



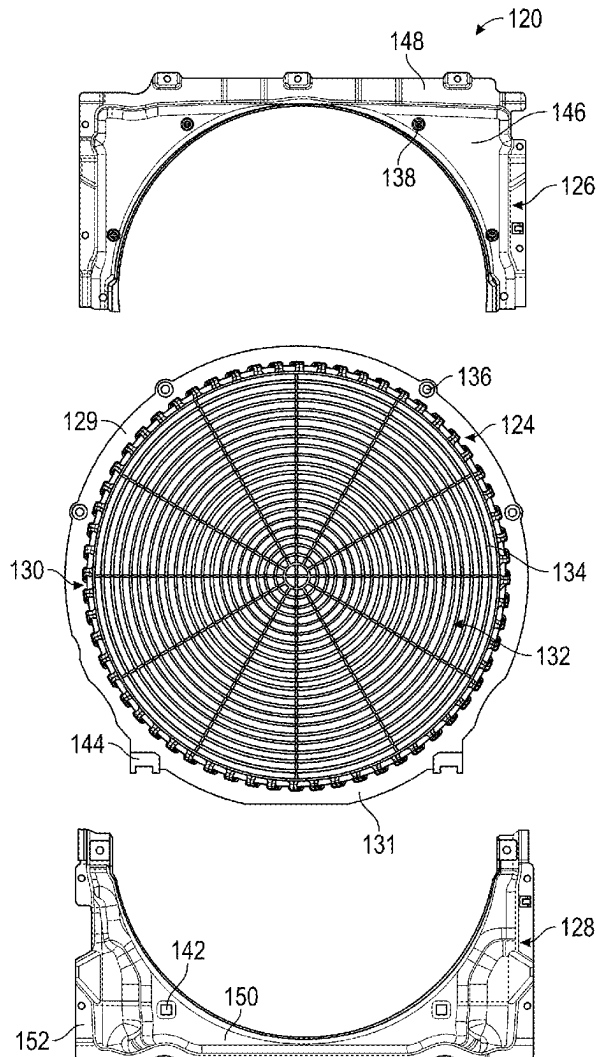
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(19) **United States**(12) **Patent Application Publication**
Kelly(10) **Pub. No.: US 2025/0257682 A1**(43) **Pub. Date: Aug. 14, 2025**(54) **FAN SHROUD AND ROCK SCREEN
ASSEMBLY**(52) **U.S. Cl.**CPC **F01P 11/10** (2013.01); **F01P 5/06**
(2013.01); **F01P 11/12** (2013.01); **F01P**
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(57)

ABSTRACT(21) Appl. No.: **19/046,784**(22) Filed: **Feb. 6, 2025****Related U.S. Application Data**(60) Provisional application No. 63/552,754, filed on Feb.
13, 2024.**Publication Classification**(51) **Int. Cl.****F01P 11/10** (2006.01)**F01P 5/06** (2006.01)**F01P 11/12** (2006.01)

An engine system can comprise an engine and a cooling module assembly which comprises a radiator. In some examples, an assembly, such as the cooling module assembly, can include a radiator and a fan shroud and screen assembly arranged at a rear side of the radiator. The fan shroud and screen assembly includes a screen and first and second shroud portions coupled to and around the screen, where the first and second shroud portions and the screen form a cavity, and where the first and second shroud portions are directly coupled to the rear side of the radiator. The assembly further comprises a fan disposed within the cavity and configured to spin freely within the cavity without being attached to the fan shroud and screen assembly.



