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(54) Title: FLEXIBLE IMPACT PROTECTORS

(57) Abstract: The current invention relates to impact protectors and impact protector mountings for parts or structures that are susceptible to impact or the forces of an impact. Protectors of the invention are useful to protect any parts or structures in vehicles, including bicycles, motorcycles, cars, trucks, off-road vehicles, utility vehicles, and other vehicles. Protectors of the invention can be used to protect any parts and structures, including sprockets, disc brake rotors, engine parts, and other components susceptible to impact damage.

FLEXIBLE IMPACT PROTECTORS

1.0 FIELD OF THE INVENTION

The current invention relates to protectors and mounting of protectors for parts or structures that are susceptible to impact or the forces of an impact. Protectors of the invention are useful to protect any parts or structures, especially parts and structures found in vehicles, including bicycles, motorcycles, cars, trucks, off-road vehicles, utility vehicles, and other vehicles. Impact protector mountings and protectors of the invention can provide added protection for any parts and structures, including sprockets, disc brake rotors, engine parts, and other components susceptible to impact damage.

2.0 BACKGROUND

Parts and structures of objects, in particular moving objects like vehicles of any kind, can be subject to stress caused by an impact. The stress or force of an impact can cause damage to parts and structures, either directly or indirectly, and lessening or avoiding such damage can be desirable. Examples of applications where parts and structures may be subject to impact forces include vehicles of any kind, for example, land vehicles, water going vehicles, under-water vehicles, air vehicles and space vehicles. Other examples are parts and structures in industrial applications, manufacturing applications, household applications, farming applications, and any other application where added protection against impact forces is desired. Specific examples of parts and structures that may suffer under impact forces, and that may benefit from a protector, are sprockets used in vehicles, including on bicycles, motorcycles, and ATVs, and disc brake rotors. Protecting sprockets and disc brakes can pose a challenge. Problems may arise where a protector for sprockets and disc brakes is built from material that is insufficiently flexible. Other problems may arise where the stiffness of the protector is higher in the direction from an oncoming impact as compared to a direction that is perpendicular to the impact, which may lead to bending and deformation under impact. Other problems may arise from the manner in which a protector is attached or mounted to protect certain parts or structures. For example, a protector for sprockets and disc brakes may be mounted using a rigid configuration or rigid materials, like rigid bolts, and such rigid materials have to be strengthened to withstand impact thereby adding to the weight of a vehicle, which

may be undesirable. Known impact protectors sold under the brands e.thirteen, Mountain Racing Products, Mr.Dirt, Truvativ, Full Speed Ahead, Race Face, Roox, Blackspire, Gamut USA, Fastway Performance, Promoto, Scotts, Moose, and others allow for damage to mounting components and the items that they aim to protect due to rigid designs that are unable to adequately mitigate impact forces. Problems may arise where an impact may lead to bending and deformation or to movement of mounting components under impact. A specific concern pertains to bicycle sprocket protection, where an impact protector is mounted to a bicycle crank arm, substantially coaxially with a sprocket or cluster of sprockets. The bicycle crank arm is designed to transfer force from the rider's legs to the sprockets and from the sprockets to the driving wheel. Impact at an impact protector for bicycle sprockets can typically bend the crank arm, which then requires replacement. Other problems may arise from the manner in which a protector is attached or mounted to protect certain parts or structures. For example, impact protector mountings are less desirable if they transmit excessive impact forces onto parts that are not designed to withstand such forces. For example, bicycle impact protectors that are mounted by merely clamping the protector to a frame using a bicycle bottom bracket as a single bolted connection may result in damage to a bottom bracket or bicycle drivetrain component under impact. Examples of such protectors are shown in U.S. Patent No. 7,066,856. Bicycle bottom brackets thread into bicycle frames to provide a rotational mounting for bicycle crank arms. Bicycle bottom brackets are not well suited to mitigate significant impact forces. An impact on a bottom bracket can damage the bottom bracket, possibly causing an unsafe operating condition for the rider. Of additional concern in the design of impact protectors are movements of the impact protector in case of an impact. For example, impact protector designs that clamp between the bottom bracket and bicycle frame can rotate during impact and thereby expose components they were aimed to protect against impact forces. Yet another consideration in designing impact protectors is the means by which the protector is attached. For example, where screws are used to gouge the impact protector into the bicycle frame, dangerous frame damage from the points of the screws may result. Also, elaborate and heavy clamping mechanisms are not ideal due to the extremely large number of frame design variations and layouts. Additionally, due to the lightweight nature of bicycle frame designs and the reliance on thin walled tubing, clamp type designs such as disclosed in U.S. Patent No. 5,067,930 and U.S. Patent

