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WEATHER RESISTANT ROOFING PLATE

BACKGROUND

[0001] This disclosure relates generally to roofing plates which secure a substrate to an underlying decking structure via a fastener. More particularly, this application relates to a roofing plate with a unique form configured to withstand severe weather events.

[0002] In roofing installations to which the disclosed embodiments relate, a fluid impervious membrane substrate and/or coverboard is secured by a plurality of plates to a decking structure. The decking structure is typically a substructure of sheet steel, concrete or wood. Some decking structures take a corrugated form with peaks and valleys. Additionally, in some roofing assemblies, one or more softer layers, such as insulation, are positioned beneath the membrane. However, the disclosed embodiments are intended primarily for use with flat hard substructures, commonly referred to in the field as coverboard. Fasteners are driven through a central recessed bore in the plate to secure the plate and the underlying layer(s) to the decking structure.

[0003] After installation of the plates to secure the primary membrane and/or coverboard, an overlying portion 74 of an adjacent membrane is placed over the plate and fastener and sealed around the outer edges of the plate to provide additional waterproofing. The overlying membrane section may be sealed to the underlying membrane around the plate via one or both of heat welding and adhesive.

[0004] The particular plate disclosed herein is configured for use with hard flat roof surfaces, as opposed to softer surfaces and fleece back systems. The plates must combine strong uplift protection, weatherproofing and impact resistance. Such known plates for use with hard flat roofing surfaces heretofore have been formed from sheets of metal with various ridges, undulations, corrugations and teeth. A known problem exists within such systems wherein severe weather, including hail, cause damage to the top (overlying) membrane which compromises

the waterproofing integrity of the system. Damage may be caused by large ice balls or other projectile striking the overlying membrane 74 in a relative position to the plate such that the force of the ice ball causes a puncture to the overlying membrane. Most commonly, this occurs by ice balls contacting the overlying membrane at the outer edges of the plate, the inner edges around the counterbore, the underlying fastener head and/or other corrugated areas of the plate.

[0005] Regulatory guidelines and designations have been developed, which set minimum thresholds of a measured ability to withstand impact events without puncturing the overlying membrane. The various regulatory designations represent thresholds measured in impact energy (commonly joules), and include for example: moderate hail (MH), severe hail (SH; typically 15-25 J) and very severe hail (VSH; typically 70-85 J).

[0006] Thus, it would be useful to provide a roofing plate that improves upon or eliminates the above noted drawbacks. It would additionally be useful to provide a method of ensuring that a roofing plate can withstand a predetermined intensity of impact event.

SUMMARY

[0007] In one embodiment, a roofing plate includes a solid body defining a fastener opening from a top surface to a bottom surface. The solid body has rounded edges.

[0008] In another embodiment, a roofing assembly has a roofing substructure, a flat roofing element above the roofing substructure, a roofing plate above the roofing element, a fluid impermeable membrane above the roofing plate, a fastener extending through a bore in the roofing plate, through the roofing element, and embedded into at least a portion of the roofing substructure to fix the roofing plate in place. The roofing plate has no vertices.

[0009] In yet another embodiment, a roofing plate includes a polymer body defining a fastener opening from a top surface to a bottom surface. The fastener opening has an upper counterbore section with a diameter greater than a diameter

of a lower primary bore section. The solid body defines an outer periphery with rounded edges. The counterbore section has a top with a rounded upper periphery and a bottom inner edge that is rounded. An IBS area defined as an area of the roofing plate that contacts a 2-inch diameter coaxial sphere (impact surface) is within an approximate range of 0.100 in² to 0.400 in².

BRIEF DESCRIPTION OF DRAWINGS

[0010] Figure 1 shows a side cross sectional view of an embodiment of the disclosed weather resistant roofing plate;

[0011] Figure 2 shows a side cross sectional view of the roofing plate being contacted by a projectile;

[0012] Figure 3 shows a side cross sectional view of the roofing plate installed on a roof fixing a membrane in place;

[0013] Figure 4 shows a perspective view of an embodiment of the disclosed roofing plate;

[0014] Figures 5A and 5B are the enlarged cross-sectional views of the roofing plate installation of Figure 2 focusing on the counterbore section;

[0015] Figure 6A is a side elevation view of a preferred embodiment of the disclosed roofing plate and an enlarged view of a portion thereof, including exemplary dimensions;

[0016] Figure 6B is a side cross sectional view of the preferred embodiment of the roofing plate of Figure 6A and an enlarged view of a portion thereof, including exemplary dimensions;

[0017] Figure 6C shows a bottom elevation and bottom perspective view of the preferred embodiment of the roofing plate of Figures 6A-6B;

[0018] Figure 7 shows typical use settings of the disclosed roofing plate to secure a membrane and/or coverboard and insulation;

[0019] Figure 8 shows another embodiment of a roofing plate and includes a depiction of impact testing;

[0020] Figure 9 shows an embodiment of a roofing plate according to the disclosure;

[0021] Figure 10 shows aspects of the embodiment of the roofing plate of Figure 9;

[0022] Figure 11 is a top view of the roofing plate of Figure 9;

[0023] Figure 12 is an isolated top view of a projection ring used to determine a factor of impact resistance;

[0024] Figure 13 is a section perspective view of the roofing plate of Figure 9;

[0025] Figure 14 is an enlarged view of box A from Figure 13;

[0026] Figure 15 is another section view of the plate of Figure 9;

[0027] Figure 16 is an enlarged view of box B from Figure 15, showing a tangent line for determining radius of curvature of the top edge of the hole;

[0028] Figure 17 is another perspective view of the plate of Figure 9;

[0029] Figure 18 is a perspective view of an exemplary plate that failed an impact testing due to insufficient IBS area;

[0030] Figure 19 show the roofing plate of Figure 9 and objects or techniques for determining IBS are; and

[0031] Figure 20 is a partial section view of the plate of Figure 19.

Detailed Description

[0032] Among the benefits and improvements disclosed herein, other objects and advantages of the disclosed embodiments will become apparent from the following wherein like numerals represent like parts throughout the figures. Detailed embodiments of a weather resistant roofing plate, are disclosed; however, it is to be understood that the disclosed embodiments are merely illustrative of the invention that may be embodied in various forms. In addition, each of the examples given in connection with the various embodiments of the invention are intended to be illustrative, and not restrictive.

[0033] Throughout the specification and claims, the following terms take the meanings explicitly associated herein, unless the context clearly dictates otherwise. The phrase “in some embodiments” as used herein does not necessarily refer to the same embodiment(s), although it may. The phrases “in another embodiment” and “in some other embodiments” as used herein do not necessarily refer to a different embodiment, although it may. Thus, as described below, various embodiments may be readily combined without departing from the scope or spirit of the invention.

[0034] In addition, as used herein, the term “or” is equivalent to the term “and/or,” unless the context clearly dictates otherwise. The term “based on” is not exclusive and allows for being based on additional factors not described unless the context clearly dictates otherwise. In addition, throughout the specification, the meaning of “a,” “an,” and “the” include plural references. The meaning of “in” includes “in” and “on.”

[0035] Further, the terms “substantial,” “substantially,” “similar,” “similarly,” “analogous,” “analogously,” “approximate,” “approximately,” and any combination thereof mean that differences between compared features or characteristics is less than 25% of the respective values/magnitudes in which the compared features or characteristics are measured and/or defined.

[0036] As shown in the Figures, an embodiment of the plate 10 includes a solid body 12 with a round shape. The depicted preferred embodiment is a circular plate, however other shapes without pointed edges or vertices between surfaces or edges may be employed, such as ovular or quasi-polygonal with rounded edges and/or corners. Generally, the depicted plate 10 can be said to have a quasi-frusto-conical shape with rounded or “soft” vertices/edges.

[0037] The plate 10 most generally includes a body 12 with a fastener opening 14 extending through from a top surface 26 to bottom surface 22 of the body. As shown, the depicted preferred embodiment has a fastener opening that comprises a primary bore 20 and a counterbore 21.

[0038] With reference to Figure 6C, in some embodiments, the bottom surface may include a plurality of ribs 30 that extend radially from a central hub section 32 to an outer annular section 34. The ribs 30, hub 32 and outer annular section 34 are preferably coplanar and collectively define a solid, flat primary bottom surface 22. In this depicted embodiment, a plurality of teeth 24 extend downward from portions of the primary bottom surface 22. Preferably, the teeth 24 are arranged on the primary surface in a circumferentially-offset pattern, wherein inner teeth on the central hub 32 are not co-radial with outer teeth on the annular section 34. This relative arrangement has been shown to improve rip resistance in a roofing installation. In practice, the teeth 24 grip the roof surface and the primary surface 22 sits flat atop the membrane or coverboard. The flat primary surface 22 formed by the combination of the coplanar hub 32, ribs 30 and outer annular section 34 in combination with the quasi-random pattern of teeth 24 has been shown to improve strength and resistance to uplift forces.

[0039] Other embodiments of the plate exist wherein teeth are not present. Such a toothless embodiment is especially useful in affixing a coverboard over a softer layer, such as insulation, with a membrane installed above. Additionally, some embodiments include a solid flat bottom surface in lieu of the hub/ribs/annular section configuration shown in Figure 6C.

[0040] Additionally, other embodiments of the plate exist wherein the primary bottom surface is a solid unitary surface without the open areas 36 that define the hub, ribs and outer annular section.

[0041] As shown, the outer shape of the plate 10 is defined by a peripheral edge 16 that has a rounded contour between the top surface 26 and bottom surface 22. The rounded contour extends about the entire outer periphery of the plate such that when the plate 10 is installed on a flat roof, there are no vertices or pointed edges along the outer edge of the plate, and no vertices or pointed edges formed at the plate/roofing surface interface. This characteristic and concept can be best understood with reference to Figure 3 showing an exemplary installation on a flat roofing surface. Notably, the disclosed embodiments are often described

herein as being installed on a “roof” or a “roofing surface” generally depicted as reference numeral 70. But it is understood that other elements may be present between the plate and the actual roof deck, which elements may include one or more of a coverboard, insulation and an underlying waterproof membrane 72. The waterproof membrane 72 is shown in the schematic example of Figure 7 as well as the plate installation of Figure 3. Any such installation is intended to fall within the scope of the invention disclosed herein.