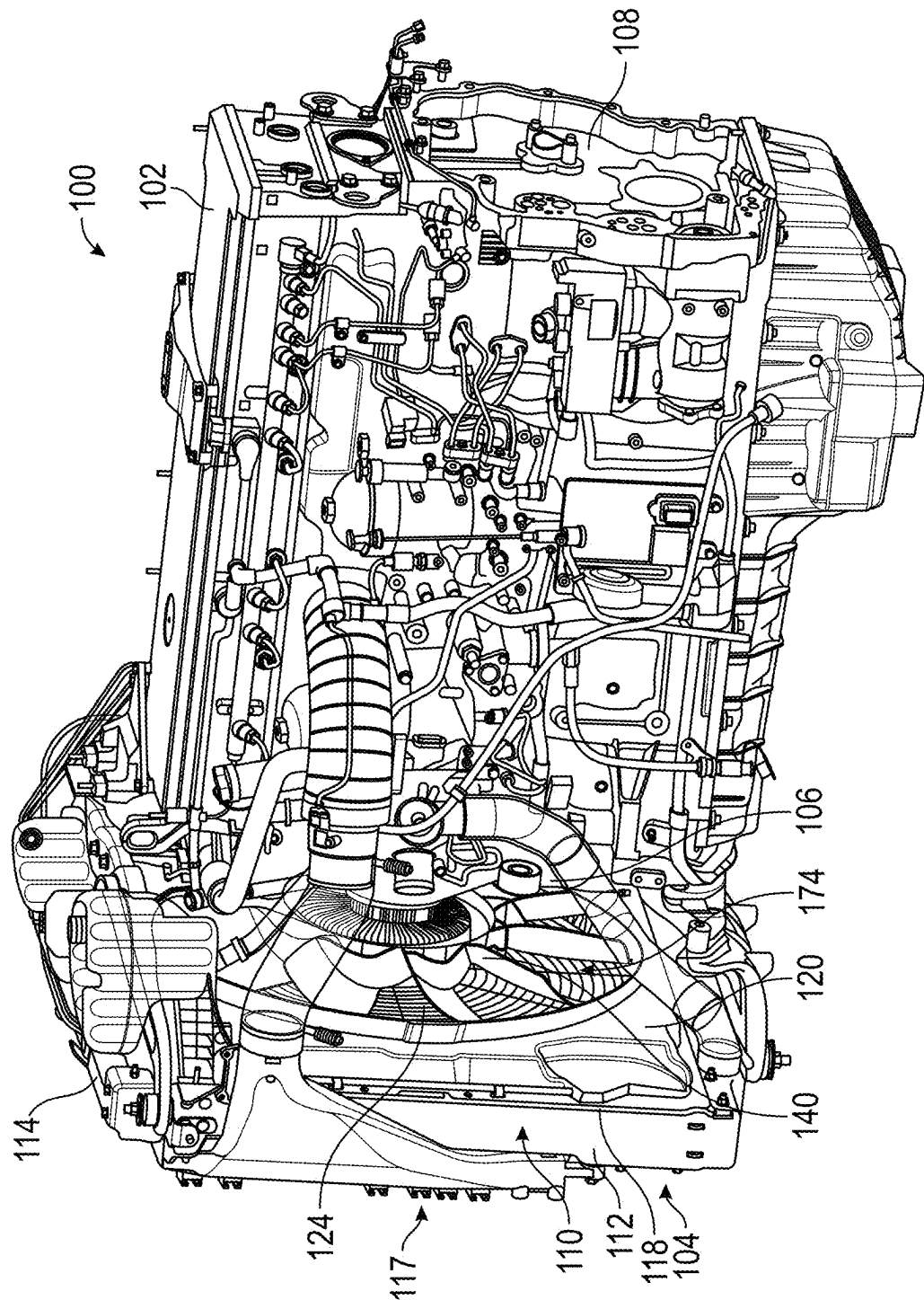


FIG. 1

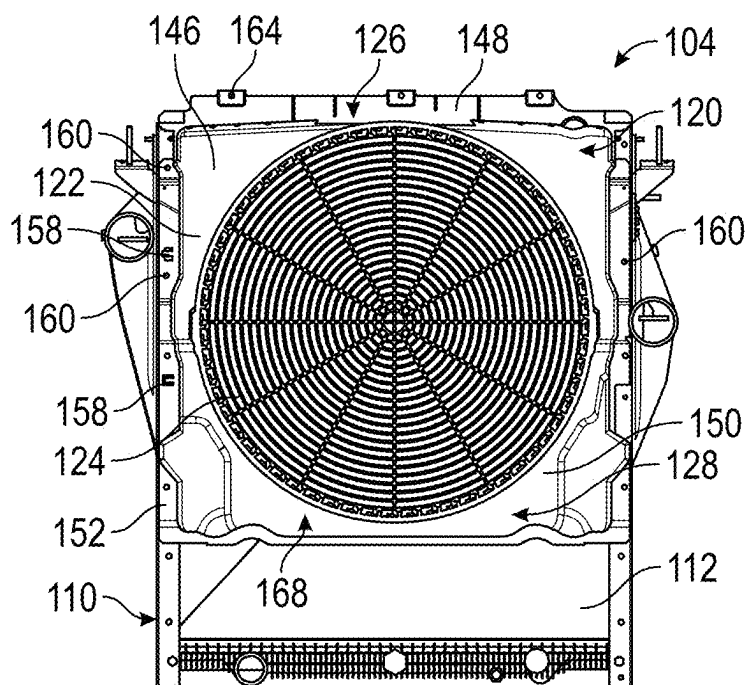


FIG. 2

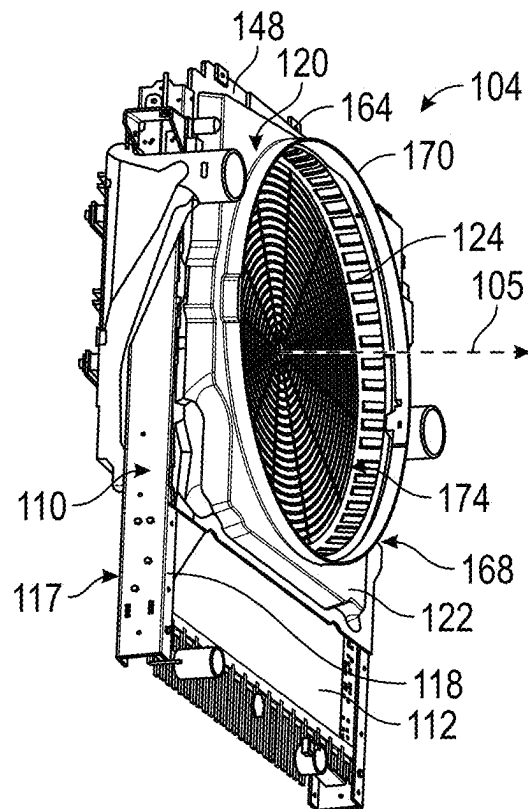


FIG. 3

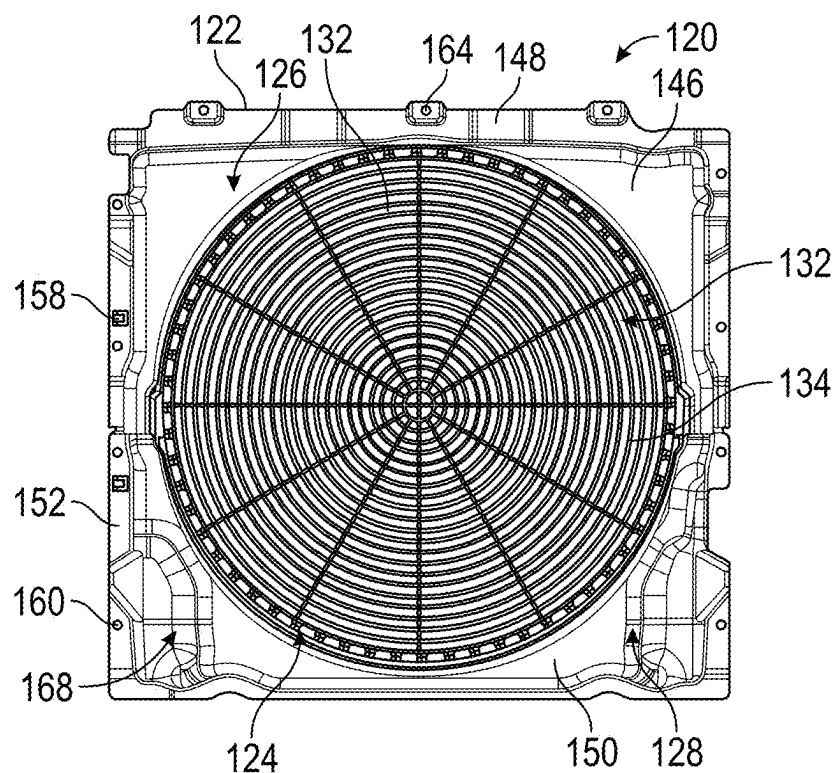


FIG. 4

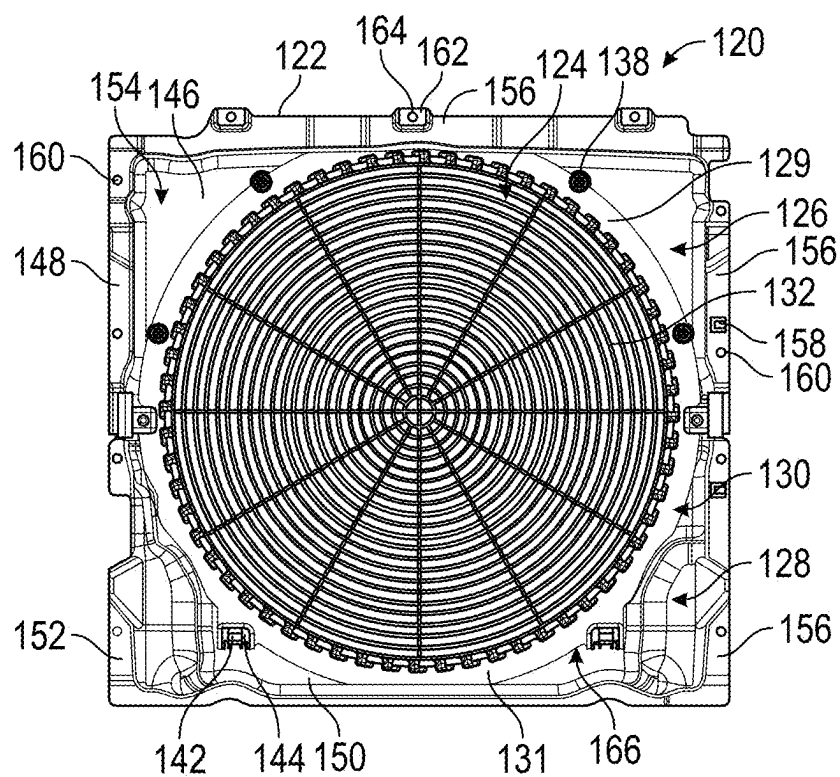


FIG. 5

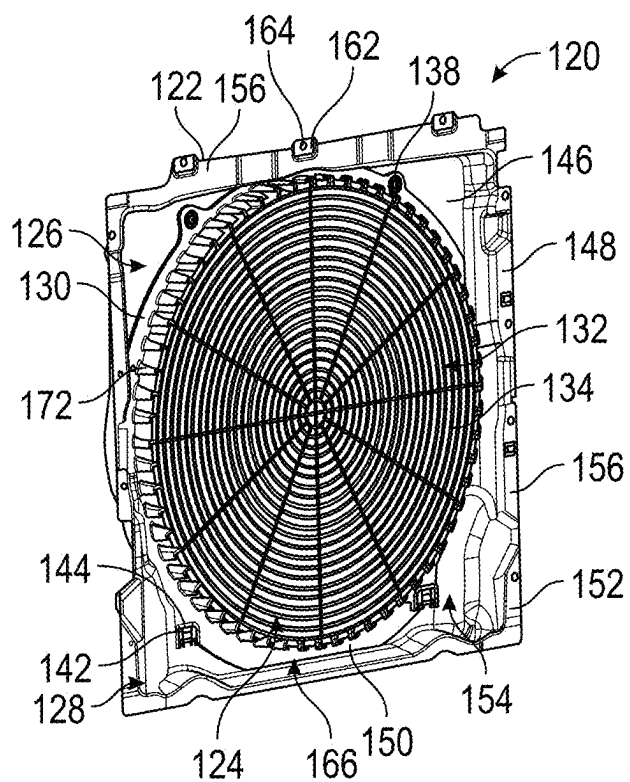


FIG. 6

