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(54) Title: FAN SHROUD WITH COMPLEMENTARY TWO-SIDED RIBBING

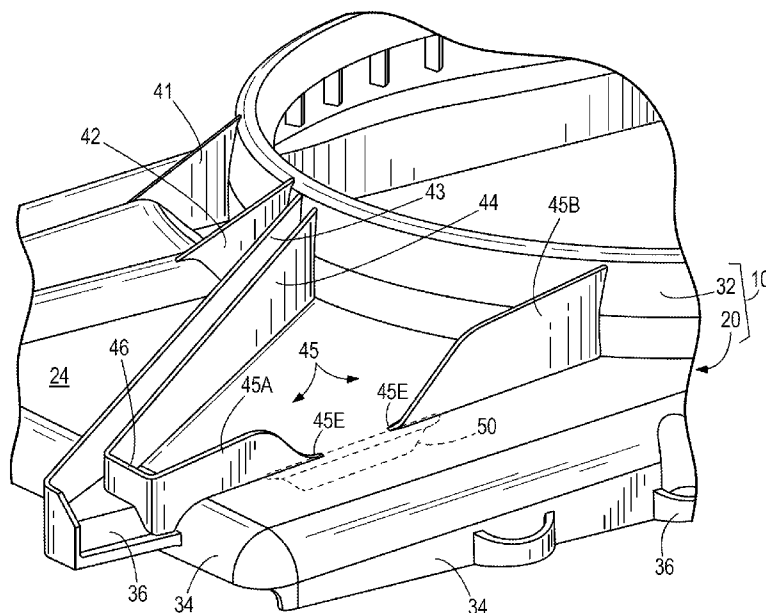


FIG. 1

(57) Abstract: A fan shroud has a panel including a first surface and a second surface substantially opposite the first surface. A first rib extends substantially perpendicularly from the first surface, and the first rib has an area of discontinuity where a height of the first rib is reduced. A second rib extends substantially perpendicularly from the second surface, and the second rib is substantially aligned with the first rib and positioned substantially opposite the area of discontinuity of the first rib.



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FAN SHROUD WITH COMPLEMENTARY TWO-SIDED RIBBING**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/692,874, filed August 24, 2012, the entire contents of which are incorporated by reference herein.

BACKGROUND

[0002] The present invention relates to structural ribbing for stiffening thin panels, such as those found in plastic shrouds (e.g., a plenum portion of an engine-cooling fan shroud). The purpose of the ribbing is to strengthen and stiffen the underlying panel structure. When a rib is reduced in height or depth (transverse to the panel), its stiffness is reduced. It is often desirable to avoid abrupt changes in stiffness because they create regions where the part can be relatively easily flexed or deformed compared to surrounding areas with higher stiffness. Furthermore, abrupt stiffness transitions generally lead to stresses and deflection higher than they would otherwise be if the rib height transition were more gradual. In certain environments, such as vehicle engine compartments where packaging space can be very limited, structural ribbing may be compromised by an adjacent under hood item(s) that interferes with the desired structural ribbing. This can lead to an undesirable trade-off between size and mechanical strength.

SUMMARY

[0003] In one aspect, the invention provides a fan shroud having a panel including a first surface and a second surface substantially opposite the first surface. A first rib extends substantially perpendicularly from the first surface, the first rib having an area of discontinuity where a height of the first rib is reduced. A second rib extends substantially perpendicularly from the second surface. The second rib is substantially aligned with the first rib and positioned substantially opposite the area of discontinuity of the first rib.

[0004] In another aspect, the invention provides a fan shroud including a generally cylindrical barrel portion having an opening configured to receive a fan. A plenum portion adjacent the barrel portion defines an exterior surface and an interior surface opposite the exterior surface. A first rib extends substantially perpendicularly from the exterior surface and defines a path between the barrel portion and an outer edge of the plenum portion. A

second rib extends substantially perpendicularly from the interior surface. The second rib does not extend from the barrel portion to the outer edge, but extends substantially along the path defined by the first rib, substantially opposite an area of discontinuity in the first rib.

[0005] In another aspect, the invention provides a fan shroud having a panel including a first surface and a second surface substantially opposite the first surface. A first rib extends substantially perpendicularly from the first surface, the first rib having a portion of decreasing height corresponding to a decreased stiffening effect of the first rib. A second rib is positioned on the second surface substantially opposite the portion of decreasing height to compensate for the decreased stiffening effect of the first rib.

[0006] Other aspects of the invention will become apparent by consideration of the detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Fig. 1 is a perspective view of a ribbed panel, embodied as a plenum portion of an engine cooling fan shroud, according to one aspect of the invention.

[0008] Fig. 2 is an alternate perspective view of a first side of the ribbed panel shown in Fig. 1.

[0009] Fig. 3 is a perspective view of a second opposite side of the ribbed panel shown in Figs. 1-2.

