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Vezina et al.

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(45) **Date of Patent:** **Dec. 26, 2023**

(54) **SNOWMOBILE HEAT EXCHANGER ASSEMBLY**

(71) Applicant: **BOMBARDIER RECREATIONAL PRODUCTS INC.**, Valcourt (CA)

(72) Inventors: **Sebastien Vezina**, Sherbrooke (CA);
Jonathan Fortier, Lawrenceville (CA)

(73) Assignee: **BOMBARDIER RECREATIONAL PRODUCTS INC.**, Valcourt (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **18/079,378**

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(65) **Prior Publication Data**
US 2023/0113806 A1 Apr. 13, 2023

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(63) Continuation of application No. 16/523,403, filed on Jul. 26, 2019, now Pat. No. 11,524,569, which is a (Continued)

(51) **Int. Cl.**
B60K 11/02 (2006.01)
B60K 11/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **B60K 11/02** (2013.01); **B60K 11/04** (2013.01); **B62M 27/02** (2013.01); **F28D 1/035** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC F28D 1/035; F28D 1/0358; F28D 2021/00944; F28F 3/12; F28F 3/14; B60K 11/02; B60K 11/04
See application file for complete search history.

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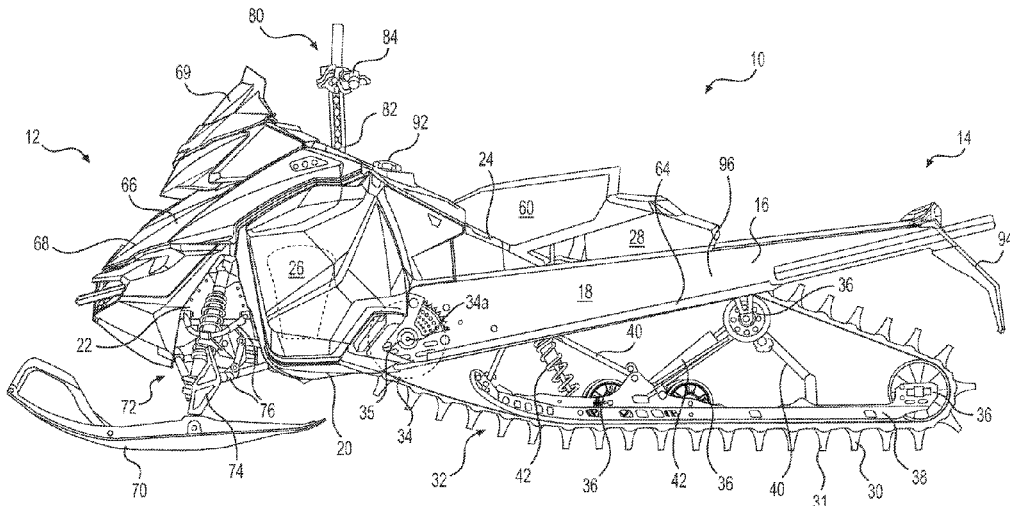
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Primary Examiner — Jacob D Knutson
(74) *Attorney, Agent, or Firm* — BCF LLP

(57) **ABSTRACT**

According to one aspect of the present technology, there is provided a snowmobile having: a tunnel; a motor; at least one ski; and a drive track. At least a portion of the tunnel is formed by a heat exchanger assembly having: a front portion; a middle portion; a rear portion; a top part; and a bottom part. The bottom part defines at least one recess. The top and bottom parts define therebetween a passage formed in part by the at least one recess. A first portion of the passage is defined by the at least one recess extending longitudinally. The drive track has: a plurality of lugs; and a plurality of studs. Portions of the plurality of lugs being laterally aligned with the first portion of the passage being free of studs.

16 Claims, 42 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/439,210, filed on Feb. 22, 2017, now Pat. No. 10,406,910, which is a continuation-in-part of application No. PCT/IB2014/064343, filed on Sep. 9, 2014, which is a continuation of application No. 14/473,036, filed on Aug. 29, 2014, now abandoned.

- (60) Provisional application No. 61/872,204, filed on Aug. 30, 2013.
- (51) **Int. Cl.**
F28D 1/03 (2006.01)
B62M 27/02 (2006.01)
F28F 3/12 (2006.01)
F28D 21/00 (2006.01)
F28F 3/14 (2006.01)
- (52) **U.S. Cl.**
 CPC *F28D 1/0358* (2013.01); *F28F 3/12* (2013.01); *F28F 3/14* (2013.01); *B60Y 2200/252* (2013.01); *B62M 2027/023* (2013.01); *B62M 2027/026* (2013.01); *B62M 2027/027* (2013.01); *B62M 2027/028* (2013.01); *F28D 2021/0094* (2013.01)

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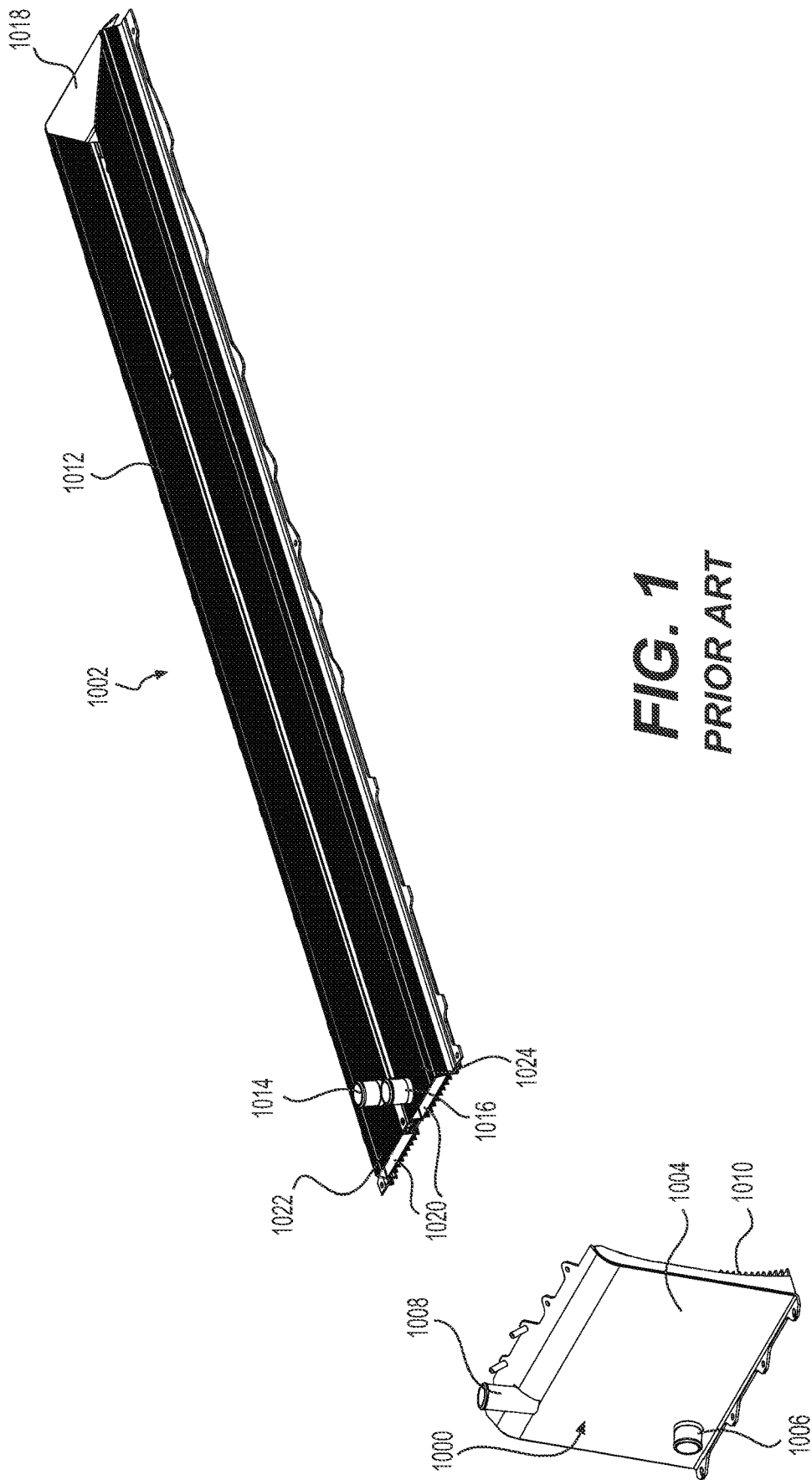


FIG. 1
PRIOR ART

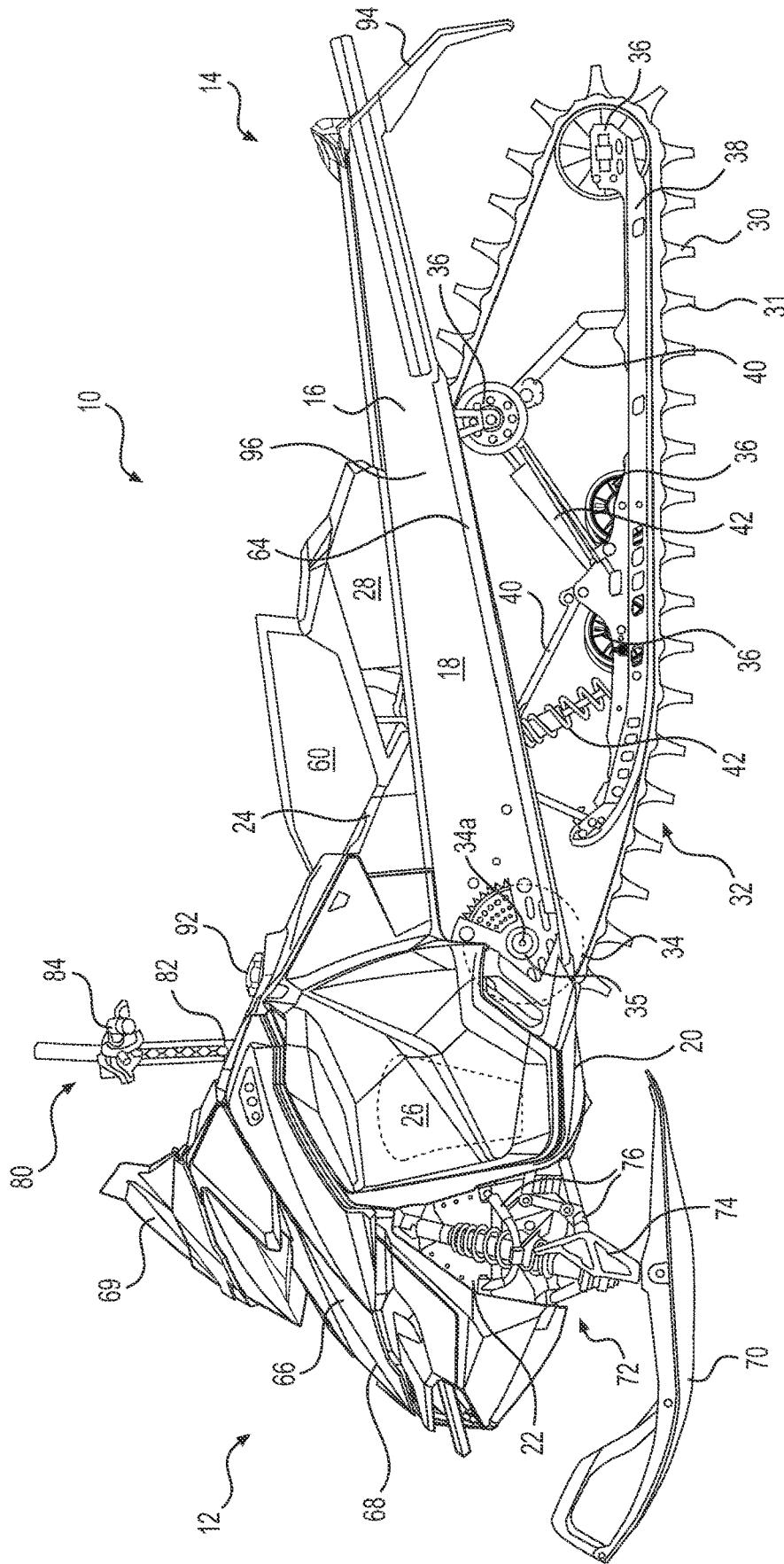


FIG. 2

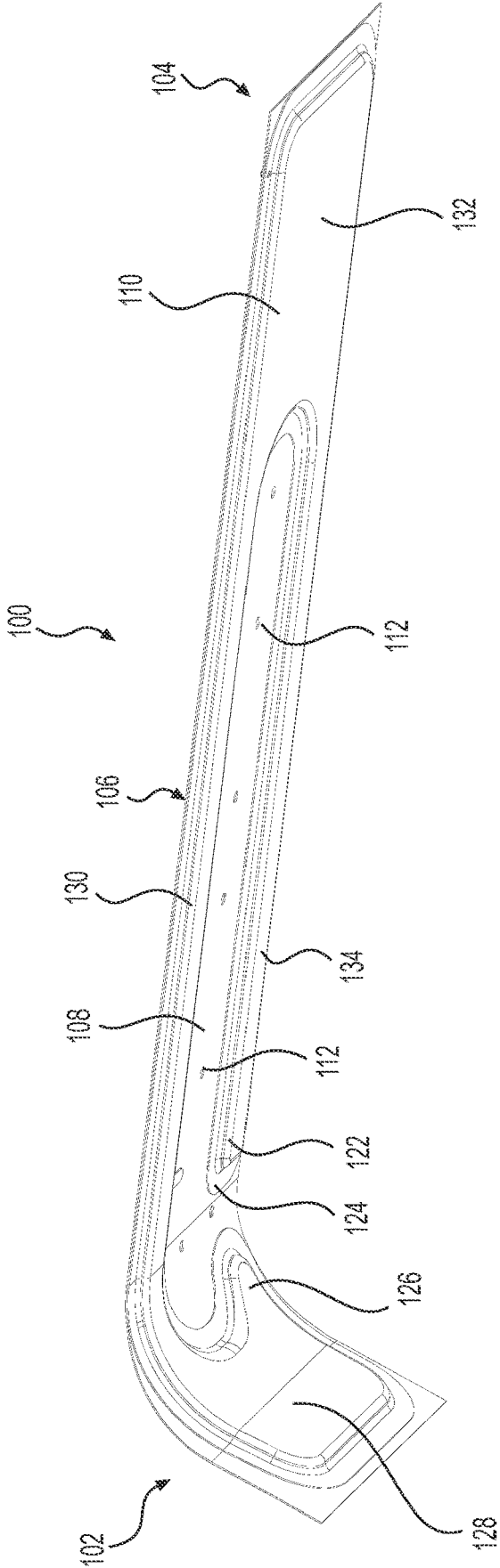


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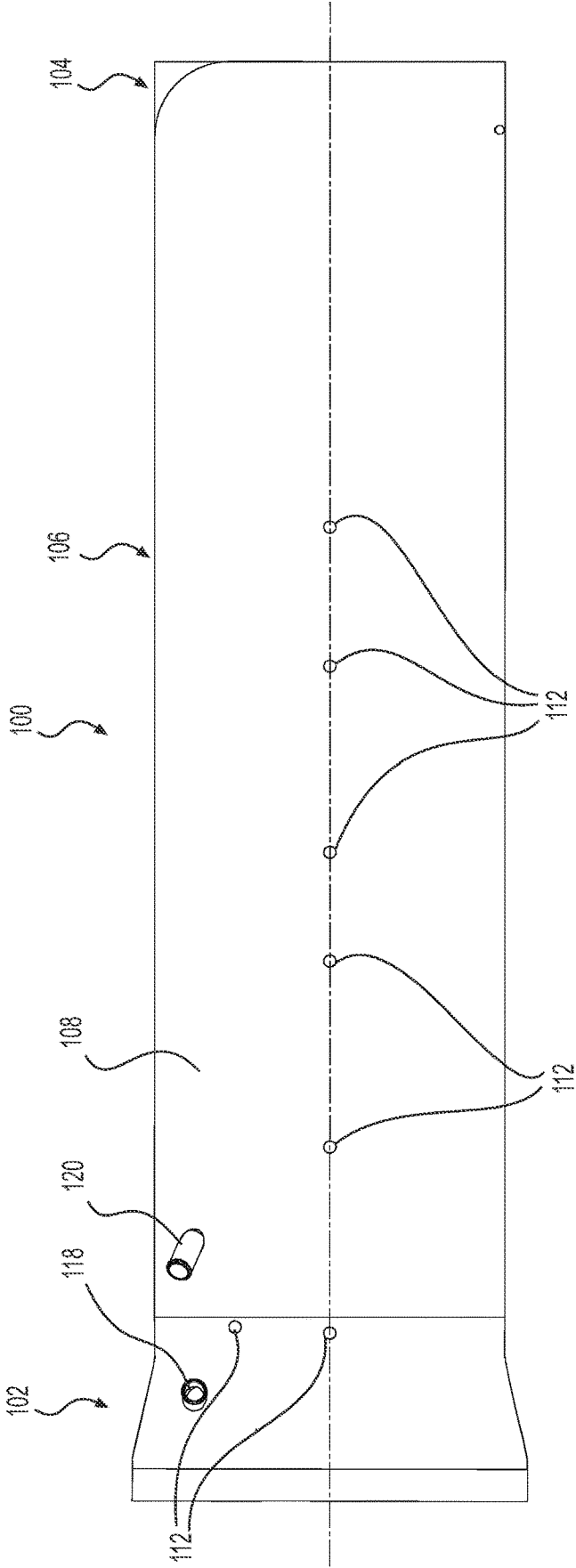


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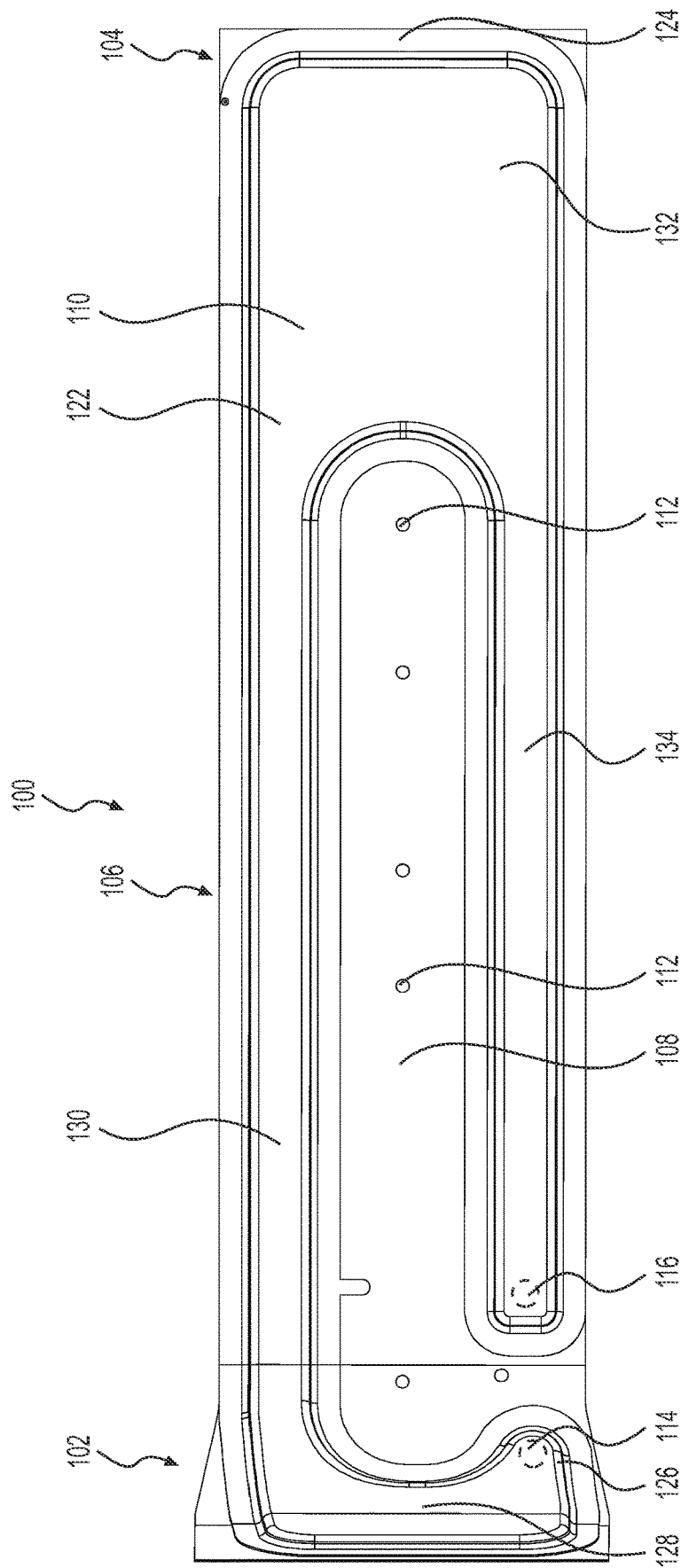


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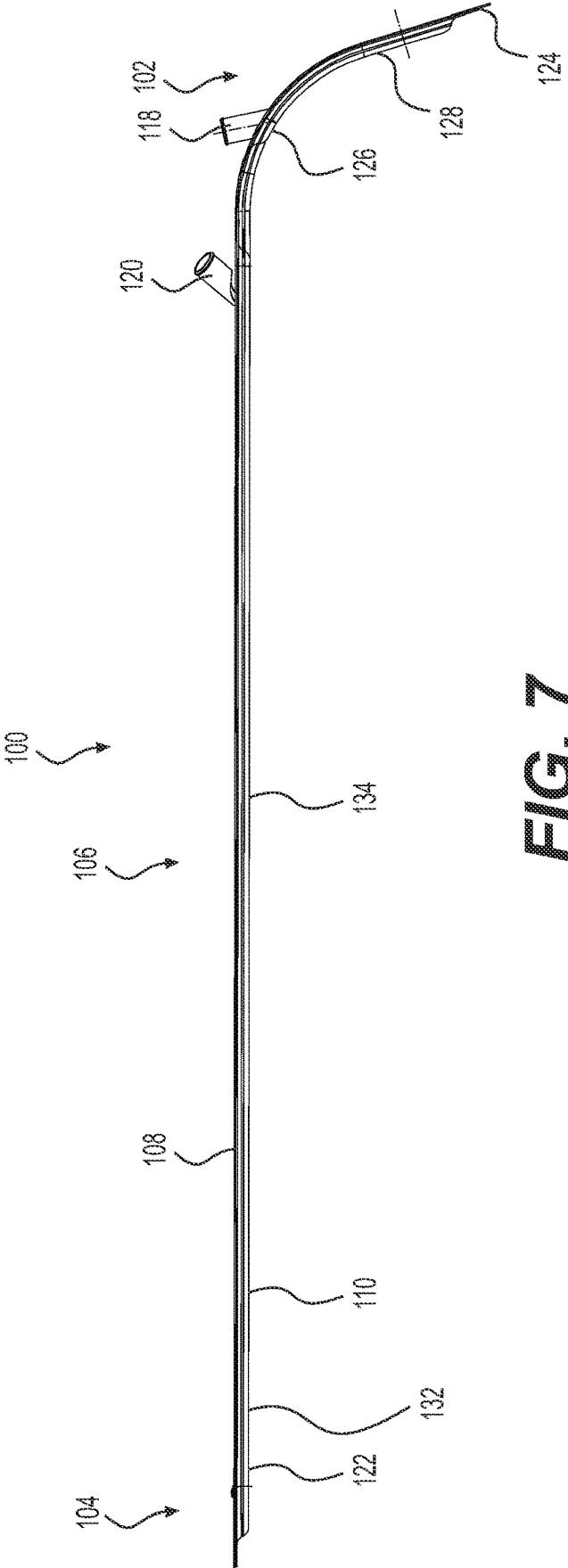