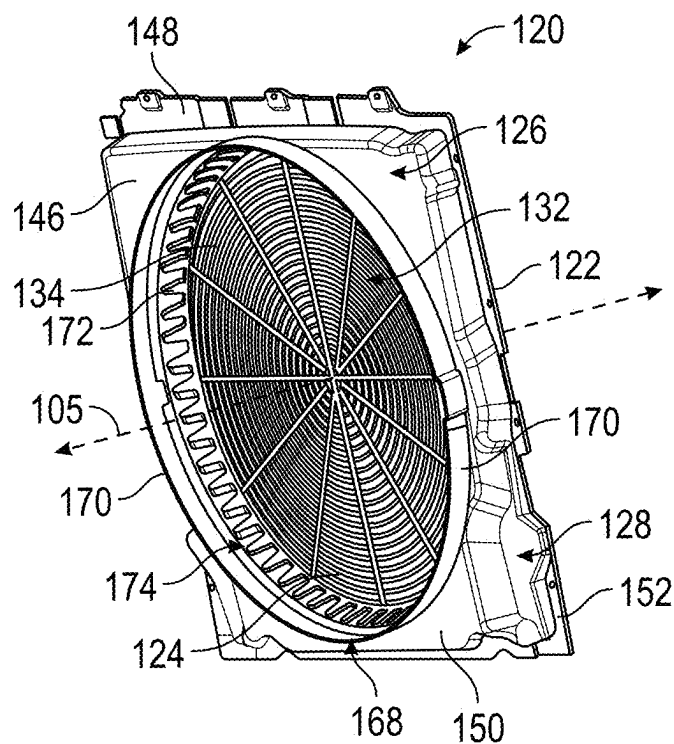


FIG. 7

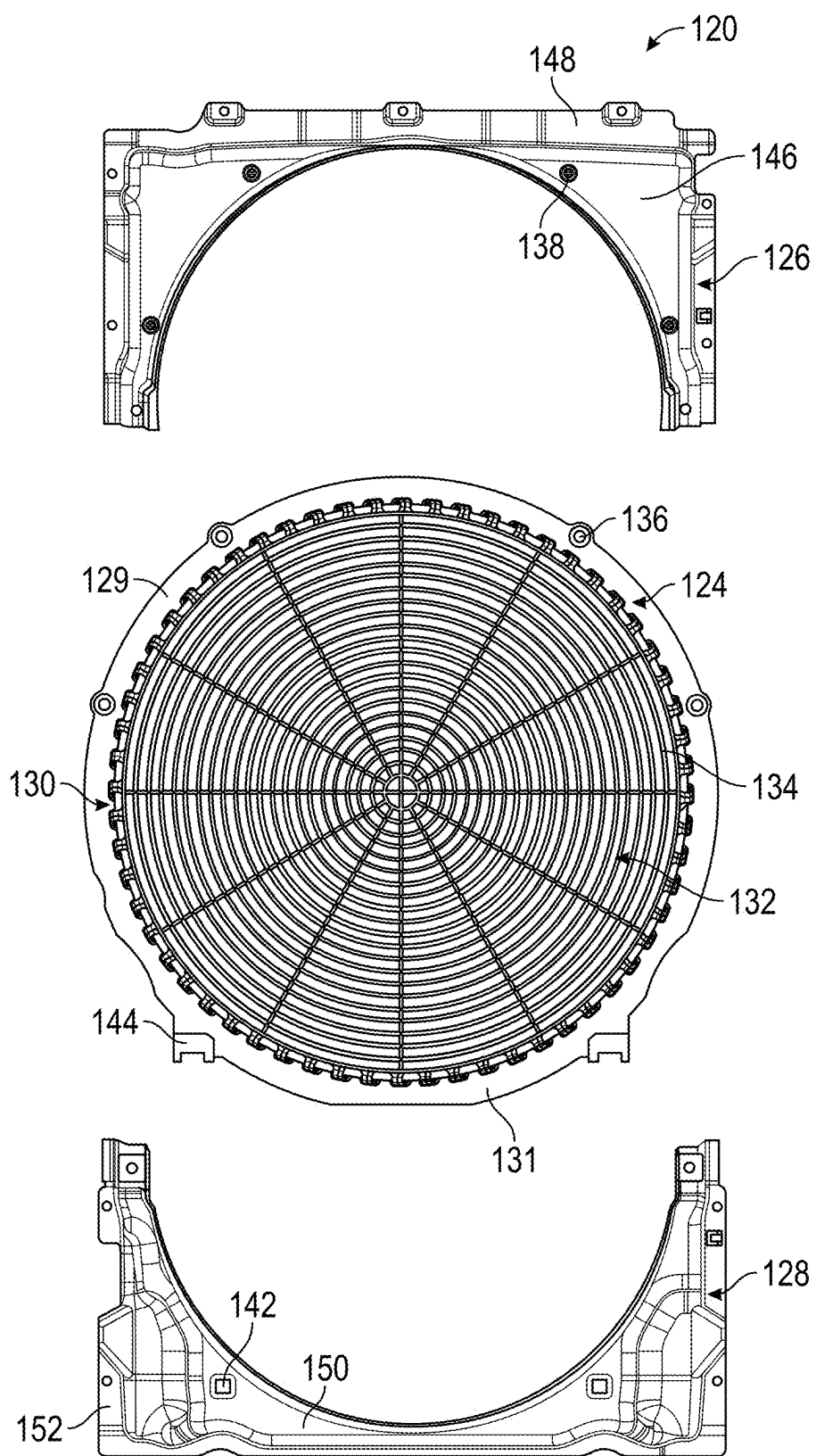


FIG. 8

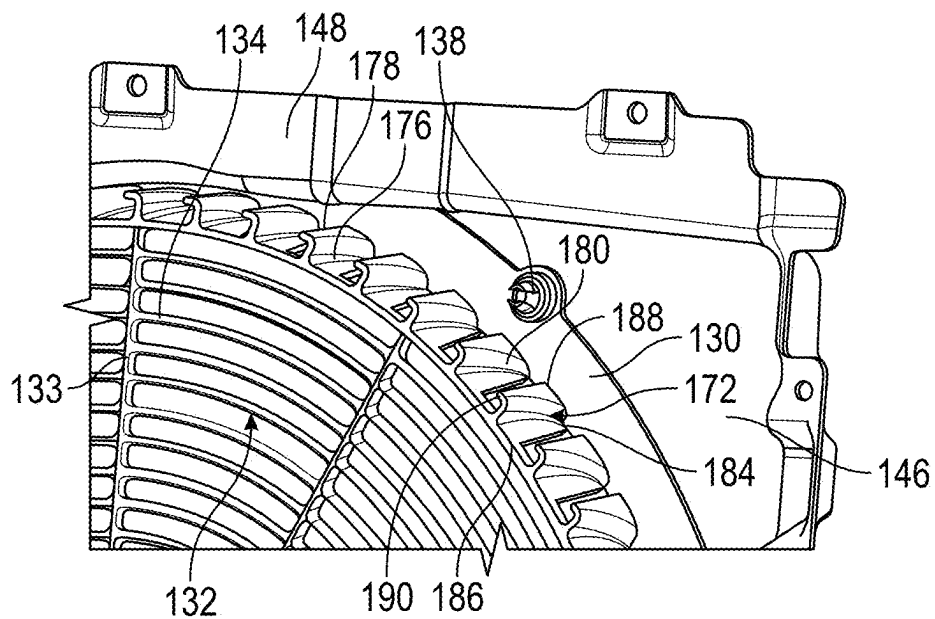


FIG. 9A

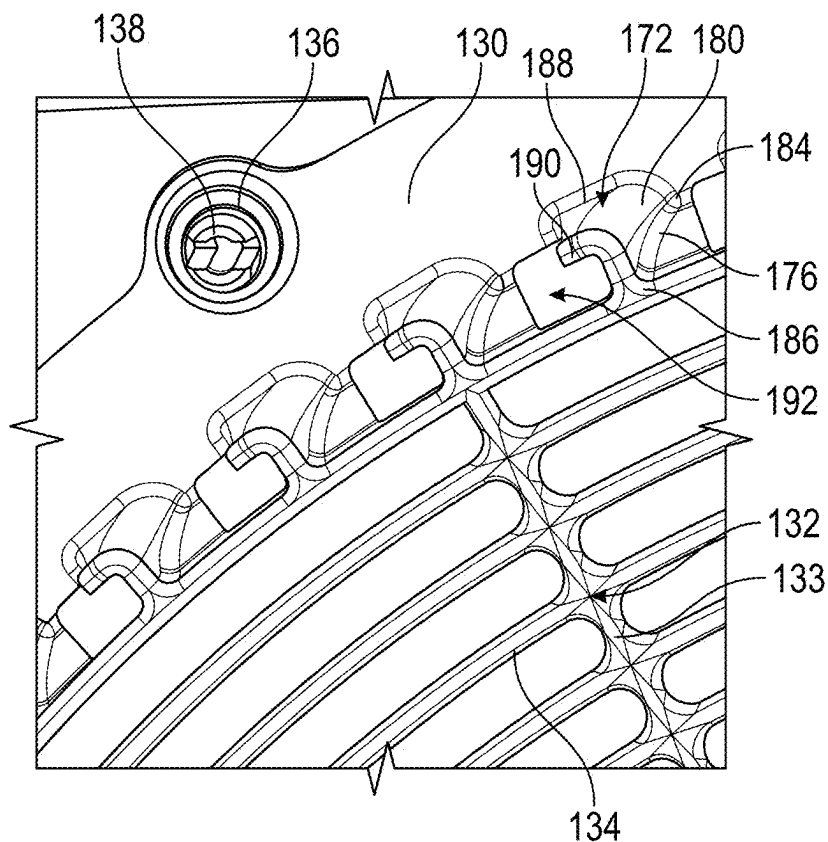


FIG. 9B

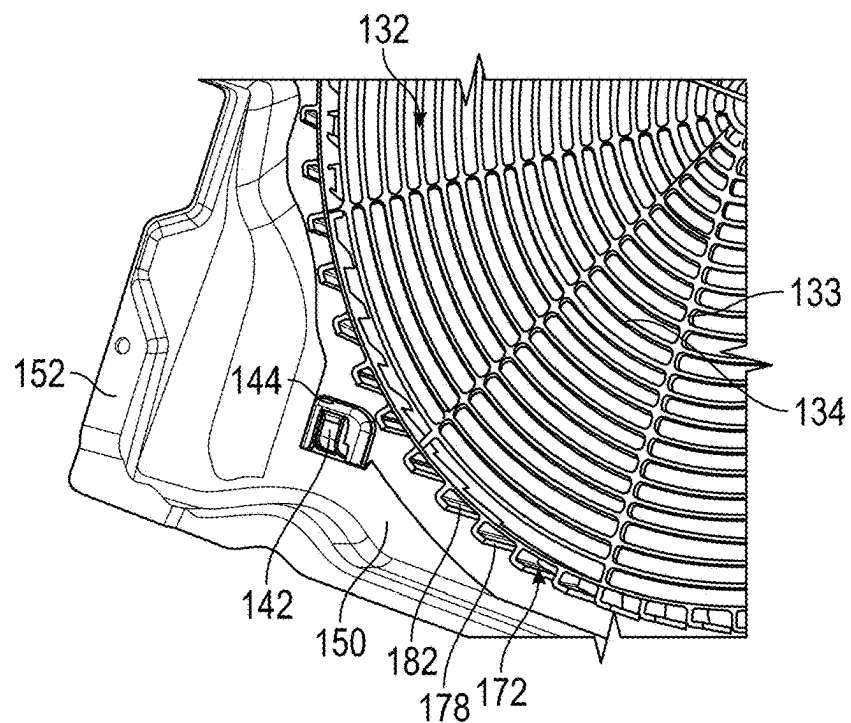


FIG. 10A

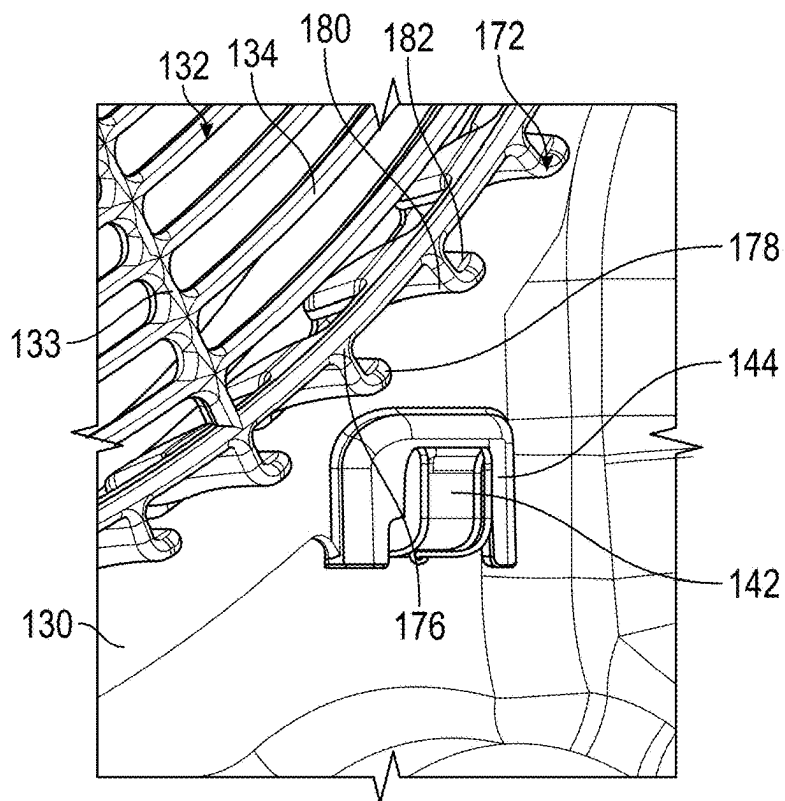
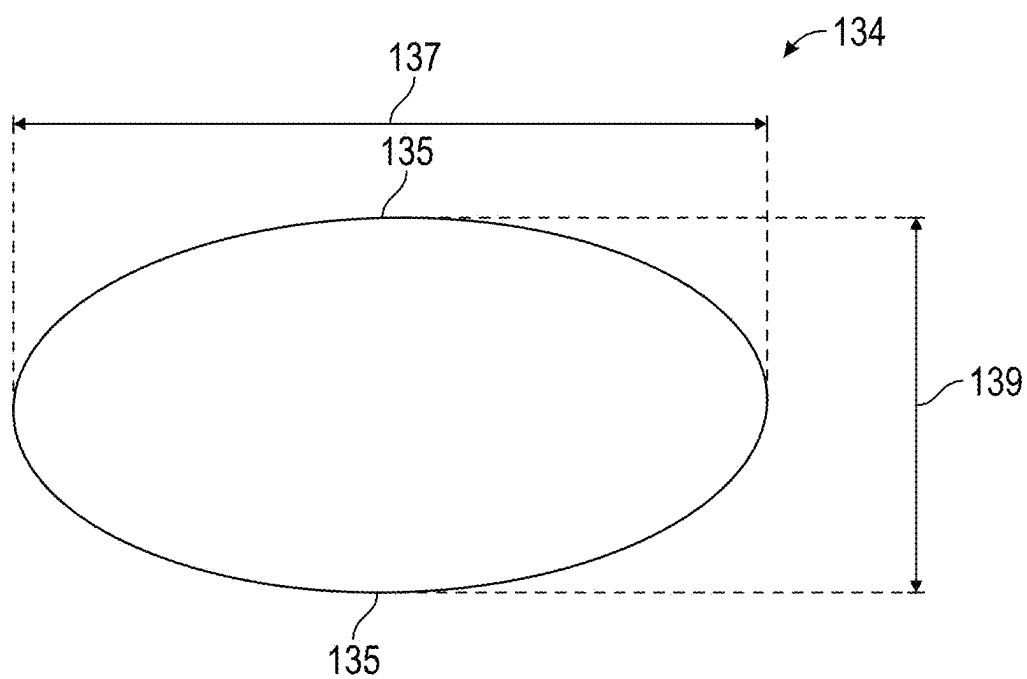