[0042] With reference to Figures 5A and 5B, the plate 10 defines a fastener opening 14 with a primary bore section 20 having a first diameter $D1$ and counterbore section 21 having a second diameter $D2$ greater than the first diameter. The counterbore section has a curved inner bottom edge 76 between the cylindrical side wall and the bottom wall of the counterbore section with a radius of curvature F . Additionally, like the outer periphery 16 of the plate, the outer (upper) periphery 18 of the counterbore 21 has a similar curved contour about entire periphery such that there are no exposed vertices or other intersecting geometry or surfaces which may form sharp edges. The absence of vertices described herein contributes to the resilience and “weather proofing” capability of the plate in that it reduces instances of punctures to the overlying membrane 74 caused by impact from projectiles like hail.

[0043] Certain elements within the plate 10 contribute considerably to the impact resistance of the plate, especially from larger projectiles at stronger impact forces. Dimensions of certain elements within the plate 10 are carefully configured to provide a plate that combines high resistance to impact and uplift forces. The depicted embodiment can withstand severe weather events, including significant hail storms with high impact contact, and achieved a Very Severe Hail “VSH” rating under Factory Mutual standards.

[0044] One significant dimensional measurement or relationship uncovered with respect to the disclosed embodiments is referred to herein as the “Ice Breaking Surface” (IBS) area. IBS area is a calculated measurement that refers to the area of contact between a 2-inch sphere and the top of the plate when

concentric (coaxial) "bullseye" contact is made. With reference to Figures 9-20, the IBS area is shown as reference numeral 55 (255 in the embodiment of Figure 18). As explained below, IBS area refers to the surface area of a ring-shaped projection circumscribing the central fastener opening 14.

[0045] The IBS is an area on the top surface of the plate where a 2-inch spherical projectile (i.e., an ice ball) would be at the highest risk of causing membrane penetration when making impact. There are two key occurrences that must be protected in order to prevent or at least minimize probability of membrane puncture via a projectile, each of which are tested at "bullseye" impact conditions. A direct bullseye is defined as the condition wherein the 2-inch spherical projectile makes impact with the plate directly at its center on the counterbore (i.e., the plate and ice ball are concentric or coaxial), and is understood as one of the conditions most likely to cause membrane puncture. First, the plate must protect against the head penetrating the membrane when a 2-inch spherical projectile hits a direct bullseye. Bullseye impact exploits a vulnerability of the fastener head possibly penetrating the membrane because the alignment allows the projectile to get as close to the fastener as possible without breaking the plate. Additionally, the plate must protect against a "hole punch" type of penetration through the membrane when direct bullseye impact occurs. Hole punch penetration is penetration of the membrane caused by the projectile contacting the outer edge surrounding the hole 14 or counterbore 28.

[0046] Testing has revealed that the lower limit of IBS area is 0.108 in² within plates with similar features as the inventive plate 10, as hole punch penetration occurs at an unacceptable frequency. IBS areas above the 0.108 in² threshold have shown acceptable results. For example, a preferred embodiment of the plate 10 shown in Figures 9-17 includes an IBS area of approximately 0.239 in². An exemplary plate with unacceptably small IBS area is shown as reference numeral 200 in Figure 18 with the IBS area identified as numeral 255.

[0047] With reference primarily to Figures 10-14, the IBS area 55 is formed by the following steps:

1. A Projection Ring 60 is a 2-dimensional ring determined on a plane 62 above the plate 10 parallel to the flat bottom 22, i.e., perpendicular to a central axis of the plate, which is thereafter used for projecting the IBS onto the 3-dimensional plate surface.
2. On the plane 62, a contact ring 66 is defined on the plane. The contact ring 66 is concentric with the center hole 14 of the plate 10 and a circle of a tangent contact circle formed when a 2-inch sphere hits the plate bullseye. The 2-inch contact ring 66 is shown in Figures 12 and 14.
3. The outer edge 68 of the Projection Ring 60 has a diameter D_o equal to the sum of the diameter D_c of the 2-inch contact ring 66 and half the radius of curvature R_c of the 2-inch contact ring 66.
4. The inner edge 70 of the Projection Ring 60 has a diameter D_i equal to the diameter D_c of the 2-inch contact ring 66 minus half the radius of curvature R_c of the 2-inch contact circle in most cases. If the inner edge 70 extends past the curved surface 18 of the plate about the counterbore 21 and into the projection of the cylindrical counterbore wall 28, then only the portion up to the counterbore wall is used as the position of the inner edge 70.
5. The 2-dimensional Projection Ring 60 is defined between the outer edge 68 and inner edge 70 on the plane 62, and is thereafter projected onto the curved surface 18 of the plate 10, thereby forming the IBS to determine the IBS area 55.

[0048] Notably, the radius of curvature is measured on the plate at the tangent point created when the 2-inch sphere makes concentric bullseye contact with the plate, which is depicted in Figures 13-14.

[0049] Standoff distance C is another important factor in ensuring weather resistance. "Standoff distance" C is defined as the distance between the outer surface of a 2" diameter projectile (hail ball) and head of an installed fastener, and preferably is large enough to prevent contact between the projectile. However, this characteristic is not necessarily a requirement for the inventive plate 10.

[0050] The radius of curvature F of the counterbore inner edge 76 is another key factor in performance of the plate 10 as it has shown to contribute substantially to uplift resistance of a plate. For example, sample roofing plates with either or both of a larger overall diameter or smaller radius F of counterbore bore inner edge 76 were shown to fail uplift testing due, in part, to an increase in bending moment. Other sample plates with one or more of a too small IBS area 55, and/or relatedly too small an impact zone radius of curvature (G) about the counterbore, and/or too small radius of curvature around the periphery 16 of the plate, and/or too short standoff distance (C) were shown to fail impact testing, with the most reliable indicator of impact resistance being IBS area 55.

[0051] Many other relative dimensions contribute to the efficacy of the plate by providing a plate with substantial resistance to uplift forces caused by wind, while also being resistant to physical contact (by hail balls or other projectiles) without puncturing the upper membrane 74.

[0052] Dimensions and preferred ranges thereof of key measurements within a preferred embodiment of the plate 10 are identified in Table 1 below. With reference to Figures 2, 3, 5A-5B, 9-11, 13-17, 19 and 20, respective key features are defined as follows:

- A: plate diameter
- B: overall height
- C: standoff distance
- D: fastener head shelf
- E: 2-inch contact diameter
- F: counterbore radius
- G: impact zone radius of curvature
- H: IBS area

[0053] The below Table 1 provides dimensions of a preferred embodiment and preferred ranges for each feature/measurement A-H. The combination of dimensions, shapes and contours are configured in part to maximize the impact surface area between a projectile, such as a hail ball, and the plate to prevent or

reduce the chance of a puncture caused by impact force. Preferably, the plate has key dimensions similar to those provided in Table 1, however, this is not limiting provided that the IBS area of a plate is within an acceptable range.

Table 1

Feature	Preferred dimension (in.)	Preferred range (in.)	Contribution
A. plate diameter	2.255	2.100-2.500	Impacts membrane surface area clamping and bending moment experienced by plate during uplift forces.
B. Height	0.393	0.350-0.450; (≤ 0.394 most preferred)	Impacts roof aesthetics, trip hazard, dirt and debris collection.
C. Standoff distance	0.066	0.025-0.100; (≥ 0.050 most preferred)	Can impact membrane penetration from hail and projectiles from contact with fastener head.
D. Fastener head shelf	0.155	0.125-0.200; (≥ 0.115 most preferred)	Impacts wind uplift value.
E. 2-inch contact diameter	0.641	0.450-0.850 (0.590-0.840 most preferred)	Circle created when 2-inch sphere makes concentric contact with top of plate. Determined by relationship/ratio of standoff distance (C), counterbore radius (F), and impact zone radius of curvature (G).
F. Counterbore radius	0.040	0.015-0.060 (≥ 0.020 most preferred)	Impacts wind uplift value.
G. Radius of curvature at impact surface	0.094	0.040-0.150 (≥ 0.051 most preferred)	Impacts membrane penetration from Hail and projectiles. Similar to a "hole-punch" effect.
H. IBS area	0.239 in ²	0.100-0.400 in ²	Area of contact between 2-inch sphere and top of

		(≥ 0.108 most preferred)	plate when concentric contact is made.
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[0054] The preferred dimension values in Table 1 refer to a specific preferred embodiment that has shown resistance to puncture and wind uplift, while maintaining an acceptable aesthetic and installation efficiency (i.e., not too big or tall in the eye of installers, easy to install). Understandably, other dimensions, even some outside of the preferred ranges of Table 1, can theoretically be used with acceptable impact resistance and uplift performance, but they may be less aesthetically pleasing, cumbersome to install or impart another drawback. Additionally, as noted above, the most important metric/dimension in preventing puncture via projectile impact is IBS area (H), which is necessarily dependent on 2-inch contact diameter (E), counterbore radius (F), and radius of curvature at impact surface (G). Thus, adjustment of one or more of these variables in ways that may fall outside a preferred range while yielding a plate with acceptable IBS area is possible and within the capabilities of one of skill in the art. The relationship of the elements with these preferred dimensions yields a plate 10 that performs well for its intended use in its intended setting.

[0055] Unlike known roofing plates for use with flat roofing structures, the disclosed roofing plate 10 is preferably formed from a polymeric material or hybrid that withstands impact on its surfaces without shattering, even in cold weather. For instance, in one preferred embodiment, the plate is molded from a polymer with rubber component. In one embodiment, the plate 10 is formed from a nylon resin. In one embodiment, the polymer is fiber reinforced. In other embodiments, the polymer is non-fiber reinforced. In some embodiments, the plate may be formed from an amide material. In some embodiments, the plate is formed from a polyamide.

[0056] With reference to the disclosed embodiments, a high performing impact resistant roofing plate 10 has been depicted and described. The plate 10 includes rounded edges and vertices to reduce the chances of a membrane puncture from high impact contact from a projectile. Preferably, the IBS area of the curved top

edge about the fastener opening 14 (or counterbore 21) is above 0.108 in² in order to provide the requisite impact resistance.