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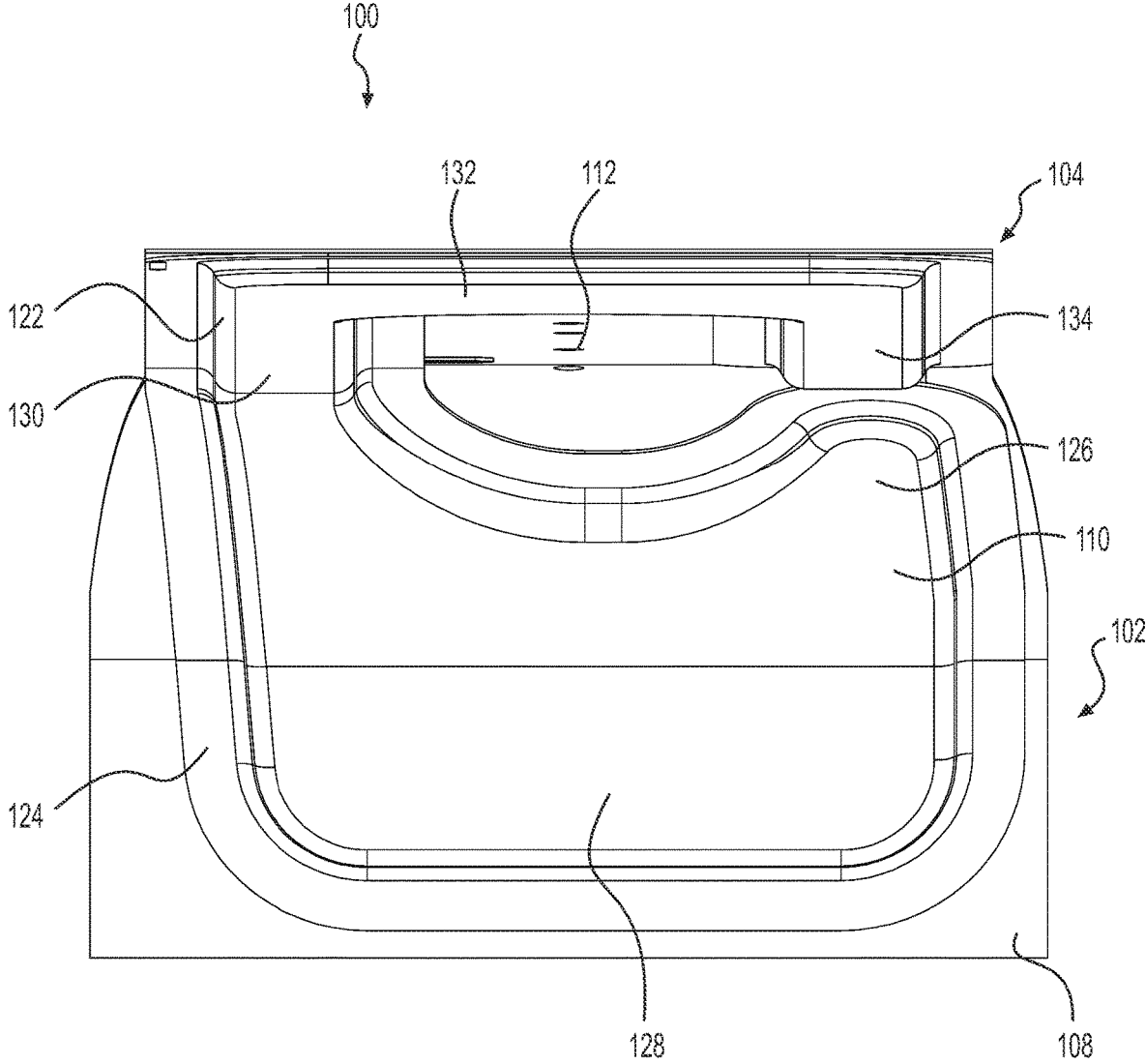


FIG. 8

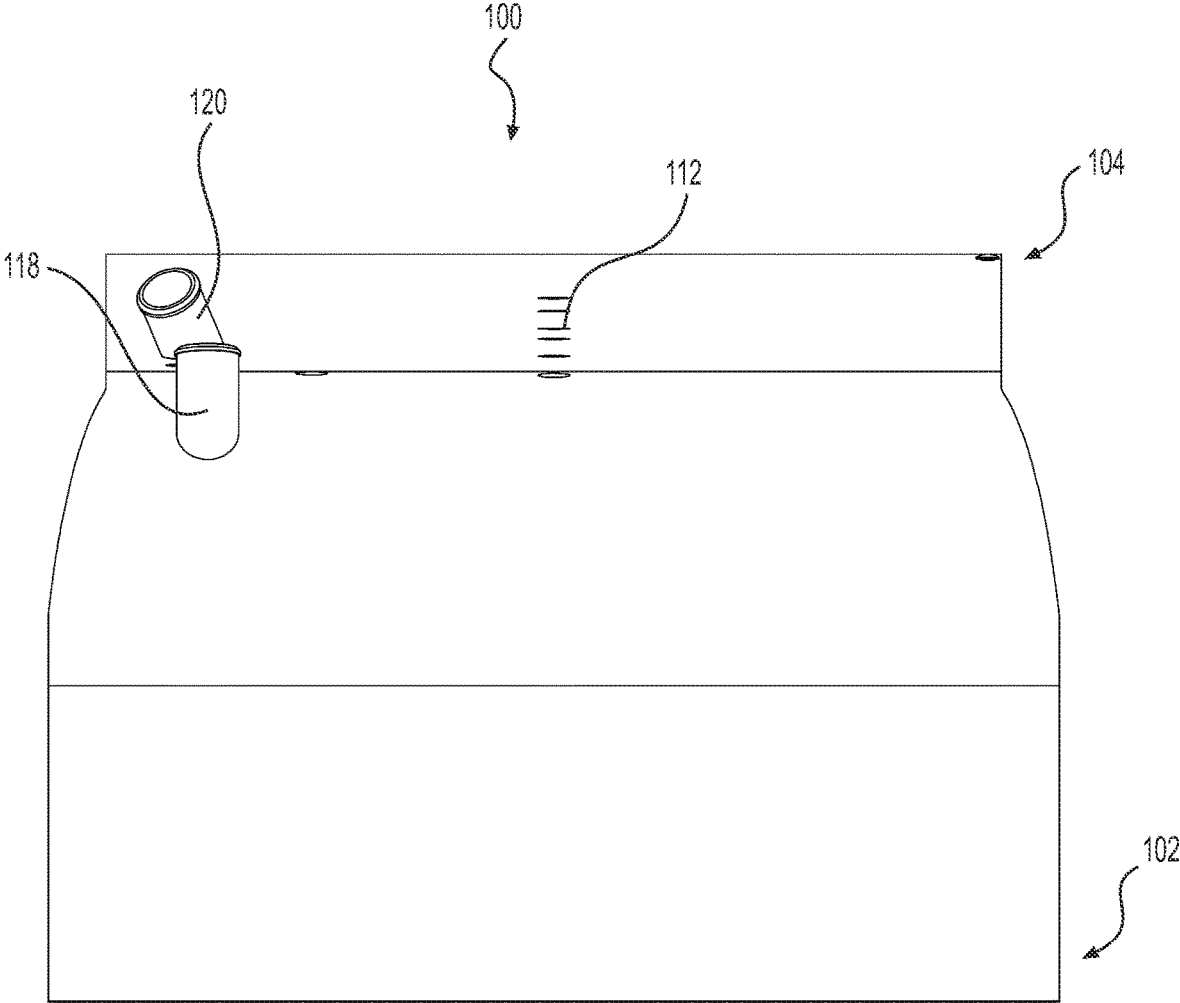


FIG. 9

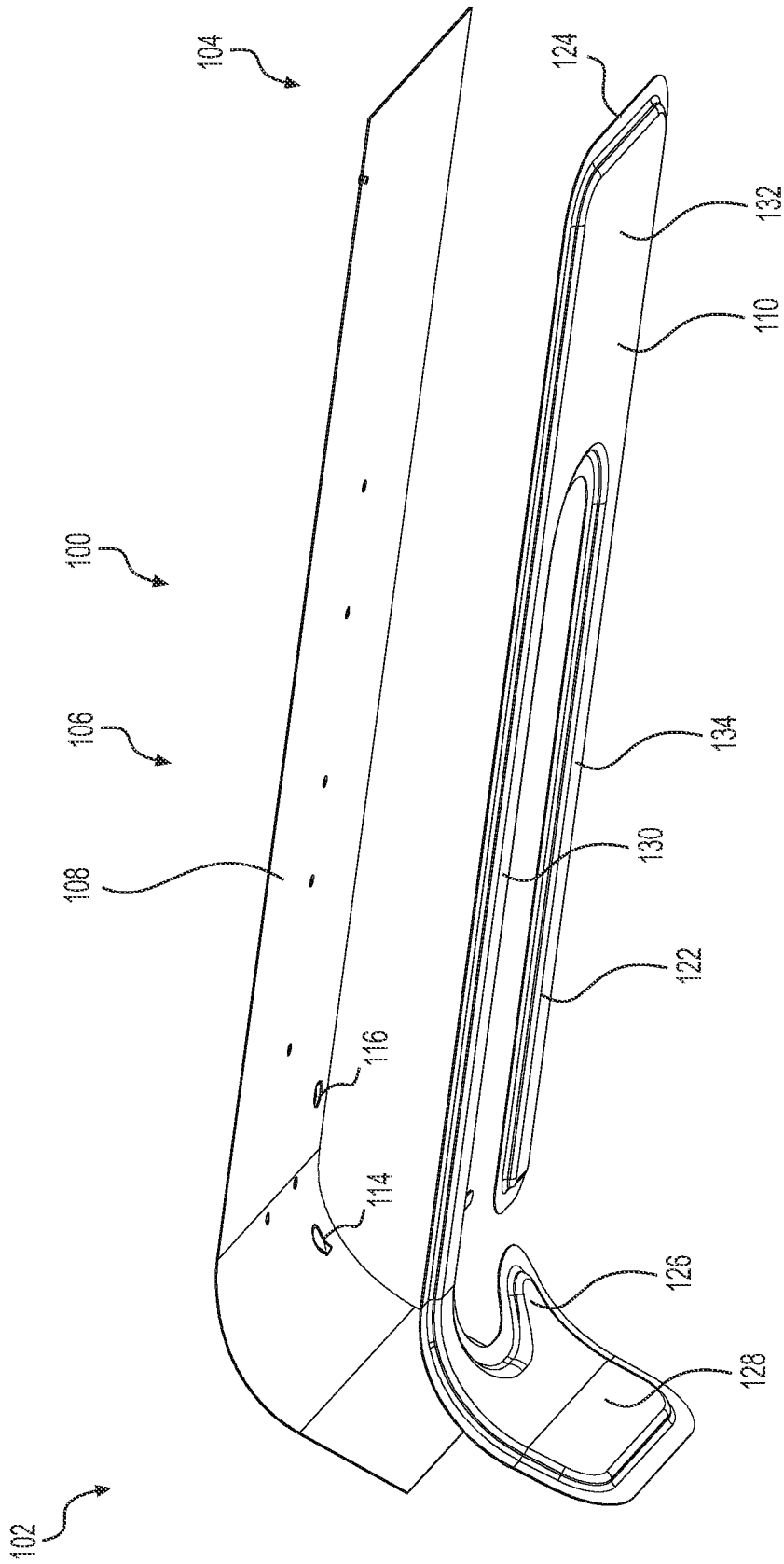


FIG. 10

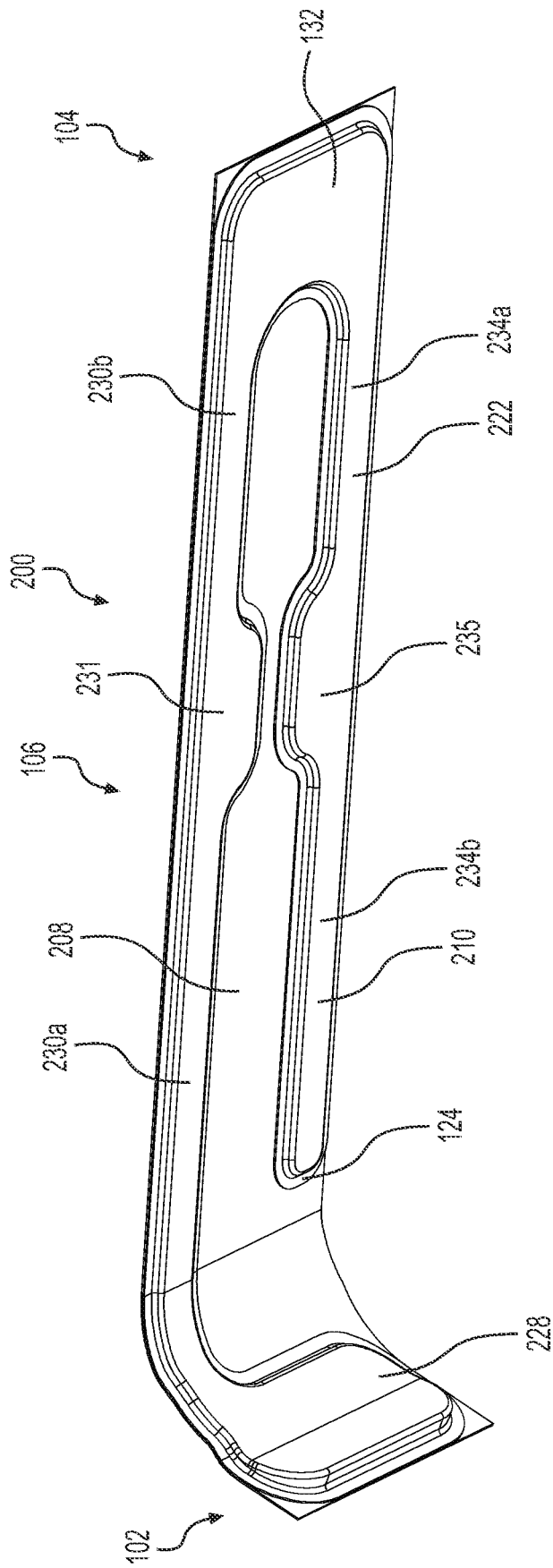


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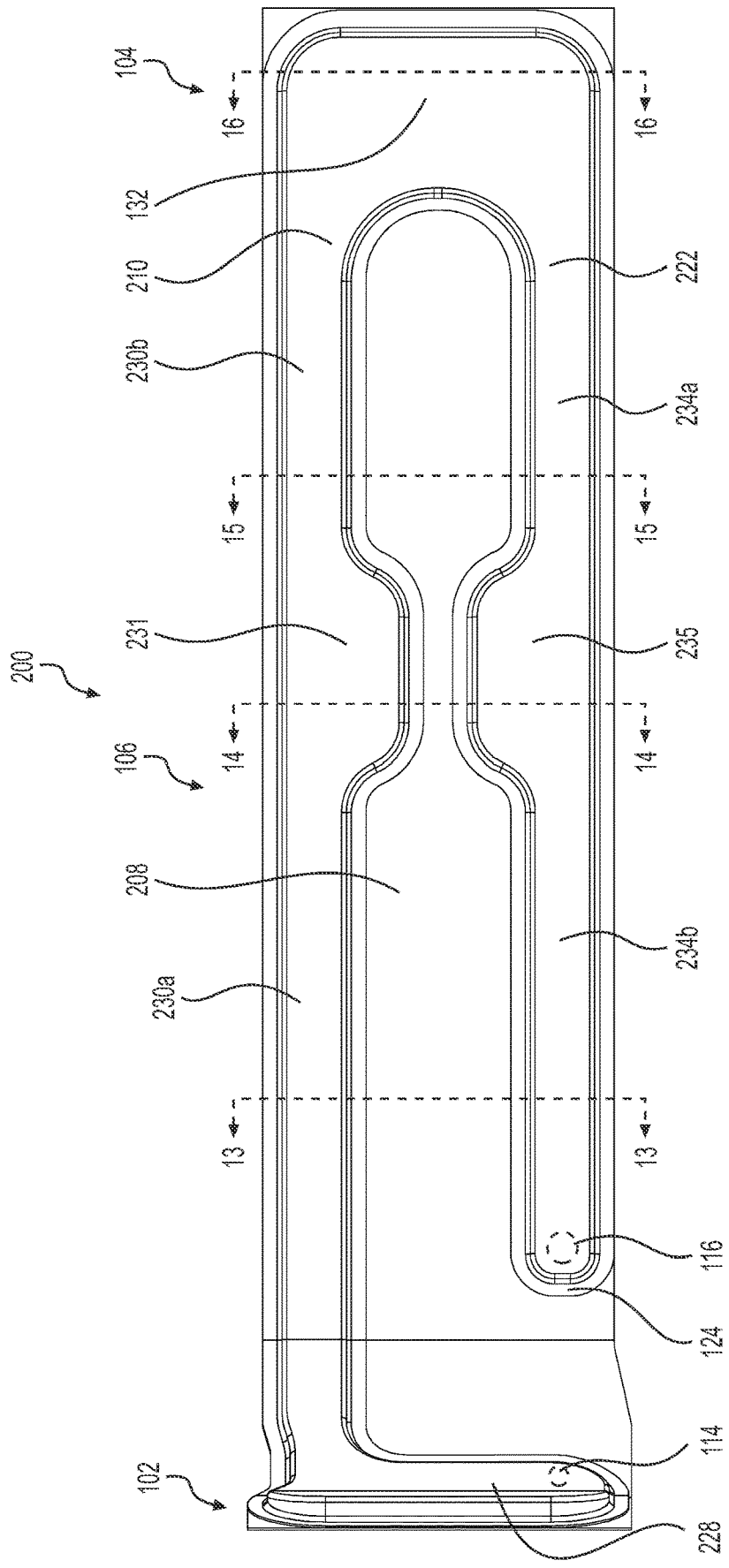


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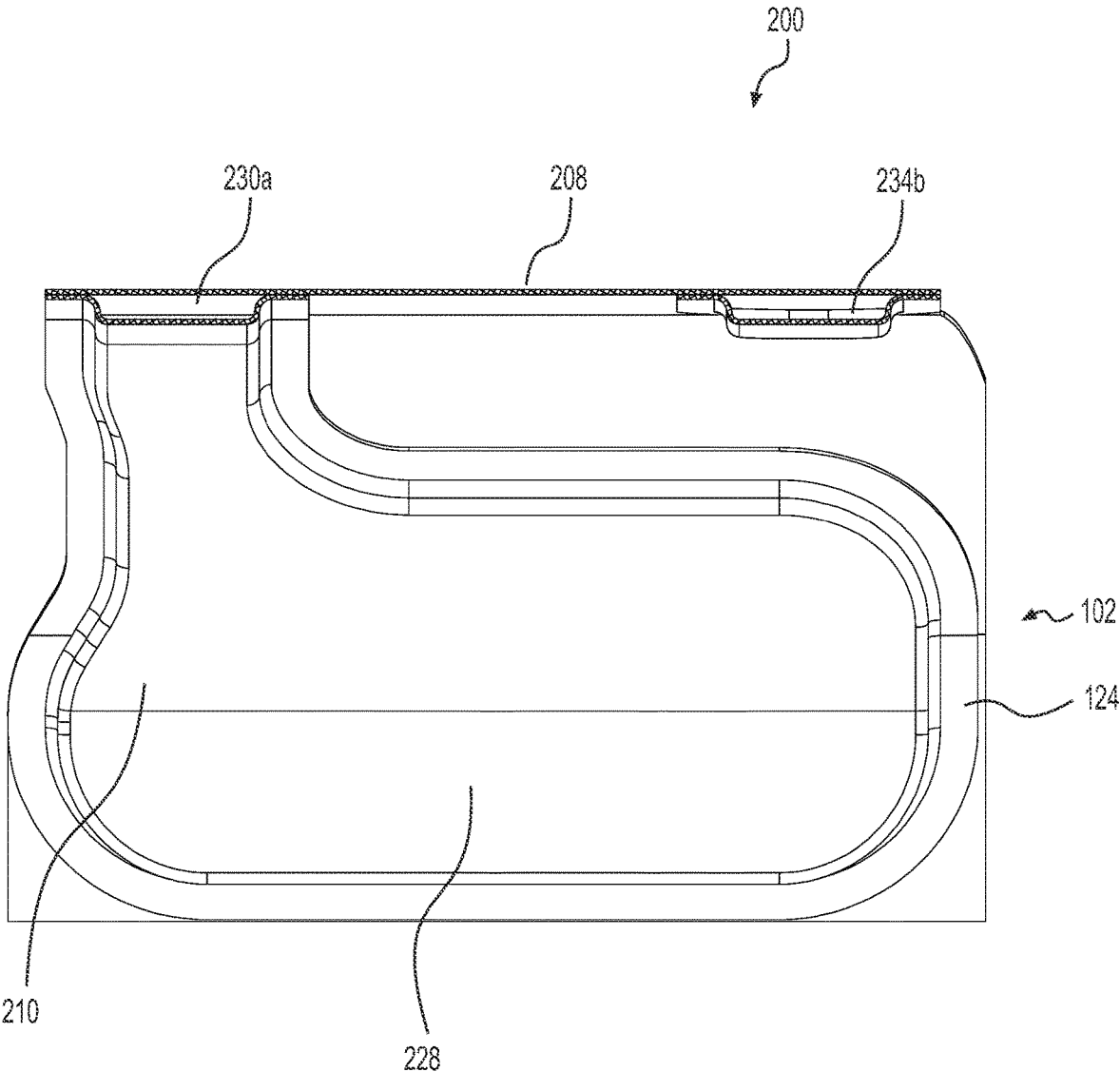


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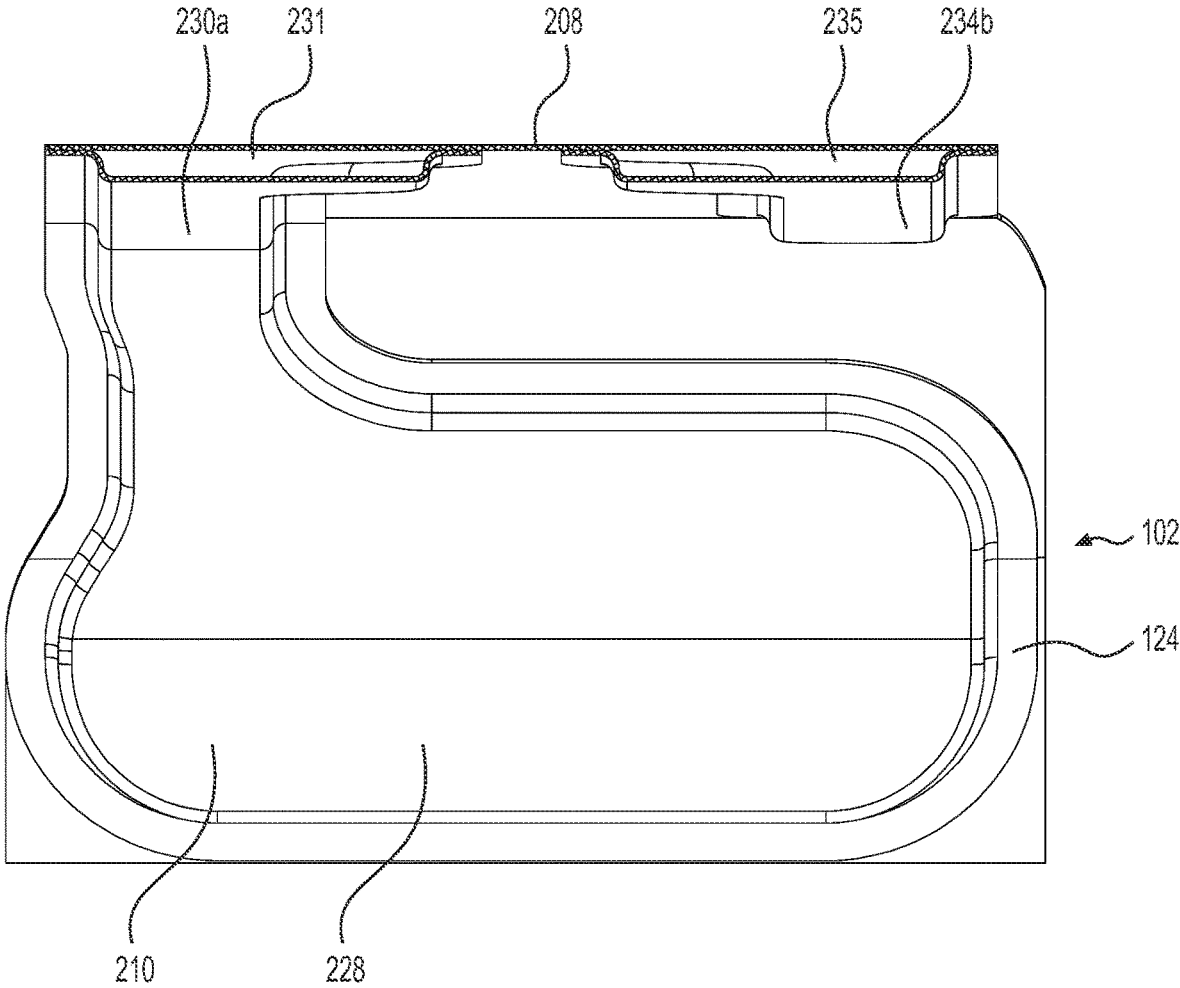


