhaust manifold coupled to the engine and a muffler in fluid communication with the exhaust manifold.

20. The snowmobile as recited in claim **19** wherein, the exhaust manifold is coupled to a forward side of the engine and the air outlets of the air intake system are coupled to an aft side of the engine.

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