[0057] It should be understood that the foregoing description is only illustrative of the various exemplary embodiments. Various alternatives and modifications can be devised by those skilled in the art without departing from the disclosure. Accordingly, the disclosure is intended to embrace all such alternatives, modifications and variances which fall within the scope of the disclosure.

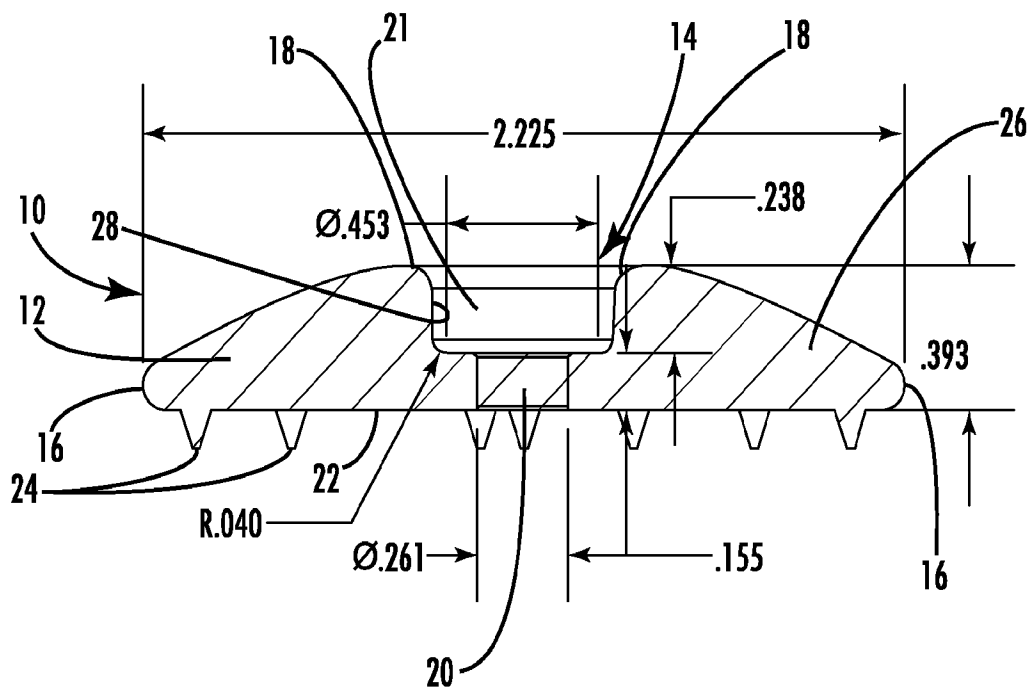
REPRESENTATIVE CLAIMS

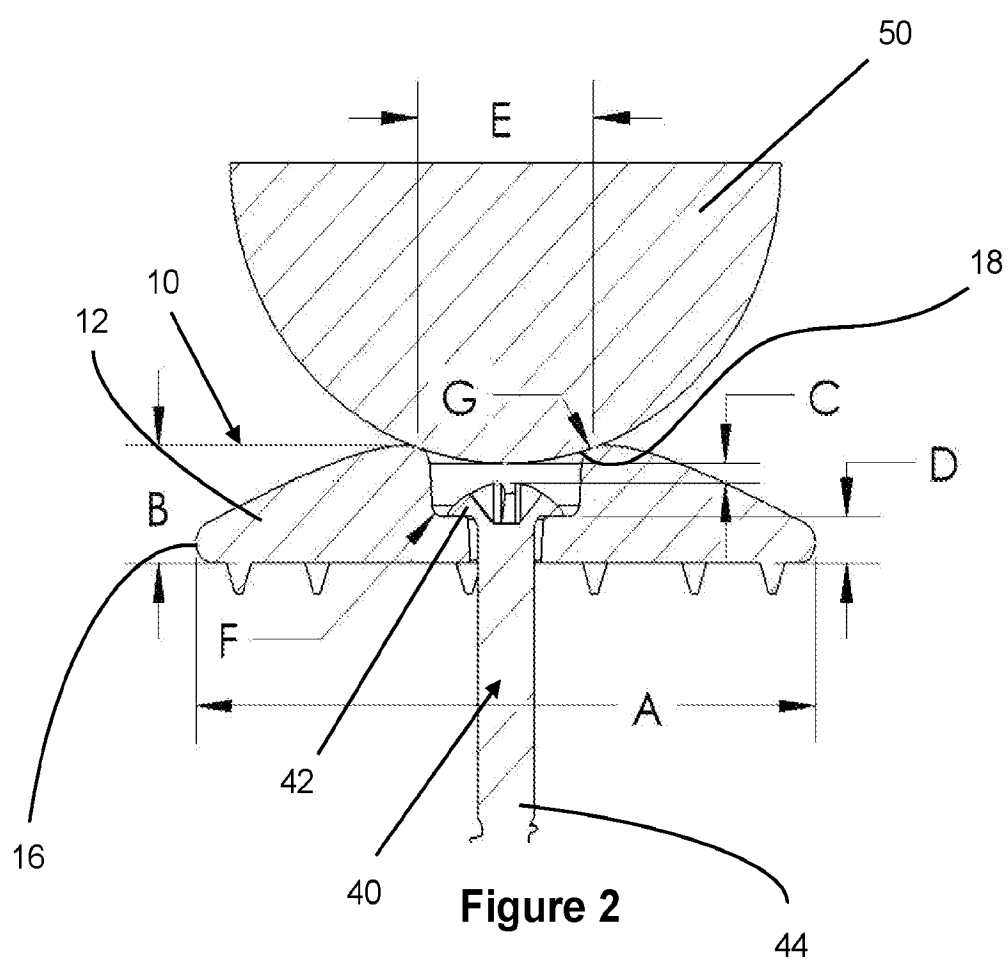
What is claimed is:

1. A roofing plate comprising:
a solid body defining a fastener opening from a top surface to a bottom surface, wherein
the solid body has rounded edges.
2. The roofing plate of claim 1, wherein the fastener opening comprises a main section and a counterbore section having a greater diameter than the main section.
3. The roofing plate of claim 1, wherein the top of the counterbore section has a rounded upper periphery.
4. The roofing plate of claim 1, wherein the bottom of the counterbore section has a rounded inner periphery.
5. The roofing plate of claim 1, wherein the plate is formed from a polymer material.
6. The roofing plate of claim 1, wherein the plate has a rounded outer peripheral edge.
7. The roofing plate of claim 1, wherein an IBS area defined as an area of the roofing plate that contacts a 2-inch diameter coaxial sphere (impact surface) is above 0.108 in².
8. The roofing plate of claim 7, wherein a radius of curvature at the impact surface is greater than 0.051 inches.

9. The roofing plate of claim 1, wherein an IBS area defined as an area of the roofing plate that contacts a 2-inch diameter coaxial sphere (impact surface) is within an approximate range of 0.100 in² to 0.400 in².
10. The roofing plate of claim 9, wherein a radius of curvature at the impact surface is within an approximate range of 0.040 inches to 0.150 inches.
11. The roofing plate of claim 1, wherein the bottom surface of the plate includes a plurality of downwardly extending teeth.
12. The roofing plate of claim 1, wherein the bottom surface of the plate does not include any downwardly extending teeth.
13. The roofing plate of claim 1, wherein the plate is rated for Very Severe Hail (VSH) under Factory Mutual standards.
14. The roofing plate of claim 3, wherein the counterbore section has a rounded bottom inner edge.
15. A roofing assembly, comprising:
 - a roofing substructure;
 - a flat roofing element above the roofing substructure;
 - a roofing plate above the roofing element;
 - a fluid impermeable membrane above the roofing plate; and
 - a fastener extending through a bore in the roofing plate, through the roofing element, and embedded into at least a portion of the roofing substructure to fix the roofing plate in place, wherein
 - the roofing plate has no vertices.
16. The roofing assembly of claim 15, comprising an underlying membrane between the roofing plate and the roofing element.

17. The roofing assembly of claim 15, wherein
the fastener bore includes a primary bore section and a counterbore section
having a greater diameter than the primary bore section, and
the counterbore section has a rounded upper peripheral edge.
18. The roofing assembly of claim 17, wherein the counterbore section has a
rounded bottom inner edge.
19. The roofing assembly of claim 7, wherein an IBS area defined as an area
of the roofing plate that contacts a 2-inch diameter coaxial sphere is above 0.108
in².
20. A roofing plate comprising:
a polymer body defining a fastener opening from a top surface to a bottom
surface and having an upper counterbore section with a diameter greater than a
diameter of a lower primary bore section, wherein
the solid body defines an outer periphery with rounded edges,
the counterbore section has a top with a rounded upper periphery,
the counterbore section has a bottom inner edge that is rounded, and
an IBS area defined as an area of the roofing plate that contacts a 2-inch
diameter coaxial sphere (impact surface) is within an approximate range of 0.100
in² to 0.400 in².