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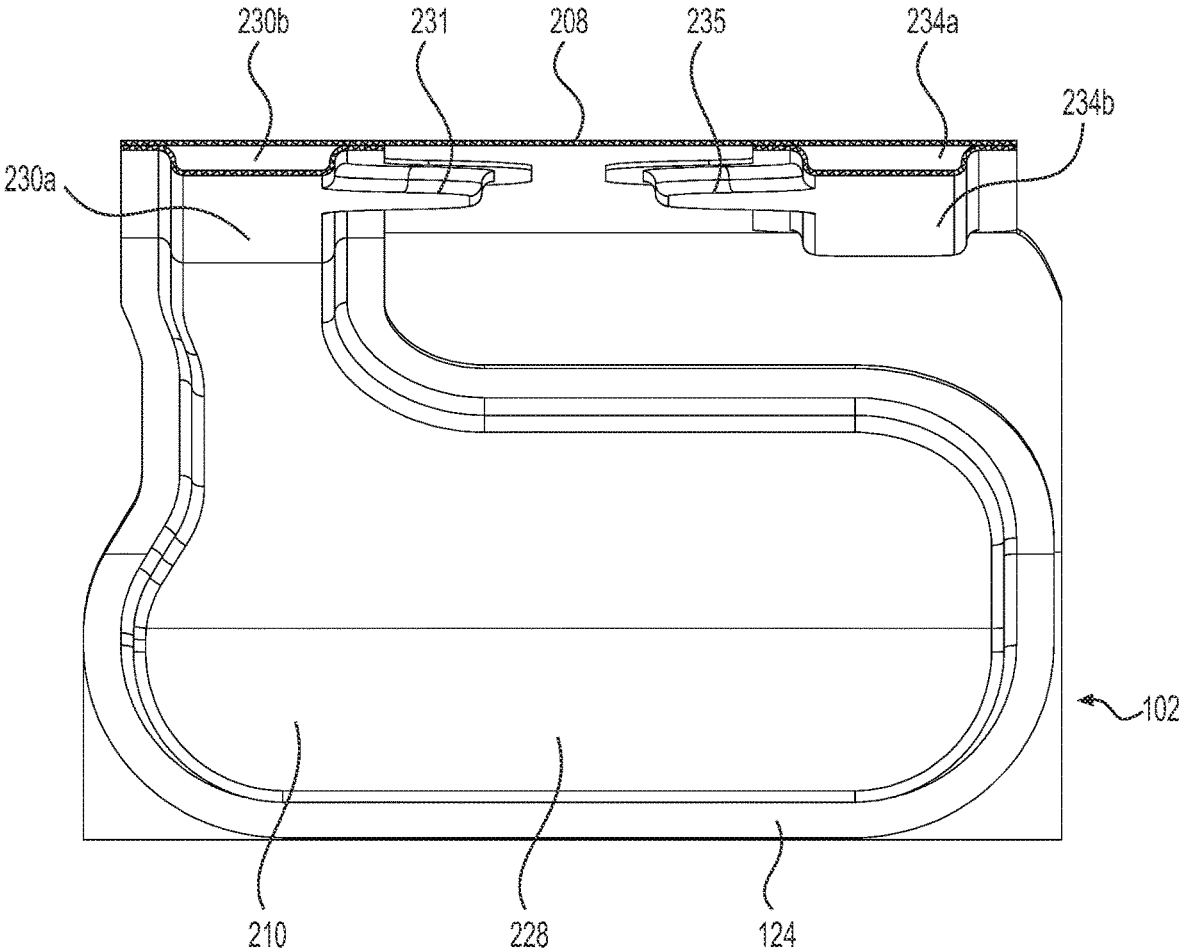


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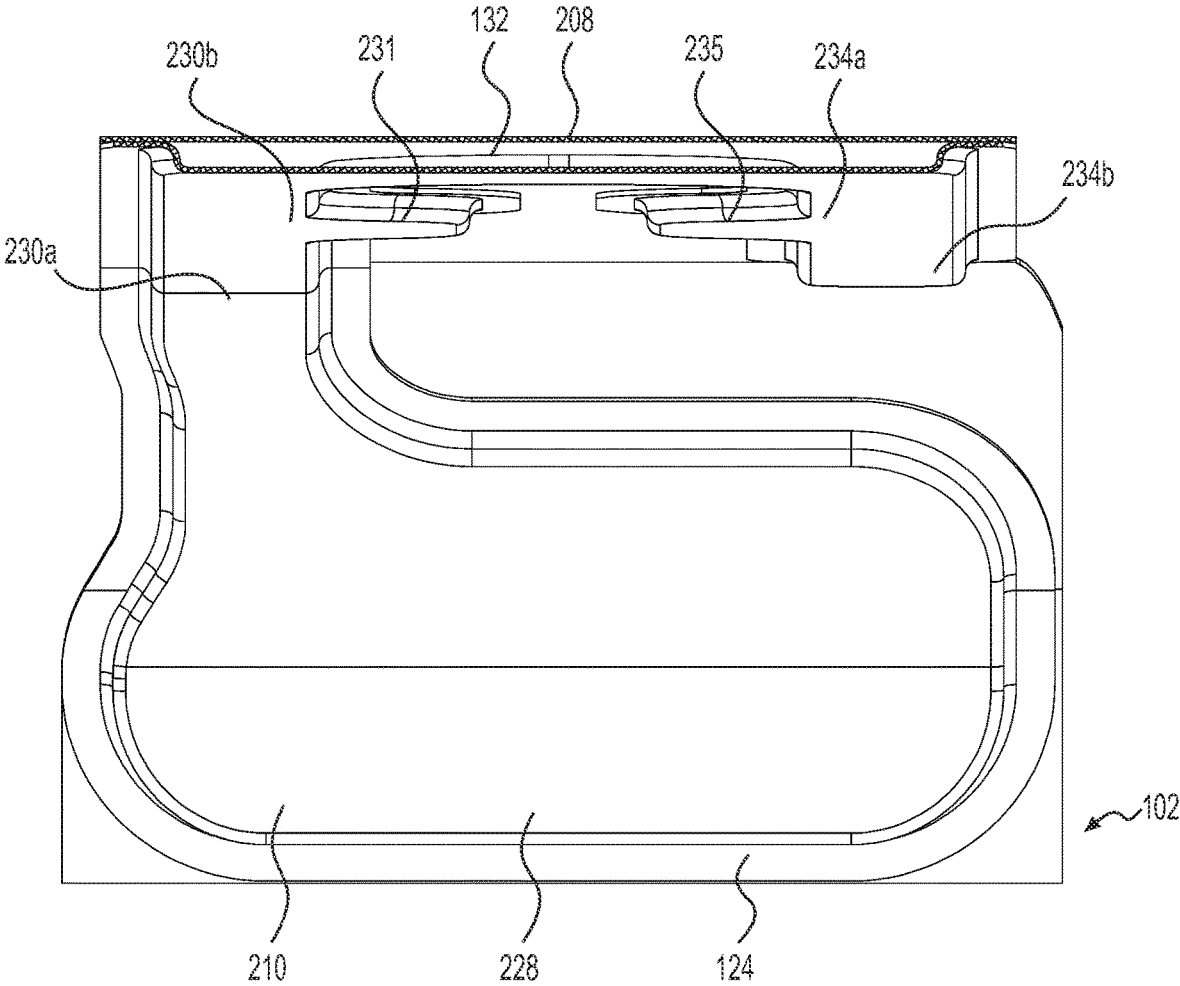


FIG. 16

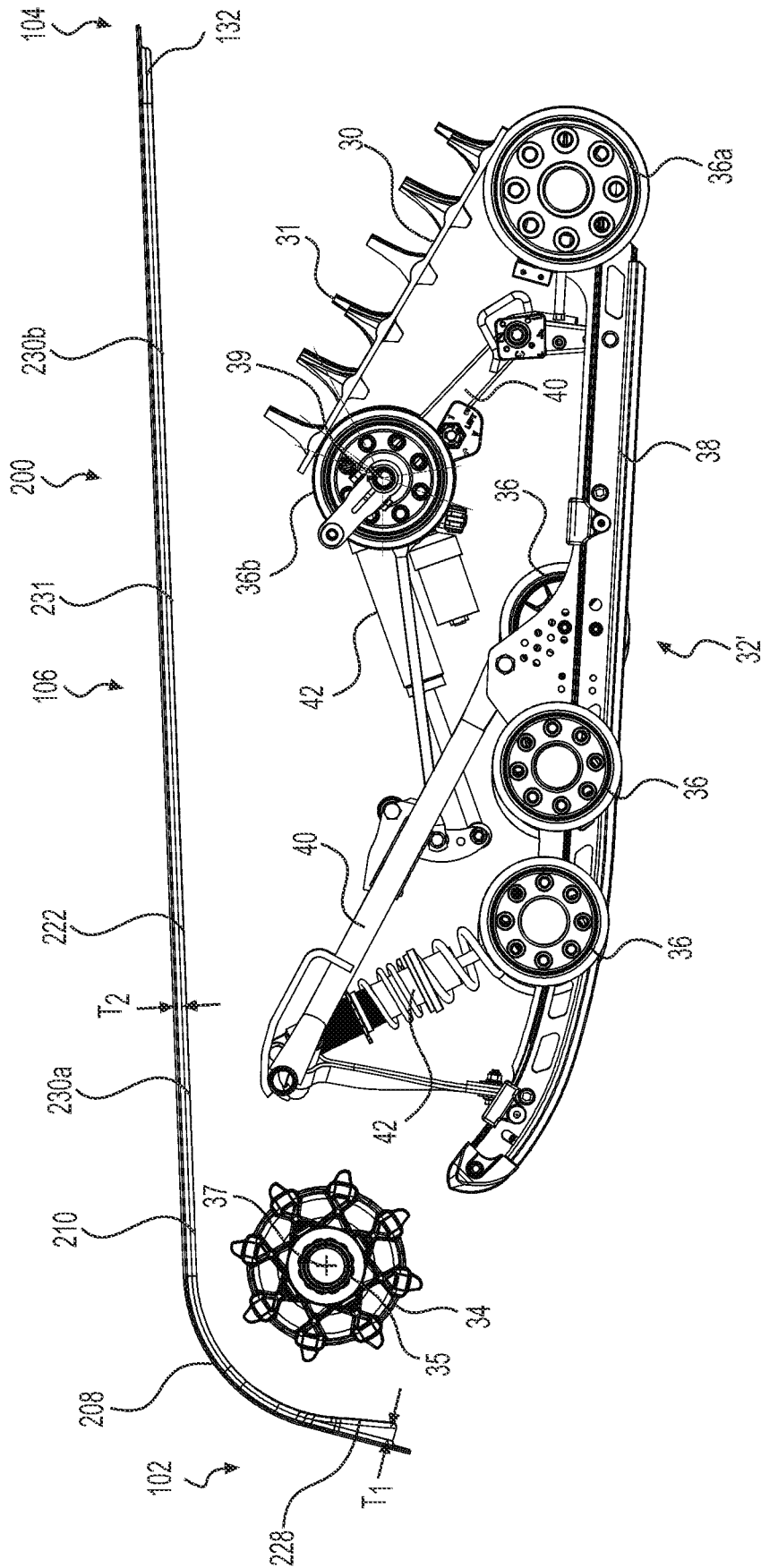


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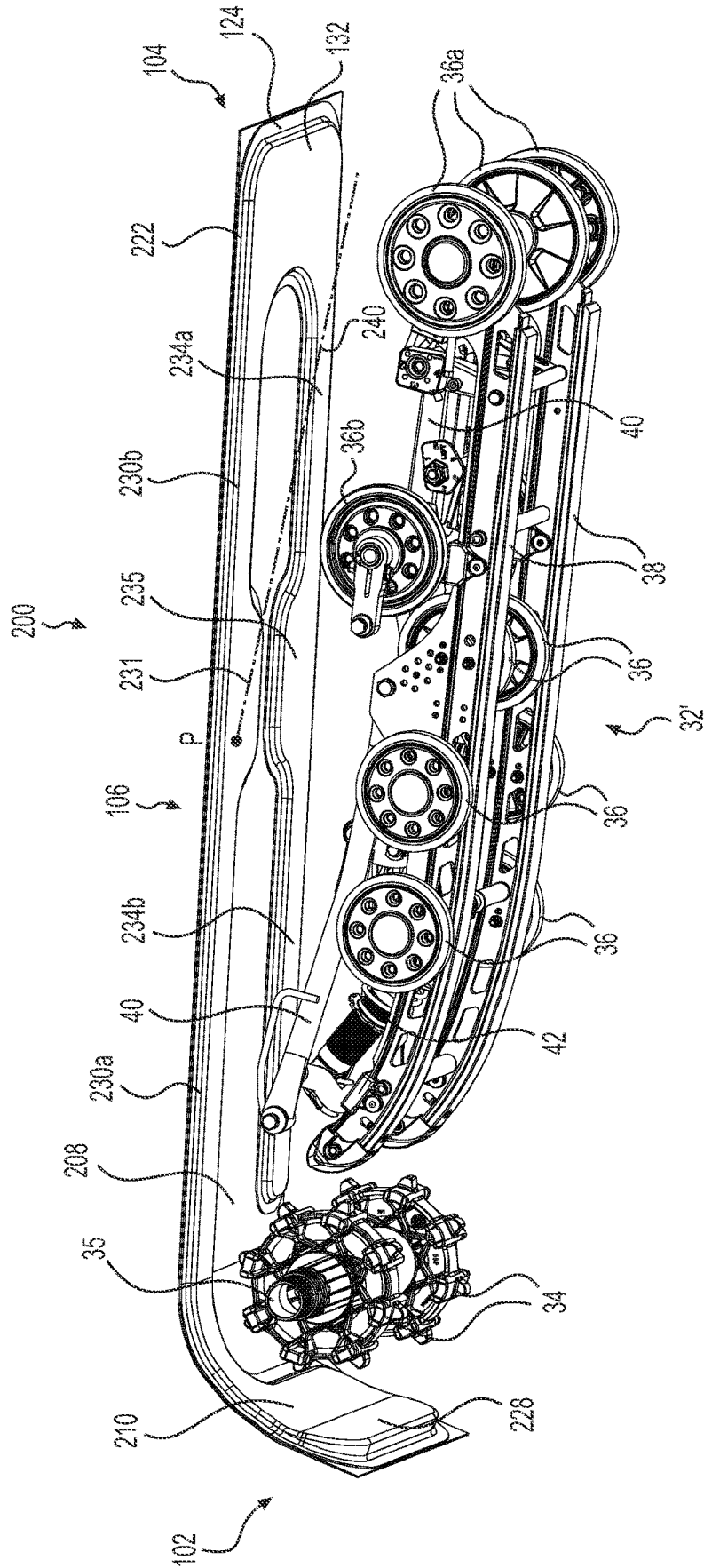


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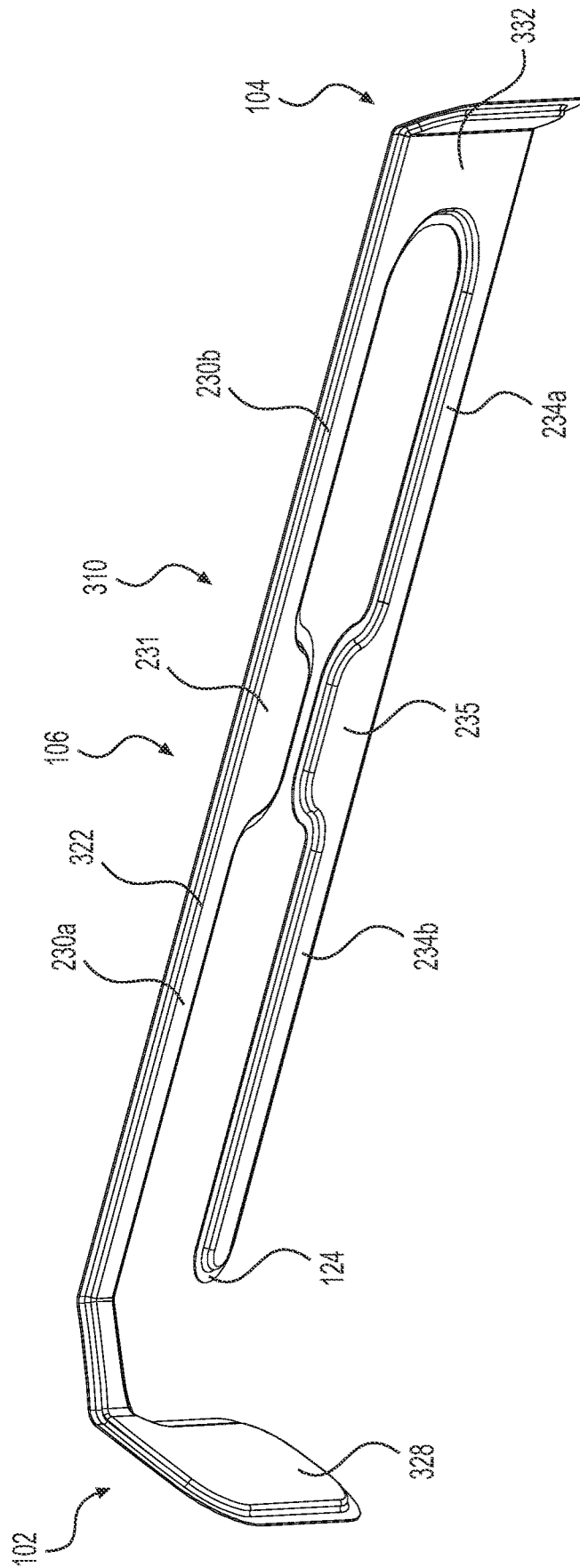


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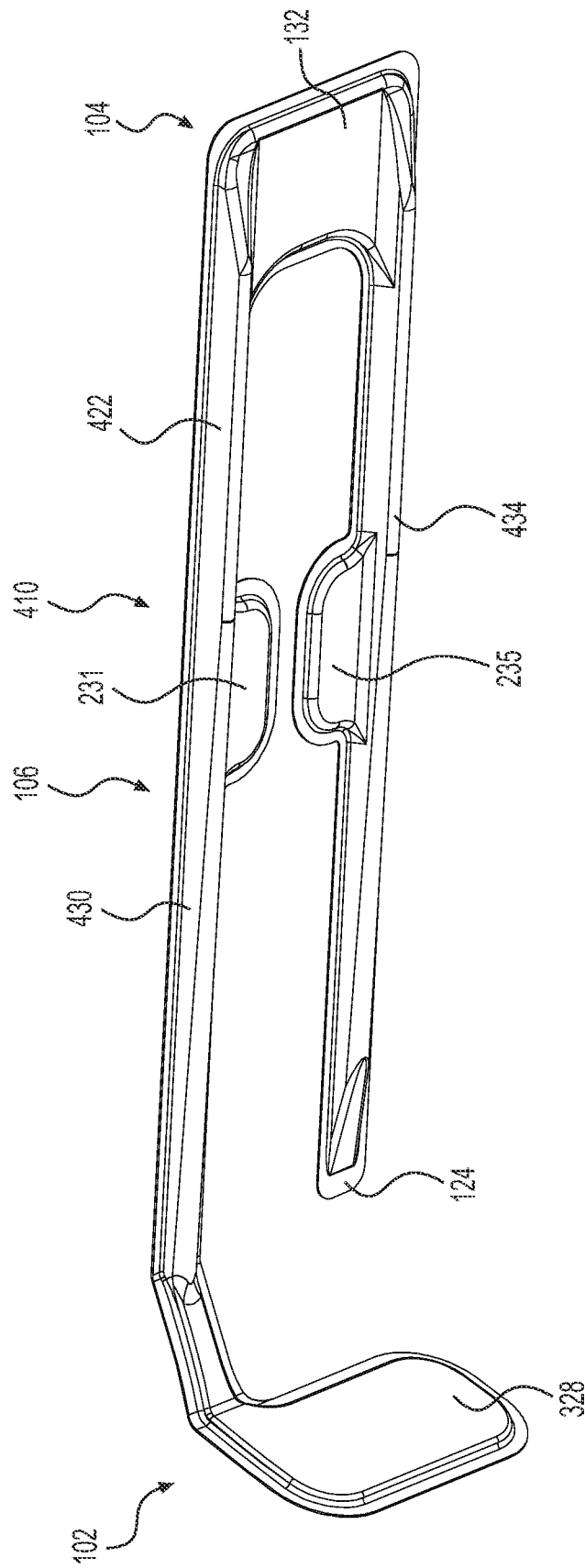


FIG. 21

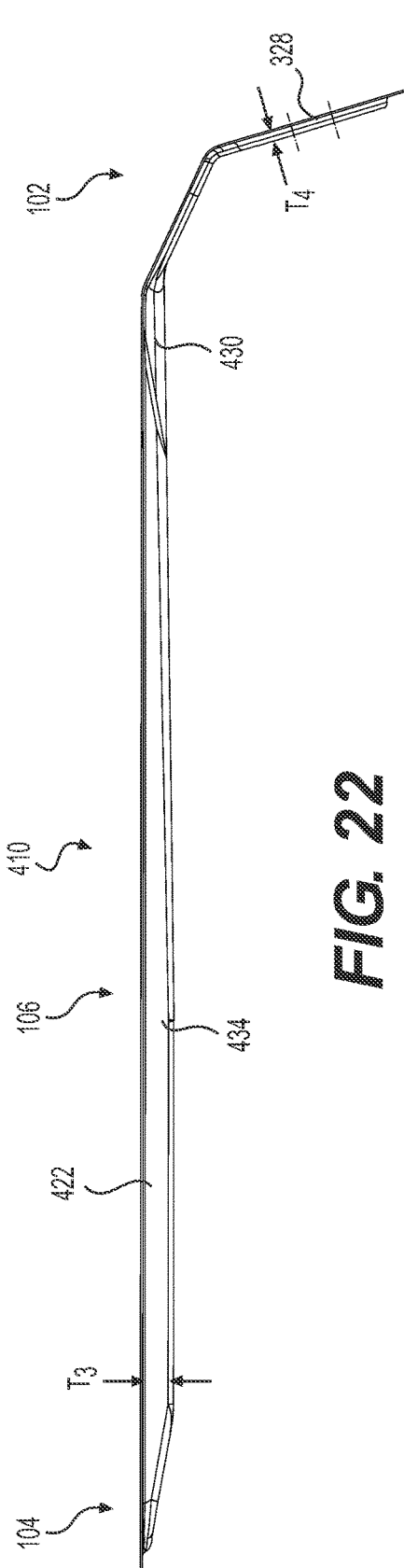


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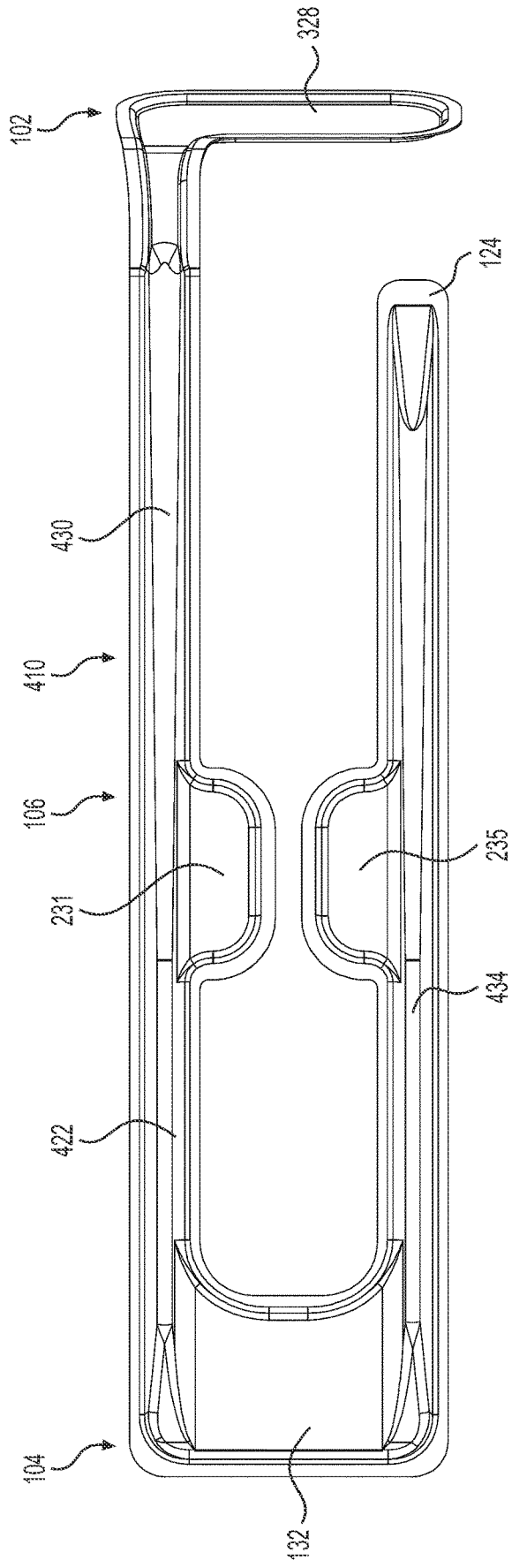