No. 7,066,856 can cause structural damage by crushing thin walled tubes during clamping. Further challenges arise for bicycle impact protector mountings when considering the need for chain guides on bicycles. Many bicycles used for downhill and aggressive type riding include devices known as chain guides or chain retention systems to prevent derailment of a chain on a front sprocket or sprockets of a bicycle. Typically these devices incorporate an outer and inner impact protector mounted to the bicycle crank arm. Some designs use an outer impact protector that is mounted to a bicycle crank arm, in conjunction with an inner impact protector that is an integrated part of an inner chain guide plate. These designs frequently pose problems when the inner protector deforms due to impact and causes binding in, or damage to, the bicycle drivetrain.

There is a need for an impact protector that can better absorb impact while minimizing damage to mounting components. There is also a need for an impact protector with a lighter weight than current products. There is a further need for an impact protector with more affordable manufacturing costs. There is a need for impact protector mountings that can minimize damage to mounting components, bicycle crank arms, bottom brackets, frames, or other parts. A need also exists for mountings that can maintain the location of the protector in relation to parts that are to be protected. A need further exists for mountings that are sufficiently light in weight. Furthermore, a need exists for impact protector mountings that integrate with bicycle chain guides while minimizing damage to bicycle crank arms, bottom brackets, frames, or other parts. Finally, a need exists for protector mountings that are more cost effective. The present invention provides impact protectors and impact protector mountings that satisfy one or more of these needs.

3.0 SUMMARY OF THE INVENTION

The current invention relates to impact protectors, impact protector mountings, and mounting methods to protect parts and structures from forces, in particular impact forces. Impact protectors, impact protector mountings, and mounting methods of the current invention are useful for vehicles of all kinds, including land vehicles, water vehicles, under-water vehicles, air vehicles, and space vehicles. Impact protectors, impact protector mountings, and mounting methods of the current invention are also useful to protect parts and structures of a machine, a factory, an assembly line, farming equipment, an arms-system, and any other kind of application with parts and

structures for which added protection is desired. Impact protector mountings of the current invention are especially useful for bicycles or other vehicles that use drivetrain components that can benefit from impact from protection. In certain embodiments, an impact protector of the current invention comprises structures, designs, or arrangements that are flexible. In certain other embodiments, an impact protector of the current invention is capable of flexing under impact so as to reduce the transmission of stress, for example, the transmission of stress to a mounting component. In certain other embodiments, an impact protector of the invention is capable of flexing in a direction that is parallel or substantially parallel to the direction of the impact. In certain other embodiments, an impact protector of the invention is incapable or substantially incapable of flexing in a direction that is perpendicular or substantially perpendicular to the direction of the impact. In certain embodiments, an impact protector mounting of the current invention comprises structures, designs, or arrangements that locate an impact protector in relation to a sprocket. In certain other embodiments, an impact protector mounting of the current invention locates an impact protector at a location inboard of a sprocket or sprockets. In certain other embodiments, an impact protector mounting of the invention shares components with a chain guide or chain retention system. In certain other embodiments, an impact protector mounting of the current invention separates an impact protector component from a chain guide component. In certain other embodiments, an impact protector mounting of the invention directs impact force from an impact protector to a frame structure without intermediately transferring force through a drivetrain component such as a bottom bracket or crank arm. In certain other embodiments, an impact protector mounting of the invention uses multiple connections to locate an impact protector to a frame structure. In certain other embodiments, these connections are bolted connections. In certain other embodiments, an impact protector mounting of the invention uses multiple connections to locate an impact protector to a mounting plate which uses multiple connections to locate to a frame structure. In certain other embodiments, these connections are bolted connections. In certain other embodiments, these locations are splined connections. In certain other embodiments, a connection adaptor can be a removable component that can be replaced if damaged. Multiple design methods are shown to meet the requirements of different aesthetic needs and manufacturing costs.