[0010] Fig. 4 is a cross-section view of a ribbed panel according to another construction of the invention.

[0011] Fig. 5 is a cross-section view of a ribbed panel according to another construction of the invention.

[0012] Fig. 6 is a cross-section view of a ribbed panel according to another construction of the invention.

[0013] Fig. 7 is a cross-section view of a ribbed panel according to another construction of the invention.

[0014] Fig. 8 is a cross-section view of a ribbed panel according to another construction of the invention.

[0015] Fig. 9 is a cross-section view of a ribbed panel according to another construction of the invention.

DETAILED DESCRIPTION

[0016] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways.

[0017] Figs. 1-3 illustrate a fan shroud 10 including a panel 20 having a first side or surface 24 and a second side or surface 28 opposite the first side 24. In the illustrated construction, the panel 20 forms a plenum portion of the fan shroud 10, which can be a shroud for an engine-cooling fan assembly, which is commonly positioned adjacent a radiator in the engine bay of an automobile. The fan shroud 10 further includes a cylindrical barrel portion 32 projecting from the first side 24 and configured to receive a fan (not shown). The first side 24 can be an exterior or exposed side (e.g., facing rearward toward an engine), and the second side 28 can be an interior or concealed side (e.g., positioned against a radiator). The second side 28 is generally concave, forming a hollowed-out area. Side surfaces 34 extended from the first side 24 and projecting from the second side 28 form or bound the hollowed-out area of the second side 28. The panel 20 includes a plurality of mounting structures or coupling portions 36 to secure the fan shroud 10 within its environment. Although the illustrated coupling portions 36 are generally positioned about a periphery or outer edge of the panel 20, and may be particularly adapted for use within an automobile application of the fan shroud 10, other coupling arrangements or mounting structures are contemplated, along with other applications of the fan shroud 10.

[0018] The panel 20 includes a plurality of ribs 41, 42, 43, 44, 45 formed on the first or exterior side 24. Two of the ribs 41, 42 form a first rib pair extending from the barrel portion 32 toward one of the coupling portions 36. Another two of the ribs 43, 44 form a second rib pair also extending from the barrel portion 32 toward another one of the coupling portions 36.

The rib 45 also extends from the barrel portion 32 toward the same coupling portion 36 as the second rib pair 43, 44. In the illustrated construction, the rib 45 is coupled with the adjacent rib 44 via a connector rib portion 46. Other constructions and orientations are contemplated. As described in further detail below, the rib 45 is a discontinuous rib, which does not span across the panel 20 and does not span between two structural connection points (e.g., points of significant thickness increase over the nominal panel thickness, such as the barrel portion 32 and the coupling portions 36) on the first side 24 of the panel 20.

[0019] As shown in Figs. 1 and 2, the rib 45 is formed of two rib segments 45A, 45B that are aligned with each other, but not co-extensive as the rib segments 45A, 45B have facing ends 45E that each terminate into the first surface 24 before reaching each other. In the illustrated construction, a smooth transition occurs from the maximum height of each of the rib segments 45A, 45B to a height of zero where the rib segments 45A, 45B terminate into the first surface 24 at the facing ends 45E. The outer end of the first rib segment 45A is directly integrated with the connector ribbing portion 46 and the coupling portion 36 to extend therefrom. The outer end of the second rib segment 45B is directly integrated with the barrel portion 32 to extend outwardly therefrom. In the illustrated construction, the rib 45 extends substantially radially outward from the barrel portion 32 in that it extends from the barrel portion 32 to become increasingly distant from the barrel portion 32 and its axis, which is the fan axis.

[0020] Although not shown, the height of the rib 45 may be only partially reduced between the rib segments 45A, 45B. Whether the rib 45 is completely segmented into two separate rib segments 45A, 45B as shown or partially segmented by a section of significantly reduced height, the overall strength and rigidity provided by the rib 45 is reduced. Typically, the area of height reduction (or rib elimination) between the rib segments 45A, 45B is provided as a necessary means to avoid physical interference between components mounted adjacent the panel 20. For example, as presented as part of the engine-cooling fan shroud 10 for an automobile, the panel 20 may be mounted in a tight space next to moving or stationary engine components, electrical wiring, hoses, mounts for accessories, a hood latch, etc.

[0021] In order to make up for the discontinuity in the rib 45, a complementary rib 50 is provided on the second surface 28 as shown in Fig. 1 (where the panel surface 24 is rendered transparent) and Fig. 3. The complementary rib 50 is aligned with the discontinuous rib 45 that projects from the first surface 24 and is positioned in the area of the discontinuity. The

complementary rib 50 functions as a “bridge” to maintain structural continuity across the discontinuity or reduced-height section of the rib 45 on the first side 24. By aligned, it is meant that the complementary rib 50 substantially follows a path established or defined by the discontinuous rib 45, as opposed to the complementary rib 50 defining its own separate path that establishes a different strengthening direction. In other words, if the complementary rib 50 were flipped across the panel 20 to the first surface 24, it would generally form an extension of the first rib 45 in the area of discontinuity. The ribs 45, 50 need not be linear to be aligned, so long as they cooperate to form a consistent or complementary path of extension.