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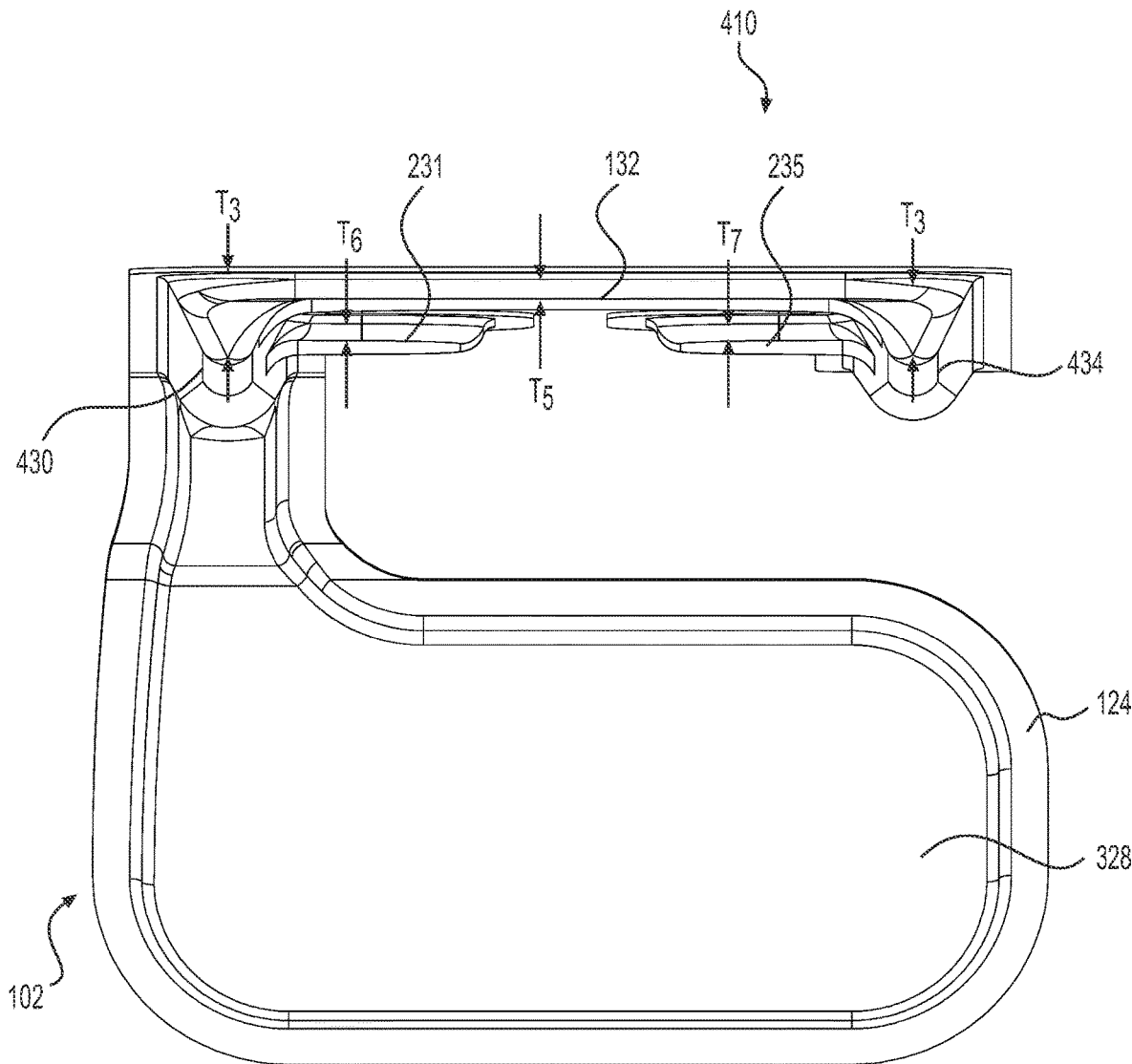


FIG. 24

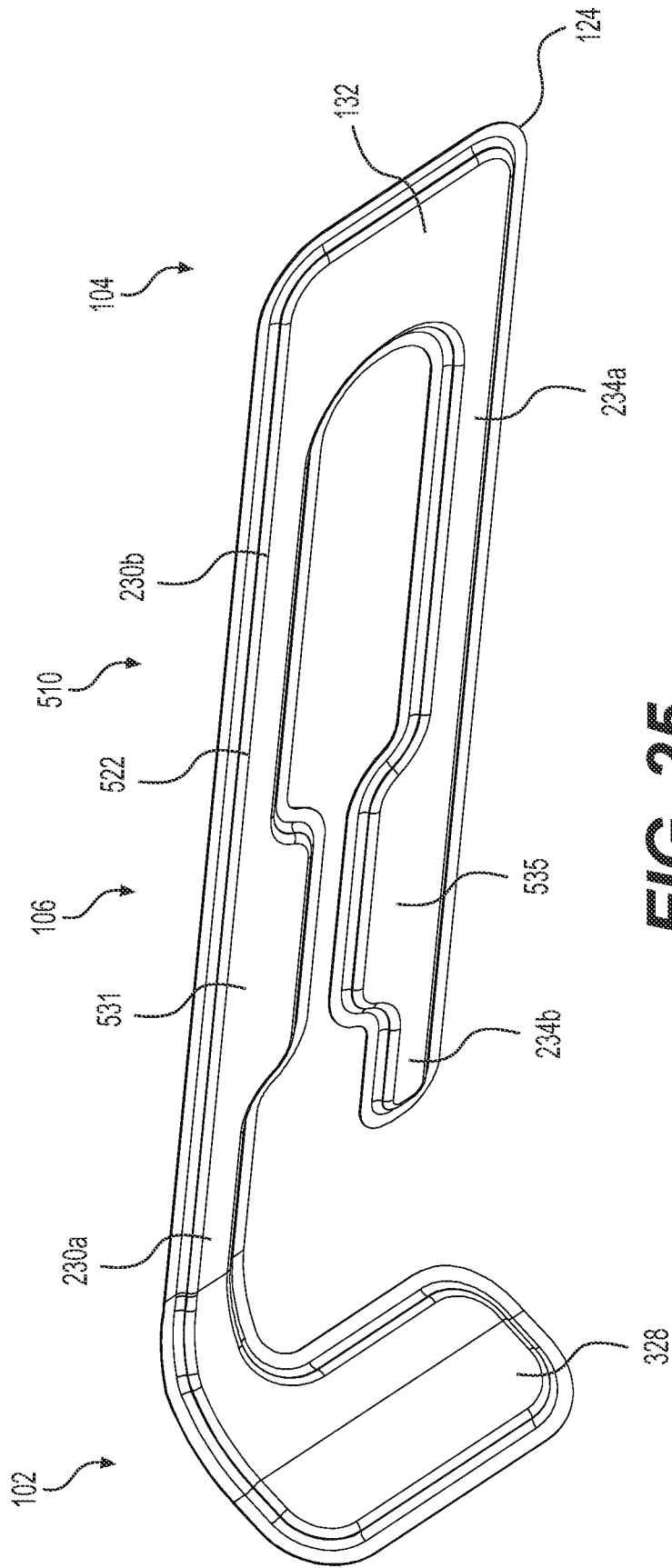


FIG. 25

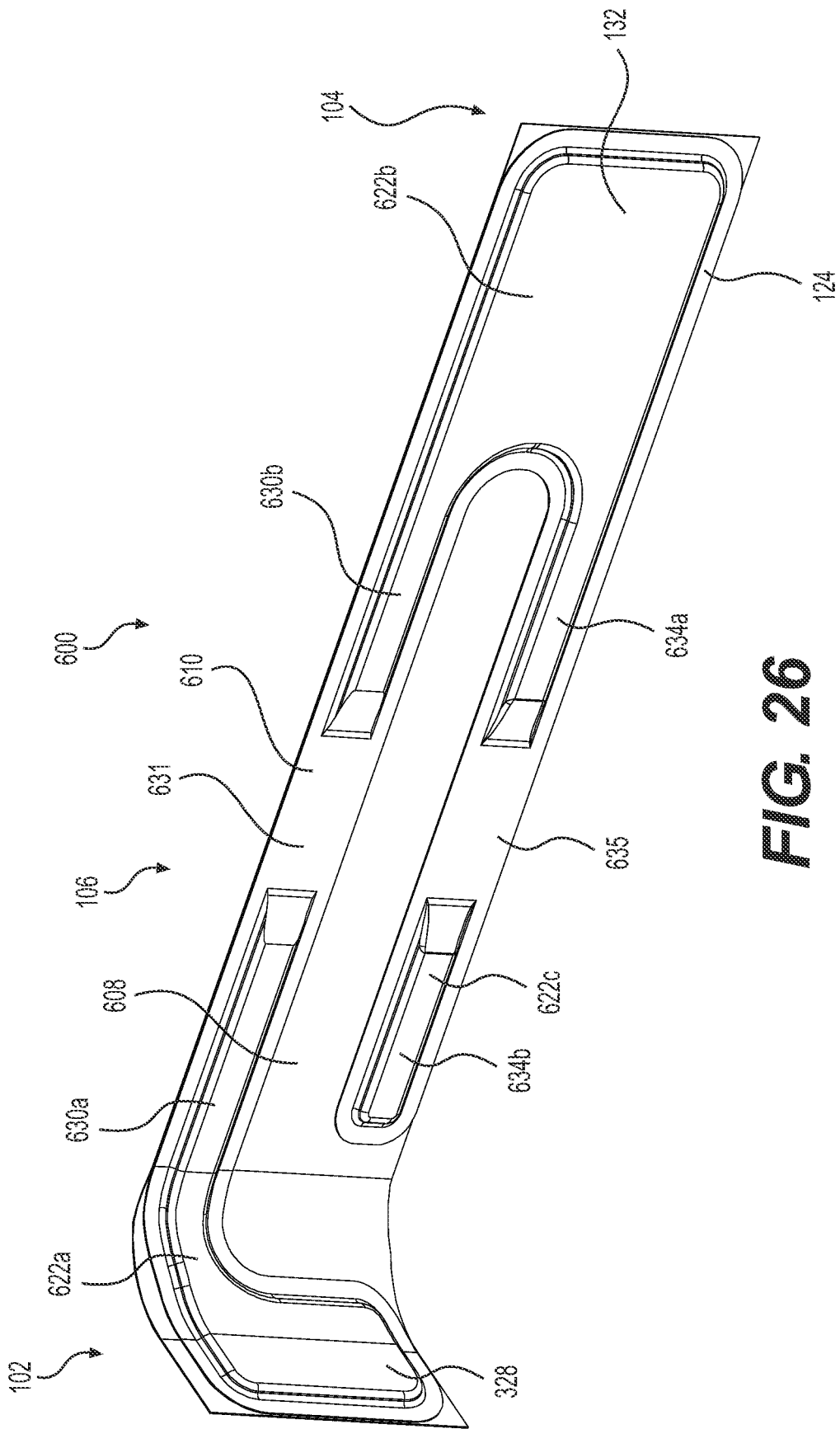


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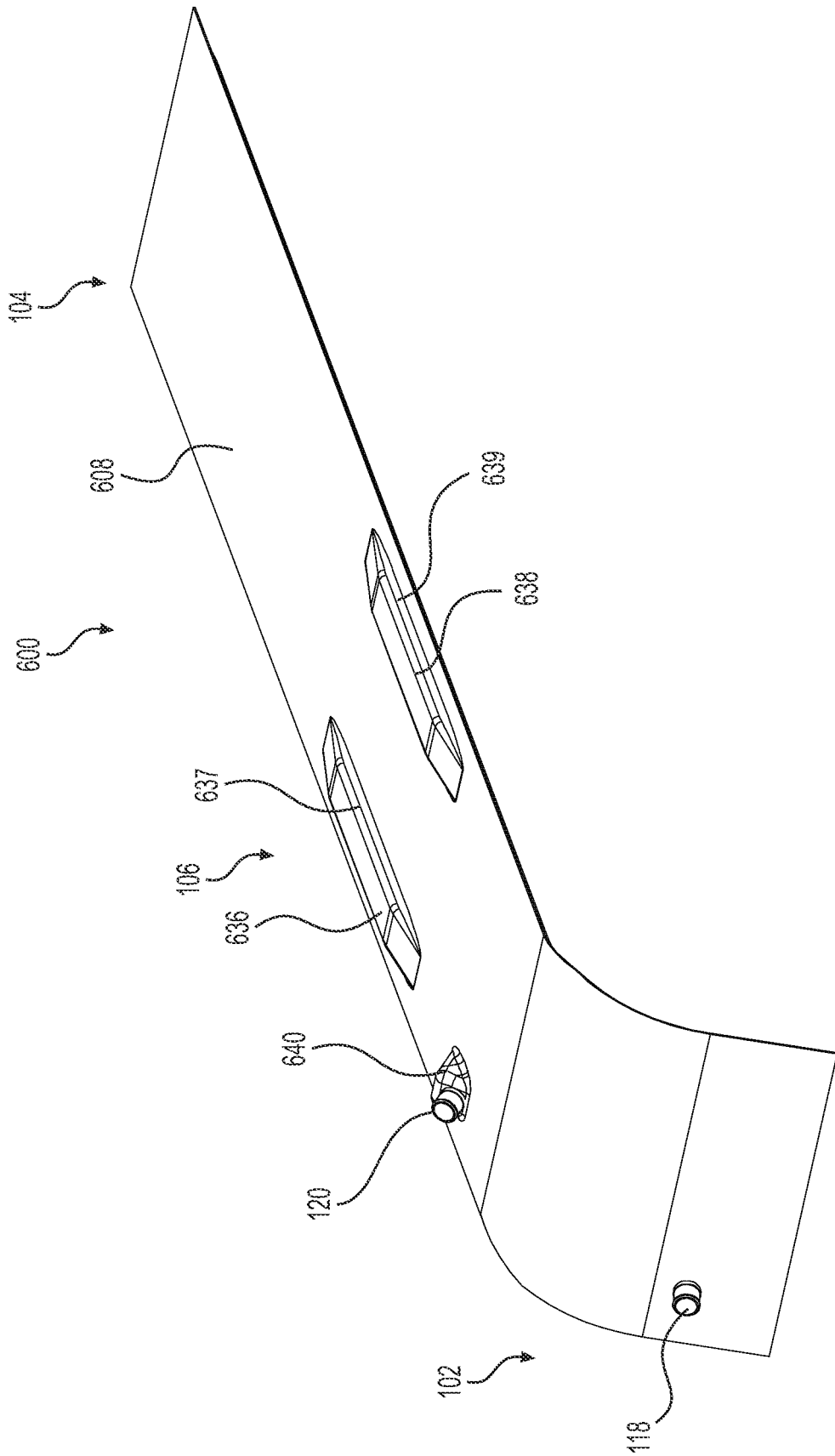