FIG. 10B

**FIG. 11**

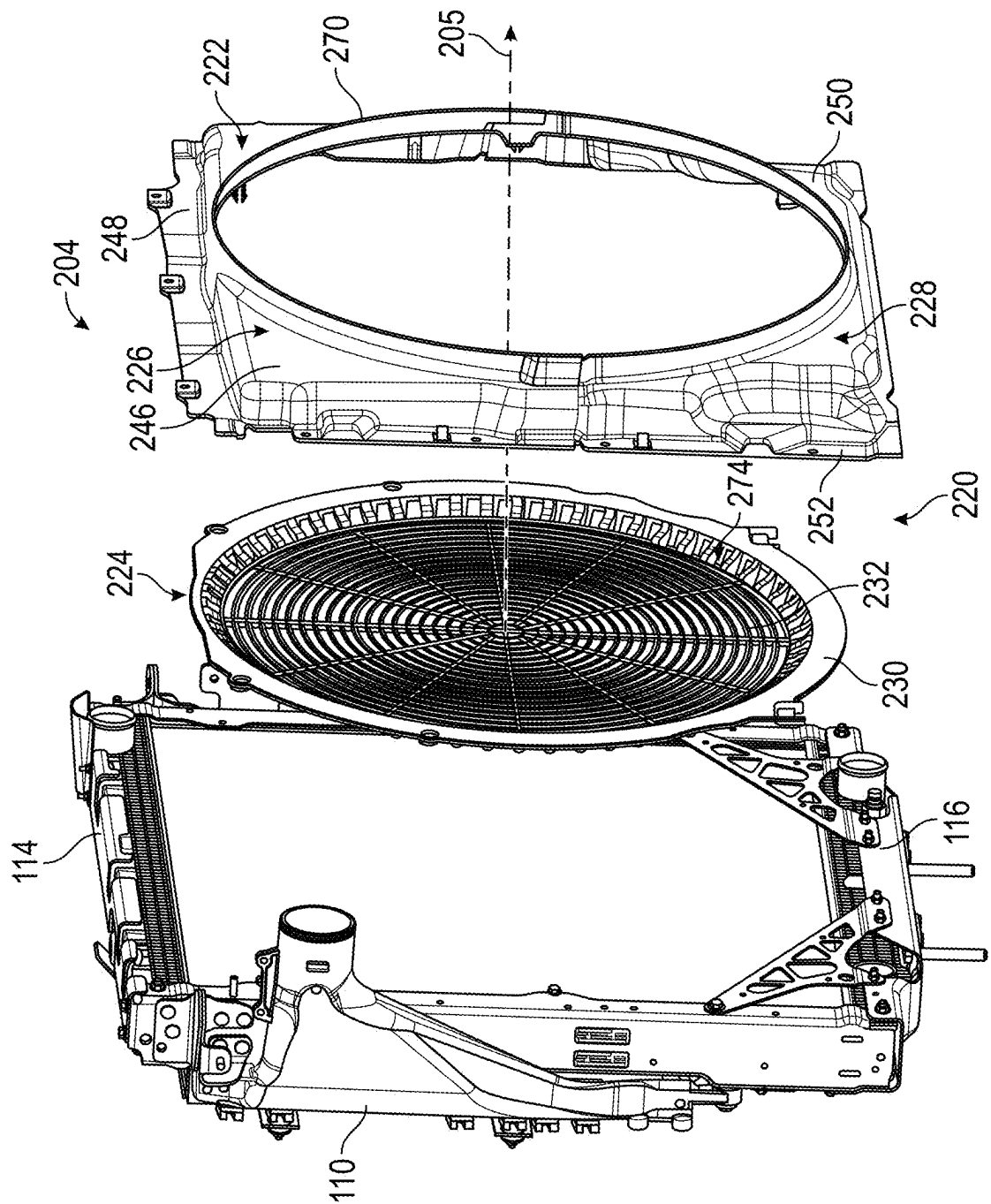


FIG. 12

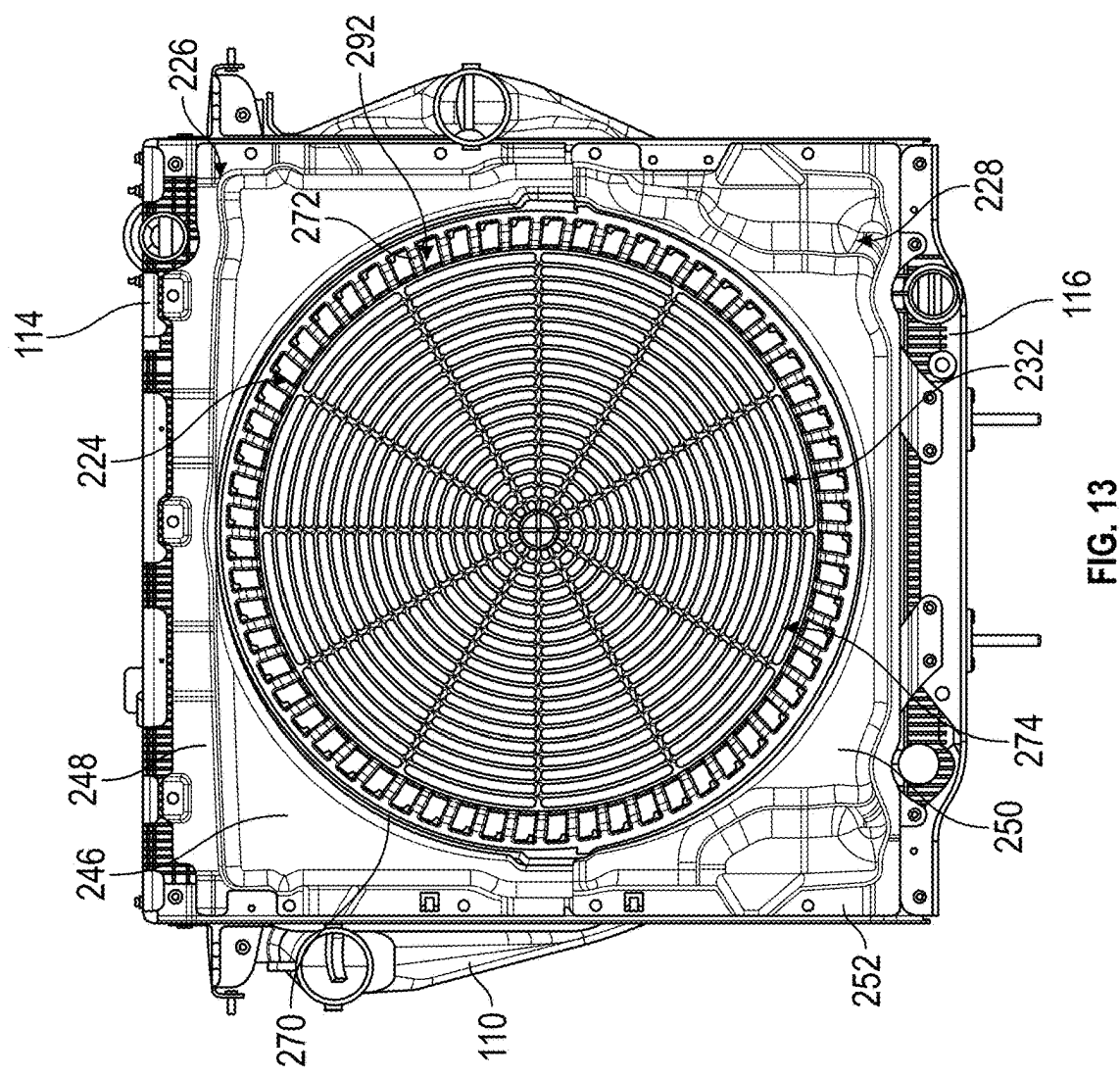


FIG. 13

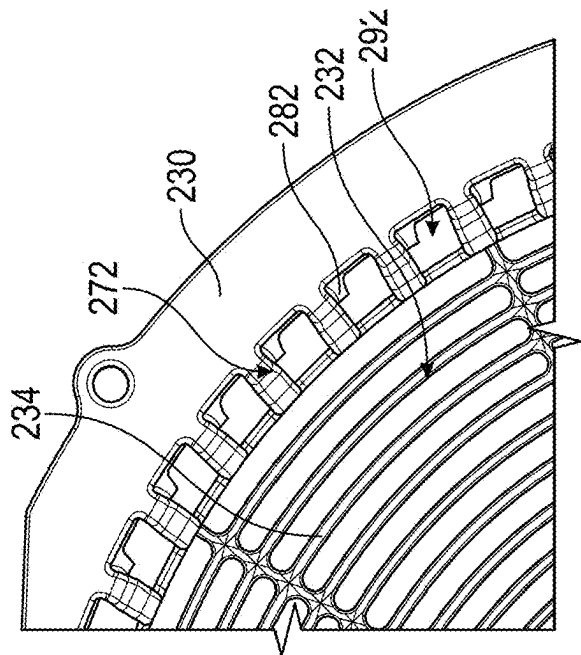


FIG. 14

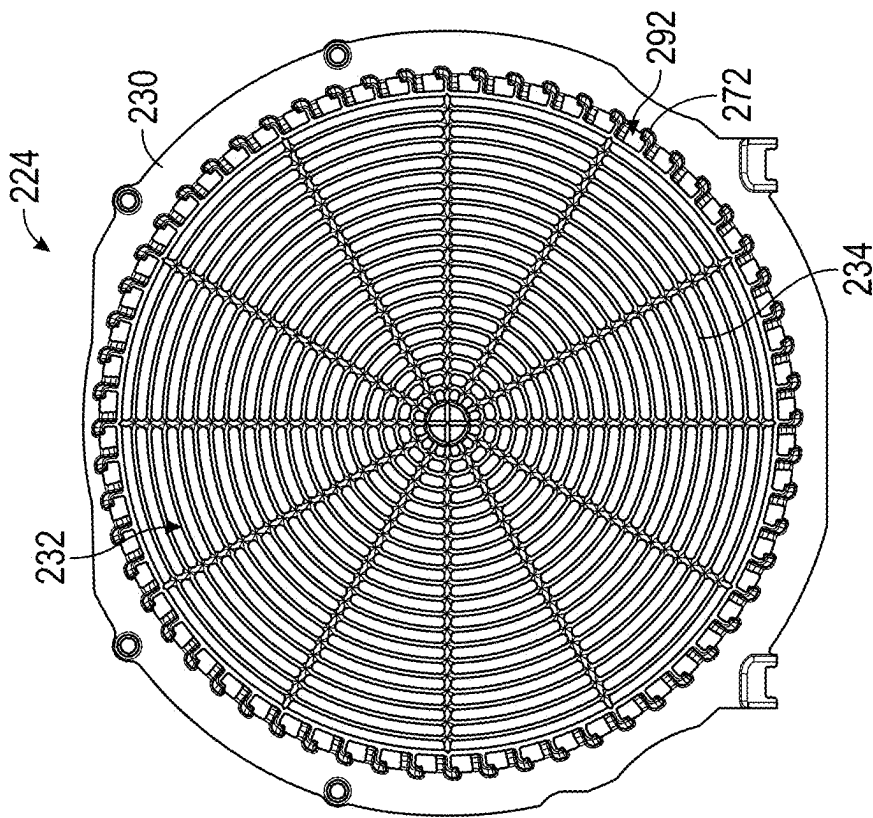


FIG. 15

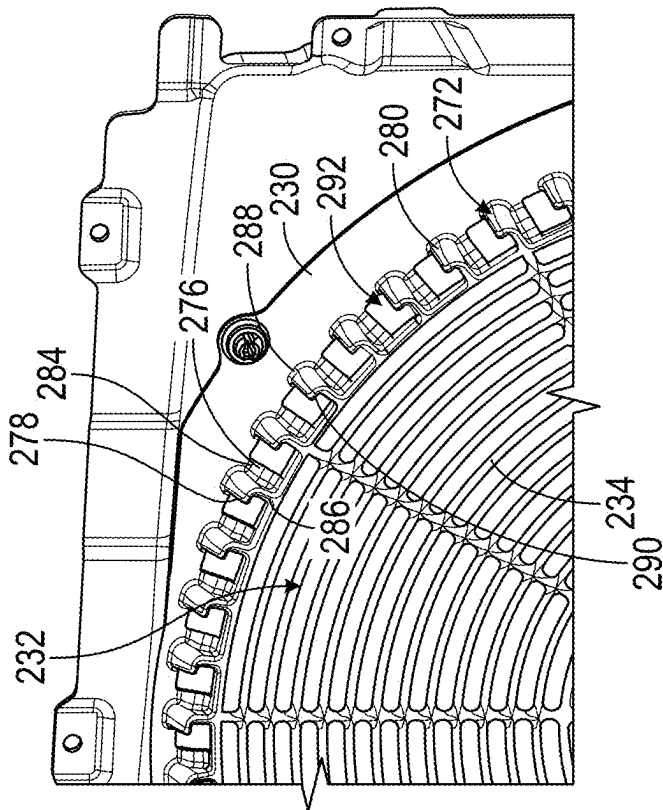


FIG. 16A

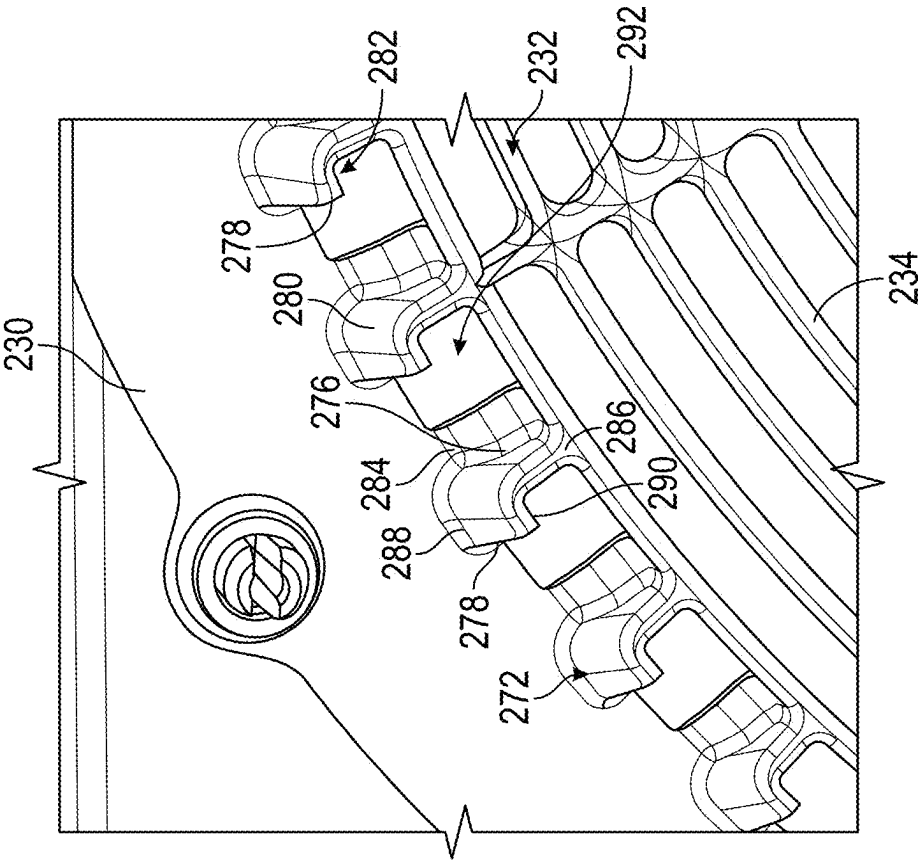


FIG. 16B

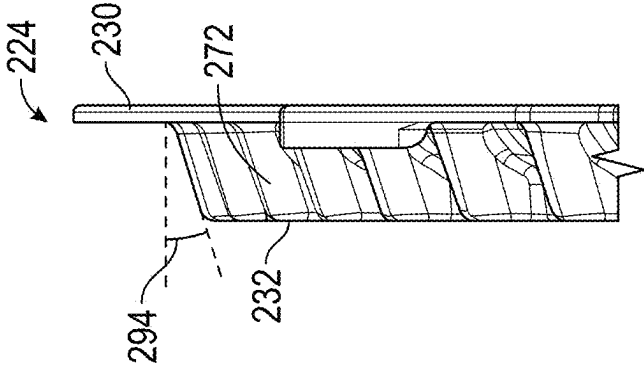


FIG. 17

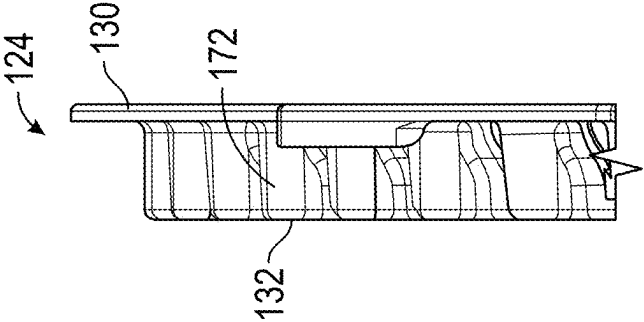


FIG. 18

FAN SHROUD AND ROCK SCREEN ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/552,754, filed Feb. 13, 2024, which is incorporated by reference herein in its entirety.

FIELD

[0002] This disclosure generally relates to radiators, and related components, for engine systems of vehicles.

BACKGROUND

[0003] A vehicle typically includes an engine system with a radiator for cooling an engine. A fan, which may be mounted within a fan shroud, can be disposed between the radiator and the engine. In some instances, during operation of the vehicle, debris can be thrown up toward the fan and/or engine from the tires. This may cause the fan to pick up the debris and send it toward a rear side of the radiator, which can result in degradation of the radiator. A screen (which may comprise metal, for example) can be attached to the rear side of the radiator in order to prevent debris from interacting with the radiator. However, such screens can be expensive, heavy, and reduce airflow through the radiator.

SUMMARY

[0004] Described herein are engine systems, radiators, cooling module assemblies, and fan shroud and rock screen assemblies for an engine system. An engine system for a vehicle can comprise a radiator disposed at a front side of an engine in order to provide cooling to the engine. A fan can be arranged adjacent (e.g., behind) the radiator to pull air through the radiator. During operation of the vehicle, debris can be thrown up toward the rear side of the radiator (the side facing the fan and the engine). Thus, in some examples, the engine system can comprise a fan shroud and rock screen assembly that is configured to mount to the radiator, receive the fan therein, and prevent debris from contacting the radiator. The fan shroud and rock screen assembly can comprise a two-part fan shroud that couples around and to a rock screen. The fan shroud can be directly coupled to the radiator, and the fan shroud and rock screen assembly form a cavity in which the fan can rotate freely (without being directly coupled to any part of the fan shroud and rock screen assembly). The fan shroud and rock screen can be removably coupled to one another via one or more mating interfaces that enable easy servicing of the radiator, fan, or alternate components of the cooling module assembly. In some examples, the fan shroud and rock screen assembly can be formed by injection molding. As such, the fan shroud and rock screen assemblies described herein can be cost effective, lightweight, durable, and allow optimum airflow through the rock screen, thereby maintaining a cooling performance of the radiator.

[0005] In some examples, an assembly can comprise a radiator and a fan shroud and screen assembly arranged at a rear side of the radiator. The fan shroud and screen assembly can comprise a screen and first and second shroud portions coupled to and around the screen. The first and second shroud portions and the screen form a cavity, and the first

and second shroud portions are directly coupled to the rear side of the radiator. The assembly can further comprise a fan disposed within the cavity and configured to spin freely within the cavity without being attached to the fan shroud and screen assembly.

[0006] In some examples, an assembly can comprise a rock screen comprising a screen portion and an outer rim, where the screen portion is offset from the outer rim, in an axial direction relative to a central longitudinal axis of the assembly. The assembly can further comprise a first shroud portion removably coupled to a first half of the outer rim and a second shroud portion removably coupled to a second half of the outer rim. When coupled together, the screen portion and the first and second shroud portions form a cavity configured to receive a fan therein.

[0007] In some examples, an engine system can comprise a radiator and a fan shroud and rock screen assembly mounted to a rear side of the radiator. The fan shroud and rock screen assembly can comprise a rock screen and first and second fan shrouds which are each removably coupled to and disposed around the rock screen. The first and second fan shrouds and the rock screen form a cavity on a rear side of the fan shroud and rock screen assembly, and the first and second fan shrouds are directly coupled to the rear side of the radiator. The system can further comprise a fan disposed within the cavity and configured to spin within the cavity, where the fan is configured to pull air through the radiator, from a front side to the rear side of the radiator. The system can further comprise an engine arranged behind the fan shroud and rock screen assembly such that the fan shroud and rock screen assembly is disposed between the radiator and the engine.

[0008] The foregoing and other objects, features, and advantages of the disclosed technology will become more apparent from the following detailed description, which proceeds with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of an exemplary engine system for a vehicle, where the engine system includes an engine and a cooling module assembly.

[0010] FIG. 2 is a rear view of the cooling module assembly of FIG. 1, where the cooling module assembly includes a radiator and a fan shroud and rock screen assembly for the radiator.

[0011] FIG. 3 is a rear perspective view of the cooling module assembly of FIG. 2.

[0012] FIG. 4 is a rear view of the fan shroud and rock screen assembly.

[0013] FIG. 5 is a front view of the fan shroud and rock screen assembly of FIG. 4.

[0014] FIG. 6 is a front perspective view of the fan shroud and rock screen assembly of FIG. 4.

[0015] FIG. 7 is a rear perspective view of the fan shroud and rock screen assembly of FIG. 4.

[0016] FIG. 8 is a front exploded view of the fan shroud and rock screen assembly of FIG. 4.