[0022] The complementary rib 50 can be of the same height as the discontinuous rib 45, or larger, or smaller as illustrated. In the illustrated construction, the complementary rib 50 is a standalone structure, or partial rib, which does not span across the panel 20 and does not span between two structural connection points on the second side 28 of the panel 20. Limiting the extension of the complementary rib 50 in the direction of the path (i.e., parallel to the panel 20) limits the amount of intrusion into the interior of the plenum portion defined by the panel 20. The complementary rib 50 has two opposed ends 50E, each of which terminates into the second surface 28. In the illustrated construction, the height of the complementary rib 50 smoothly transitions from maximum height to zero height where the rib 50 terminates into the second surface 28 at each of the opposed ends 50E. The areas of height transition adjacent the ends 50E of the complementary rib 50 can overlap with the areas of height transition adjacent the ends 45E of each of the respective rib portions 45A, 45B such that they directly overlie each other on opposite sides of the panel 20 as shown in Fig. 1. However, other arrangements may also be employed. For example, it should be appreciated that a panel can be provided with a discontinuous rib having a single rib portion, where the panel further includes a complementary rib on the opposite side, with features otherwise similar to the illustrated construction described above. In this case, the first rib and the second, complementary rib are discontinuous in that neither in itself spans between two structural connection points, but together, they do.

[0023] The addition of the complementary rib 50 to the interior of the panel 20 in the plenum portion of the fan shroud 10 provides a significant benefit in achieving high strength with great packaging flexibility. Furthermore, because the complementary rib 50 extends substantially radially outward with respect to the barrel portion 32 (and subsequently, the fan

axis), it does not unduly restrict the air flow through the fan shroud 10, and particularly does not unduly restrict the air flow within the plenum portion defined by the panel 20.

[0024] The fan shroud 10 can be a molded plastic panel in which all of the features shown, including the panel 10 with all of the ribs are integrally formed as a single piece. However, the invention is not necessarily limited to such a construction, as it may be successfully applied to other constructions as well.

[0025] Figs. 4-9 illustrate additional constructions of panels with particular arrangements of complementary ribs generally conforming to the above description. In Fig. 4, the panel 20 includes a discontinuous rib formed by respective rib portions 45A, 45B on the first side 24 that are disconnected from each other, leaving a gap therebetween. In this gap, there is no ribbing on the first side 24. Rather, a complementary rib 50 on the second side 28 is positioned to span the gap, overlapping with both of the rib portions 45A, 45B on the first side 24. Although not able to be shown in the cross-sectional view, the complementary rib 50 is substantially aligned with the rib portions 45A, 45B. In this construction, each of the rib portions 45A, 45B has a distal end that is connected or integrated with a structural connection point (e.g., an upstanding wall portion at each end extending outward in a common direction from the central panel portion).

[0026] In Fig. 5, the panel 20 includes a discontinuous rib formed by respective rib portions 45A, 45B on the first side 24 that are disconnected from each other, leaving a gap therebetween. In this gap, there is no ribbing on the first side 24. Rather, a complementary rib 50 on the second side 28 is positioned to span the gap, overlapping with both of the rib portions 45A, 45B on the first side 24. Although not able to be shown in the cross-sectional view, the complementary rib 50 is substantially aligned with the rib portions 45A, 45B. In this construction, only the rib portion 45B on the right has a distal end that is connected or integrated with a structural connection point (e.g., an upstanding wall portion extending outward from the central panel portion). The rib portion 45A on the left tapers down in height toward the outer edge of the panel 20.

[0027] Figs. 6-9 illustrate constructions in which a single discontinuous rib portion 45 on the first side 24 of the panel 20 is complemented by a rib 50 on the second side 28 of the panel 20. In Fig. 6, the rib portion 45 has a substantially uniform height from one end toward a central portion of the panel 20 at which the height abruptly drops to zero and the rib portion