FIG. 27

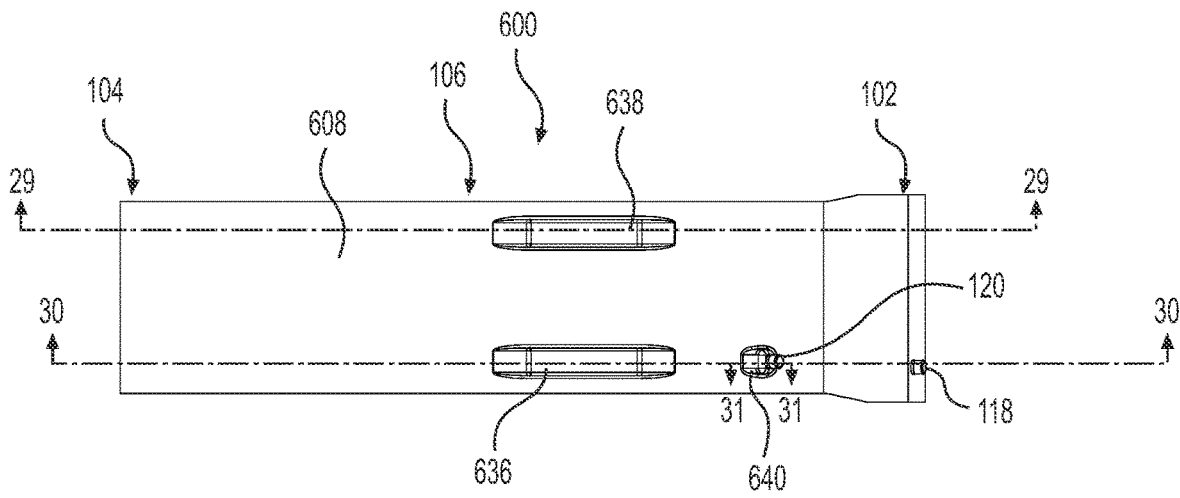


FIG. 28

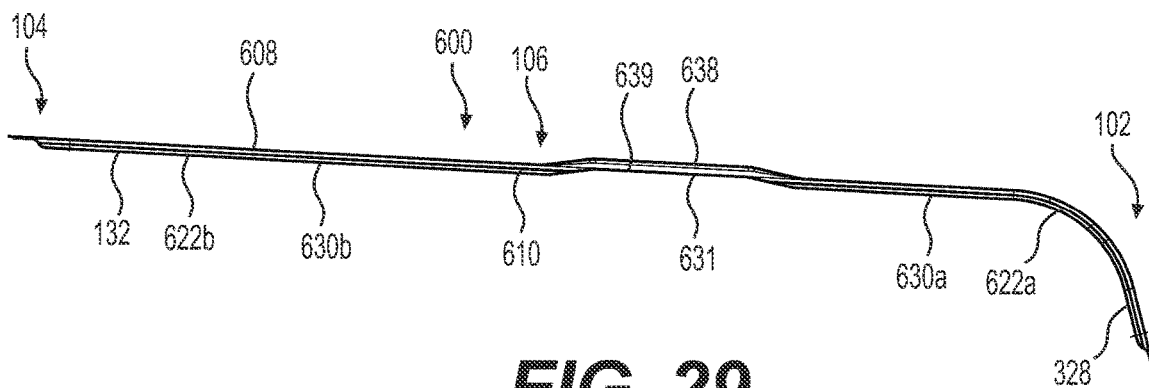


FIG. 29

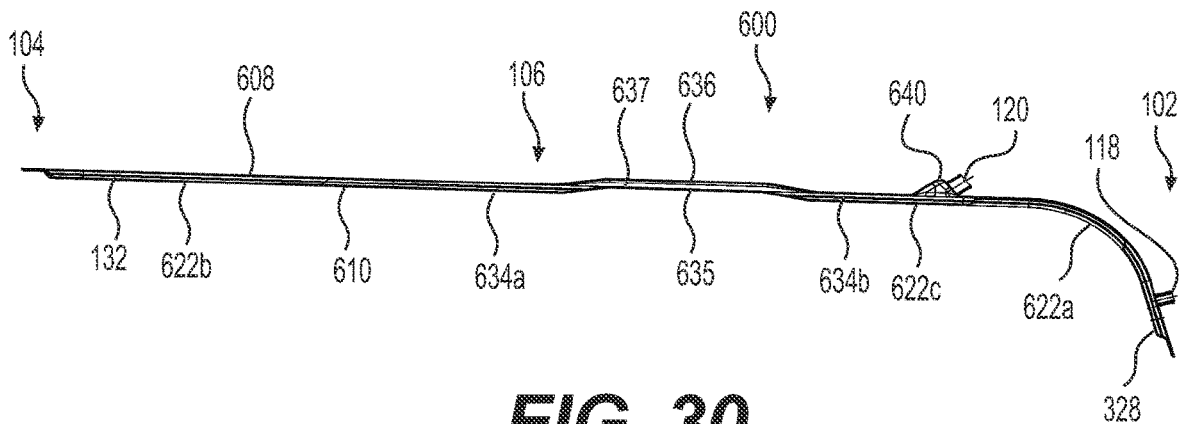


FIG. 30

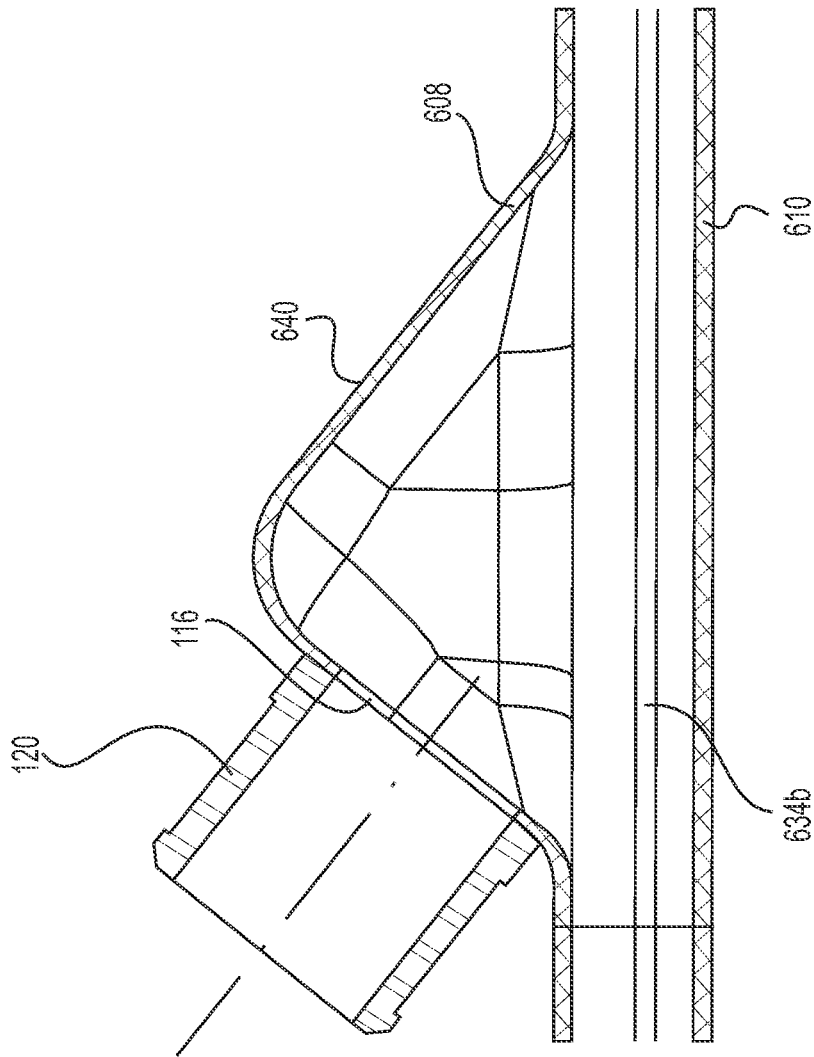


FIG. 31

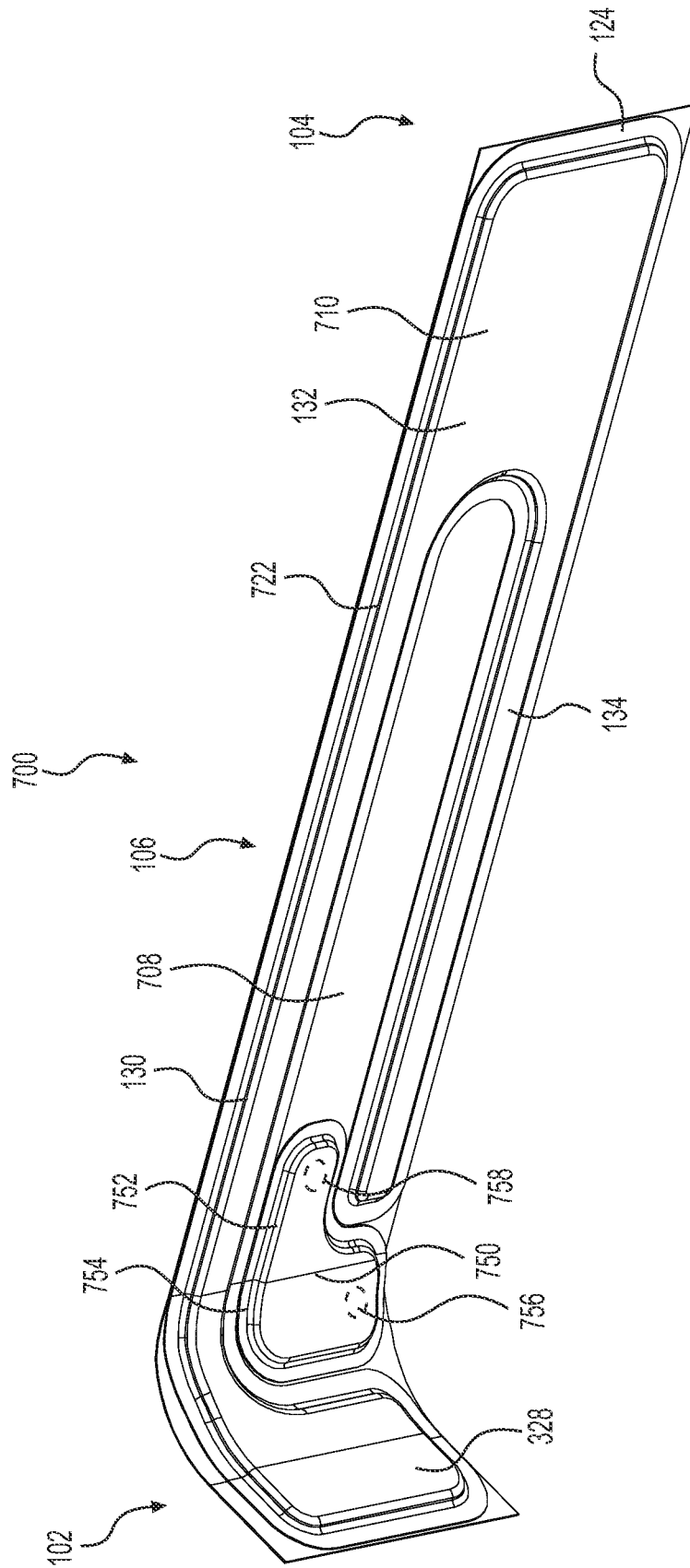


FIG. 32

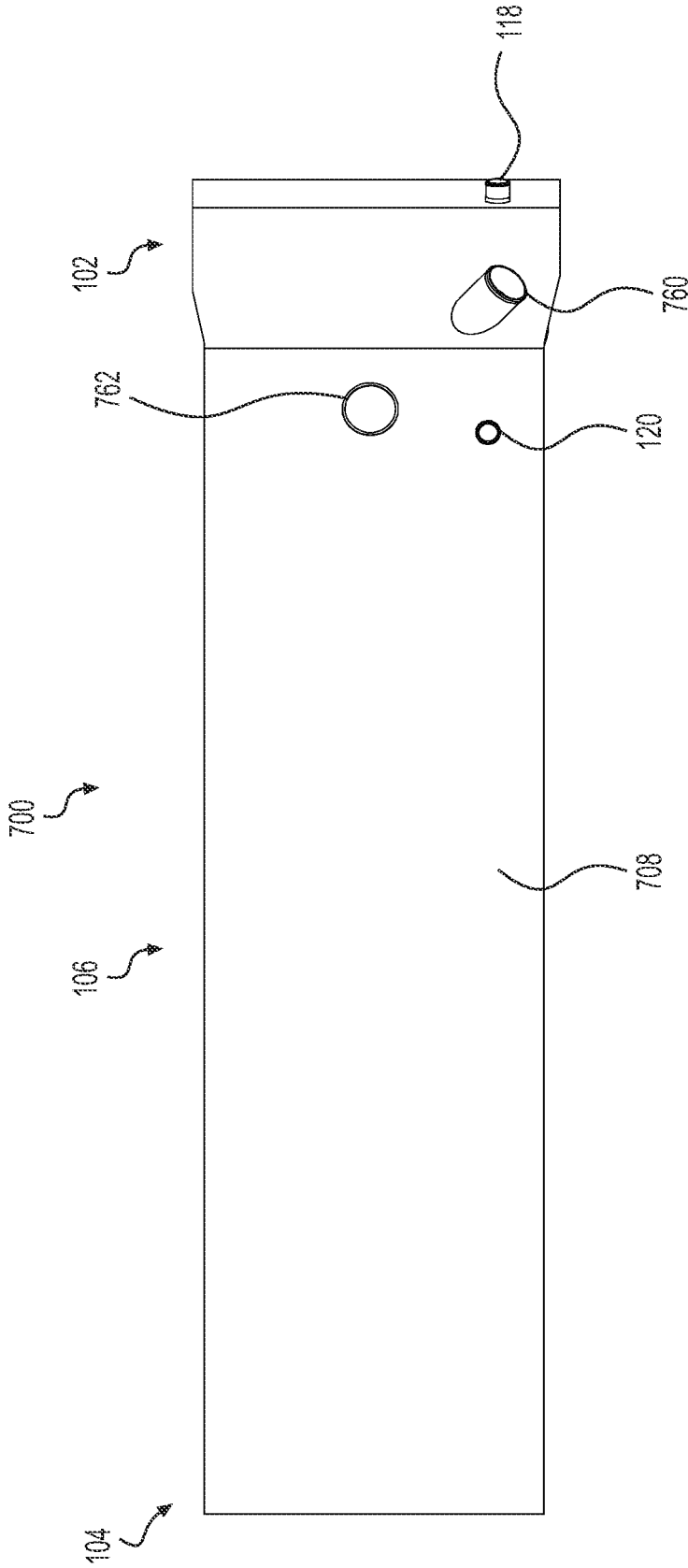


FIG. 33

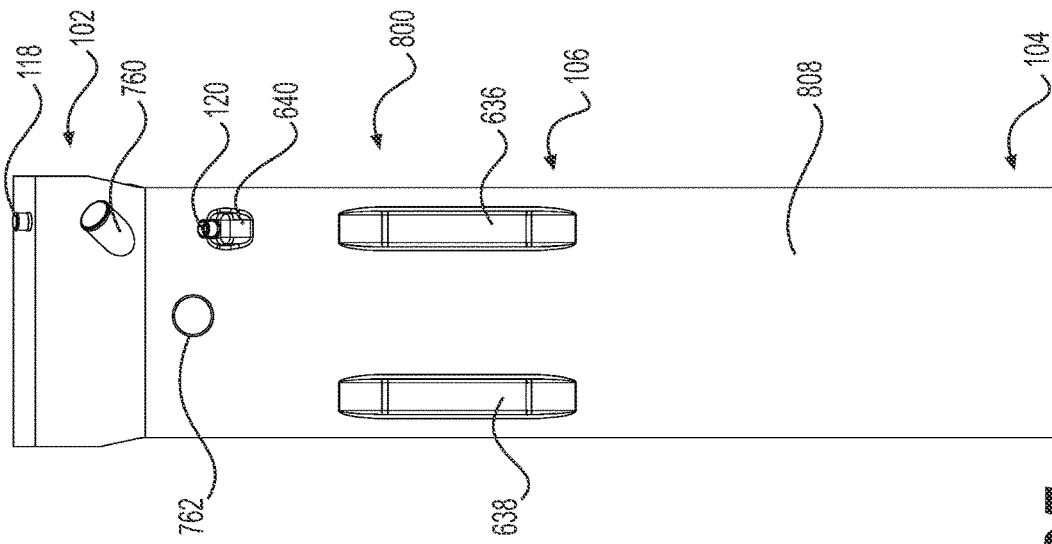


FIG. 35

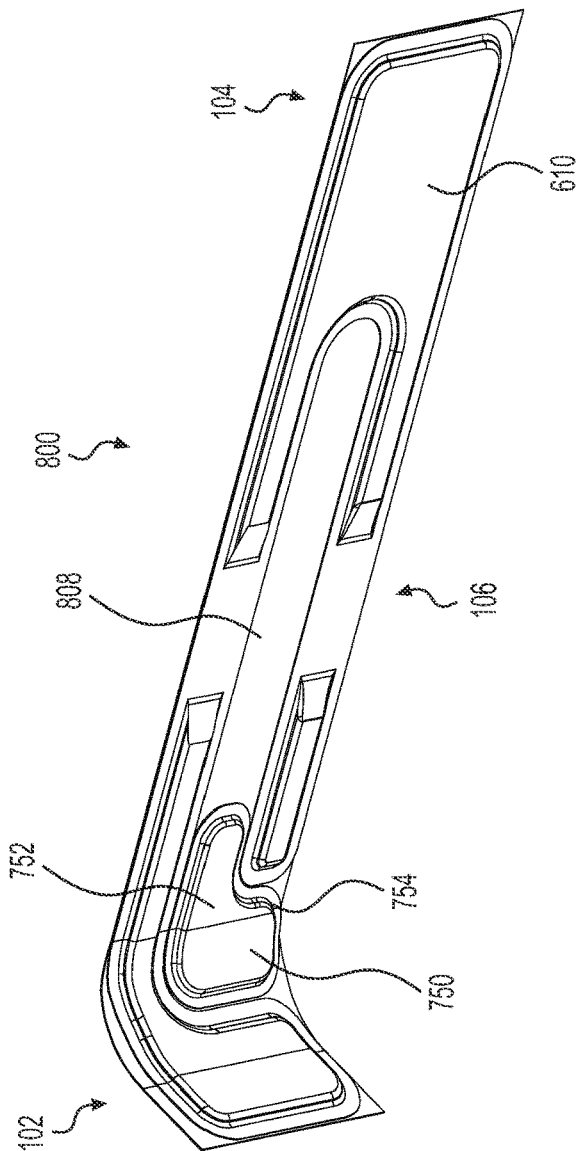


FIG. 34

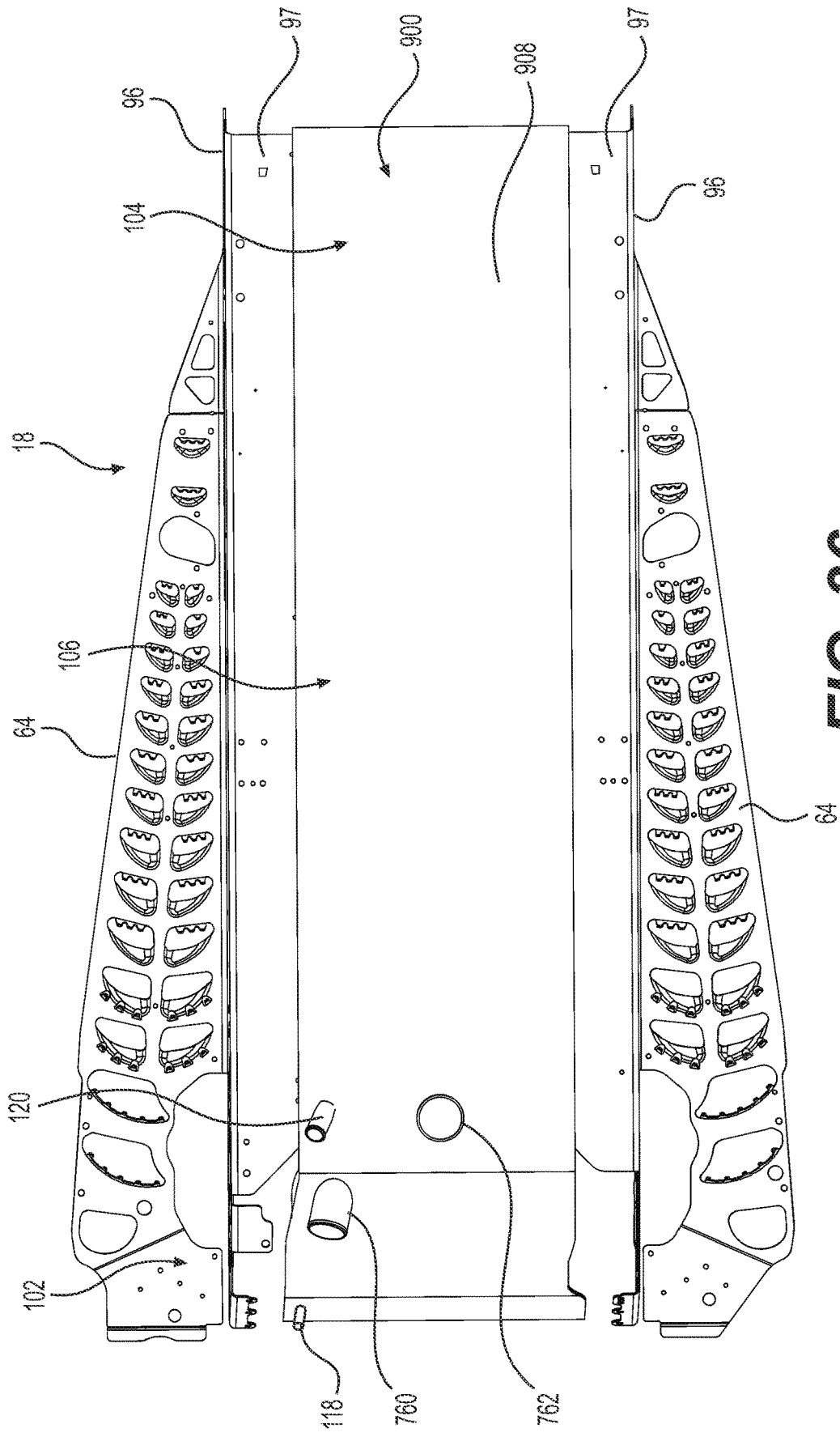


FIG. 36

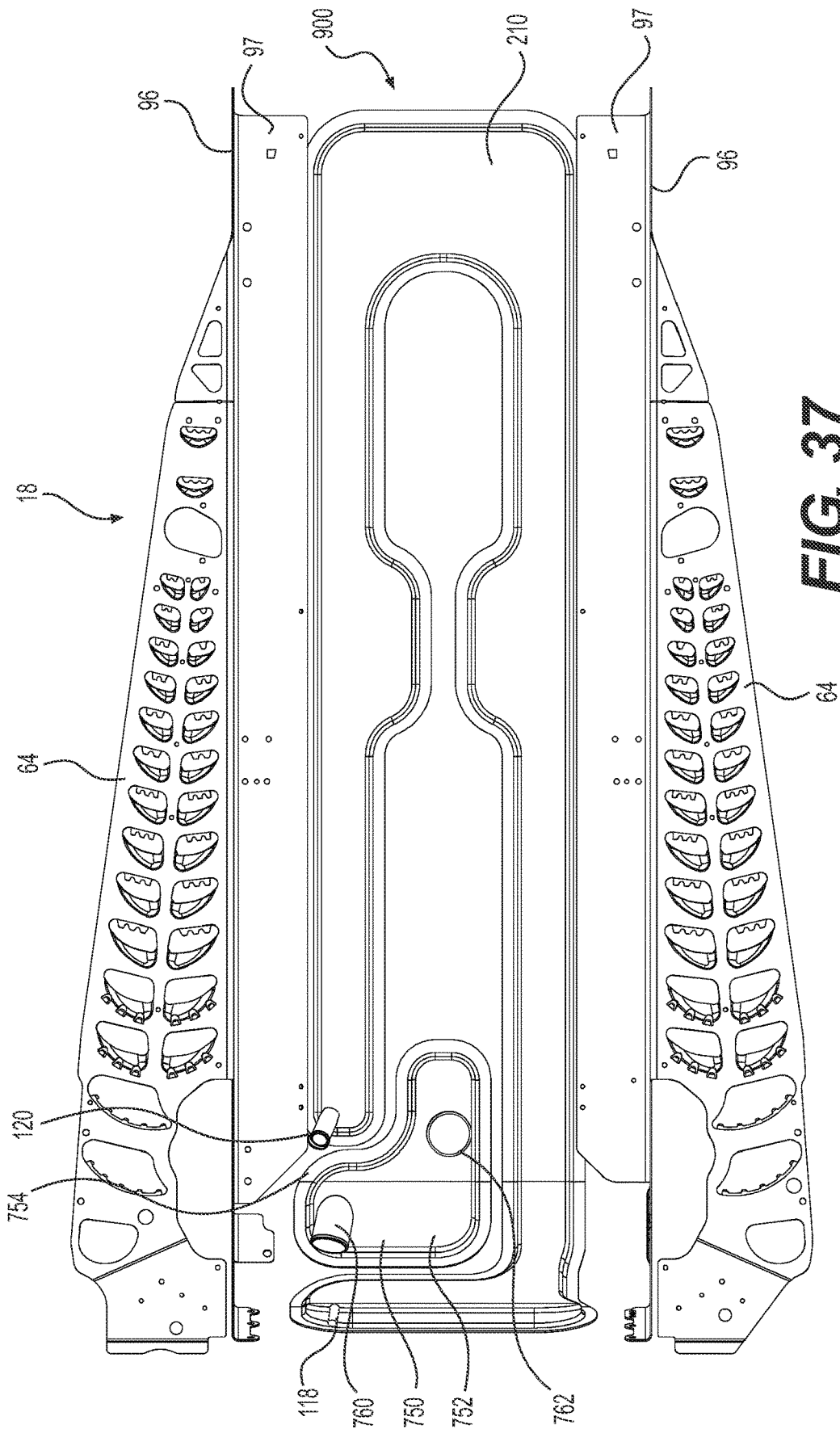


FIG. 37

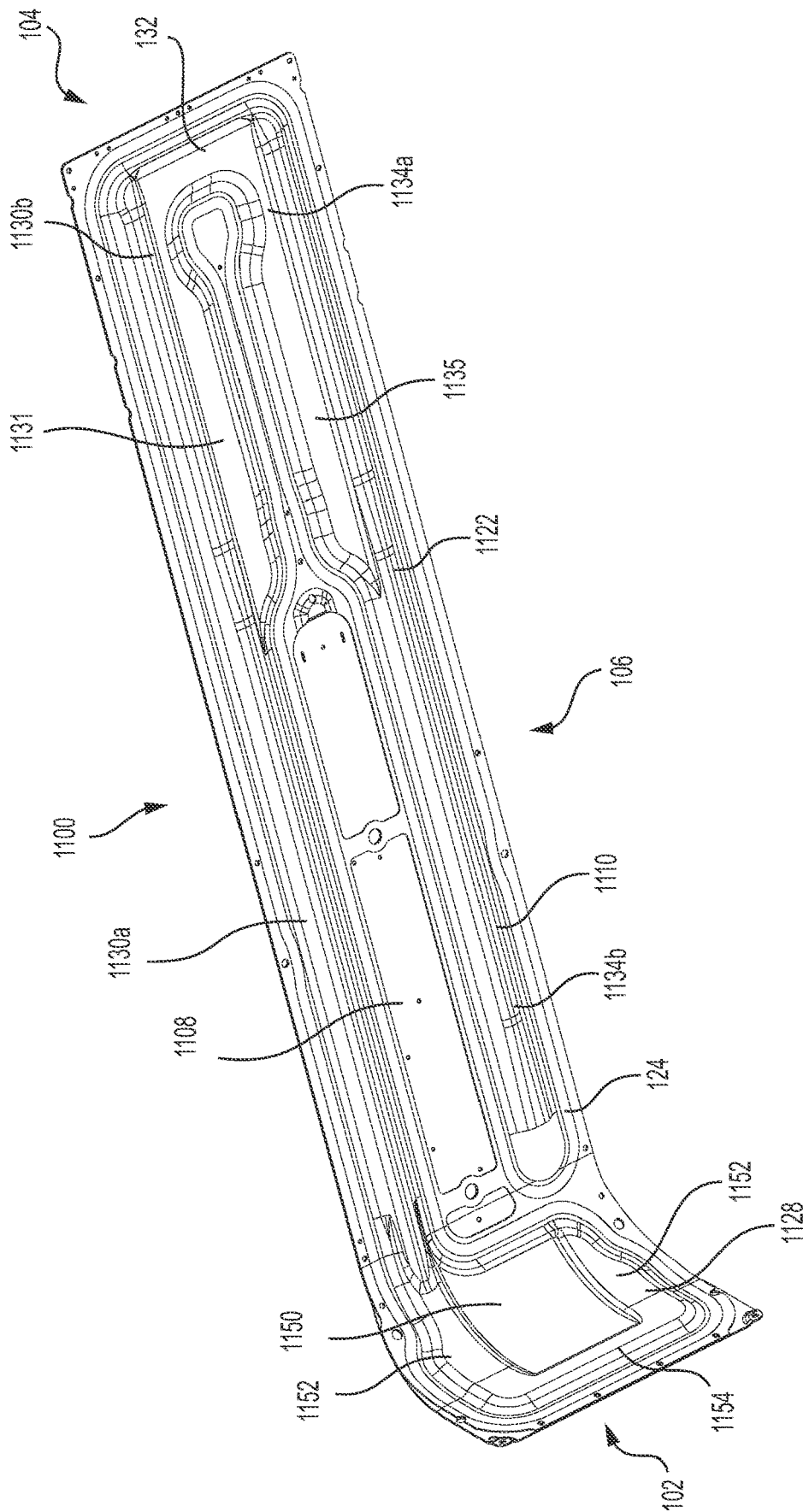


FIG. 38

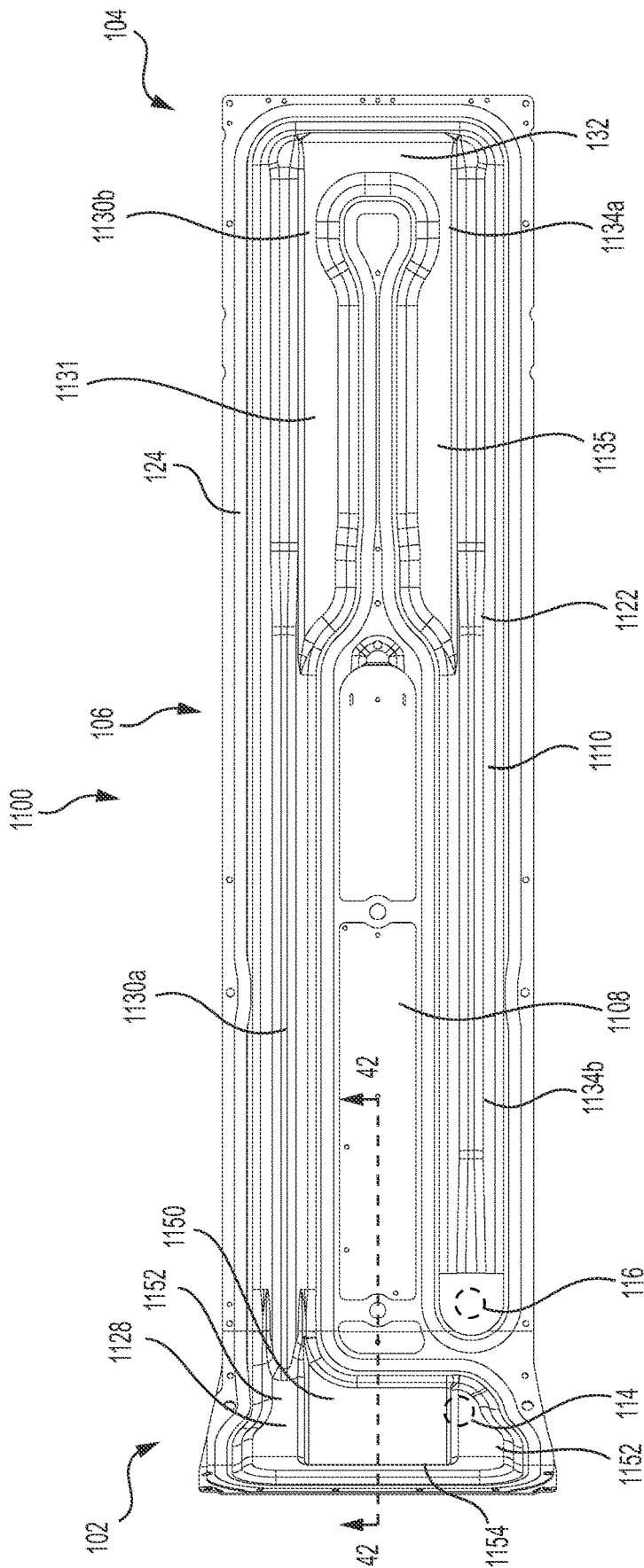


FIG. 39

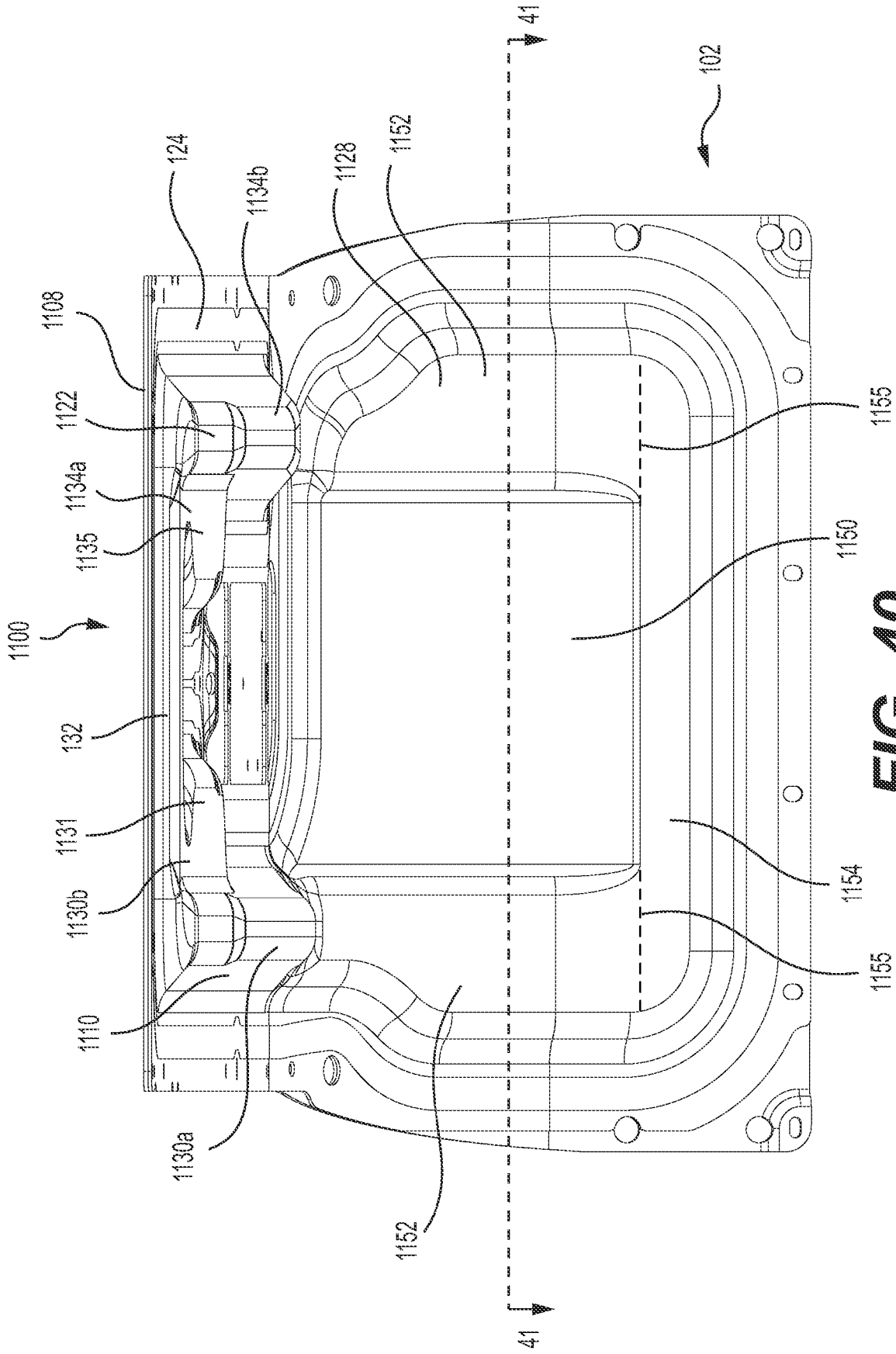


FIG. 40

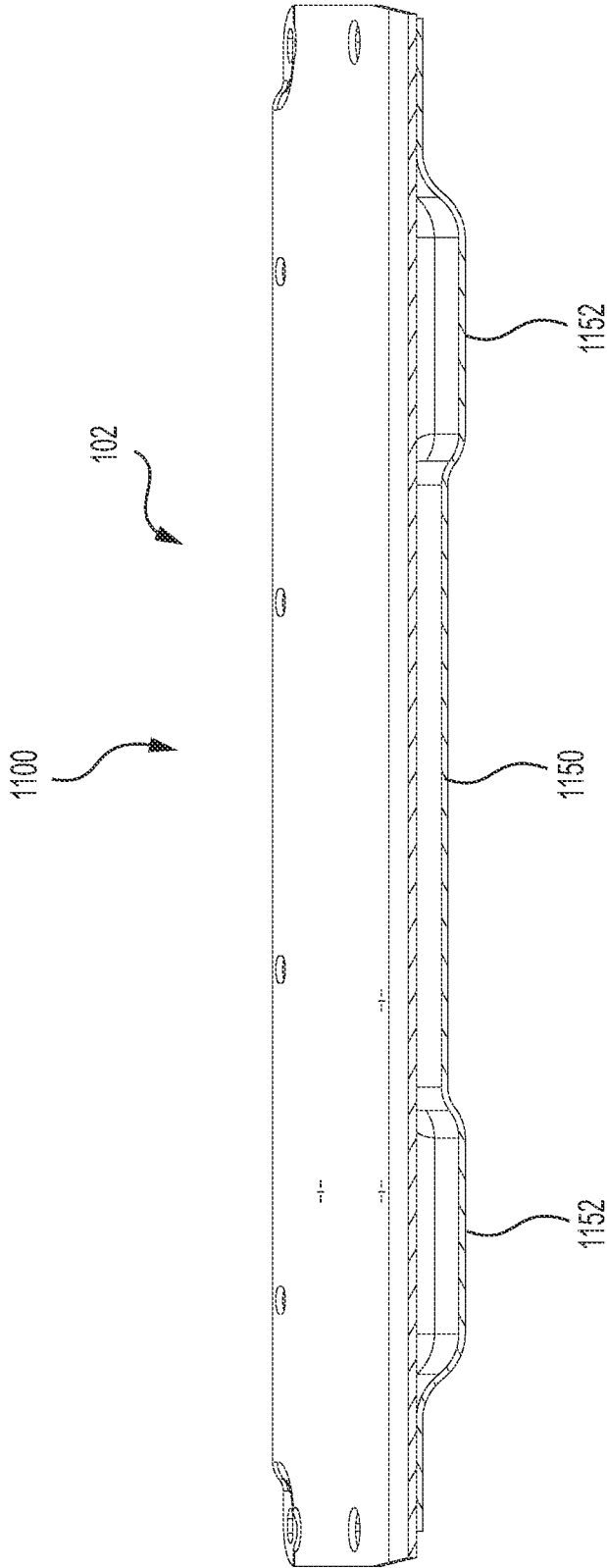


FIG. 41

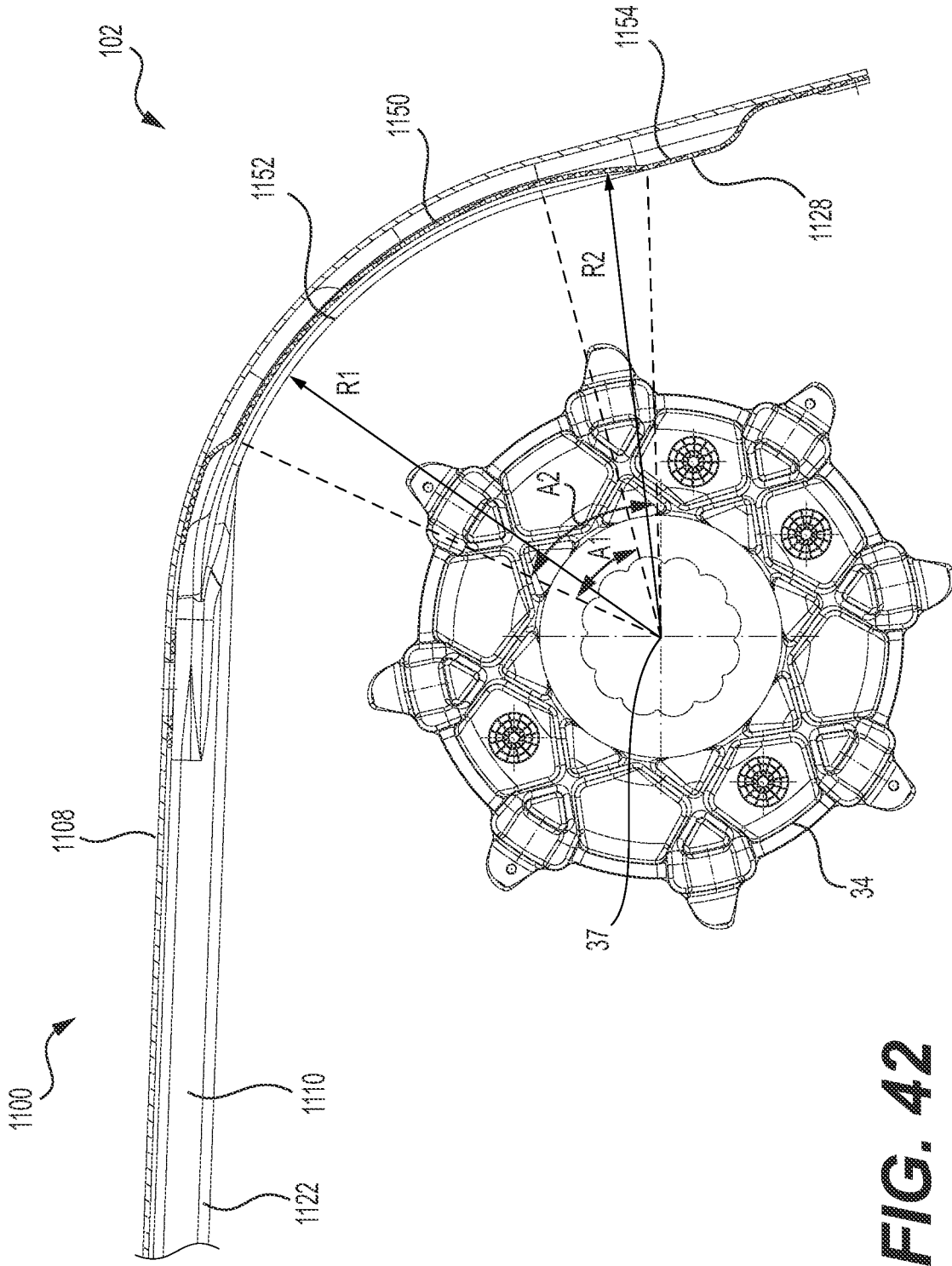


FIG. 42

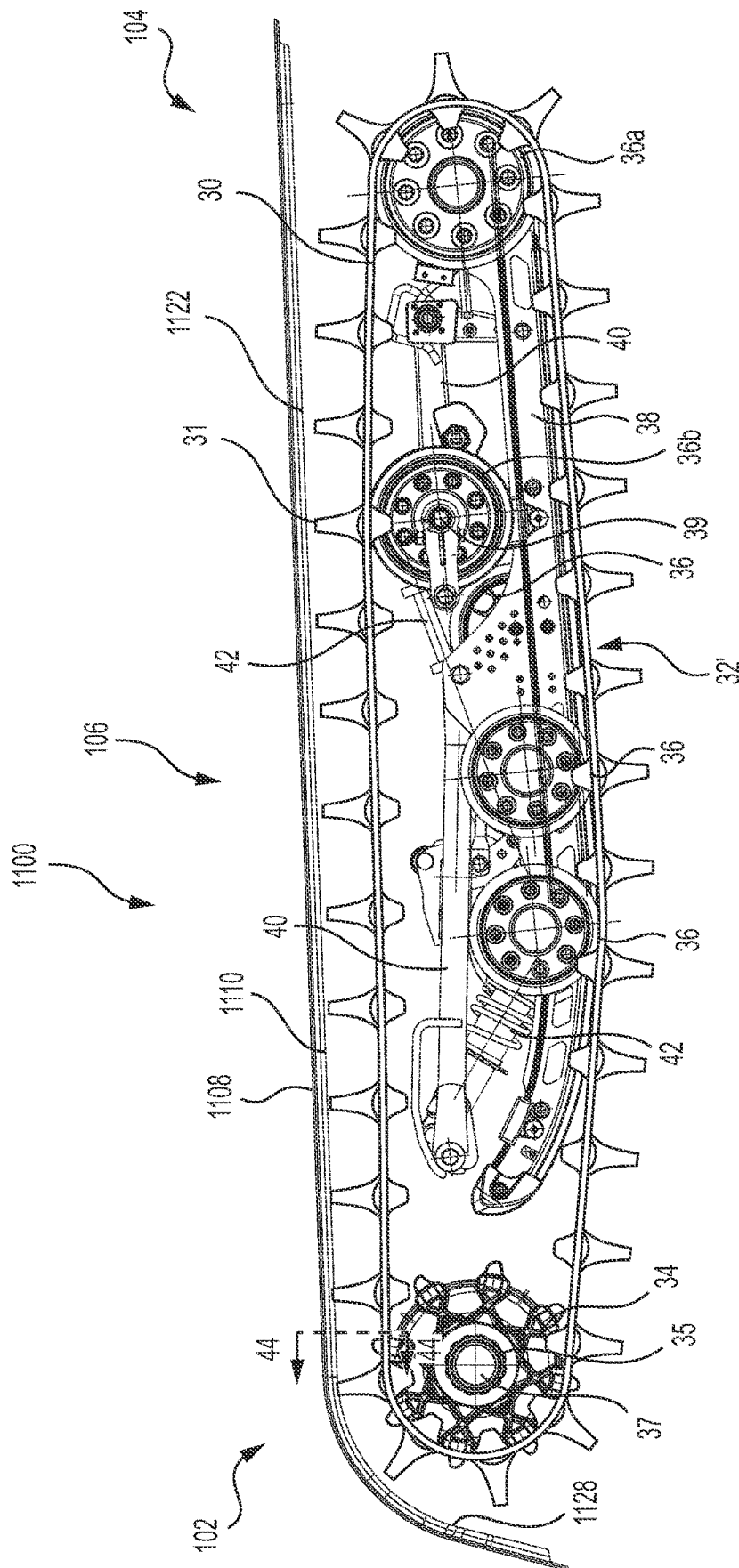


FIG. 43

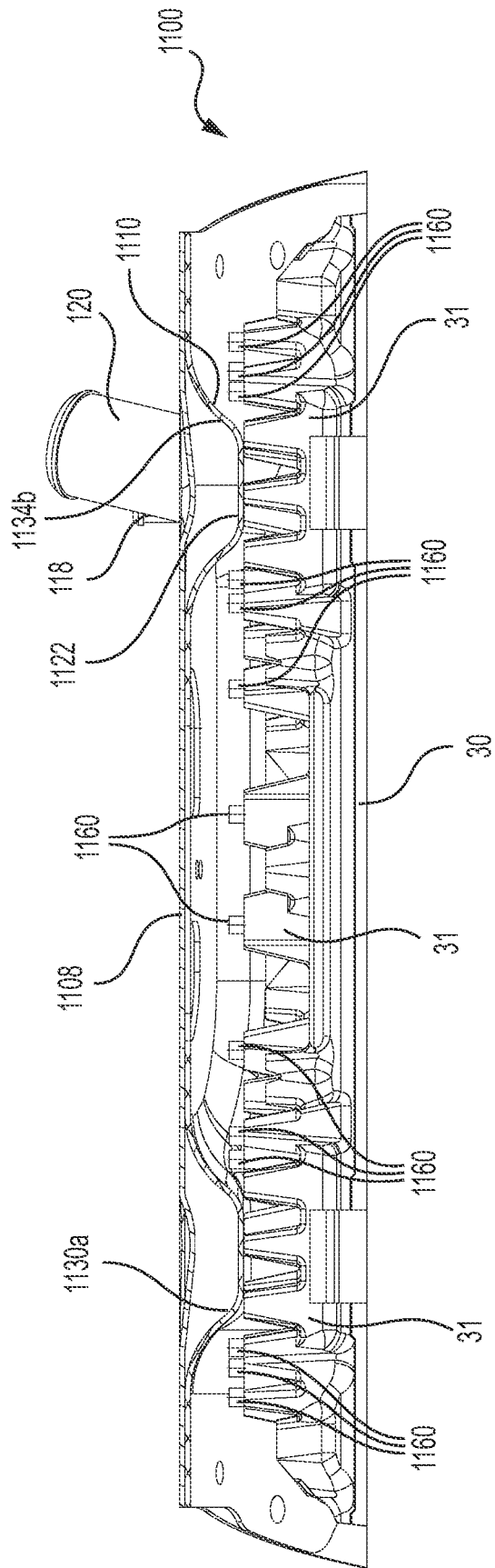


FIG. 44

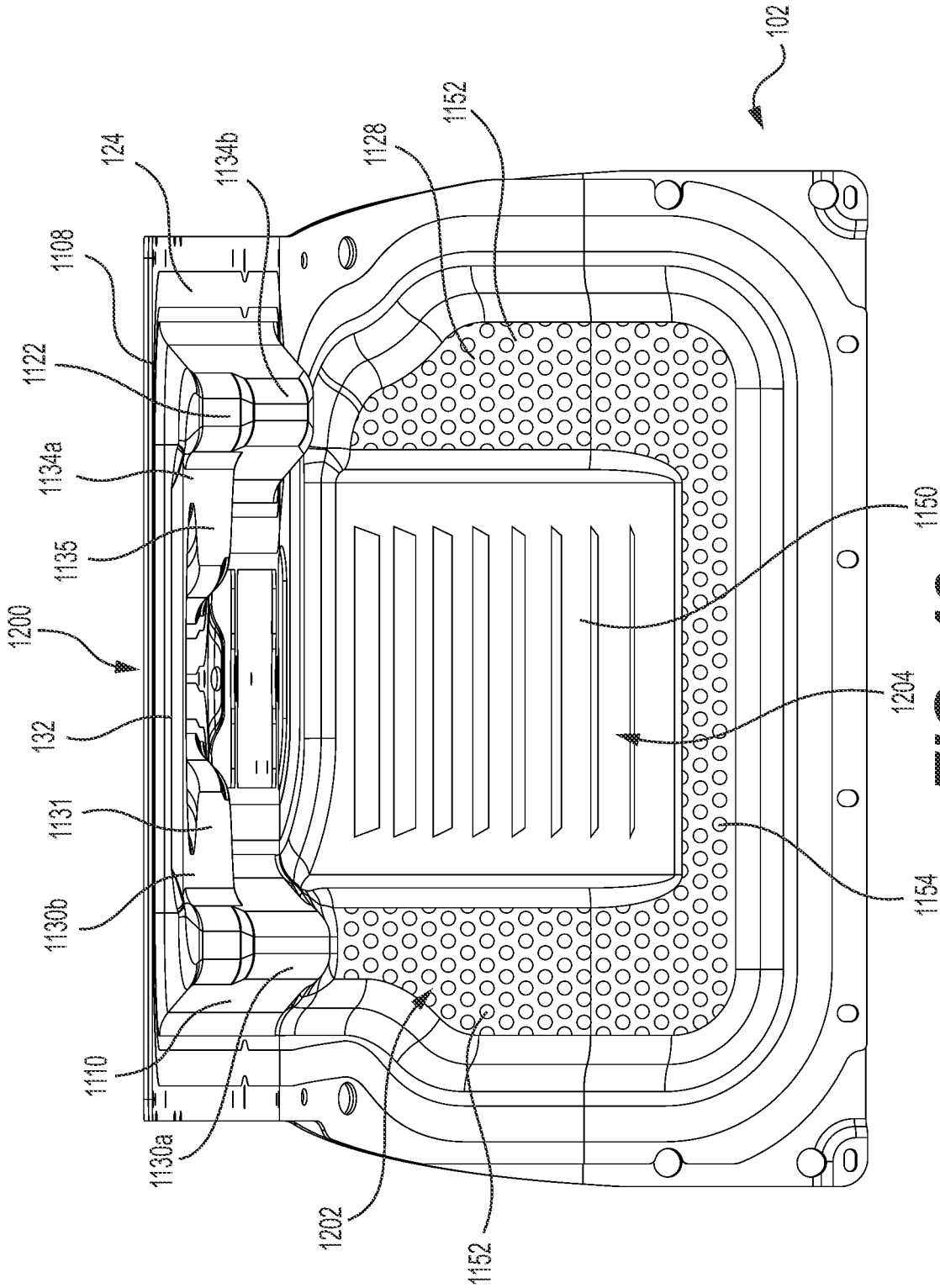


FIG. 46

SNOWMOBILE HEAT EXCHANGER ASSEMBLY

CROSS-REFERENCE

The present application is a continuation of U.S. patent application Ser. No. 16/523,403, filed Jul. 26, 2019, which is a continuation of U.S. patent application Ser. No. 15/439,210, filed Feb. 22, 2017, which is a continuation-in-part of International Patent Application No. PCT/IB2014/064343, filed Sep. 9, 2014. Through International Patent Application No. PCT/IB2014/064343, the present application is a continuation of U.S. patent application Ser. No. 14/473,036, filed Aug. 29, 2014, which claims priority to U.S. Provisional Patent Application No. 61/872,204, filed Aug. 30, 2013. The entirety of these five applications is incorporated herein by reference.

FIELD OF TECHNOLOGY

The present technology relates to heat exchanger assemblies for snowmobiles.

BACKGROUND

Snowmobiles are powered by engines that need to be cooled. In some snowmobiles, a coolant is circulated around and through the engine thereby absorbing the heat generated by the engine. When the hot coolant leaves the engine, it needs to be cooled before being returned to the engine. To do so, the coolant is circulated through one or more heat exchanger assemblies.

FIG. 1 illustrates an exemplary implementation of a prior art arrangement of heat exchanger assemblies for a snowmobile. The arrangement includes a front heat exchanger assembly **1000** and a heat exchanger assembly **1002**.