[0017] FIG. 9A is a detail view of a portion of the fan shroud and rock screen assembly of FIG. 4, depicting a removable mating interface between the rock screen and a first shroud portion of the fan shroud.

[0018] FIG. 9B is another detail view of the portion of the fan shroud and rock screen assembly of FIG. 9A, which also depicts vanes of the rock screen.

[0019] FIG. 10A is detail view of a portion of the fan shroud and rock screen assembly of FIG. 4, depicting a removable mating interface between the rock screen and a second shroud portion of the fan shroud.

[0020] FIG. 10B is another detail view of the portion of the fan shroud and rock screen assembly of FIG. 4.

[0021] FIG. 11 is a plan view of an exemplary shape of a rung for the rock screen of the fan shroud and rock screen assembly of FIG. 4.

[0022] FIG. 12 is an exploded view of an exemplary cooling module assembly including a radiator and fan shroud and rock screen assembly for the radiator.

[0023] FIG. 13 is a rear view of the fan shroud and rock screen assembly of FIG. 12 coupled to the radiator.

[0024] FIG. 14 is a rear, detail view of a portion of the rock screen of the fan shroud and rock screen assembly of FIG. 12, which depicts vanes of the rock screen.

[0025] FIG. 15 is a front view of the rock screen of the fan shroud and rock screen assembly of FIG. 12.

[0026] FIG. 16A is a front, detail view of a portion of the rock screen of FIG. 15.

[0027] FIG. 16B is a front, detail view of another portion of the rock screen of FIG. 15.

[0028] FIG. 17 is a side view of a portion of the rock screen of FIG. 15.

[0029] FIG. 18 is a side view of a portion of the rock screen of FIG. 8.

DETAILED DESCRIPTION

Explanation of Terms

[0030] For purposes of this description, certain aspects, advantages, and novel features of the embodiments of this disclosure are described herein. The disclosed methods, apparatus, and systems should not be construed as being limiting in any way. Instead, the present disclosure is directed toward all novel and nonobvious features and aspects of the various disclosed embodiments, alone and in various combinations and sub-combinations with one another. The methods, apparatus, and systems are not limited to any specific aspect or feature or combination thereof, nor do the disclosed embodiments require that any one or more specific advantages be present or problems be solved. The scope of this disclosure includes any features disclosed herein combined with any other features disclosed herein, unless physically impossible.

[0031] Although the operations of some of the disclosed embodiments are described in a particular, sequential order for convenient presentation, it should be understood that this manner of description encompasses rearrangement, unless a particular ordering is required by specific language set forth below. For example, operations described sequentially may in some cases be rearranged or performed concurrently. Moreover, for the sake of simplicity, the attached figures may not show the various ways in which the disclosed methods can be used in conjunction with other methods.

[0032] As used in this disclosure and in the claims, the singular forms “a,” “an,” and “the” include the plural forms unless the context clearly dictates otherwise. Additionally, the term “includes” means “comprises.” Further, the terms “coupled” and “associated” generally mean electrically, electromagnetically, and/or physically (e.g., mechanically or chemically) coupled or linked and does not exclude the

presence of intermediate elements between the coupled or associated items absent specific contrary language.

[0033] In the description, certain terms may be used such as “forward,” “front,” “rear,” “back,” “up,” “down,” “upper,” “lower,” “horizontal,” “vertical,” “left,” “right,” “longitudinal,” “lateral,” and the like. These terms are used, where applicable, to provide some clarity of description when dealing with relative relationships. However, these terms are not intended to imply absolute relationships, positions, and/or orientations. For example, with respect to an object, an “upper” surface can become a “lower” surface by turning the object over. Nevertheless, it is still the same object.

[0034] Similar components in different embodiments are described in the specification and illustrated in the figures with similar reference numbers for improved understanding and readability. However, it should be understood that this numbering convention is merely for convenience and is not intended to limit and/or exclude any claim scope.

[0035] Although there are alternatives for various components, parameters, operating conditions, etc., set forth herein, that does not mean that those alternatives are necessarily equivalent and/or perform equally well. Nor does it mean that the alternatives are listed in a preferred order unless stated otherwise.

Overview of the Disclosed Technology

[0036] As introduced above, a motor vehicle (such as a car, truck, semi-trailer truck, etc.) typically includes an engine system including an engine, and a radiator and fan arranged to provide cooling to the engine. In some examples, the fan can be disposed between the radiator and the engine and can be configured to pull air through the radiator (from a front side to a rear or back side of the radiator). In some instances, the fan can be mounted within a fan shroud. During operation of the vehicle, debris can be thrown up toward the fan and/or engine by the vehicle tires. This may cause the fan to pick up the debris and send it toward the rear side of the radiator (the side facing the engine), which can result in degradation of the radiator. A screen (which may comprise metal, for example) can be attached to the rear side of the radiator to prevent debris from interacting with the radiator. However, such screens can be expensive, heavy, and require more solid structural support regions (due to being directly attached to the radiator and/or fan) that reduce airflow therethrough, thereby reducing airflow through the radiator, and as a result, reducing cooling to the engine.

[0037] Thus, there is a need for assemblies and/or components that are lightweight, durable, cost effective, and have a minimal impact to airflow through the radiator.