45 terminates. The complementary rib 50 on the second side 28 is substantially aligned with the rib portion 45 and overlaps with the rib portion 45. As illustrated, the complementary rib 50 has a substantially uniform height from one end toward the central portion of the panel 20 at which the height abruptly drops to zero, but not before extending past the point of termination of the rib portion 45 to lie across from the full-height portion of the rib 45. In Fig. 7, the rib portion 45 on the first side 24 spans substantially across the panel 20, but has a non-uniform height that increases continuously from a minimum (e.g., zero) at one end to a maximum at the other end. The complementary rib 50 on the second side 28 is substantially aligned with the rib portion 45 and overlaps with the rib portion 45 along substantially an entire length of the rib portion 45. As illustrated, the complementary rib 50 has a non-uniform height that increases continuously from a minimum (e.g., zero) at one end to a maximum at the other end. The orientation of the height increase in the complementary rib 50 is opposite that of the rib 45, and the maximum heights of each are approximately equal. As such, the combined height of the ribs 45, 50 is substantially equal at any given point across the panel 20 so that the complementary rib 50 completely offsets the loss in stiffening ability presented by the decreased height in the rib portion 45. In Fig. 8, the arrangement of the ribs 45, 50 is substantially identical to that of Fig. 7, except that the complementary rib 50 does not have a maximum height matching that of the rib portion 45 on the first side 24. Even so, the complementary rib 50 overlaps an area of discontinuity in the rib portion 45 where the height is reduced, such that the complementary rib 50 at least partially offsets the loss in stiffening ability presented by the decreased height in the rib portion 45. In other constructions, the complementary rib 50 may not overlap the entire rib portion 45 all the way across the panel 20 as shown. In Fig. 9, the rib portion 45 has a substantially uniform height from one end toward a central portion of the panel 20 at which the height decreases (e.g., the height transitions to zero and the rib portion 45 terminates). The complementary rib 50 on the second side 28 is substantially aligned with the rib portion 45 and has a substantially uniform height from one end toward the central portion of the panel 20 at which the height decreases (e.g., the height transitions to zero). The height transitioning portion of the complementary rib 50 overlaps with the height transitioning portion of the rib portion 45 so that, similar to Fig. 7, the combined height of the ribs 45, 50 is substantially equal at any given point across the panel 20 and the complementary rib 50 completely offsets the loss in stiffening ability presented by the decreased height in the rib portion 45.

CLAIMS

What is claimed is:

1. A fan shroud comprising:

a panel including a first surface and a second surface substantially opposite the first surface;

a first rib extending substantially perpendicularly from the first surface to define a height, the first rib having an area of discontinuity where a height of the first rib is reduced; and

a second rib extending substantially perpendicularly from the second surface, the second rib being aligned with the first rib and being positioned directly across from the area of discontinuity of the first rib.

2. The fan shroud of claim 1, wherein the panel is a plenum portion of the fan shroud.

3. The fan shroud of claim 2, wherein the fan shroud includes a generally cylindrical barrel portion adjacent the plenum portion, and the first rib forms an integral extension from the barrel portion.

4. The fan shroud of claim 3, wherein the first rib extends substantially radially outwardly from the barrel portion.

5. The fan shroud of claim 2, wherein the first rib is formed on an exterior of the plenum portion, and the second rib is formed on an interior of the plenum portion.

6. The fan shroud of claim 1, wherein the first rib includes two aligned rib portions separated by the area of discontinuity.

7. The fan shroud of claim 6, wherein the height of the first rib is reduced to zero in the area of discontinuity.

8. The fan shroud of claim 1, wherein the height of the first rib is reduced to zero in the area of discontinuity.

9. The fan shroud of claim 1, wherein the combination of the first rib and the second rib span between a pair of structurally-reinforced portions of the fan shroud.
10. The fan shroud of claim 9, wherein the pair of structurally-reinforced portions includes a generally cylindrical barrel portion and a mounting structure positioned at an outer edge portion of the panel.
11. A fan shroud comprising:
 - a generally cylindrical barrel portion having an opening configured to receive a fan;
 - a plenum portion adjacent the barrel portion and defining an exterior surface and an interior surface opposite the exterior surface;
 - a first rib extending substantially perpendicularly from the exterior surface and defining a path between the barrel portion and an outer edge of the plenum portion; and
 - a second rib extending substantially perpendicularly from the interior surface, wherein the second rib does not extend from the barrel portion to the outer edge, but extends substantially along the path defined by the first rib, substantially opposite an area of discontinuity in the first rib.
12. The fan shroud of claim 11, wherein the first rib forms an integral extension from the barrel portion.
13. The fan shroud of claim 12, wherein the first rib follows the path to become increasingly distant from the barrel portion.
14. The fan shroud of claim 11, wherein the first rib includes two aligned rib portions separated by the area of discontinuity.
15. The fan shroud of claim 14, wherein the height of the first rib is reduced to zero in the area of discontinuity so that the first rib includes a pair of facing ends.
16. The fan shroud of claim 15, wherein the height of the first rib is reduced gradually over a smooth transition toward each of the facing ends.