The front heat exchanger assembly **1000** has a body **1004** defining an internal volume, an outlet pipe **1006** and an inlet pipe **1008**. The pipes **1006**, **1008** are welded to the body **1004**. Fins **1010** are formed on the back of the body **1004**. The front heat exchanger **1000** defines in part a front of a tunnel of the snowmobile.

The heat exchanger assembly **1002** defines in part a top of the tunnel of the snowmobile. The heat exchanger assembly **1002** has a body **1012**, and inlet pipe **1014**, an outlet pipe **1016**, and a connector **1018**. Fins **1020** are formed on the bottom of the body **1012**. The body **1012** is formed by being extruded. The extrusion process forms two passages **1022**, **1024**. The connector **1018**, also formed by extrusion, is connected to the back of the two passages **1022**, **1024** to fluidly connect the two together thereby forming a single passage. The passages **1022**, **1024** are capped at their front ends. The inlet pipe **1014** is welded at a front of the passage **1022** and the outlet pipe **1016** is welded at a front of the passage **1024**.

A pipe (not shown) connects the inlet pipe **1014** of the heat exchanger assembly **1002** to the engine to receive hot coolant from the engine. Another pipe (not shown) connects the outlet pipe **1016** of the heat exchange assembly **1002** to the inlet pipe **1008** of the heat exchanger assembly **1000** to allow coolant to flow from the heat exchanger assembly **1002** to the heat exchanger assembly **1000**. Another pipe (not shown) connects the outlet pipe **1006** of the heat exchanger assembly **1000** to the engine to return cooled coolant to the engine.

During operation of the snowmobile, coolant flows from the engine to the heat exchanger assembly **1002**. In the heat

exchanger assembly **1002**, coolant first flows through the passage **1022**, then through the connector **1018**, and then through the passage **1024**. From the passage **1024** the coolant flows to the heat exchanger assembly **1000**. From the heat exchanger assembly **1000**, the coolant is returned to the engine.

The coolant in the heat exchanger assemblies **1000**, **1002** is cooled by a combination of air flowing along the surfaces of the heat exchanger assemblies **1000**, **1002** and snow being projected on the surfaces of the heat exchanger assemblies **1000**, **1002** by the drive track of the snowmobile.

Although the arrangement of the heat exchanger assemblies **1000**, **1002** effectively cools the coolant of the engine, it has some disadvantages.

First, the heat exchanger assemblies **1000**, **1002** are separate from each other, which increases the complexity of their assembly to the snowmobile.

Also, since the body **1012** of the heat exchanger assembly **1002** is extruded, the passages **1022**, **1024** need to have a constant cross-sectional area along their lengths. As such, they are not shaped to take mostly advantage of the regions where more cooling can occur such as where the snow is being sprayed by the drive track. Therefore, the overall internal volume of the heat exchanger assembly **1002** is greater than necessary, which results in a larger volume of coolant being provided in the cooling system. Therefore, the snowmobile is heavier than necessary due to the coolant.

Finally, also due to the manner in which the bodies **1004**, **1012** of the heat exchanger assemblies **1000**, **1002** are manufactured, the pipes **1006**, **1008**, **1014** and **1016** are welded generally perpendicular to the surfaces on which they are welded. This is because placing the pipes **1006**, **1008**, **1014** and **1016** at an angle to their respective connection surfaces would make welding difficult. As a result, the pipes **1006**, **1008**, **1014** and **1016** take more room by being perpendicular than if they were disposed at another angle.

Accordingly, it would be desirable to have a heat exchanger assembly that can replace two heat exchanger assemblies such as the ones described above.

It would also be desirable to have a heat exchanger assembly that takes advantage of areas where more cooling can occur.

It would also be desirable to have a heat exchanger assembly that facilitates the welding of at least one of the inlet and outlet pipes at an angle to the surface to which it is being welded.

SUMMARY

It is an object of the present technology to ameliorate at least some of the inconveniences present in the prior art.

According to one aspect of the present technology, there is provided a snowmobile having: a frame having a tunnel; a motor supported by the frame; at least one ski connected to the frame; a rear suspension assembly connected to the tunnel; a drive track disposed around the rear suspension assembly and at least in part below the tunnel, the drive track being operatively connected to the motor; and drive sprockets operatively connecting the motor to the drive track. At least a portion of the tunnel is formed by a heat exchanger assembly. The heat exchanger assembly has: a front portion; a middle portion rearward of the front portion; a rear portion rearward of the middle portion, at least one of the front and rear portions being curved from the middle portion, the at least one of the front and rear portions extending below the middle portion; a top part; and a bottom part disposed below the top part and being joined to the top part, the bottom part

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defining at least one recess. The top and bottom parts define therebetween a passage formed in part by the at least one recess. The passage has an inlet and an outlet. A first portion of the passage is defined by the at least one recess extending longitudinally. The drive track has: a plurality of lugs extending from an outer surface of the drive track; and a plurality of studs connected to and extending from the plurality of lugs. Portions of the plurality of lugs being laterally aligned with the first portion of the passage being free of studs such that in response to the rear suspension assembly being compressed to at least one position: the portions of the plurality of lugs being laterally aligned with the first portion of the passage come into contact with the first portion of the passage; and the plurality of studs are prevented from coming into contact with the first portion of the passage.

In some implementations, some of the plurality of studs are disposed to a right of the first portion of the passage; and some of the plurality of studs are disposed to a left of the first portion of the passage.

In some implementations, the first portion of the passage extends longitudinally along a first lateral side of the heat exchanger. A second portion of the passage defined by the at least one recess extends longitudinally along a second lateral side of the heat exchanger. Portions of the plurality of lugs being laterally aligned with the second portion of the passage being free of studs such that in response to the rear suspension assembly being compressed to the at least one position: the portions of the plurality of lugs being laterally aligned with the second portion of the passage come into contact with the second portion of the passage; and the plurality of studs are prevented from coming into contact with the second portion of the passage.

In some implementations, some of the plurality of studs are disposed laterally between the first and second portions of the passage.

In some implementations, some of the plurality of studs are disposed laterally outward of the first portion of the passage; and some of the plurality of studs are disposed laterally outward of the second portion of the passage.

In some implementations, some of the plurality of studs are disposed laterally outward of the first portion of the passage; and some of the plurality of studs are disposed laterally outward of the second portion of the passage.

In some implementations, the inlet and the outlet of the passage fluidly communicate with the motor; and the heat exchanger assembly is adapted to have at least one motor fluid flowing therethrough for cooling the at least one motor fluid.

In some implementations, at least a portion of the passage is wider than at least another portion of the passage.

In some implementations, at least one of the inlet and the outlet is defined in the at least one of the front and rear portions extending below the middle portion.

In some implementations, the at least one of the front and rear portions extending below the middle portion is the front portion; and the outlet is defined in the front portion.

In some implementations, the inlet is disposed near a first end of the passage; and the outlet is disposed near a second end of the passage.

In some implementations, the passage extends longitudinally along a first lateral side of the heat exchanger, then laterally along the rear portion, then longitudinally along a second lateral side of the heat exchanger and then laterally along the front portion.

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In some implementations, the passage extends at least in part along the middle portion and the at least one of the front and rear portions.

In some implementations, at least a portion of the passage is thicker than at least another portion of the passage.

In some implementations, the passage extends at least in part along the front portion. A width of a portion of the passage extending along the front portion is at least three quarters of a width of the front portion.

In some implementations, the at least one of the front and rear portions extending below the middle portion is the front portion; and the recess extends at least in part along the middle portion and the front portion and is curved to follow a curvature defined by the front portion and the middle portion.

For purposes of this application, terms related to spatial orientation such as forwardly, rearward, upwardly, downwardly, left, and right, are as they would normally be understood by a driver of the vehicle sitting thereon in a normal riding position. Terms related to spatial orientation when describing or referring to components or sub-assemblies of the vehicle, separately from the vehicle, such as a heat exchanger assembly for example, should be understood as they would be understood when these components or sub-assemblies are mounted to the vehicle, unless specified otherwise in this application.

Implementations of the present technology each have at least one of the above-mentioned object and/or aspects, but do not necessarily have all of them. It should be understood that some aspects of the present technology that have resulted from attempting to attain the above-mentioned object may not satisfy this object and/or may satisfy other objects not specifically recited herein.

Additional and/or alternative features, aspects and advantages of implementations of the present technology will become apparent from the following description, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present technology, as well as other aspects and further features thereof, reference is made to the following description which is to be used in conjunction with the accompanying drawings, where:

FIG. 1 is a perspective view taken from a top, front, left side of a prior art arrangement of heat exchanger assemblies;

FIG. 2 is a left side elevation view of a snowmobile;

FIG. 3 is a perspective view taken from a top, front, left side of a portion of the frame of the snowmobile of FIG. 2;

FIG. 4 is a perspective view taken from a bottom, rear, left side of a first implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 5 is a top plan view of the heat exchanger assembly of FIG. 4;

FIG. 6 is a bottom plan view of the heat exchanger assembly of FIG. 4;

FIG. 7 is a right side elevation view of the heat exchanger assembly of FIG. 4;

FIG. 8 is a rear elevation view of the heat exchanger assembly of FIG. 4;

FIG. 9 is a front elevation view of the heat exchanger assembly of FIG. 4;

FIG. 10 is an exploded view of the heat exchanger assembly of FIG. 4;

FIG. 11 is a perspective view taken from a bottom, rear, left side of a second implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

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FIG. 12 is a bottom plan view of the heat exchanger assembly of FIG. 11;

FIG. 13 is a cross-sectional view of the heat exchanger assembly of FIG. 11 taken through line 13-13 of FIG. 12;

FIG. 14 is a cross-sectional view of the heat exchanger assembly of FIG. 11 taken through line 14-14 of FIG. 12;

FIG. 15 is a cross-sectional view of the heat exchanger assembly of FIG. 11 taken through line 15-15 of FIG. 12;

FIG. 16 is a cross-sectional view of the heat exchanger assembly of FIG. 11 taken through line 16-16 of FIG. 12;

FIG. 17 is a left side elevation view of a drive sprocket, an alternative implementation of a suspension assembly and a portion of a drive track of the snowmobile of FIG. 2 and the heat exchanger assembly of FIG. 11;

FIG. 18 is a perspective view taken from a bottom, rear, left side of the components of FIG. 17;

FIG. 19 is a perspective view taken from a bottom, rear, left side of the components of FIG. 17 with the track portion removed and the suspension assembly in a compressed configuration;

FIG. 20 is a perspective view taken from a bottom, rear, left side of a bottom part of a third implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 21 is a perspective view taken from a bottom, rear, left side of a bottom part of a fourth implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 22 is a right side elevation view of the bottom part of the heat exchanger assembly of FIG. 21;

FIG. 23 is a bottom plan view of the bottom part of the heat exchanger assembly of FIG. 21;

FIG. 24 is a rear elevation view of the bottom part of the heat exchanger assembly of FIG. 21;

FIG. 25 is a perspective view taken from a bottom, rear, left side of a bottom part of a fifth implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 26 is a perspective view taken from a bottom, rear, left side of a sixth implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 27 is a perspective view taken from a top, front, left side of the heat exchanger assembly of FIG. 26;

FIG. 28 is top plan view of the heat exchanger assembly of FIG. 26;

FIG. 29 is a cross-sectional view of the heat exchanger assembly of FIG. 26 taken through line 29-29 of FIG. 28;

FIG. 30 is a cross-sectional view of the heat exchanger assembly of FIG. 26 taken through line 30-30 of FIG. 28;

FIG. 31 is a cross-sectional view of a portion of the heat exchanger assembly of FIG. 26 taken through line 31-31 of FIG. 28;

FIG. 32 is a perspective view taken from a bottom, rear, left side of a seventh implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 33 is a top plan view of the heat exchanger assembly of FIG. 32;

FIG. 34 is a perspective view taken from a bottom, rear, left side of an eighth implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 35 is a top plan view of the heat exchanger assembly of FIG. 34;

FIG. 36 is a top plan view of a tunnel of the snowmobile of FIG. 2 having a ninth implementation of a heat exchanger assembly;

FIG. 37 is a top plan view of the tunnel of the snowmobile of FIG. 2 and the ninth implementation of the heat exchanger assembly with a top part of the heat exchanger assembly removed;

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FIG. 38 is a perspective view taken from a bottom, rear, left side of a tenth implementation of a heat exchanger assembly of the snowmobile of FIG. 2;

FIG. 39 is a bottom plan view of the heat exchanger assembly of FIG. 38;

FIG. 40 is a rear elevation view of the heat exchanger assembly of FIG. 38;

FIG. 41 is a cross-sectional view of the heat exchanger assembly of FIG. 38 taken through line 41-41 of FIG. 40;

FIG. 42 is a cross-sectional view of the heat exchanger assembly of FIG. 38 taken through line 42-42 of FIG. 39 with a drive sprocket of the snowmobile of FIG. 2;

FIG. 43 is a left side elevation view of the suspension assembly of FIG. 17 in a compressed configuration, the drive sprocket and the drive track of the snowmobile of FIG. 2, and the heat exchanger assembly of FIG. 38;

FIG. 44 is a cross-sectional view of the components of FIG. 43 taken through line 44-44 of FIG. 43;

FIG. 45 is a slice of the components of FIG. 43 taken through line 44-44 of FIG. 43; and

FIG. 46 is a rear elevation view of an eleventh implementation of a heat exchanger assembly of the snowmobile of FIG. 2.

DETAILED DESCRIPTION

Referring to FIG. 2, a snowmobile 10 includes a forward end 12 and a rearward end 14. The snowmobile 10 includes a vehicle body in the form of a frame or chassis 16 which, as can be seen in FIGS. 2 and 3, includes a tunnel 18, an engine cradle portion 20, a front suspension module 22 and an upper structure 24.

A motor 26 (schematically illustrated in FIG. 2), which in the illustrated implementation is an internal combustion engine, is carried in an engine compartment defined in part by the engine cradle portion 20 of the frame 16. A fuel tank 28, supported above the tunnel 18, supplies fuel to the engine 26 for its operation. Coolant used to cool the engine 26 is circulated through a heat exchanger assembly 100 (FIG. 3), described in greater detail below, to be cooled. The heat exchanger assembly 100 forms part of the tunnel 18.

An endless drive track 30 is disposed generally under the tunnel 18. The drive track 30 is operatively connected to the engine 26 through a belt transmission system (not shown) and a reduction drive (not shown). The endless drive track 30 is driven to run about a rear suspension assembly 32 connected to the frame 16 for propulsion of the snowmobile 10. The endless drive track 30 has a plurality of lugs 31 extending from an outer surface thereof to provide traction to the track 30.

The rear suspension assembly 32 includes drive sprockets 34, idler wheels 36 and a pair of slide rails 38 in sliding contact with the endless drive track 30. The drive sprockets 34 are mounted on a drive axle 35 and define a sprocket axis 37. The slide rails 38 are attached to the tunnel 18 by front and rear suspension arms 40 and shock absorbers 42. It is contemplated that the snowmobile 10 could be provided with a different implementation of a rear suspension assembly 32 than the one shown herein.

A straddle-type seat 60 is positioned atop the fuel tank 28. A fuel tank filler opening covered by a cap 92 is disposed on the upper surface of the fuel tank 28 in front of the seat 60. It is contemplated that the fuel tank filler opening could be disposed elsewhere on the fuel tank 28. The seat 60 is adapted to accommodate a driver of the snowmobile 10. The seat 60 could also be configured to accommodate a passen-

ger. A footrest **64** is positioned on each side of the snowmobile **10** below the seat **60** to accommodate the driver's feet.

At the front end **12** of the snowmobile **10**, fairings **66** enclose the engine **26** and the belt transmission system, thereby providing an external shell that not only protects the engine **26** and the transmission system, but can also make the snowmobile **10** more aesthetically pleasing. The fairings **66** include a hood **68** and one or more side panels which can be opened to allow access to the engine **26** and the belt transmission system when this is required, for example, for inspection or maintenance of the engine **26** and/or the transmission system. A windshield **69** connected to the fairings **66** acts as a wind screen to lessen the force of the air on the rider while the snowmobile **10** is moving.

Two skis **70** positioned at the forward end **12** of the snowmobile **10** are attached to the front suspension module **22** of the frame **16** through a front suspension assembly **72**. The front suspension module **22** is connected to the front end of the engine cradle portion **20**. The front suspension assembly **72** includes ski legs **74**, supporting arms **76** and ball joints (not shown) for operatively connecting to the respective ski leg **74**, supporting arms **76** and a steering column **82**.

A steering assembly **80**, including the steering column **82** and a handlebar **84**, is provided generally forward of the seat **60**. The steering column **82** is rotatably connected to the frame **16**. The lower end of the steering column **82** is connected to the ski legs **74** via steering rods (not shown). The handlebar **84** is attached to the upper end of the steering column **82**. The handlebar **84** is positioned in front of the seat **60**. The handlebar **84** is used to rotate the steering column **82**, and thereby the skis **70**, in order to steer the snowmobile **10**. A throttle operator (not shown) in the form of a finger-actuated throttle lever is mounted to the right side of the handlebar **84**. Other types of throttle operators, such as a thumb-actuated throttle lever and a twist grip, are also contemplated. A brake actuator (not indicated), in the form of a hand brake lever, is provided on the left side of the handlebar **84** for braking the snowmobile **10** in a known manner. It is contemplated that the windshield **69** could be connected directly to the handlebar **84**.

At the rear end of the snowmobile **10**, a snow flap **94** extends downward from the rear end of the tunnel **18**. The snow flap **94** protects against dirt and snow that can be projected upward from the drive track **30** when the snowmobile **10** is being driven. It is contemplated that the snow flap **94** could be omitted.

The snowmobile **10** includes other components such as a display cluster, an exhaust system, an air intake system, and the like. As it is believed that these components would be readily recognized by one of ordinary skill in the art, further explanation and description of these components will not be provided herein.

Turning now to FIG. **3**, the tunnel **18** will be described in more detail. The tunnel **18** has two side portions **96**. Each side portion **96** is made from a bent piece of sheet metal. Each side portion has a horizontally extending top portion **97** (FIG. **36**) and is bent at its bottom to form a rear part of the footrest **64**. The heat exchanger assembly **100** rests on the top portions **97** between the side portions **96**, thereby forming a majority of the top and front of the tunnel **18**. The heat exchanger assembly **100** is fastened, welded or otherwise connected to the side portions **96**. Trims **98** are disposed near the top of each side portion **96** to hide the connection between the heat exchanger assembly **100** and the side portions **96** of the tunnel **18**.

Turning now to FIGS. **4** to **10**, the heat exchanger assembly **100** will be described in more detail. The heat exchanger assembly **100** has a front portion **102**, a rear portion **104** and a middle portion **106** between the front and rear portions **102**, **104**. As can be seen, the front portion **102** is curved down from the middle portion **106** such that the front portion **102** extends below the middle portion **106**. As best seen in FIG. **10**, the heat exchanger assembly **100** is made of two main parts: a top part **108** and a bottom part **110**.

The top part **108** is made of a piece of sheet metal that is curved down at its front. The front portion of the top part **108** is flat, and then curves to the middle portion of the top part **108**. The middle and rear portion of the top part **108** are flat. A plurality of apertures **112** (only some of which are labeled for clarity) are formed in the top part **108** to permit the attachments of various components of the snowmobile **10** to the heat exchanger assembly **100** such as the fuel tank **28**. As can be seen in FIG. **10**, an aperture is formed in the curved portion of the top part **108** to form an outlet **114** of a passage (discussed below) of the heat exchanger assembly **100**. As can be also seen in FIG. **10**, another aperture is formed in the middle portion of the top part **108** rearward of the outlet **114** to form an inlet **116** of the passage of the heat exchanger assembly **100**. It is contemplated that the outlet **114** could be disposed rearward of the inlet **116** or that they could be at a same distance from the front of the top part **108**. Although shown on the right side near a front of the top part **108**, it is contemplated that the outlet **114** and inlet **116** could be anywhere on the top part **108** as long as the geometry of the passage discussed below is modified accordingly. An outlet pipe **118** is welded or otherwise joined to the top part **108** around the outlet **114** and an inlet pipe **120** is welded or otherwise joined to the top part **108** around the inlet **116**.

The bottom part **110** is made of a piece of sheet metal that is curved down at its front such that its curvature matches the curvature of the top part **108**. Once curved, the bottom part **110** is stamped to form a recess **122**. The piece of sheet metal from which the bottom part **110** is made is initially shaped such that only a border **124** is left around the recess **122**, thereby reducing the weight of the bottom part **110**. Alternatively, it is contemplated that the sheet metal could be cut after the recess **122** has been formed so as to only leave the border **124** around the recess **122**. It is also contemplated that the sheet metal could not be cut. The border **124** of the bottom part **110** is welded or otherwise joined to the top part **108** to form the heat exchanger assembly **100**. Additional details regarding the method of manufacturing the heat exchanger assembly **100** will be provided further below.

By joining the top part **108** to the bottom part **110**, a passage is formed between the recess **122** and the top part **108**. The recess **122** defines the shape of the passage. This passage permits the flow of engine coolant through the heat exchanger assembly **100**. Although in the present implementation the heat exchanger **100** is used to cool engine coolant, it is contemplated that it could be used to cool other motor fluids such as, for example, oil used to lubricate the engine **26** or air to be supplied to the engine **26**.

During operation of the engine **26**, the hot engine coolant flows from the engine **26** through a pipe (not shown) connected to the inlet pipe **120**, then through the inlet pipe **120** and then into the passage formed between the top and bottom parts **108**, **110** via the inlet **116**.

As can be seen in FIG. **6**, the inlet **116** (shown in dotted lines) is disposed over a front of a narrow portion **134** of the passage. From the inlet **116**, the coolant flows rearward into the narrow and long portion **134** of the passage defined by

a narrow part of the recess 122 and extending along the middle portion 106 on a right side thereof.

From the portion 134 of the passage, the coolant flows rearward and laterally into a portion 132 of the passage defined by a wide part of the recess 122 along the rear portion 104 of the heat exchanger assembly 100. In an exemplary implementation, a width of the passage in the portion 132 is at least three quarters of the width of the top part 108 in the rear portion 104. The portion 132 of the passage is located above the rear idler wheels 36A (see FIG. 17). As the track 30 passes around the rear idler wheels 36A, it projects snow onto the portion of the bottom part 110 defining the portion 132 of the passage. Making the portion 132 wide and long increases the amount of cooling obtained from this projected snow since a large surface is exposed to the projected snow.

From the portion 132 of the passage, the coolant flows forward into a narrow and long portion 130 of the passage defined by a narrow part of the recess 122 and extending along the middle portion 106 on a left side thereof.

From the portion 130, the coolant flows forwardly and then laterally into a portion 128 of the passage defined by a wide part of the recess 122 along the front portion 102 of the heat exchanger assembly 100. As can be seen, the portion 128 of the passage is curved to follow a curvature of the top part 108. In an exemplary implementation, a width of the passage in the portion 128 is at least three quarters of the width of the top part 108 in the front portion 102. The portion 128 of the passage is located forwardly of the sprocket axis 37 (i.e. the axis of rotation of the sprockets 35). As the track 30 passes around the sprockets 35, it projects snow onto the portion of the bottom part 110 defining the portion 128 of the passage. Making the portion 128 wide and long increases the amount of cooling obtained from this projected snow since a large surface is exposed to the projected snow.

From the portion 128 of the passage, the coolant flows rearward into a narrow portion 126 of the passage above which the outlet 114 is located (shown in dotted lines in FIG. 6). The coolant then flows out of the passage via the outlet 114, through the outlet pipe 118 and finally through a pipe (not shown) connected between the outlet pipe 118 and the engine 26 to return the now cooled coolant to the engine 26.

Turning now to FIGS. 11 to 37, various alternative implementations of the heat exchanger assembly 100 will be described. For simplicity, the elements of each of the heat exchanger assemblies described below which are similar to those of the heat exchanger assembly 100 or to elements of another one of the heat exchanger assemblies described below have been labelled with the same reference numerals and will not be described again in detail.