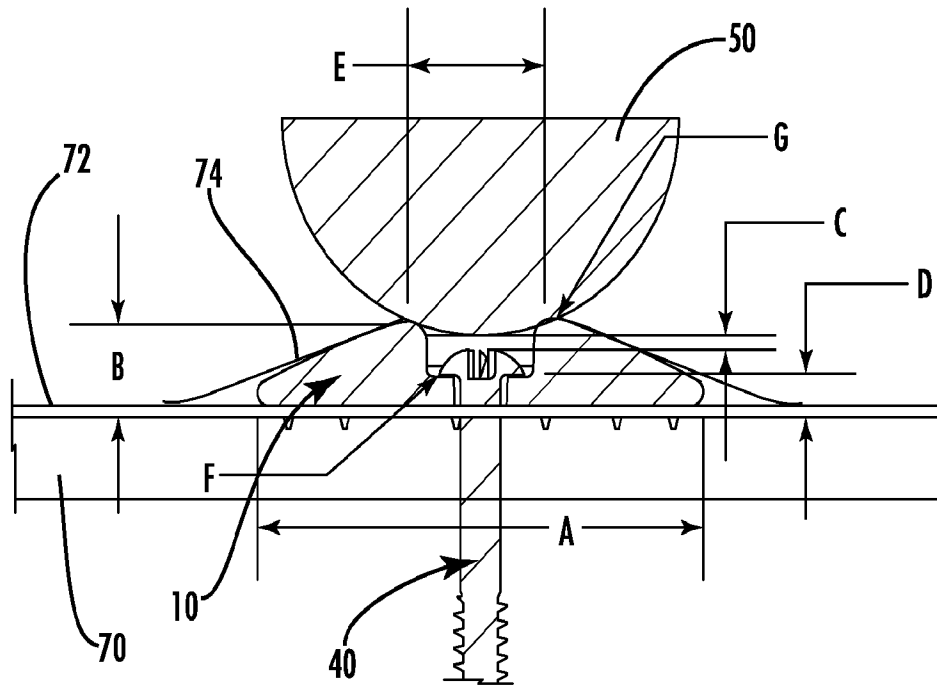


FIG. 3

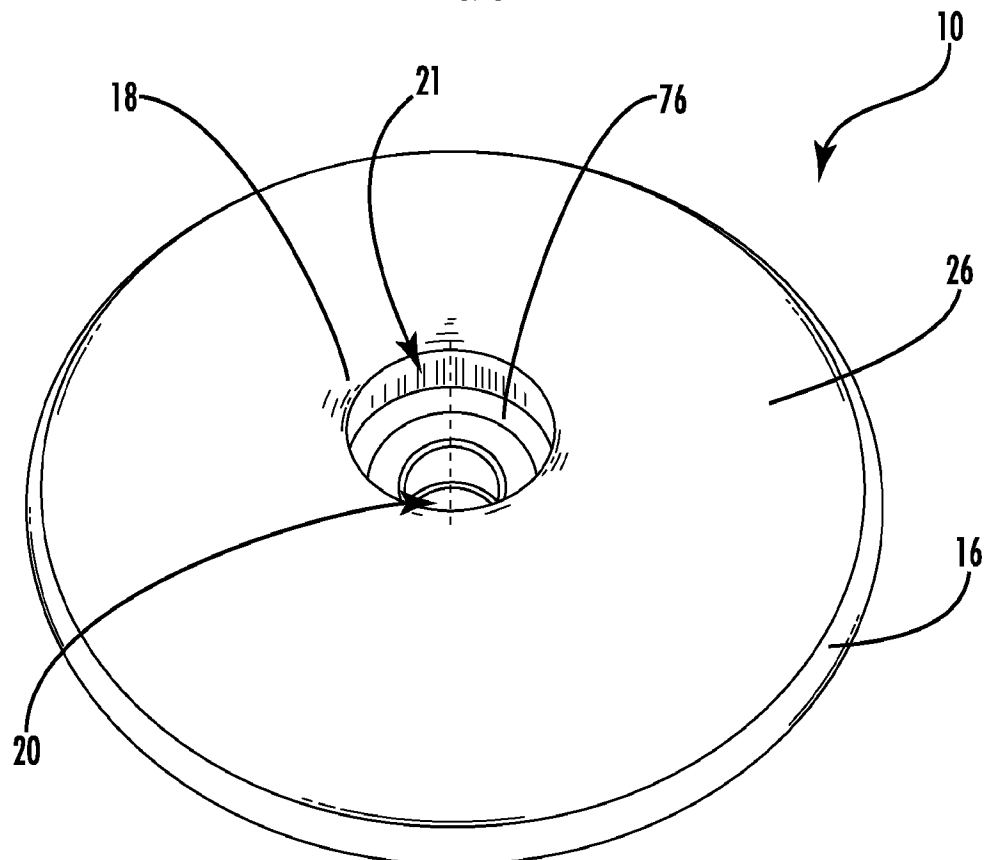


FIG. 4

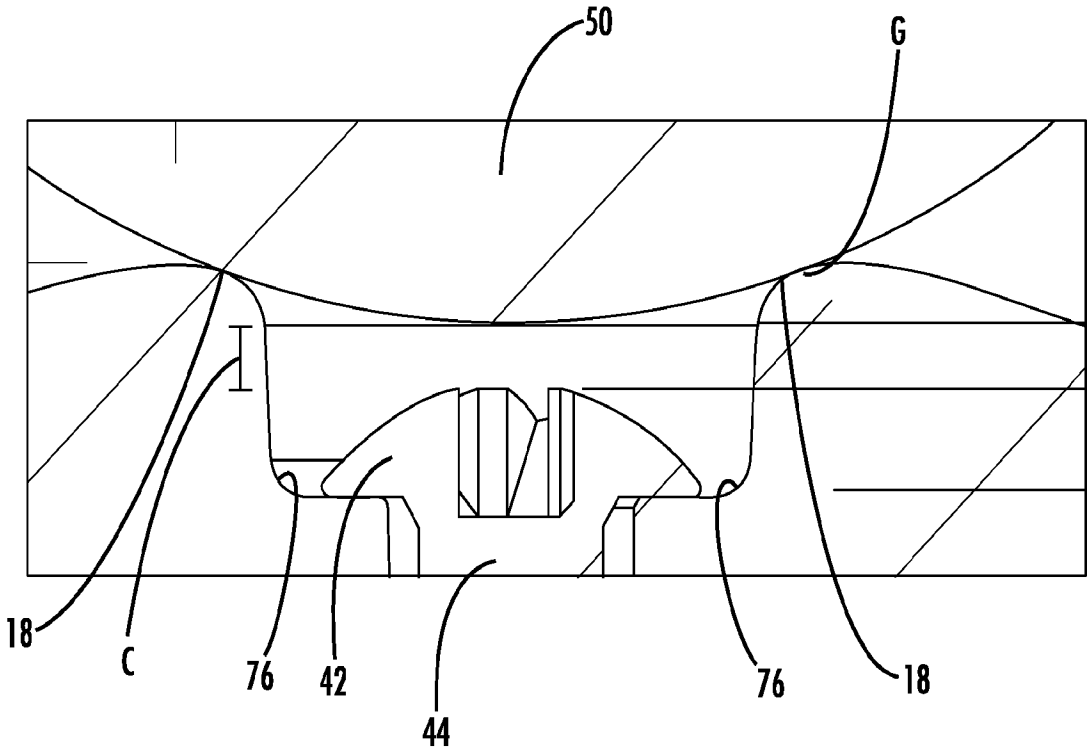


FIG. 5A

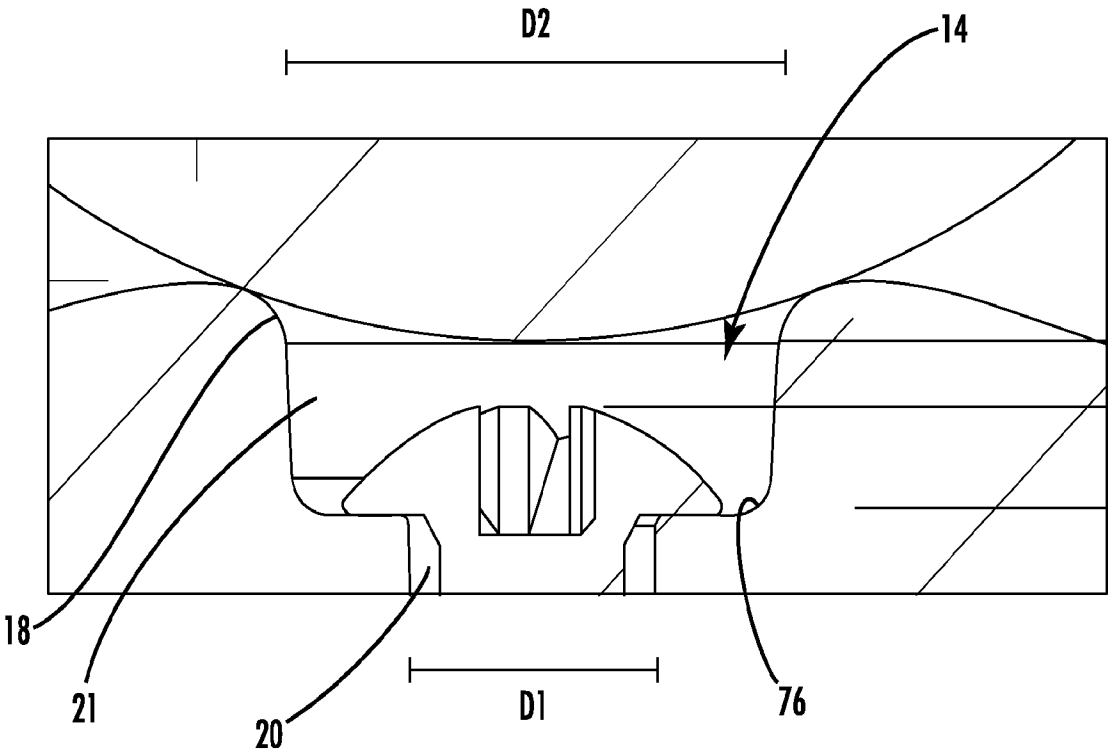