17. The fan shroud of claim 16, wherein the second rib includes a pair of opposed ends from which the height of the second rib gradually increases over a smooth transition, and wherein the smooth transitions adjacent the opposed ends of the second rib overlap with the smooth transitions adjacent the facing ends of the first rib.
18. The fan shroud of claim 11, wherein the height of the first rib is reduced to zero in the area of discontinuity.
19. The fan shroud of claim 11, wherein the combination of the first rib and the second rib span between the generally cylindrical barrel portion and a mounting structure positioned at the outer edge.
20. A fan shroud comprising:
 - a panel including a first surface and a second surface substantially opposite the first surface;
 - a first rib extending substantially perpendicularly from the first surface to define a height, the first rib having a portion of decreasing height corresponding to a decreased stiffening effect of the first rib; and
 - a second rib positioned on the second surface substantially opposite the portion of decreasing height to compensate for the decreased stiffening effect of the first rib.

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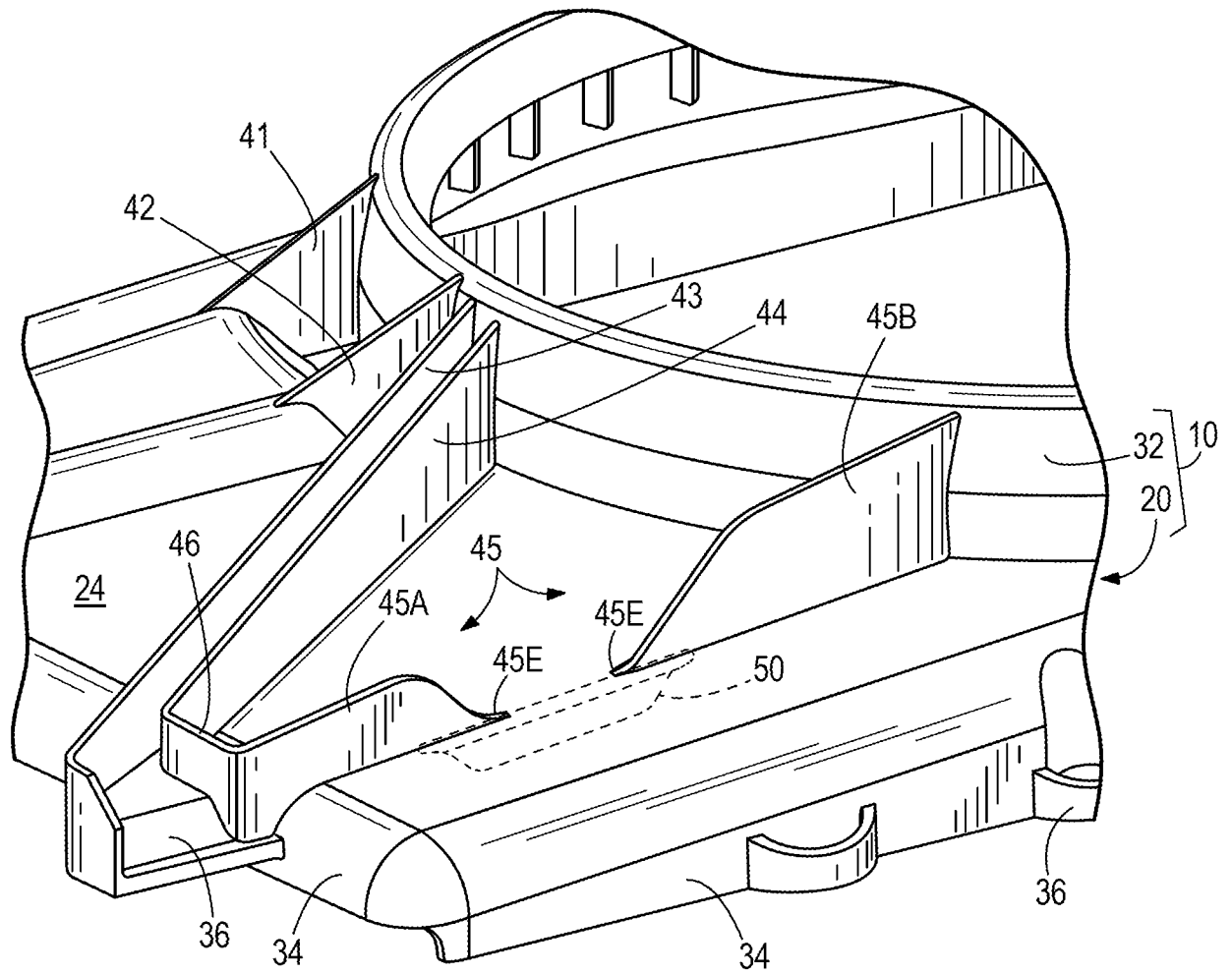