[0038] Described herein are examples of an integrated fan shroud and rock screen (or a fan shroud and rock screen assembly) configured to be coupled to a rear side of a radiator of an engine system. A rock screen can be removably coupled to a fan shroud (which can be a 2-part fan shroud in some examples). The fan shroud can be coupled to the rear side of the radiator (and thus the rock screen is not directly coupled to the radiator). In some examples, the integrated fan shroud and rock screen can be formed by injection molding, making the assembly lightweight, durable, and relatively low cost (as compared to a screen made of metal). Further, the rock screen can comprise vanes that are configured to minimize or eliminate the impact to

airflow through the radiator when the integrated fan shroud and rock screen are coupled thereto (as compared to the radiator without the integrated fan shroud and rock screen attached thereto). In this way, the integrated fan shroud and rock screen assemblies described herein can maintain an engine cooling performance of the radiator (to be the same or similar to the radiator without an attached rock screen).

Examples of the Disclosed Technology

[0039] FIG. 1 is a perspective view of a portion of an engine system 100. The engine system 100 can be installed in a motor vehicle, such as a car, truck, semi-trailer truck, etc. As shown in FIG. 1, the engine system 100 includes an engine 102 (or engine block) and a cooling module assembly 104 configured to cool the engine 102. It should be noted that the engine system 100 can include additional components than those depicted in FIG. 1. Further, in some instances, the cooling module assembly shown and described herein can be used within an alternate engine system having a differently configured engine.

[0040] The cooling module assembly 104 is arranged at a front side 106 of the engine 102 (which is disposed opposite a rear side 108 of the engine 102). In some examples, the front side 106 of the engine 102 can be closer to a front end of the vehicle in which the engine system 100 is installed than the rear side 108 of the engine 102. Thus, the cooling module assembly 104 can be referred to as being arranged in front of the engine 102.

[0041] The cooling module assembly 104 is shown apart from the engine 102 in the rear and rear perspective views of FIGS. 2 and 3, respectively. The cooling module assembly includes a radiator 110 and a fan shroud and rock screen assembly 120 that is mounted to a rear side of the radiator 110. In some instances, the fan shroud and rock screen assembly 120 can be referred to as a fan shroud and screen assembly 120 (e.g., since the screen of the assembly can block more than just rocks from contacting the radiator).

[0042] As described further below, a fan 140 can spin freely within the fan shroud and rock screen assembly 120, without being attached to the fan shroud and rock screen assembly 120. As used herein, “spin freely” can refer to the fan 140 rotating within a cavity defined by the fan shroud and rock screen assembly 120 while no part of the fan 140 is directly coupled to any part of the fan shroud and rock screen assembly 120.

[0043] The radiator 110 can include a core 112, a coolant inlet tank 114, and a coolant outlet tank 116 (see FIG. 1 and FIGS. 12-13). The radiator 110 can have a front side 117 (that faces away from the engine 102) and an opposite, rear side 118 (that faces toward the engine 102).

[0044] The fan shroud and rock screen assembly 120 can also be referred to herein as an integrated fan shroud and rock screen assembly 120 since the rock screen and fan shroud components are coupled together and then coupled as an assembly to the radiator 110. For example, the fan shroud and rock screen assembly 120 can be coupled to the rear side 118 of the radiator 110, as shown in FIGS. 1-3. Thus, the fan shroud and rock screen assembly 120 can be disposed between the radiator 110 and the engine 102 (as shown in FIG. 1).

[0045] A fan 140 is disposed within and spins freely within the fan shroud and rock screen assembly 120, as shown in FIG. 1. The fan 140 is not directly coupled to the fan shroud and rock screen assembly 120. Instead, in some

instances, a central hub of the fan 140 is rotatably coupled to the engine 102. As shown in FIG. 1 and used herein, the “fan” (e.g., fan 140) comprises a plurality of fan blades coupled to a central hub that is rotatably coupled to (and rotated by) the engine 102.

[0046] In some examples, the fan 140 can be referred to as a “puller fan” since it is configured to pull air through the core 112 of the radiator 110. For example, the fan 140 can pull air from in front of the radiator 110 (e.g., from the front of the vehicle in which the engine system 100 is installed), back through the radiator 110 and toward the engine 102.

[0047] The fan shroud and rock screen assembly 120 is shown alone in FIGS. 4-8. FIG. 4 is a rear view, FIG. 5 is a front view, FIG. 6 is a front perspective view, FIG. 7 is a rear perspective view, and FIG. 8 is a front exploded view of the fan shroud and rock screen assembly 120. The fan and rock screen assembly 120 comprises a fan shroud 122 and a rock screen 124 that are removably coupled to one another.

[0048] In some examples, the fan shroud 122 can be a two-part fan shroud that comprises a first shroud portion 126 and a second shroud portion 128, which couple together to and around the rock screen 124. In some instances, the first shroud portion 126 can be referred to as the upper shroud portion 126 and the second shroud portion 128 can be referred to as the lower shroud portion, due to their relative arrangements within the engine system 100, and relative to a ground surface on which the vehicle in which the engine system 100 is installed sits.

[0049] In some examples, the fan shroud and rock screen assembly 120 can be formed by injection molding, and thus comprise an injection-molded plastic. This can result in a relatively lightweight and low-cost component (as compared to more traditional metal rock screen), which is also durable. In some examples, the fan shroud and rock screen assembly 120 can comprise a glass-filled polypropylene.

[0050] The rock screen 124 can have an overall circular shape and comprise an outer rim 130 (or coupling portion) and screen portion 132 (as shown in FIGS. 5, 6, and 8). The screen portion 132 can extend outward from the outer rim 130, in an axial direction relative to a central longitudinal axis 105 of the fan shroud and rock screen assembly 120 (as shown in FIG. 7, and which can be co-axial with a rotational axis of the fan 140). The screen portion 132 can be displaced away from the outer rim 130 (in the axial direction) by a plurality of vanes 172 that extend around a circumference of the rock screen 124, each vane 172 extending between the outer rim 130 and the screen portion 132 (as shown in FIGS. 6 and 7 and described in greater detail below with reference to FIGS. 9A-10B).

[0051] The screen portion 132 comprises a plurality of rungs 134 that extend circumferentially around or along the screen portion 132. The rungs 134 can be shaped and arranged to block debris from entering the rock screen 124 (e.g., from its rear end or side, as depicted in FIGS. 3, 4, and 7) with minimal reduction in airflow through the cooling module assembly 104, as described in further detail below with reference to FIGS. 9A-11.

[0052] The outer rim 130 of the rock screen 124 comprises a plurality of coupling elements (or mating elements) that are configured to couple to corresponding coupling elements on the fan shroud 122, thereby coupling the rock screen 124 and fan shroud 122 to one another. For example, the rock screen 124 can be coupled to the first shroud portion 126 by

a first mating interface and coupled to the second shroud portion 128 by a second mating interface.

[0053] For example, the rock screen 124 comprises a plurality of apertures 136 on a first or upper half 129 of the outer rim 130. As shown in FIGS. 5 and 8, the outer rim 130 can comprise four apertures 136 spaced apart from one another around the first or upper half 129 of the outer rim 130. However, in other examples, the outer rim 130 can comprise more or less than four apertures 136 on its first or upper half 129, such as two, three, five, or the like.

[0054] The first shroud portion 126 can comprise a plurality of protruding elements 138 (corresponding to the number of apertures 136, e.g., four shown in FIG. 8) that are each configured to extend and snap into a respective aperture 136. For example, as shown in FIGS. 9A and 9B, each protruding element 138 can have two opposing elements or prongs that are biased away from one another such that the protruding element 138 is retained within the respective aperture 136, and that can be pressed together to release the protruding element 138 from the respective aperture 136. As a result, the first shroud portion 126 can be releasably coupled to the rock screen 127 via the protruding elements 138 and apertures 136 (which can be referred to as the first mating interface).

[0055] Alternatively, in some examples, instead of protruding elements 138, the first shroud portion 126 can comprise a plurality of apertures, where each aperture is configured to align with a respective aperture 136 of the outer rim 130 when the first shroud portion 126 and the rock screen 124 are mated together. Each pair of overlapping (or aligned) apertures 136 of the rock screen 124 and apertures of the first shroud portion 126 could be configured to receive a fastener (which may be a bolt, screw, or other known fastener), thereby coupling the outer rim 130 to the first shroud portion 126).

[0056] The second shroud portion 128 can comprise one or more hooks 142. As shown in FIGS. 5, 6, and 8, the second shroud portion 128 comprises two hooks 142 that are disposed on opposite sides of the second shroud portion 128. Each hook 142 is configured to receive therein and hook around a corresponding mating feature on the second or lower half 131 of the outer rim 130 of the rock screen 124. In some examples, the mating feature on the outer rim 130 is a protrusion 144, as shown in FIGS. 8, 10A, and 10B. Thus, the complementary hooks 142 and protrusions 144 can be referred to as the second mating interface.

[0057] As shown in FIGS. 5, 6, and 8, the outer rim 130 can comprise two hooks 142 that are spaced apart from one another. However, in other examples, the outer rim 130 can comprise more or less than two hooks 142 on its second or lower half, such as one, three, or the like.

[0058] In some examples, the protrusions 144 can extend outward from the outer rim 130 and have an outward facing surface for receiving the hooks 142 thereon. In some instances, each protrusion 144 can have a raised bump or bead on the outward facing surface that is configured to mate with a corresponding mating feature on the respective hook 142 (such as a concave depression or dimple).

[0059] To couple the rock screen 124 to the second shroud portion 128, the protrusions 144 of the lower half 131 of the outer rim 130 can slide into the hooks 142 of the second shroud portion 128 (as shown in the detail views of FIGS. 10A and 10B). The first shroud portion 126 can then be coupled to the rock screen 124 by inserting the protruding

elements 138 into the respective apertures 136 in the outer rim 130 (thereby snapping the rock screen 124 and the first shroud portion 126 together).

[0060] The two-part fan shroud 122 increases the ease of servicing the cooling module assembly 104. For example, the entire rock screen 124 can be pulled out and away from the remainder of the cooling module assembly 104 (e.g., away from the radiator 110) along with the first shroud portion 126 because of the hook fasteners (comprising the hooks 142 and protrusions 144) described above. For example, keeping the first shroud portion 126 coupled to the rock screen 124, the coupled first shroud portion 126 and rock screen 124 can be pulled up and away from the second shroud portion 128 (thereby uncoupling the protrusions 144 from the hooks 142). The fan 140, radiator 110, and/or other components of the engine system 100 can then be serviced without removing the entire fan shroud and rock screen assembly 120.

[0061] The assembled fan shroud and rock screen assembly 120 can be coupled to the radiator 110. More specifically, the first and second shroud portions 126, 128 can be directly coupled to the radiator 110, but the rock screen 124 is only coupled to the first and second shroud portions 126, 128, as described above (and not directly to the radiator 110).

[0062] As shown in FIGS. 2-8, the first shroud portion 126 comprises a body 146 and an outer flange 148 extending around at least a portion of a perimeter of the body 146, and the second shroud portion 128 comprises a body 150 and an outer flange 152 extending around at least a portion of a perimeter of the body 150. The bodies 146, 150 of the respective first and second shroud portions 126, 128 are offset from the respective outer flanges 148, 152, thereby creating a cavity 154 to receive the rock screen 124 therein (as shown in FIGS. 5 and 6). This arrangement can prevent the outwardly extending screen portion 132 of the rock screen 124 (as described above) from extending past the outer flanges 148, 152.

[0063] For example, FIGS. 5 and 6 show the front side 166 of the fan shroud and rock screen assembly 120 which faces the radiator 110 (as shown in FIGS. 2 and 3). The outer flanges 148, 152 can comprise first (or front facing) surfaces 156 that mate with (and have face-to-face contact with) corresponding mating surfaces on the radiator 110 and/or additional components of the engine system 100 (as shown in FIGS. 1-3).