FIG. 5B

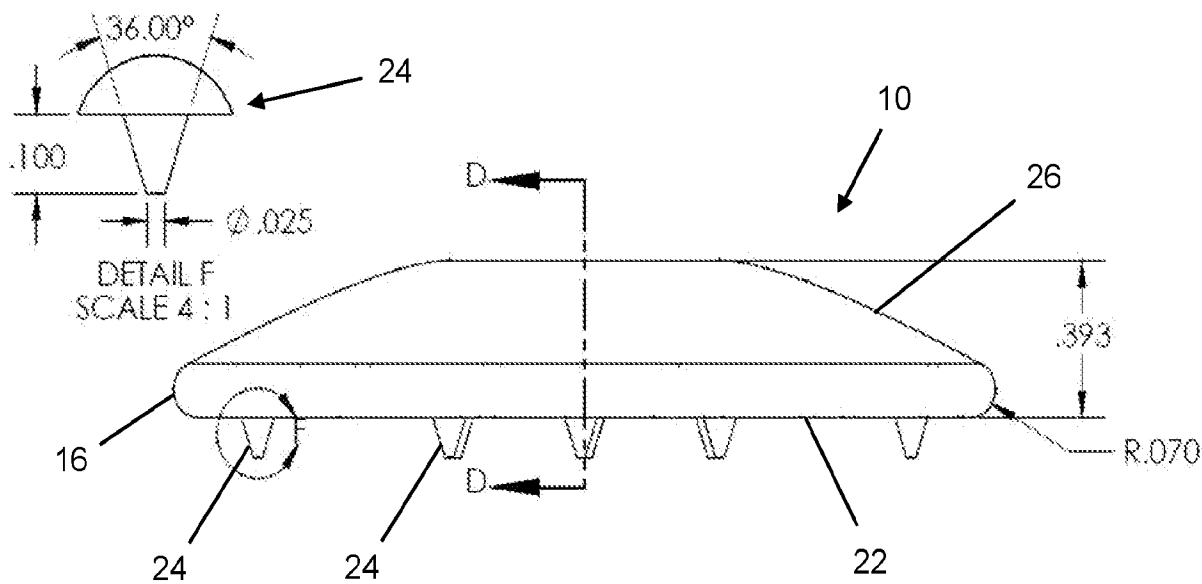


Figure 6A

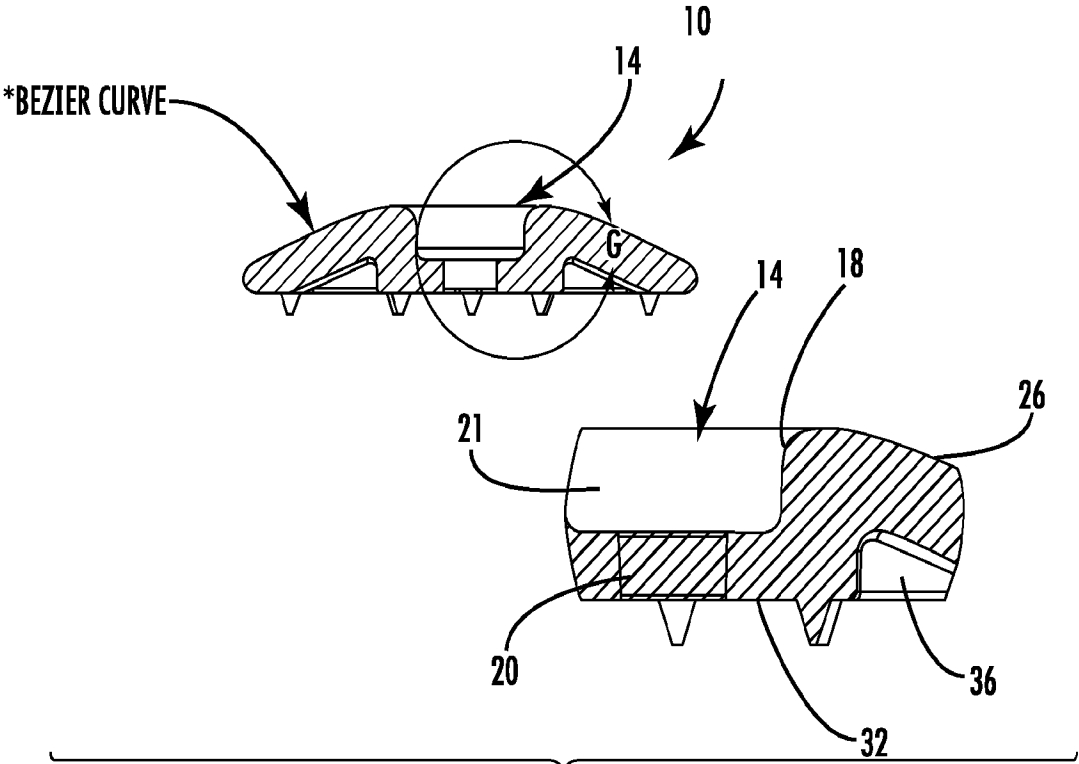


FIG. 6B

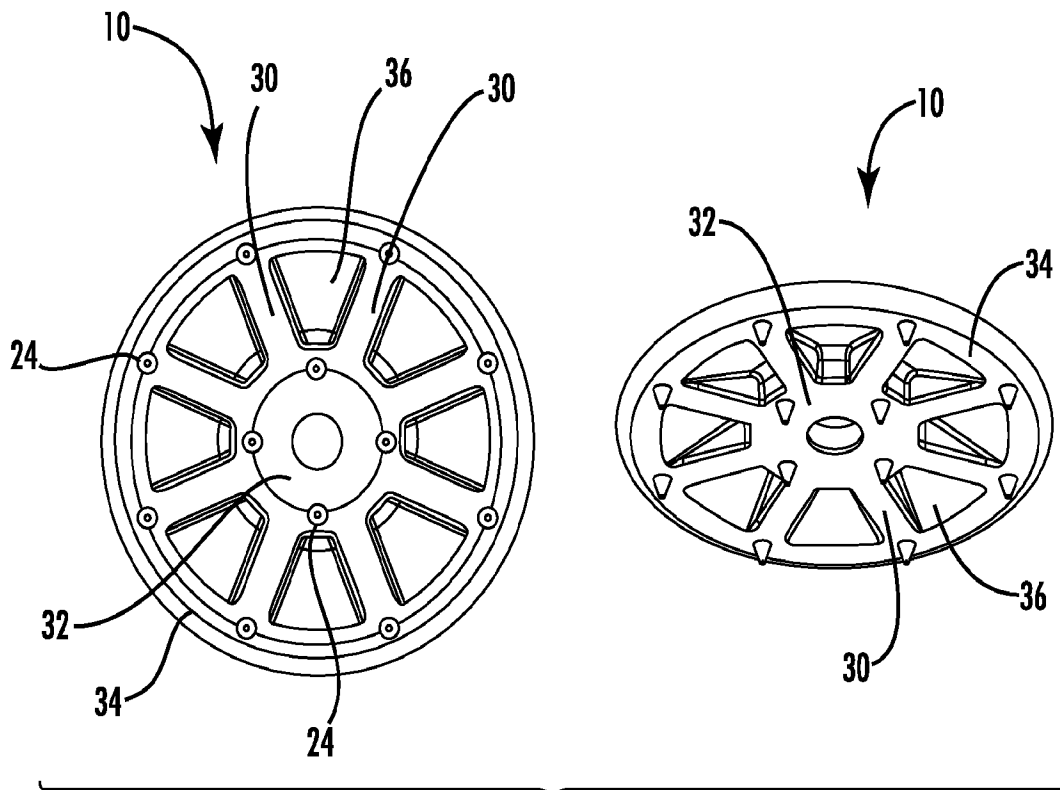
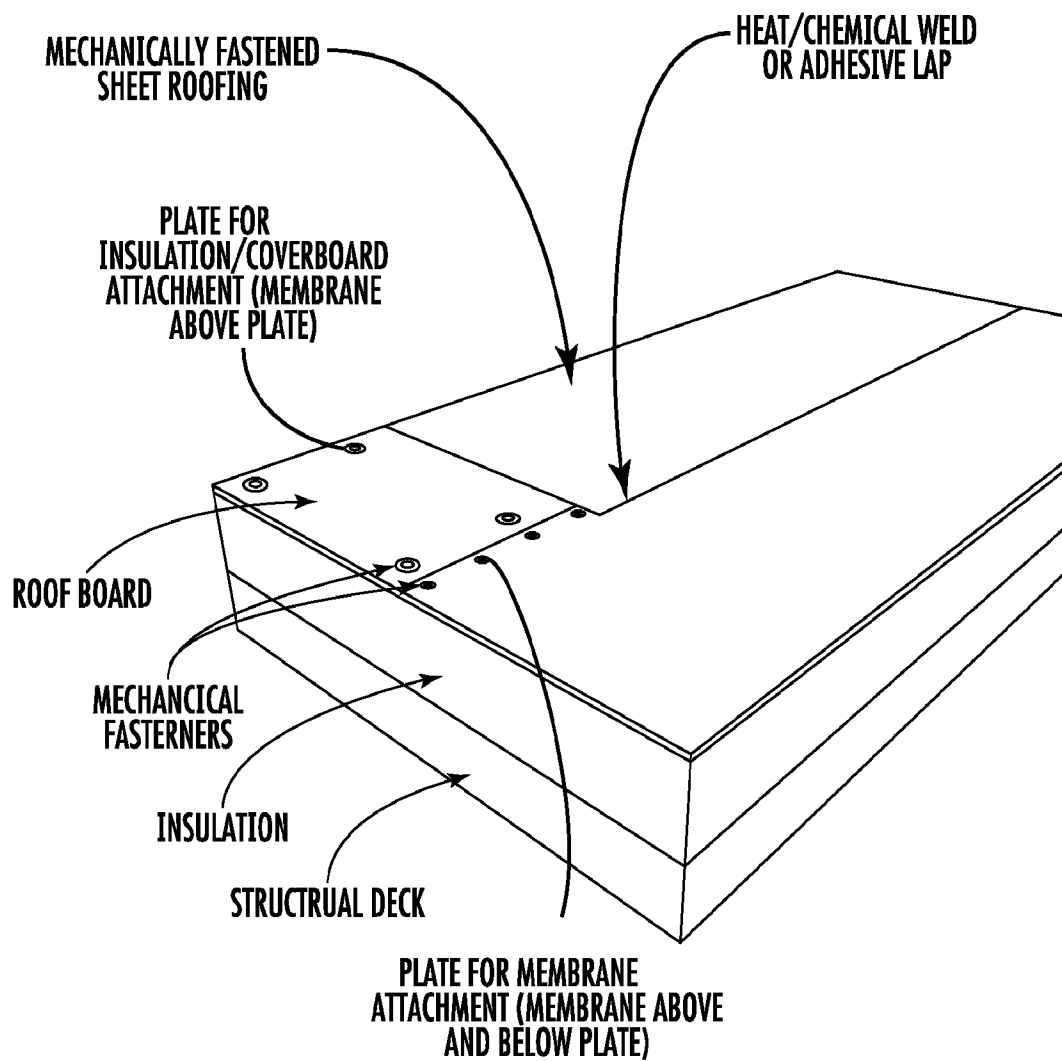