FIG. 1

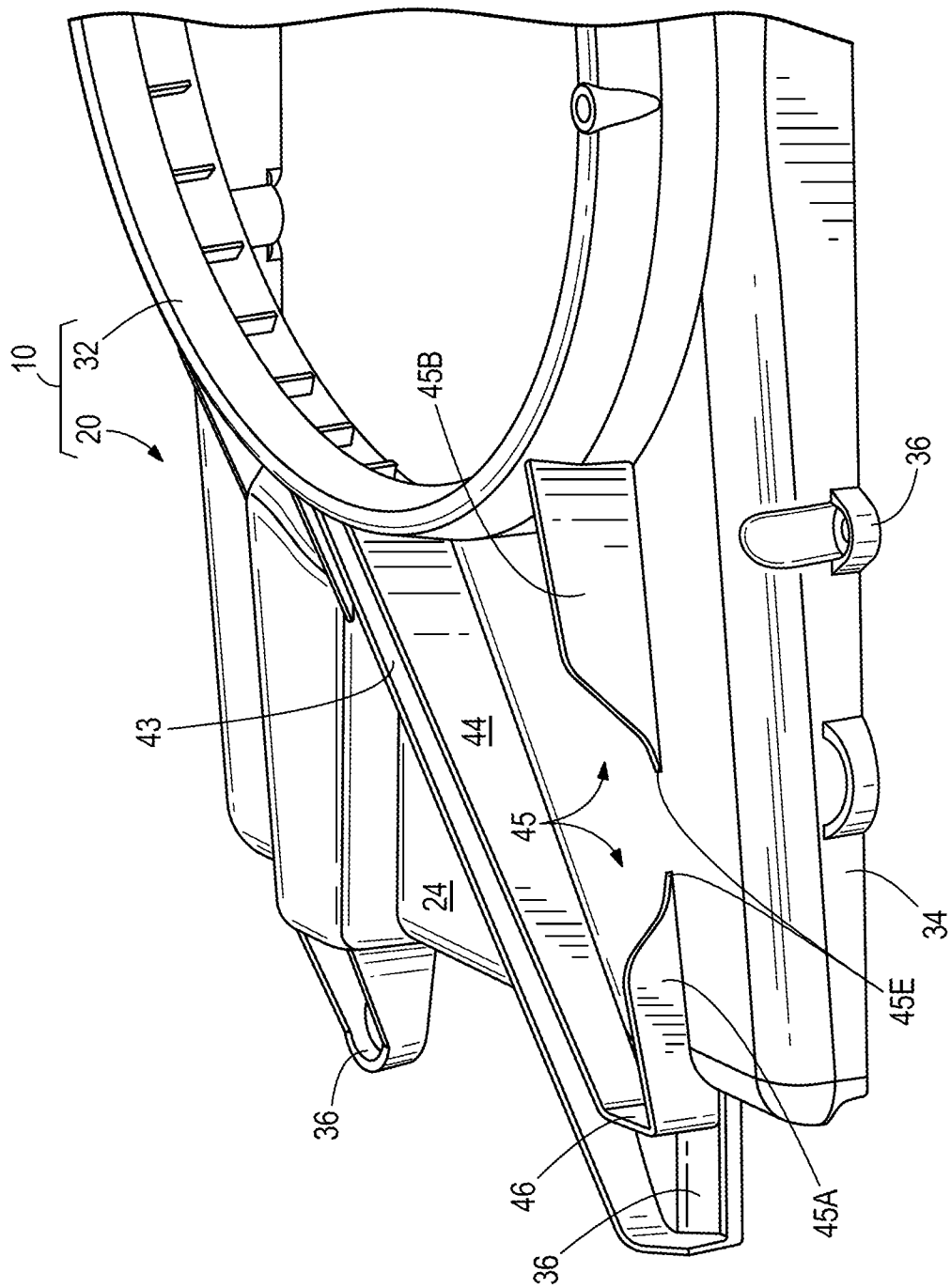


FIG. 2