[0064] In some examples, as shown in FIGS. 2, 4, and 5, the flanges 148, 152 comprise one or more mating features 158 and/or apertures 160 for receiving fasteners there-through for coupling the fan shroud 122 to the radiator 110.

[0065] In some examples, a top portion of the flange 148 can comprise recessed portions 162 (recessed from the front side 166 toward the rear side 168 of the fan shroud and rock screen assembly 120), each containing an aperture 164 for mounting the first shroud portion 126 to a component of the engine system 100, such as a mounting plate at the top of the radiator 110 and/or directly to the top tank (e.g., coolant inlet tank 114) of the radiator 110 (e.g., the same or similar to as shown in FIG. 13).

[0066] In some examples, as shown in FIGS. 3 and 7, on the rear side 168, the bodies 146, 150 of the first and second shroud portions 126, 128 each comprise a partial annular collar that forms an annular collar 170 around the rock screen 124 when assembled together. Together, the collar 170 and the recessed screen portion 132 (recessed toward

the radiator 110 and away from the rear side 168 by the vanes 172, as described above) form a cavity 174 (shown in FIGS. 3 and 7) configured to receive the fan 140 therein (as shown in FIG. 1).

[0067] As introduced above, the screen portion 132 of the rock screen 124 comprises a plurality of rungs 134 that extend circumferentially around the screen portion 132. The rungs 134 can be shaped and arranged to block debris from entering the rock screen 124 (e.g., from its rear side, as depicted in FIGS. 3, 4, and 7) with minimal reduction in airflow through the cooling module assembly 104. FIGS. 9A-10B show detail views of portions of the screen portion 132 and the rungs 134. Each rung 134 can arc between two adjacent radially extending spokes 133 and be spaced radially away from adjacent rungs 134 that are connected to the same two radially extending spokes 133 (as shown in FIGS. 9A-10B).

[0068] FIG. 11 shows an exemplary shape of a rung 134. In some examples, as shown in FIG. 11, the rungs 134 can each have an airfoil-type shape with opposing curved sides 135. In some examples, the rungs 134 can have an oval-like shape. Each rung 134 can have a length 137 and width 139, where the length to width ratio is in a range of 1.75-2.25, or about 2. The airfoil-type shape of the rungs 134 prevents the rungs 134 of the screen portion 132 from hindering airflow through the rock screen 124 (and thus the radiator 110).

[0069] As introduced above, the rock screen 124 comprises a plurality of vanes 172 that extend around a circumference of the rock screen 124, each vane 172 extending between the outer rim 130 and the screen portion 132. The vanes 172 are configured to direct airflow through the rock screen 124 and the radiator 110. In particular, the vanes 172 are shaped to pull air from the corners of the fan shroud and rock screen assembly 120 and direct it through the screen portion 132 of the rock screen 124. For example, the curvature of the vanes 172, as described further below, can pull air and direct airflow through the screen portion 132 to increase airflow and cooling performance of the radiator relative to a more-traditional metal rock screen. The shape of the vanes 172 of the rock screen 124, as described herein, can increase an effective open area for airflow of the rock screen 124. Further, by not needing additional support structure (as in a more traditional metal rock screen), airflow through the rock screen 124 can be further increased.

[0070] As shown in FIGS. 9A and 9B, each vane 172 has a base 176 and a tip 178. The base 176 extends between the outer rim 130 and the screen portion 132, with a first end 184 disposed at (e.g., connected to) the outer rim 130 and a second end 186 disposed at (e.g., connected to) the screen portion 132. The tip 178 is spaced away from the base 176 and has a first end 188 disposed at (e.g., connected to) the outer rim 130 and a second end 190 that is spaced away from both the outer rim 130 and the screen portion 132, and can be referred to as a “free end.”

[0071] Each vane 172 has a curved outer surface 180 and a curved inner surface 182, such that each vane 172 extends radially outward from the screen portion 132 and base 176 and curves in a first direction away from the base 176 (as shown in FIGS. 9A-10B). In this way, all the vanes 172 can curve in a same direction (a first circumferential direction, such as counterclockwise or clockwise direction) around the circumference of the rock screen 124.

[0072] Openings 192 are formed between adjacent vanes 172, and between the outer rim 130 and the screen portion

132. The openings 192 are configured to increase airflow through the rock screen 124, thereby increasing cooling performance of the radiator 110.

[0073] FIGS. 12-17 depict a fan shroud and rock screen assembly 220 that is similar to the fan shroud and rock screen assembly 120, except the rock screen 224 has vanes 272 that have a different profile than the vanes 172 of the rock screen 124. For example, as explained in more detail below and shown in the side view comparisons of FIGS. 17 and 18, the vanes 272 (shown in FIG. 17) are angled relative to the vanes 172 (shown in FIG. 18), thereby creating larger openings 292 for increased airflow through the rock screen 224 relative to the rock screen 124.

[0074] In FIGS. 12-17, the components of the fan shroud and rock screen assembly 220 that are the same as (or similar to) those of the fan shroud and rock screen assembly 120 are labeled correspondingly and are not re-described below for the sake of brevity. For example, the fan shroud and rock screen assembly 220 includes a fan shroud 222 comprising a first shroud portion 226 and a second shroud portion 228, which can be the same as or similar to the first shroud portion 126 and the second shroud portion 128, respectively, of the fan shroud 122. Thus, the first shroud portion 226 and second shroud portion 228 can couple to the rock screen 224 and the radiator 110 the same or similar to as described above for the fan shroud and rock screen assembly 120.

[0075] Further, the fan shroud and rock screen assembly 220 includes the rock screen 224 comprising an outer rim 230 and screen portion 232 which can be the same or similar to the outer rim 130 and the screen portion 132 of the rock screen 124. As shown in FIG. 15, the outer rim 230 can have trimmed or non-circular edges at its top and bottom portions. In some examples, the outer rim 130 of the rock screen 132 can have this same shape in order to fit with a shape of the first shroud portion 126 and second shroud portion 128.

[0076] Turning to FIGS. 12-17, the fan shroud and rock screen assembly 220 is shown as part of a cooling module assembly 204 that includes the radiator 110 in FIG. 12 (exploded view) and FIG. 13 (assembled view). In some examples, the cooling module assembly 204 can replace the cooling module assembly 104 in the engine system 100.

[0077] As shown in FIGS. 12 and 13, the first shroud portion 226 comprises a body 246 and an outer flange 248 extending around at least a portion of a perimeter of the body 246, and the second shroud portion 228 comprises a body 250 and an outer flange 252 extending around at least a portion of a perimeter of the body 250.

[0078] In some examples, as shown in FIGS. 12 and 13, the bodies 246, 250 of the first and second shroud portions 226, 228 each comprise a partial annular collar that forms an annular collar 270 around the rock screen 224 when assembled together. Together, the collar 270 and the recessed screen portion 232 of the rock screen 224 (recessed toward the radiator 110 by the vanes 272, as described above for the screen portion 132 and vanes 172) form a cavity 274 configured to receive the fan 140 therein (e.g., as shown in FIG. 1).

[0079] FIG. 14 is a rear, detail view of a portion of the rock screen 224 showing a portion of the vanes 272 and rungs 234. FIG. 15 is a front view of the full rock screen 224, while FIGS. 16A and 16B are front, detail views of portions of the rock screen 224 coupled to the fan shroud 222.

[0080] The rock screen 224 comprises a plurality of vanes 272 that extend around a circumference of the rock screen

224, each vane 272 extending between the outer rim 230 and the screen portion 232. The vanes 272 are configured to direct airflow through the rock screen 224 and the radiator 110. In particular, the vanes 272 are shaped to pull air from the corners of the fan shroud and rock screen assembly 220 and direct it through the screen portion 232 of the rock screen 224. For example, the curvature of the vanes 272, as described further below, can pull air and direct airflow through the screen portion 232 to increase airflow through the rock screen 224 (and thus cooling performance of the radiator), as compared to more traditional metal rock screens that require additional support structures and have differently-shape vanes.

[0081] As shown in FIGS. 16A and 16B, each vane 272 has a base 276 and a tip 278. The base 276 extends between the outer rim 230 and the screen portion 232, with a first end 284 disposed at (e.g., connected to) the outer rim 230 and a second end 286 disposed at (e.g., connected to) the screen portion. The tip 278 is spaced away from the base 276 and has a first end 288 disposed at (e.g., connected to) the outer rim 230 and a second end 290 that is spaced away from both the outer rim 230 and the screen portion 232, and can be referred to as a “free end”.

[0082] Each vane 272 has a curved outer surface 280 and a curved inner surface 282, such that each vane 272 extends radially outward from the screen portion 232 and base 276 and curves in a first direction away from the base 276 (as shown in FIGS. 15-16B). In this way, all the vanes 272 can curve in a same direction (a first circumferential direction, such as counterclockwise or clockwise direction) around the circumference of the rock screen 224.

[0083] Openings 292 are formed between adjacent vanes 272, and between the outer rim 230 and the screen portion 232. The openings 292 are configured to increase airflow through the rock screen 224, thereby increasing cooling performance of the radiator 110.

[0084] FIGS. 17 and 18 are partial side views of the rock screens 224 and 124, respectively, showing a difference in the shape of the vanes 272 and 172. As shown in FIG. 18, the vanes 172 of the rock screen 124 extend between the outer rim 130 and screen portion 132 in a direction that is parallel or relatively parallel to a central longitudinal axis 105 of the fan shroud and rock screen assembly 120. Said another way, the vanes 172 extend straight between the outer rim 130 and the screen portion 132 without angling.

[0085] In contrast, as shown in FIG. 19, the vanes 272 of the rock screen 224 extend between the outer rim 230 and the screen portion 232 at an angle 294. Said another way, the vanes 272 are angled between the outer rim 230 and the screen portion 232. The angle 294 is a non-zero angle, and in some examples is in a range of 15-50 degrees, 18-45 degrees, or 20-40 degrees. In some examples, the angle 294 of vanes 272 in an outer row of vanes can be about 20 degrees (e.g., 18-22 degrees). In some examples, vanes 272 in more inner rows of vanes can be larger than 20 degrees. The angling of the vanes 272, as compared to the straight vanes 172, creates even larger openings 292 for increased airflow through the rock screen 224 and improved cooling performance of the radiator 110.

[0086] In this way, an integrated fan shroud and rock screen assembly can prevent debris from contacting and/or degrading a radiator to which the fan shroud and rock screen assembly is coupled, while also being durable and relatively low cost and easy to service (as compared to metal rock

screens or rock screens that are directly coupled to the radiator). In some examples, the fan shroud and rock screen assembly can be injection molded, thereby making it cost effective and easy to manufacture. As noted above, the rock screen of the fan shroud and rock screen assembly is not directly coupled to the radiator or the fan. As a result, the rock screen is decoupled from the direct load path of the radiator and fan, and thus the durability of the rock screen is increased without requiring added structural support regions (and thus airflow through the fan shroud and rock screen assembly can be increased). Further, by having a two-part fan shroud that is removably coupled to the rock screen, the rock screen can be removed with only one part of the two-part fan shroud, thereby making the cooling module assembly of the engine system easier to service. For example, the hook features on the second shroud portion of the rock screen make the rock screen and first shroud portion particularly easy to remove from the cooling module assembly without removing the entire fan shroud and rock screen assembly.

Additional Examples of the Disclosed Technology

[0087] In view of the above-described implementations of the disclosed subject matter, this application discloses the additional examples enumerated below. It should be noted that one feature of an example in isolation or more than one feature of the example taken in combination and, optionally, in combination with one or more features of one or more further examples are further examples also falling within the disclosure of this application.

[0088] The features described herein with regard to any example can be combined with other features described in any one or more of the other examples, unless otherwise stated. For example, any one or more features of one vehicle can be combined with any one or more features of another vehicle. As another example, any one or more features of one splash shield assembly can be combined with any one or more features of another splash shield assembly.