FIG. 6C

**FIG. 7**

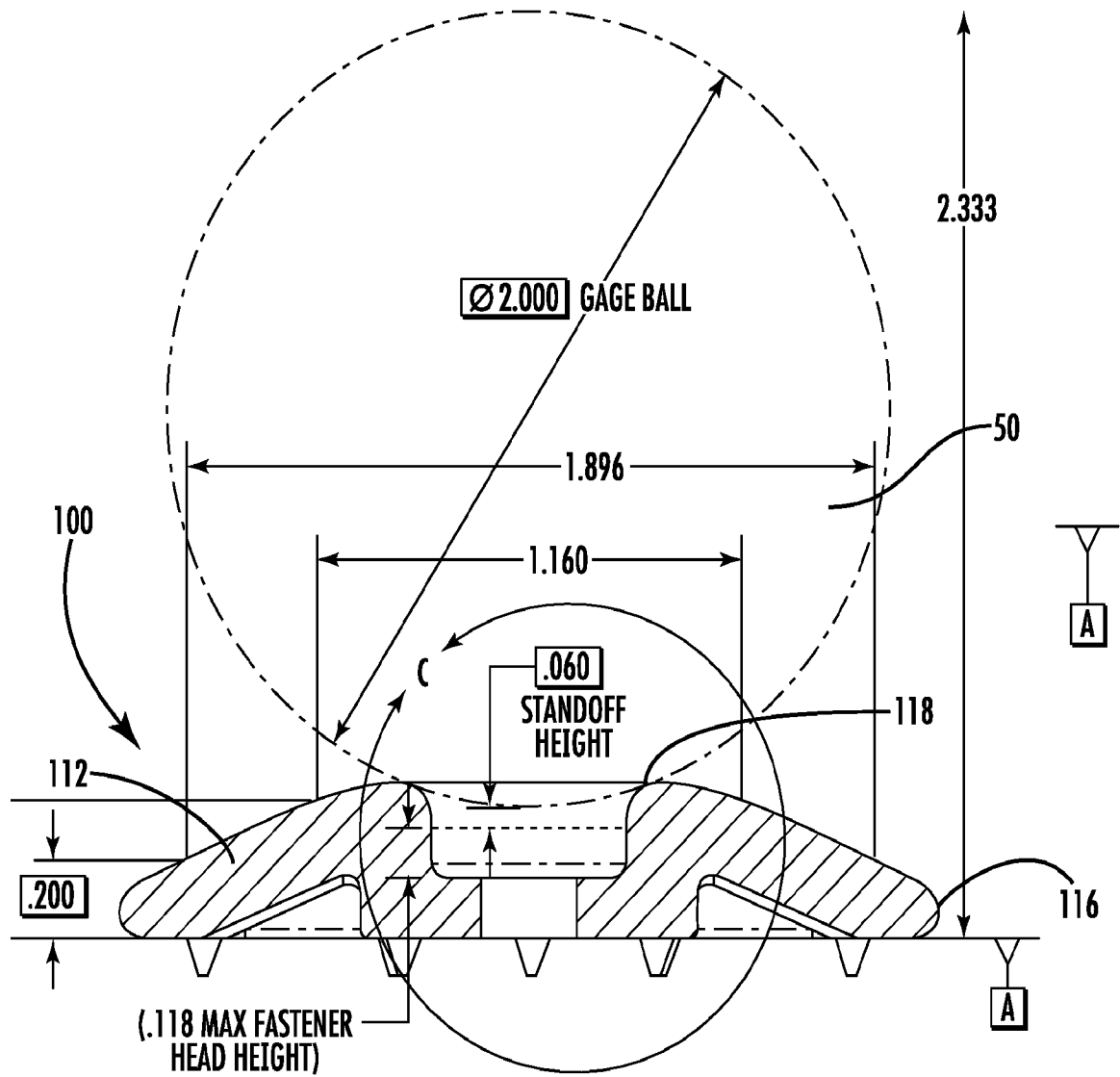


FIG. 8

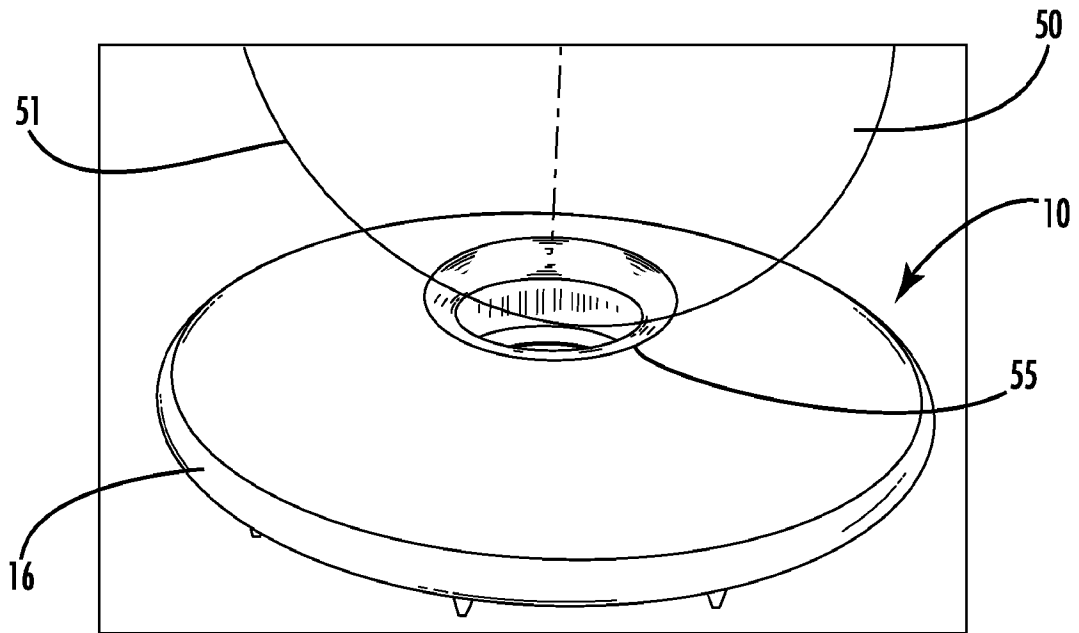


FIG. 9

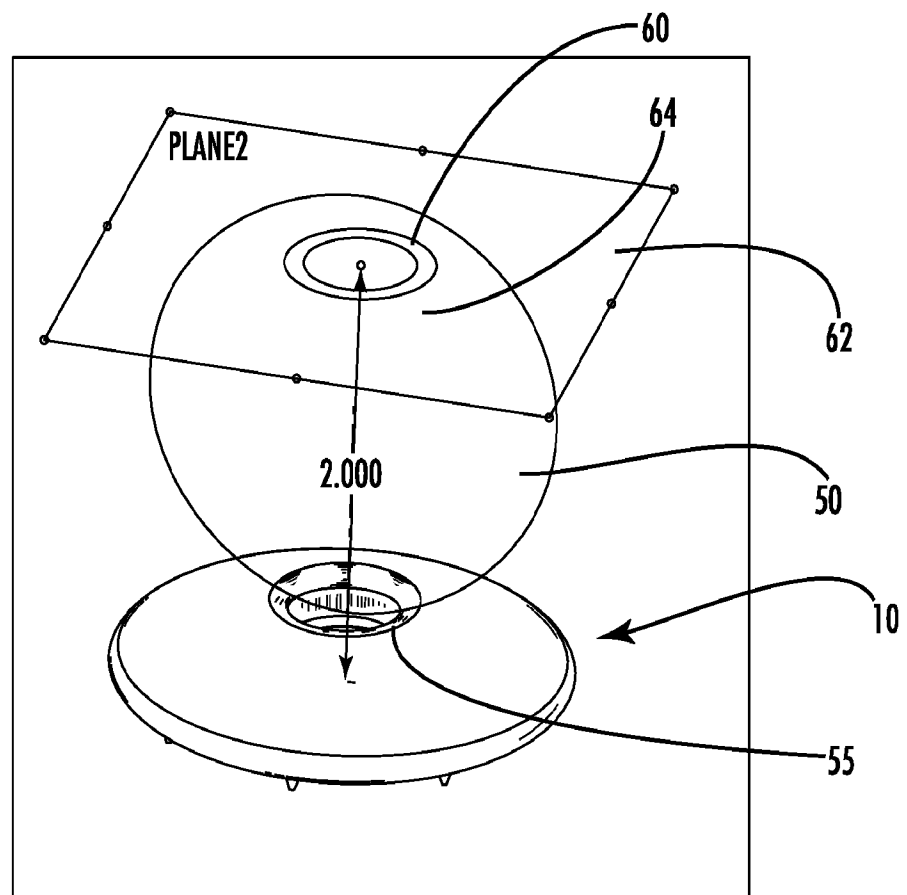


FIG. 10

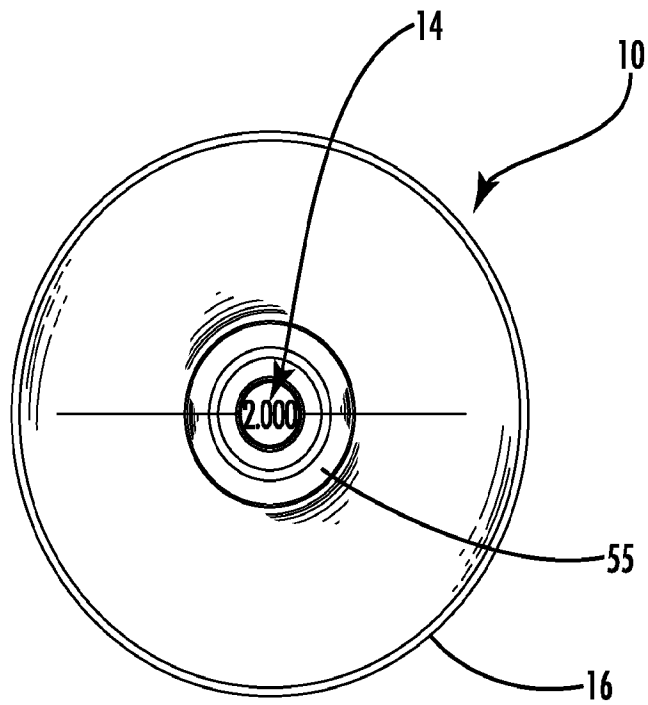


FIG. 11

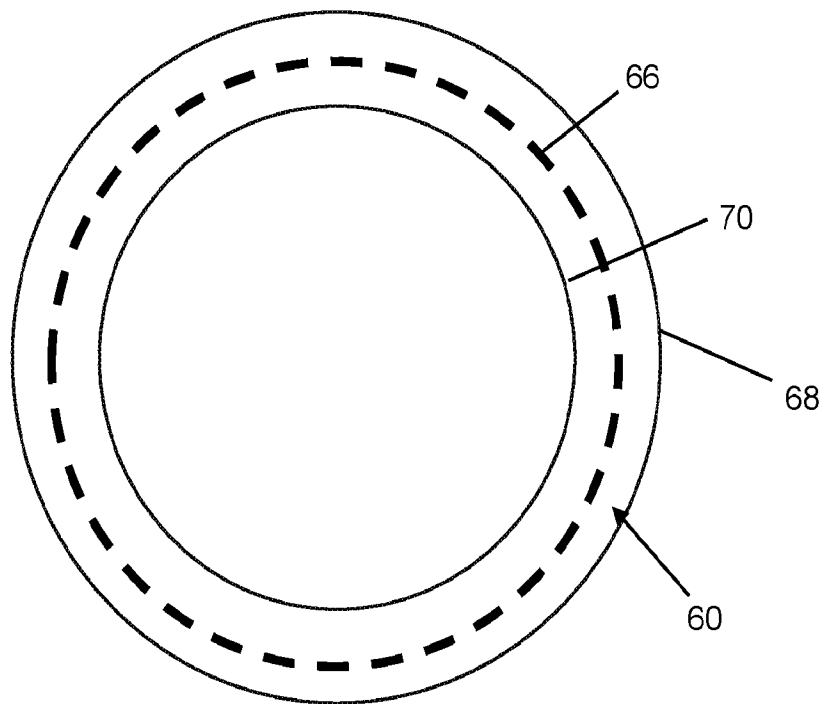


Figure 12

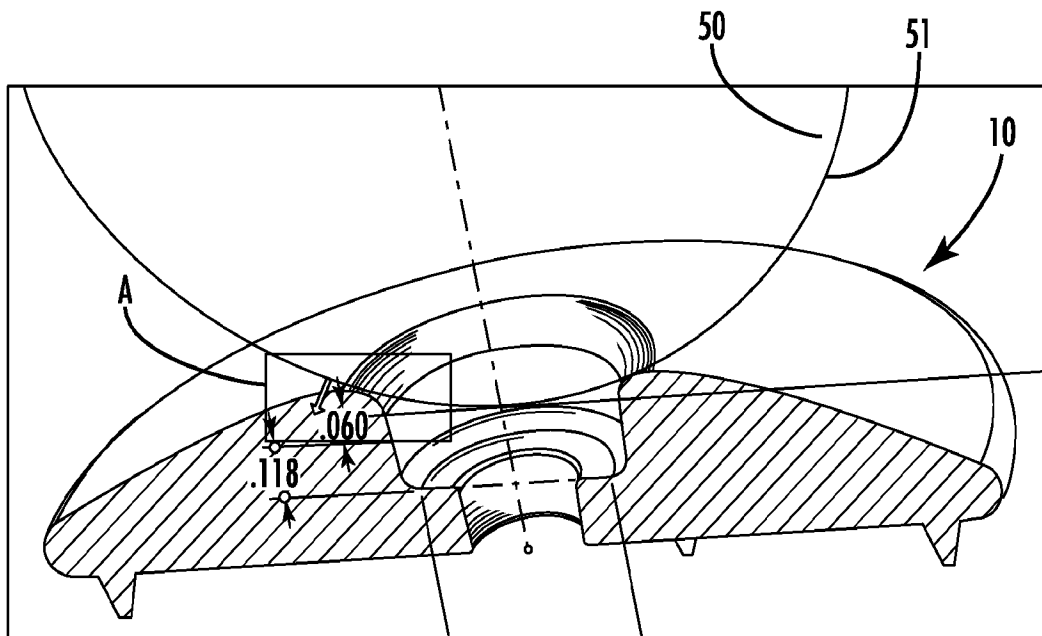


FIG. 13

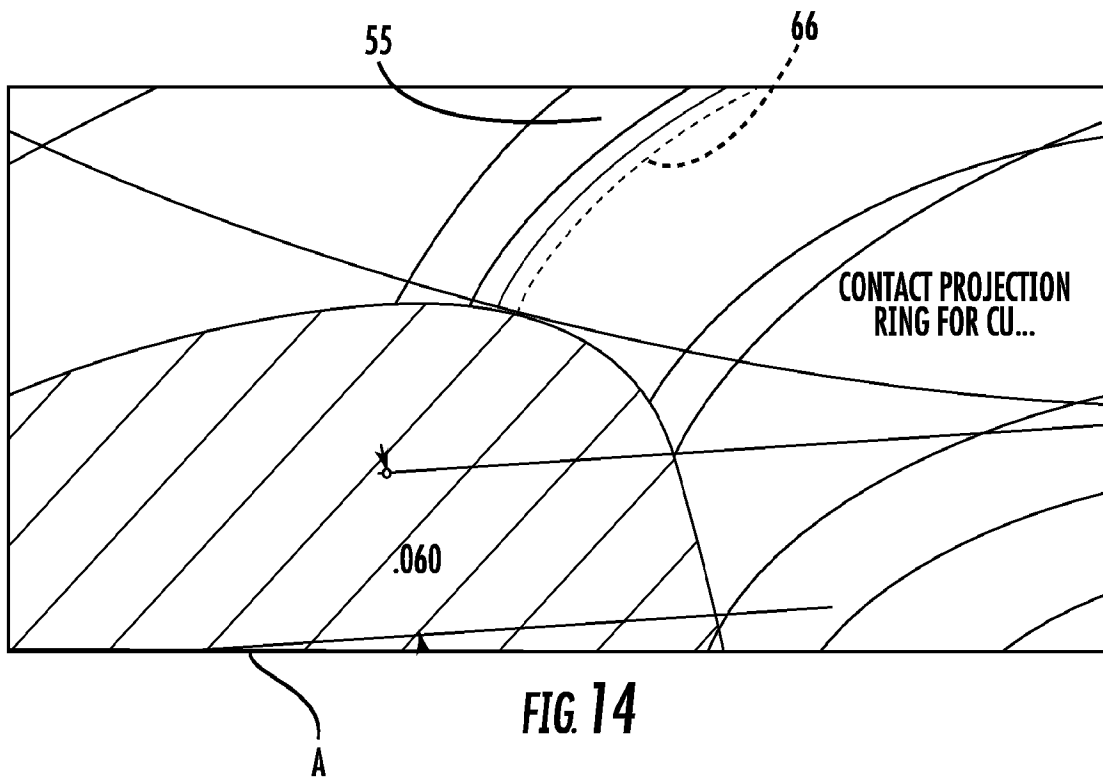


FIG. 14

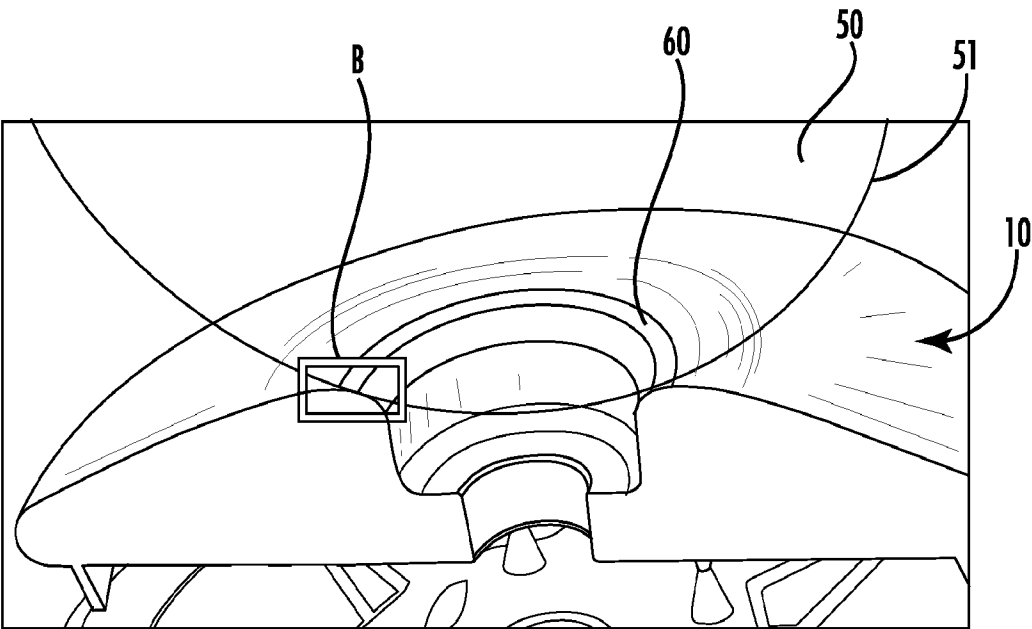


FIG. 15

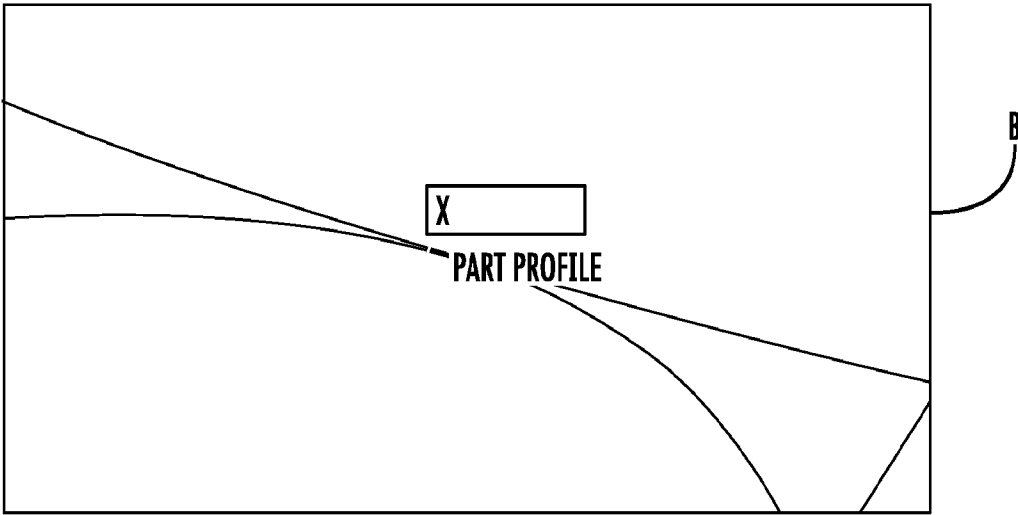


FIG. 16

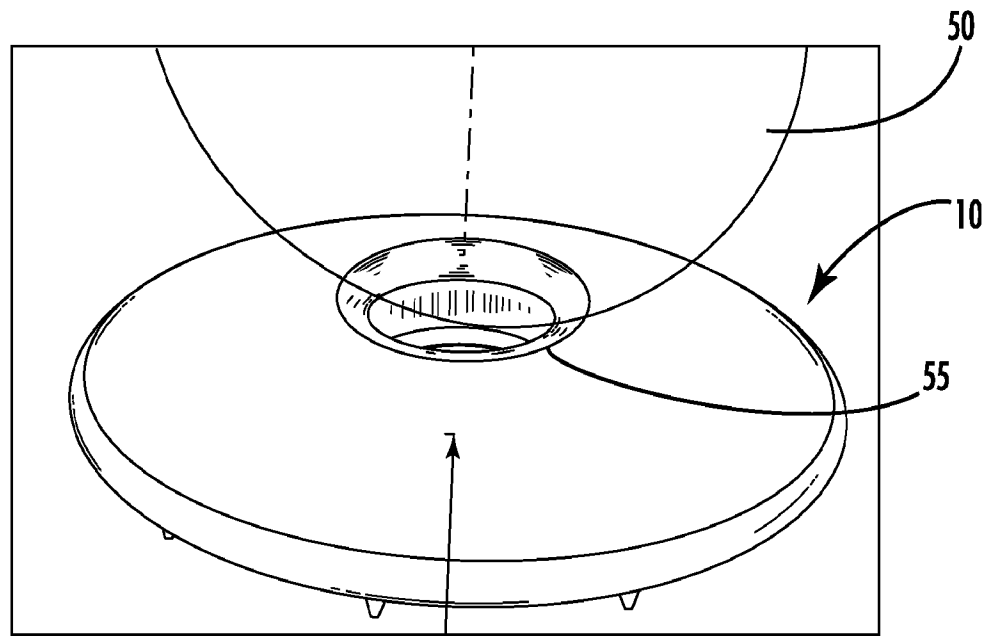


FIG. 17

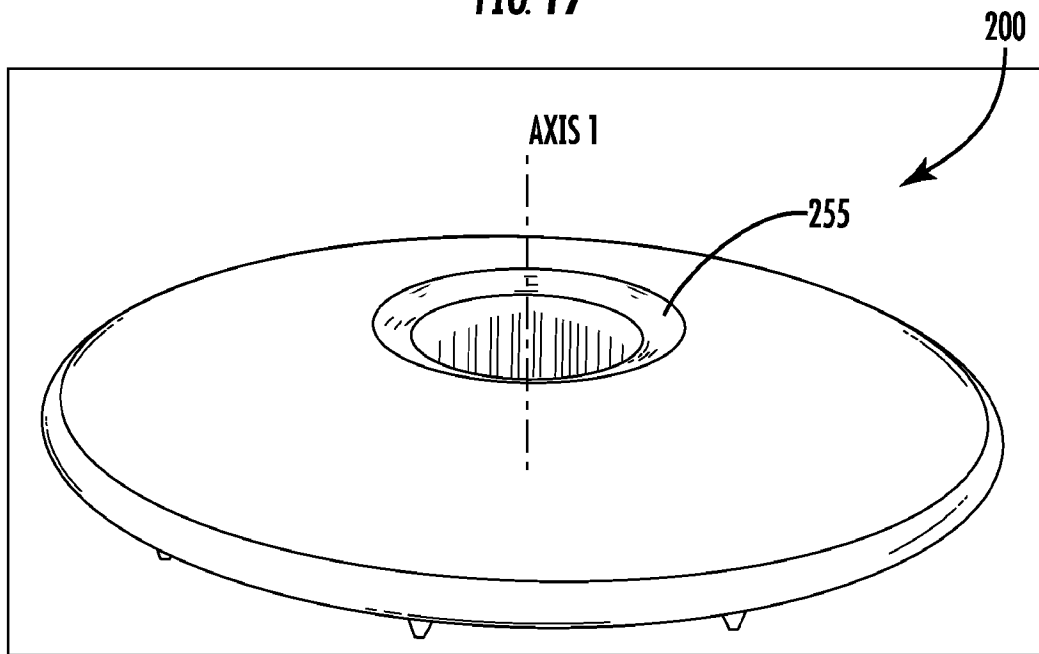


FIG. 18

17/17

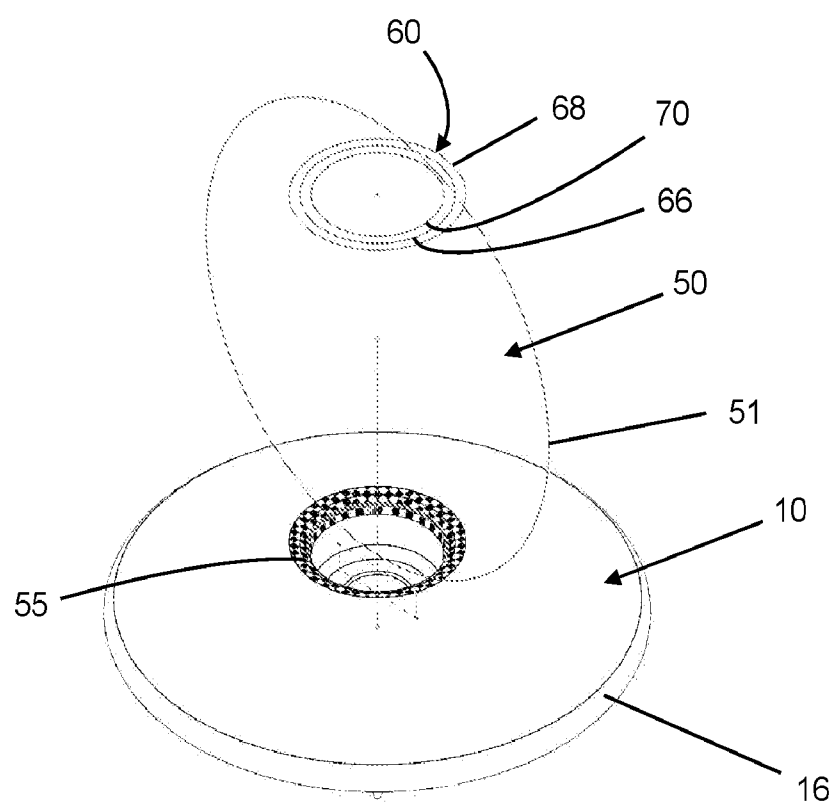


Figure 19

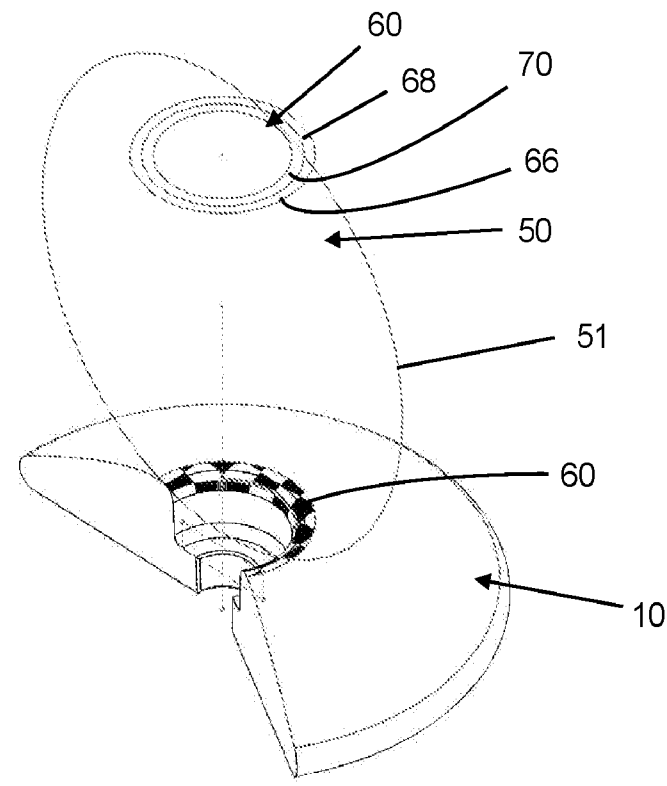


Figure 20

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/033975

A. CLASSIFICATION OF SUBJECT MATTER E04D 1/00(2006.01)i; E04D 1/36(2006.01)i; E04D 7/00(2006.01)i; E04D 1/34(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) E04D 1/00(2006.01); E04B 1/62(2006.01); E04D 