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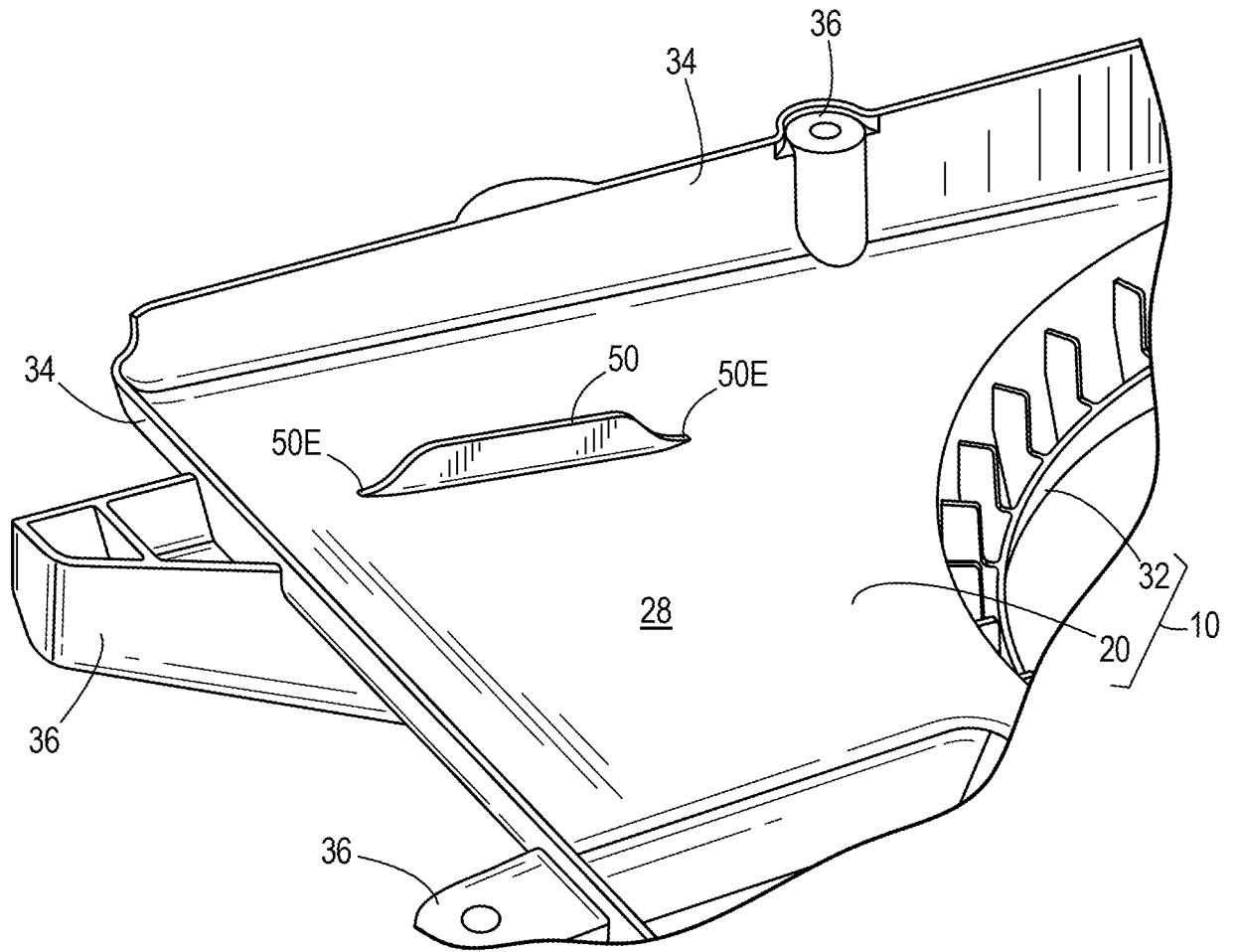