[0089] Example 1. An assembly comprising: a radiator; a fan shroud and screen assembly arranged at a rear side of the radiator, wherein the fan shroud and screen assembly comprises: a screen; and first and second shroud portions coupled to and around the screen, wherein the first and second shroud portions and the screen form a cavity, and wherein the first and second shroud portions are directly coupled to the rear side of the radiator; and a fan disposed within the cavity and configured to spin freely within the cavity without being attached to the fan shroud and screen assembly.

[0090] Example 2. The assembly of any example herein, particularly example 1, wherein the first shroud portion is removably coupled to the screen by a first mating interface, and wherein the second shroud portion is removably coupled to the screen by a second mating interface.

[0091] Example 3. The assembly of any example herein, particularly example 2, wherein the first mating interface comprises a plurality of apertures spaced apart on an outer rim of the screen and a plurality of protruding elements spaced apart on the first shroud portion, wherein each protruding element of the plurality of protruding elements is configured to extend into and couple to a respective aperture of the plurality of apertures.

[0092] Example 4. The assembly of any example herein, particularly either example 2 or example 3, wherein the

second mating interface comprises hooks spaced apart from one another on the second shroud portion and complementary protrusions spaced apart from one another on an outer rim of the screen, wherein each hook is configured to receive a respective one of the complementary protrusions.

[0093] Example 5. The assembly of any example herein, particularly any one of examples 1-4, wherein the screen comprises an outer rim, a screen portion, and a plurality of vanes that are spaced apart from one another around a circumference of the screen, wherein the plurality of vanes offset the screen portion from the outer rim in an axial direction that is relative to a central longitudinal axis of the fan shroud and screen assembly.

[0094] Example 6. The assembly of any example herein, particularly example 5, wherein each vane curves radially outward from the screen portion and in a first circumferential direction, and wherein openings for airflow are defined between adjacent vanes of the plurality of vanes and between the outer rim and the screen portion.

[0095] Example 7. The assembly of any example herein, particularly either example 5 or example 6, wherein the screen portion comprises a plurality of circumferentially extending rungs, and wherein each rung has an airfoil shape with opposing curved sides.

[0096] Example 8. The assembly of any example herein, particularly any one of examples 1-7, wherein the screen comprises an outer rim that is removably coupled to the first and second shroud portions and a screen portion that is recessed relative to the outer rim, toward the radiator.

[0097] Example 9. The assembly of any example herein, particularly any one of examples 1-8, wherein the first and second shroud portions each comprise a body and outer flange, and wherein the outer flange of each of the first and second shroud portions is directly coupled to the rear side of the radiator.

[0098] Example 10. The assembly of any example herein, particularly any one of examples 1-9, further comprising an engine block, and wherein the fan shroud and rock screen assembly is disposed between the radiator and the engine block.

[0099] Example 11. An assembly comprising: a rock screen comprising a screen portion and an outer rim, wherein the screen portion is offset from the outer rim, in an axial direction relative to a central longitudinal axis of the assembly; a first shroud portion removably coupled to a first half of the outer rim; and a second shroud portion removably coupled to a second half of the outer rim, wherein when coupled together, the screen portion and the first and second shroud portions form a cavity configured to receive a fan therein.

[0100] Example 12. The assembly of any example herein, particularly example 11, wherein the screen portion is offset from the outer rim by a plurality of vanes that are spaced apart around a circumference of the rock screen, each vane extending between the outer rim and the screen portion.

[0101] Example 13. The assembly of any example herein, particularly example 12, wherein each vane comprises a base and a tip, wherein the base extends between the screen portion and the outer rim, and wherein the tip is spaced radially and circumferentially away from the base and extends outward from the outer rim to a free end of the tip that is unattached to the screen portion.

[0102] Example 14. The assembly of any example herein, particularly any one of examples 11-13, wherein the screen portion comprises a plurality of rungs that extend circumferentially around the screen portion, and wherein the rungs are shaped and arranged to block debris from entering the rock screen without hindering airflow through the rock screen.

[0103] Example 15. The assembly of any example herein, particularly any one of examples 11-14, wherein the first half of the outer rim is an upper half and comprises a plurality of apertures, and wherein the first shroud portion comprises a plurality of protruding elements, each protruding element configured to be removably coupled with a respective aperture of the plurality of apertures.

[0104] Example 16. The assembly of any example herein, particularly any one of examples 11-15, wherein the second half of the outer rim is a lower half and comprises one or more protrusions, and wherein the second shroud portion comprises one or more hooks, each hook configured to receive a respective protrusion of the one or more protrusions.

[0105] Example 17. The assembly of any example herein, particularly any one of examples 11-16, wherein the first shroud portion comprises a first body and a first outer flange extending around at least a portion of a perimeter of the first body, wherein the second shroud portion comprises a second body and a second outer flange extending around at least a portion of a perimeter of the second body, wherein the first and second bodies are offset from the first and second outer flanges, respectively, thereby forming a cavity, and wherein the screen portion is disposed in the cavity and the outer rim is removably coupled to the first and second bodies.

[0106] Example 18. An engine system comprising: a radiator; a fan shroud and rock screen assembly mounted to a rear side of the radiator, wherein the fan shroud and rock screen assembly comprises: a rock screen; and first and second fan shrouds which are each removably coupled to and disposed around the rock screen, wherein the first and second fan shrouds and the rock screen form a cavity on a rear side of the fan shroud and rock screen assembly, and wherein the first and second fan shrouds are directly coupled to the rear side of the radiator; a fan disposed within the cavity and configured to spin within the cavity, wherein the fan is configured to pull air through the radiator, from a front side to the rear side of the radiator; and an engine arranged behind the fan shroud and rock screen assembly such that the fan shroud and rock screen assembly is disposed between the radiator and the engine.

[0107] Example 19. The engine system of any example herein, particularly example 18, wherein the rock screen comprises a screen portion and an outer rim, wherein the screen portion is offset from the outer rim, in an axial direction relative to a central longitudinal axis of the fan shroud and rock screen assembly, toward the radiator.

[0108] Example 20. The engine system of any example herein, particularly either example 18 or example 19, wherein the rock screen comprises a plurality of circumferentially extending rungs and a plurality of vanes spaced apart around a perimeter of the rock screen and curving in a same direction around the rock screen.

[0109] In view of the many possible ways in which the principles of the disclosure may be applied, it should be recognized that the illustrated configurations depict examples of the disclosed technology and should not be

taken as limiting the scope of the disclosure nor the claims. Rather, the scope of the claimed subject matter is defined by the following claims and their equivalents.

We claim:

1. An assembly comprising:
a radiator;
a fan shroud and screen assembly arranged at a rear side of the radiator, wherein the fan shroud and screen assembly comprises:
a screen; and
first and second shroud portions coupled to and around the screen, wherein the first and second shroud portions and the screen form a cavity, and wherein the first and second shroud portions are directly coupled to the rear side of the radiator; and
a fan disposed within the cavity and configured to spin freely within the cavity without being attached to the fan shroud and screen assembly.
2. The assembly of claim 1, wherein the first shroud portion is removably coupled to the screen by a first mating interface, and wherein the second shroud portion is removably coupled to the screen by a second mating interface.
3. The assembly of claim 2, wherein the first mating interface comprises a plurality of apertures spaced apart on an outer rim of the screen and a plurality of protruding elements spaced apart on the first shroud portion, wherein each protruding element of the plurality of protruding elements is configured to extend into and couple to a respective aperture of the plurality of apertures.
4. The assembly of claim 2, wherein the second mating interface comprises hooks spaced apart from one another on the second shroud portion and complementary protrusions spaced apart from one another on an outer rim of the screen, wherein each hook is configured to receive a respective one of the complementary protrusions.
5. The assembly of claim 1, wherein the screen comprises an outer rim, a screen portion, and a plurality of vanes that are spaced apart from one another around a circumference of the screen, wherein the plurality of vanes offset the screen portion from the outer rim in an axial direction that is relative to a central longitudinal axis of the fan shroud and screen assembly.
6. The assembly of claim 5, wherein each vane curves radially outward from the screen portion and in a first circumferential direction, and wherein openings for airflow are defined between adjacent vanes of the plurality of vanes and between the outer rim and the screen portion.
7. The assembly of claim 5, wherein the screen portion comprises a plurality of circumferentially extending rungs, and wherein each rung has an airfoil shape with opposing curved sides.
8. The assembly of claim 1, wherein the screen comprises an outer rim that is removably coupled to the first and second shroud portions and a screen portion that is recessed relative to the outer rim, toward the radiator.
9. The assembly of claim 1, wherein the first and second shroud portions each comprise a body and outer flange, and wherein the outer flange of each of the first and second shroud portions is directly coupled to the rear side of the radiator.
10. The assembly of claim 1, further comprising an engine block, and wherein the fan shroud and rock screen assembly is disposed between the radiator and the engine block.

11. An assembly comprising:

- a rock screen comprising a screen portion and an outer rim, wherein the screen portion is offset from the outer rim, in an axial direction relative to a central longitudinal axis of the assembly;
- a first shroud portion removably coupled to a first half of the outer rim; and
- a second shroud portion removably coupled to a second half of the outer rim, wherein when coupled together, the screen portion and the first and second shroud portions form a cavity configured to receive a fan therein.
12. The assembly of claim 11, wherein the screen portion is offset from the outer rim by a plurality of vanes that are spaced apart around a circumference of the rock screen, each vane extending between the outer rim and the screen portion.
13. The assembly of claim 12, wherein each vane comprises a base and a tip, wherein the base extends between the screen portion and the outer rim, and wherein the tip is spaced radially and circumferentially away from the base and extends outward from the outer rim to a free end of the tip that is unattached to the screen portion.
14. The assembly of claim 11, wherein the screen portion comprises a plurality of rungs that extend circumferentially around the screen portion, and wherein the rungs are shaped and arranged to block debris from entering the rock screen without hindering airflow through the rock screen.
15. The assembly of claim 11, wherein the first half of the outer rim is an upper half and comprises a plurality of apertures, and wherein the first shroud portion comprises a plurality of protruding elements, each protruding element configured to be removably coupled with a respective aperture of the plurality of apertures.
16. The assembly of claim 11, wherein the second half of the outer rim is a lower half and comprises one or more protrusions, and wherein the second shroud portion comprises one or more hooks, each hook configured to receive a respective protrusion of the one or more protrusions.
17. The assembly of claim 11, wherein the first shroud portion comprises a first body and a first outer flange extending around at least a portion of a perimeter of the first body, wherein the second shroud portion comprises a second body and a second outer flange extending around at least a portion of a perimeter of the second body, wherein the first and second bodies are offset from the first and second outer flanges, respectively, thereby forming a cavity, and wherein the screen portion is disposed in the cavity and the outer rim is removably coupled to the first and second bodies.
18. An engine system comprising:
a radiator;
a fan shroud and rock screen assembly mounted to a rear side of the radiator, wherein the fan shroud and rock screen assembly comprises:
a rock screen; and
first and second fan shrouds which are each removably coupled to and disposed around the rock screen, wherein the first and second fan shrouds and the rock screen form a cavity on a rear side of the fan shroud and rock screen assembly, and wherein the first and second fan shrouds are directly coupled to the rear side of the radiator;

a fan disposed within the cavity and configured to spin within the cavity, wherein the fan is configured to pull air through the radiator, from a front side to the rear side of the radiator; and

an engine arranged behind the fan shroud and rock screen assembly such that the fan shroud and rock screen assembly is disposed between the radiator and the engine.

19. The engine system of claim **18**, wherein the rock screen comprises a screen portion and an outer rim, wherein the screen portion is offset from the outer rim, in an axial direction relative to a central longitudinal axis of the fan shroud and rock screen assembly, toward the radiator.

20. The engine system of claim **18**, wherein the rock screen comprises a plurality of circumferentially extending rungs and a plurality of vanes spaced apart around a perimeter of the rock screen and curving in a same direction around the rock screen.

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