Turning now to FIGS. 11 to 19, a heat exchanger assembly 200 will be described. The heat exchanger assembly 200 has a top part 208 and a bottom part 210. The bottom part 210 defines a recess 222. A passage is formed between the recess 222 and the top part 208. In the heat exchanger assembly 200, the portions 126 and 128 of the passage of the heat exchanger assembly 100 have been replaced by a single portion 228. The portion 228 is similar in shape to the portion 128 described above except that, as best seen in FIG. 17, the bottom part of the portion 228 has a thickness T1 that is greater than a thickness T2 of the rest of the passage.

In the heat exchanger assembly 200, the portion 134 of the passage of the heat exchanger assembly 100 has been replaced by two long and narrow portions 234A, 234B and a wide portion 235 between the portions 234A, 234B. As can be seen by comparing FIGS. 13 to 16, the portion 235 is

wider than the portions 234A and 234B, but narrower than the portion 132. Coolant flows from the inlet 116 (shown in dotted lines in FIG. 12) to the portion 234B, to the portion 235, then to the portion 234A and then to the portion 132.

In the heat exchanger assembly 200, the portion 130 of the passage of the heat exchanger assembly 100 has been replaced by two long and narrow portions 230A, 230B and a wide portion 231 between the portions 230A, 230B. As can be seen by comparing FIGS. 13 to 16, the portion 231 is wider than the portions 230A and 230B, but narrower than the portion 132. Coolant flows from the portion 132 to the portion 230B, to the portion 231, then to the portion 230A and then to the portion 228.

FIGS. 17 to 19 show the heat exchanger assembly 200 in relation to a rear suspension assembly 32'. The rear suspension assembly 32' has main components that are similar to those of the rear suspension assembly 32 described above, but they are connected to each other differently. As the differences between the rear suspension assemblies 32 and 32' are not essential to the understanding of the operation of the heat exchanger assembly 200 they will not be described herein. The rear suspension assembly 32' has middle idler wheels 36B that are disposed forward and above the rear idler wheels 36A. The middle idler wheels 36B rotate about an axis of rotation 39.

The wider portions 231 and 235 of the passage of the heat exchanger assembly 200 are disposed along the middle portion 106 forward of the axis of rotation 39 of the middle idler wheels 36B such that as the track 30 passes around the middle idler wheels 36B, it projects snow onto the portions of the bottom part 210 defining the portions 231 and 235 of the passage. Making the portions 231 and 235 wide increases the amount of cooling obtained from this projected snow since a large surface is exposed to the projected snow. In the present implementation, the portions 231 and 235 are disposed so as to extend both forward and rearward of a point P where a line 240 intersects the heat exchanger assembly 200 for all or most degrees of compression of the rear suspension assembly 32' in order help ensure that snow is projected on at least part of the portions 231 and 235 for all or most degrees of compression of the rear suspension assembly 32'. The line 240 is a line that passes through the tops of lugs 31 disposed in a common row along a portion of the track 30 extending between the rear and middle idler wheels 36A, 36B. As can be seen in FIGS. 18 and 19, the portions 231 and 235 extend forward and rearward of the point P when the rear suspension assembly 32' is fully extended (FIG. 18) and when the rear suspension assembly 32' is fully compressed (FIG. 19).

The top portion 208 of the heat exchanger assembly 200 is similar to the top portion 108 described above except that the outlet 114 has been moved forward in order to be aligned with the portion 228 of the passage.

Turning now to FIG. 20, the bottom part 310 of another implementation of a heat exchanger assembly will be described. It should be understood that although not shown, this other implementation of the heat exchanger assembly has a top part similar to the top parts described above, but shaped to match the lateral profile of the bottom part 310, and also has inlet and outlet pipes. The bottom part 310 defines a recess 322. A passage is formed between the recess 322 and the top part. The bottom portion 310 is similar to the bottom portion 210 described above except that the portion 228 of the passage of the heat exchanger assembly has been replaced by a portion 328 and the portion 132 has been replaced by a portion 332. The portion 328 is similar in shape to the portion 228 described above except that it has

a uniform thickness. The portion 332 is similar in shape to the portion 132 except that it has a portion bent down (i.e. sharply curved down). Also, instead of being curved down as in the above implementations, the front portion 102 is bent down (i.e. sharply curved down) in two places.

Turning now to FIGS. 21 to 24, the bottom part 410 of another implementation of a heat exchanger assembly will be described. It should be understood that although not shown, this other implementation of the heat exchanger assembly has a top part similar to the top parts described above, but shaped to match the lateral profile of the bottom part 410, and also has inlet and outlet pipes. The bottom part 410 defines a recess 422. A passage is formed between the recess 422 and the top part. The bottom portion 410 is similar to the bottom portion 310 described above except that the portions 230A, 230B of the passage have been replaced by a portion 430 from which the portion 231 extends laterally and the portions 234A, 234B of the passage have been replaced by a portion 434 from which the portion 231 extends laterally. The portions 430, 434 of the passage are thicker than the portions 230A, 230B, 234A and 234B that they replace. The portions 430, 434 also have a thickness T3 (FIG. 22) that is greater than the thicknesses T4, T5, T6, T7 (FIGS. 22 and 24) of the portions 328, 132, 231 and 235 respectively.

Turning now to FIG. 25, the bottom part 510 of another implementation of a heat exchanger assembly will be described. It should be understood that although not shown, this other implementation of the heat exchanger assembly has a top part similar to the top parts described above, but shaped to match the lateral profile of the bottom part 510, and also has inlet and outlet pipes. The bottom part 510 defines a recess 522. A passage is formed between the recess 522 and the top part. The bottom portion 510 is similar to the bottom portion 210 described above except that the portions 228, 231 and 235 of the passage have been replaced by portions 328, 531 and 535 respectively. The portions 531 and 535 are longer and disposed more forward along the middle portion 106 than the portions 231 and 235 of the heat exchanger assembly 200 in order to accommodate a different geometry of rear suspension assembly.

Turning now to FIGS. 26 to 31, a heat exchanger assembly 600 will be described. The heat exchanger assembly 600 has a top part 608 joined to a bottom part 610 to form a passage therebetween. The top part 608 is similar in shape to the top part 210 but is stamped to form two long and narrow recesses 636, 638. As best seen in FIG. 31, a protrusion 640 having a generally triangular cross-section is also stamped in the top part 608. The aperture forming the inlet 116 is formed in the front angled side of the protrusion 640. It is contemplated that the protrusion 640 could have other shapes. For example, it is contemplated that the protrusion 640 could be generally hemispheric, thus permitting the inlet 116 to be formed in almost any desired orientation. The inlet pipe 120 is welded to this surface around the inlet 116. As a result, the inlet pipe 120 is disposed at an angle to the middle portion 106, but since the inlet pipe 120 is perpendicular to the front surface of the protrusion 640, welding the inlet pipe 120 to the top part 608 is more easily accomplished than if there were no protrusion 640. It is contemplated that protrusions similar to the protrusion 640 could be provided for welding the outlet and inlet pipes 118, 120 of the various implementations of heat exchanger assemblies described herein.

The bottom part 610 is curved at its front to match the curvature of the top part 608. The bottom part 610 is stamped to form three recesses 622A, 622B and 622C. The

recess 622A and the top part 608 form a front passage portion 328 and a long and narrow passage portion 630A. The recess 622B and the top part 608 form a long and narrow passage portion 630B, a rear passage portion 132 and a long and narrow passage portion 634A. The recess 622C and the top part 608 form a long and narrow passage portion 634B.

The recess 638 in the top part 608 and the flat portion 631 of the bottom part 610 between the passage portions 630A and 630B form a passage portion 639. As best seen in FIG. 29, the passage portion 639 communicates with the passage portion 630A at its front and with the passage portion 630B at its rear. The recess 636 in the top part 608 and the flat portion 635 of the bottom part 610 between the passage portions 634A and 634B form a passage portion 637. As best seen in FIG. 30, the passage portion 637 communicates with the passage portion 634B at its front and with the passage portion 634A at its rear.

During operation of the engine 26, coolant enters the heat exchanger assembly 600 via the inlet pipe 120 and the inlet 116. The coolant then flows consecutively through the passage portions 634B, 637, 634A, 132, 630B, 639, 630A and 328. From the portion 328 of the passage, the coolant then flows through the outlet 114 and the outlet pipe 118 to be returned to the engine 26.

Turning now to FIGS. 32 and 33, a heat exchanger assembly 700 will be described. The heat exchanger assembly 700 has a top part 708 joined to a bottom part 710 to form a passage therebetween and another bottom part 750 joined to the top part 708 to form another passage therebetween.

The bottom part 710 is stamped to form a recess 722 to define the passage between the bottom part 710 and the top part 708. The passage formed by the bottom part 710 is similar to the passage formed in the heat exchanger assembly 100 except that the portions 126, 128 have been replaced by a portion 328.

The bottom part 750 is stamped to form a recess 752 with a border 754 around it. The border 754 is used to weld or otherwise join the bottom part 750 to the bottom of the top part 708. As can be seen, the recess 752 is generally L-shaped and extends in part along the front portion 102 and in part along the middle portion 106. As a result, the recess 752 is also curved to follow the curvature of the top part 708. Since the recess 752 and the top part 708 define a shape of the passage, the passage formed by the recess 752 is generally L-shaped and, has seen from a lateral side of the heat exchanger assembly 700, is curved. In this this position, the passage formed by the bottom part 750 can be cooled by snow projected by the drive track 30 during operation of the snowmobile 10. The passage portion 328 extends laterally along a front of the passage formed by the bottom part 750. The passage portion 130 extends longitudinally along a left side of the passage formed by the bottom part 750. The rear portion of the passage formed by the bottom part 750 is disposed laterally between the passage portions 130 and 134. It is contemplated that instead of or in addition to the bottom part 750, another passage could be formed by another part having a recess that is joined to a top of the top part 708.

The top portion 708 is shape like the top portion 108 of the heat exchanger 100 but has two apertures formed therein to form the inlet 756 and the outlet 758 (shown in dotted lines in FIG. 32) of the passage formed by the bottom part 750. As can be seen in FIG. 33, an inlet pipe 760 is welded or otherwise joined to the top part 708 around the inlet 756 and an outlet pipe 762 is welded or otherwise joined to the top part 708 around the outlet 758.

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The passage formed by the bottom part **750** is fluidly separate from the passage formed by the bottom part **710**. As such, the passage formed by the bottom part **750** is used to cool a motor fluid other than the engine coolant such as oil used to lubricate the engine **26** or air to be supplied to the engine **26** by having this other motor fluid flowing through this other passage.

Turning now to FIGS. **34** and **35**, a heat exchanger assembly **800** will be described. The heat exchanger assembly **800** has a top part **808** joined to the bottom part **610** described above to form a first passage therebetween and the bottom part **750** described above joined to the top part **808** to form a second passage therebetween. As such, the heat exchanger assembly **800** can also be used to cool two different motor fluids. The top part **808** is similar to the top part **608** described above, but has the apertures forming the inlet **756** and the outlet **758** of the second passage. The inlet and outlet pipes **760**, **762** are welded or otherwise joined to the top part **808** around the inlet **756** and outlet **758** respectively.

Turning now to FIGS. **36** and **37**, a heat exchanger assembly **900** will be described. The heat exchanger assembly **900** has a top part **908** joined to the bottom part **210** described above to form a first passage therebetween and the bottom part **750** described above joined to the top part **908** to form a second passage therebetween. As such, the heat exchanger assembly **900** can also be used to cool two different motor fluids. The top part **908** is similar to the top part **208** described above, but has the apertures forming the inlet **756** and outlet **758** of the second passage. The inlet and outlet pipes **760**, **762** are welded or otherwise joined to the top part **908** around the inlet **756** and outlet **758** respectively.

Although the heat exchanger assemblies described above are designed to take advantage of the snow projected by the drive track **30** of the snowmobile **10** during operation of the snowmobile **10**, it should be understood that the air around the heat exchanger assemblies also cools the motor fluid(s) flowing through the heat exchanger assemblies. It is contemplated that fins or other types of heat sinks could be attached to at least some of the surfaces of the heat exchanger assemblies forming the passage(s) described above to further increase cooling of the motor fluid(s) flowing through the passage(s).

A method of manufacturing the heat exchanger assembly **100** will now be described. A similar method is used to manufacture the other heat exchangers described above.

A first part of sheet metal, such as aluminum, is cut to a desired shape in order to make the top part **108**. A front portion of the first part of sheet metal is curved from a middle portion of the first part of sheet metal using a press or other suitable machine to form the top part **108**. The apertures **112**, the outlet **114** and the inlet **116** are then cut or drilled into the top part **108**. The apertures **112**, the outlet **114** and the inlet **116** could also be stamped out of the top part **108** using a press. The outlet pipe **118** and the inlet pipe **120** are then welded or otherwise connected to the top part **108** around the outlet **114** and the inlet **116** respectively.

A second part of sheet metal, such as aluminum, is cut to a desired shape in order to make the bottom part **110**. In one implementation, the first and second parts of sheet metal have the same initial thickness. A front portion of the second part of sheet metal is curved from a middle portion of the second part of sheet metal using a press or other suitable machine such that a curvature of the second part of sheet metal corresponds to a curvature of the top part **108**. Then, using a press, the recess **122** is stamped in the second part

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of sheet metal thereby forming the bottom part **110**. This stamping also forms the border **124**.

The top part **108** is then joined to the bottom part **110** thereby forming the passage between the recess **122** and the top part **108**. In the present implementation, the top part **108** is welded to the border **124** of the bottom part **110**, such as by friction stir welding. However it is contemplated that the top part **108** could be joined to the bottom part **110** in other manners such as by brazing, bonding or fastening for example. If fasteners are used, it is contemplated that a seal could be disposed between the border **124** and the top part **110** to prevent the motor fluid to leak out of the passage.

It is contemplated that the top part **108** and the bottom part **110** could be made of other types of thin walled material. It is also contemplated that at least the bottom part **110** could be molded, in which case the recess **122** and border **124** would be formed in the mold.

To make a top part having recesses and protrusions such as the top part **608**, these are stamped in the sheet metal in a manner similar to which the recess **122** is formed in the bottom part **110**. The part **750** is formed in a manner similar to the one used to make the bottom part **110** and is joined to its corresponding top part in a similar manner.

Turning now to FIGS. **38** to **45**, a heat exchanger assembly **1100** will be described. The heat exchanger assembly **1100** has a top part **1108** and a bottom part **1110**. The bottom part **1110** defines a recess **1122**. A passage is formed between the recess **1122** and the top part **1108**. In the heat exchanger assembly **1100**, the portion **228** of the passage of the heat exchanger assembly **200** has been replaced by a portion **1128**. The portion **1128** will be described in greater detail below.

In the heat exchanger assembly **1100**, the portion **134** of the passage of the heat exchanger assembly **100** has been replaced by a short narrow portion **1134A**, a long narrow portion **1134B** and a wide portion **1135** between the portions **1134A**, **1134B**. As best seen in FIG. **39**, the portion **1135** is wider than the portions **1134A** and **1134B**, but narrower than the portion **132**. Coolant flows from the inlet **116** (shown in dotted lines in FIG. **39**) to the portion **1134B**, to the portion **1135**, then to the portion **1134A** and then to the portion **132**.

In the heat exchanger assembly **1100**, the portion **130** of the passage of the heat exchanger assembly **100** has been replaced by a long narrow portion **1130A**, a short narrow portion **230B** and a wide portion **1131** between the portions **1130A**, **1130B**. As best seen in FIG. **39**, the portion **1131** is wider than the portions **1130A** and **1130B**, but narrower than the portion **132**. Coolant flows from the portion **132** to the portion **1130B**, to the portion **1131**, then to the portion **1130A** and then to the portion **1128**.

The wider portions **1131** and **1135** of the passage of the heat exchanger assembly **1100** are disposed in the rear half of the heat exchanger assembly **1100**. Making the portions **1131** and **1135** wide increases the amount of cooling obtained from snow projected thereon since a large surface is exposed to the projected snow.

With reference to FIGS. **40** to **42**, the portion **1128** of the heat exchanger assembly **1100** will be described in more detail. The portion **1128** has a central channel **1150** defined on an outer surface thereof. The central channel **1150** is laterally between two side sections **1152** and above a bottom section **1154** of the portion **1128**.

The side sections **1152** each have an arcuate part spanning an angle **A1** at a radius **R1** from the sprocket axis **37** (see FIG. **42**) followed by a straight part up to the bottom section **1154** (as indicated by dotted lines **1155** in FIG. **40**). The straight parts of the side sections **1152** are parallel to the top

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part **1108**. The central channel **1150** defines an arcuate surface spanning an angle **A2** at a radius **R2** from the sprocket axis **37** (see FIG. **42**) up to the bottom section **1154**. The angle **A1** is less than the angle **A2**. The radius **R2** is less than the radius **R1**. As such the thickness of the passage between the central channel **1150** and the top part **1108** is less than the thickness of the passage between the side sections **1152** and the top part **1108**. The main surface to the bottom section **1154** is parallel to the top part **1108**. The thickness of the passage between the side sections **1152** and the top part **1108** is the same as the thickness of the passage between the bottom section **1154** and the top part **1108**.

With reference to FIGS. **44** and **45**, in the present implementation, the lugs **31** of the endless drive track **30** are provided with studs **1160** to improve traction. It will be noted that the portions of the lugs **31** that are laterally aligned with the portions **1130A** and **1134B** of the passage of the heat exchanger assembly **1100** are free of studs **1160**. When the rear suspension assembly **32'** is compressed as shown in FIGS. **43** to **45**, and in other positions of the rear suspension assembly **32'** (not shown), the portions of the lugs **31** that are laterally aligned with the portions **1130A** and **1134B** come into contact with the portions **1130A**, **1134B**, thus preventing the studs **1160** located to the left and right of the portions **1130A**, **1134B** from coming into contact with the bottom of the heat exchanger assembly **1100**. It is contemplated that portions of the heat exchanger assemblies previously described above with respect to FIGS. **4** to **37** could similarly prevent studs **1160** provided on the lugs **31** of the endless drive track **30** from coming into contact with a bottom surface thereof.

As the central channel **1150** of the portion **1128** of the heat exchanger assembly **110** is disposed further from the drive sprocket **34** than the side sections **1152**, the portions of the lugs **31** that are laterally aligned with the central channel **1150** can be provided with studs that are longer than the studs **1160** shown in FIGS. **44** and **45**. Alternatively, the portion of the endless drive track **30** that is laterally aligned with the central channel **1150** can be provided with lugs **1131** (shown in dotted lines in FIG. **45**) that are longer than the lugs **31**.

Turning now to FIG. **46**, a heat exchanger assembly **1200** will be described. The heat exchanger assembly **1200** is the same as the heat exchanger assembly **1100** described above, except that the surface of the side and bottom sections **1152**, **1154** of the portion **1128** is provided with dimples **1202** and the surface of the central channel **1150** of the portion **1128** is provided with fins **1204**. The dimples **1202** and the fins **1204** increase the heat exchanging surface area of the portions of the passages to which they are connected, thereby improving the heat exchanging efficiency of the portion **1128**. It is contemplated that the dimples **1202** or the fins **1204** could be omitted. It is also contemplated that dimples and/or fins could be provided on other portions of the heat exchanger assembly **1200**. It is contemplated that features other than dimples and fins that increase the heat exchanging surface area of the heat exchanger assembly **1200** could be provided instead of or in addition to the dimples **1202** and fins **1204**. It is contemplated that portions of the heat exchanger assemblies previously described above with respect to FIGS. **4** to **37** could also be provided with dimples, fins and/or other features increasing the heat exchanging surface area.

Modifications and improvements to the above-described implementations of the present technology may become apparent to those skilled in the art. The foregoing description is intended to be exemplary rather than limiting. The scope

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of the present technology is therefore intended to be limited solely by the scope of the appended claims.

What is claimed is:

1. A snowmobile comprising:

a frame having a tunnel;
a motor supported by the frame;
at least one ski connected to the frame;
a rear suspension assembly connected to the tunnel;
a drive track disposed around the rear suspension assembly and at least in part below the tunnel, the drive track being operatively connected to the motor; and
drive sprockets operatively connecting the motor to the drive track,

at least a portion of the tunnel being formed by a heat exchanger assembly, the heat exchanger assembly comprising:

a front portion;
a middle portion rearward of the front portion;
a rear portion rearward of the middle portion, at least one of the front and rear portions being curved from the middle portion, the at least one of the front and rear portions extending below the middle portion;
a top part; and
a bottom part disposed below the top part and being joined to the top part, the bottom part defining at least one recess,
the top and bottom parts defining therebetween a passage formed in part by the at least one recess,
the passage having an inlet and an outlet,
a first portion of the passage defined by the at least one recess extending longitudinally;

the drive track comprising:

a plurality of lugs extending from an outer surface of the drive track; and
a plurality of studs connected to and extending from the plurality of lugs,

portions of the plurality of lugs being laterally aligned with the first portion of the passage being free of studs such that in response to the rear suspension assembly being compressed to at least one position: the portions of the plurality of lugs being laterally aligned with the first portion of the passage come into contact with the first portion of the passage; and

the plurality of studs are prevented from coming into contact with the first portion of the passage.

2. The snowmobile of claim **1**, wherein:

some of the plurality of studs are disposed to a right of the first portion of the passage; and
some of the plurality of studs are disposed to a left of the first portion of the passage.

3. The snowmobile of claim **1**, wherein:

the first portion of the passage extends longitudinally along a first lateral side of the heat exchanger;
a second portion of the passage defined by the at least one recess extends longitudinally along a second lateral side of the heat exchanger;

portions of the plurality of lugs being laterally aligned with the second portion of the passage being free of studs such that in response to the rear suspension assembly being compressed to the at least one position: the portions of the plurality of lugs being laterally aligned with the second portion of the passage come into contact with the second portion of the passage; and

the plurality of studs are prevented from coming into contact with the second portion of the passage.

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- 4. The snowmobile of claim 3, wherein some of the plurality of studs are disposed laterally between the first and second portions of the passage.
- 5. The snowmobile of claim 4, wherein:
 some of the plurality of studs are disposed laterally outward of the first portion of the passage; and
 some of the plurality of studs are disposed laterally outward of the second portion of the passage.
- 6. The snowmobile of claim 3, wherein:
 some of the plurality of studs are disposed laterally outward of the first portion of the passage; and
 some of the plurality of studs are disposed laterally outward of the second portion of the passage.
- 7. The snowmobile of claim 1, wherein:
 the inlet and the outlet of the passage fluidly communicate with the motor; and
 the heat exchanger assembly is adapted to have at least one motor fluid flowing therethrough for cooling the at least one motor fluid.
- 8. The snowmobile of claim 1, wherein at least a portion of the passage is wider than at least another portion of the passage.
- 9. The snowmobile of claim 1, wherein at least one of the inlet and the outlet is defined in the at least one of the front and rear portions extending below the middle portion.
- 10. The snowmobile of claim 9, wherein:
 the at least one of the front and rear portions extending below the middle portion is the front portion; and
 the outlet is defined in the front portion.

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- 11. The snowmobile of claim 1, wherein:
 the inlet is disposed near a first end of the passage; and
 the outlet is disposed near a second end of the passage.
- 12. The snowmobile of claim 1, wherein the passage extends longitudinally along a first lateral side of the heat exchanger, then laterally along the rear portion, then longitudinally along a second lateral side of the heat exchanger and then laterally along the front portion.
- 13. The snowmobile of claim 1, wherein the passage extends at least in part along the middle portion and the at least one of the front and rear portions.
- 14. The snowmobile of claim 1, wherein at least a portion of the passage is thicker than at least another portion of the passage.
- 15. The snowmobile of claim 1, wherein the passage extends at least in part along the front portion; and
 wherein a width of a portion of the passage extending along the front portion is at least three quarters of a width of the front portion.
- 16. The snowmobile of claim 1, wherein:
 the at least one of the front and rear portions extending below the middle portion is the front portion; and
 the recess extends at least in part along the middle portion and the front portion and is curved to follow a curvature defined by the front portion and the middle portion.

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