FIG. 3

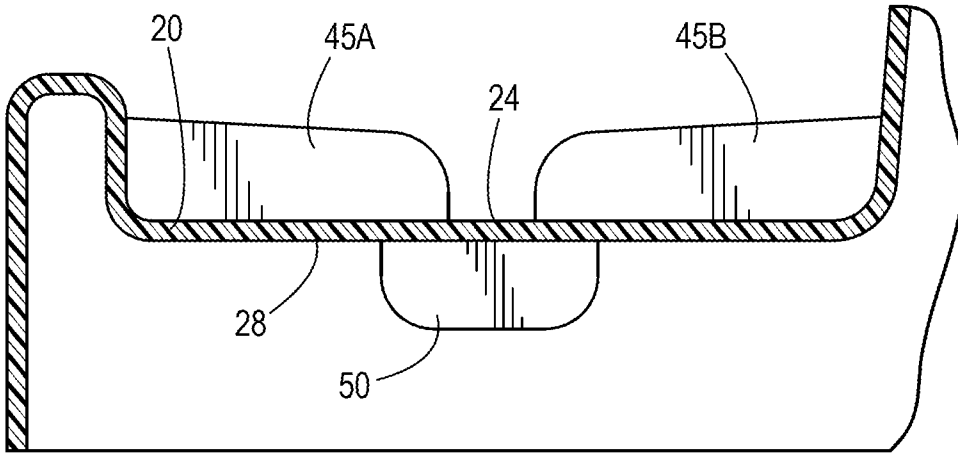


FIG. 4

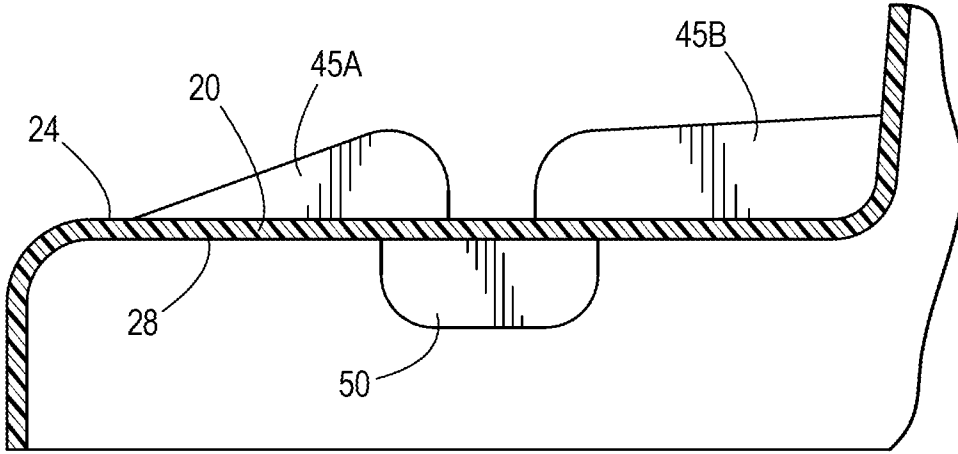


FIG. 5

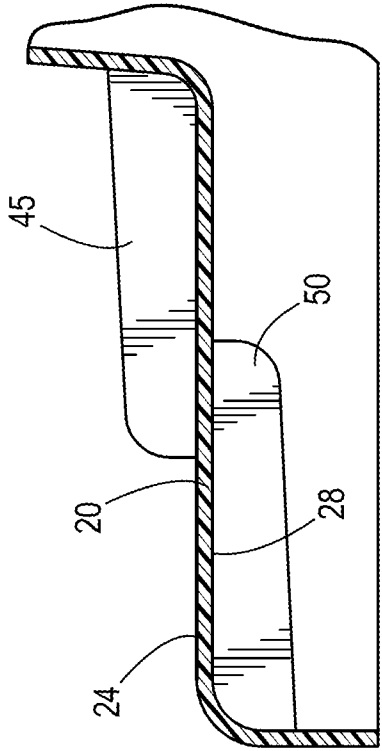


FIG. 6

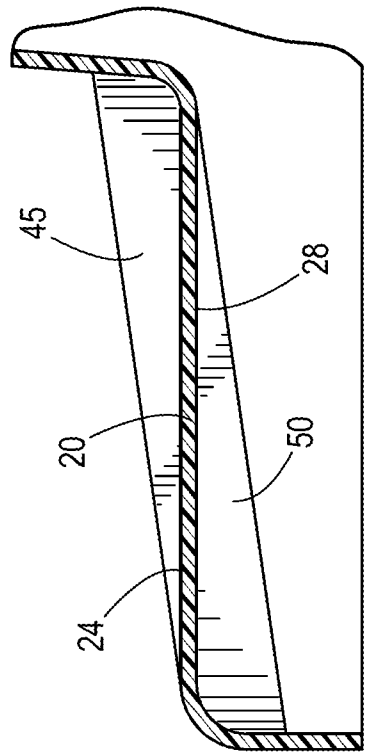


FIG. 7

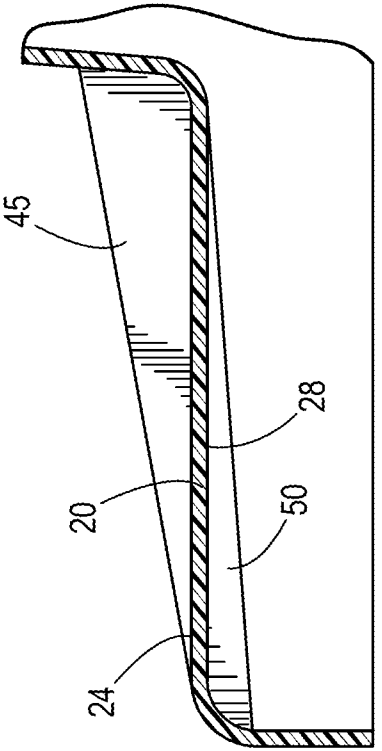


FIG. 8

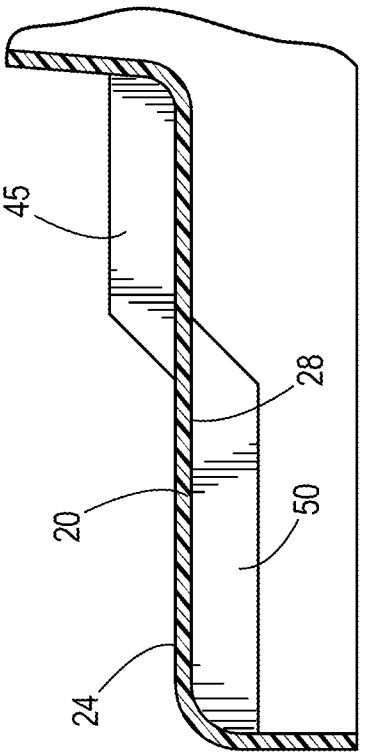


FIG. 9