5/14(2006.01); F16B 21/07(2006.01); F16B 43/00(2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: weather, resistance, roofing plate, fastener, hail, round, bore, impact		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4726164 A (REINWALL et al.) 23 February 1988 (1988-02-23) column 2, line 28 - column 3, line 57 and figures 1-6	1-20
A	US 6233889 B1 (HULSEY, TOMMY RAY) 22 May 2001 (2001-05-22) column 5, lines 12-28 and figures 5-7	1-20
A	US 4380413 A (DEWEY, GEORGE G.) 19 April 1983 (1983-04-19) column 3, lines 34-47 and figures 3A-3B	1-20
A	US 2015-0292547 A1 (DURO-LAST, INC.) 15 October 2015 (2015-10-15) figure 4	1-20
A	JP 2004-100244 A (JAPAN POWER FASTENING CO., LTD.) 02 April 2004 (2004-04-02) paragraph [0024] and figures 2-3	1-20
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: “A” document defining the general state of the art which is not considered to be of particular relevance “D” document cited by the applicant in the international application “E” earlier application or patent but published on or after the international filing date “L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) “O” document referring to an oral disclosure, use, exhibition or other means “P” document published prior to the international filing date but later than the priority date claimed “T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention “X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone “Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art “&” document member of the same patent family		
Date of the actual completion of the international search 08 October 2024		Date of mailing of the international search report 10 October 2024
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer PARK, Tae Wook Telephone No. +82-42-481-3405

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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				US	9719551	B2	01 August 2017

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