4.0 BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates a side view of a flexible impact protector in a non-impacted state.

FIGURE 2 shows a close up cutaway three-dimensional view example of the present invention in a non-impacted state. Flexures detailed in Figure 1 and the common area measurement dimensions are illustrated.

FIGURE 3 illustrates a flexible impact protector of FIGURES 1 and 2 in an impacted state.

FIGURE 4 shows a three dimensional view of the impact protector shown in FIGURES 1, 2, and 3 in a non-impacted state.

FIGURE 5 illustrates a side view of an alternate design flexible impact protector in a non-impacted state.

FIGURE 6 shows the flexible impact protector shown in Figure 5 in an impacted state.

FIGURE 7 illustrates a three-dimensional view of the flexible impact protector shown in Figures 5 and 6 in a non-impacted state.

FIGURE 8 illustrates a side view of an alternate design flexible impact protector in a non-impacted state.

FIGURE 9 shows the flexible impact protector shown in Figure 8 in an impacted state.

FIGURE 10 illustrates a three-dimensional view of the flexible impact protector shown in Figures 8 and 9 in a non-impacted state.

FIGURE 11 illustrates a side view of an alternate design flexible impact protector in a non-impacted state.

FIGURE 12 shows the flexible impact protector shown in Figure 11 in an impacted state.

FIGURE 13 illustrates a three-dimensional view of the flexible impact protector shown in Figures 11 and 12 in a non-impacted state.

FIGURE 14 illustrates a side view of an alternate design flexible impact protector in a non-impacted state.

FIGURE 15 shows the flexible impact protector shown in Figure 14 in an impacted state.

FIGURE 16 illustrates a three-dimensional view of the flexible impact protector shown in Figures 14 and 15 in a non-impacted state.

FIGURE 17 shows a side view of an alternate design multi part flexible impact protector in a non-impacted state.

FIGURE 18 shows a side view of an alternate design multi part flexible impact protector shown in Figure 17 in an impacted state.

FIGURE 19 illustrates a side view of an alternate design of the flexible impact protector shown in Figures 1, 2, 3, and 4 in a non-impacted state.

FIGURE 20 illustrates a side view of an alternate design flexible impact protector shown in Figures 5, 6, and 7 in a non-impacted state.

FIGURE 21a illustrates a side view of an alternate design flexible impact protector shown in Figures 8, 9, and 10 in a non-impacted state.

FIGURE 21b illustrates a side view of an alternate design flexible impact protector shown in Figures 11, 12, and 13 in a non-impacted state.

FIGURE 22 illustrates a use of damping material to augment the impact mitigation capability of the flexible impact protector shown in Figures 1, 2, 3, and 4.

FIGURE 23a illustrates a side view of an impact protector mounting plate used in certain embodiments of the current invention.

FIGURE 23b illustrates a side view of an impact protector mounting plate used in certain embodiments of the current invention and which can share mounting locations with other components.

FIGURE 24a shows a close up cutaway three-dimensional view example of an embodiment of the present invention as shown in FIGURE 23a.

FIGURE 24b shows a close up cutaway three-dimensional view example of an embodiment of the present invention as shown in FIGURE 23b.

FIGURE 25a illustrates a side view of an embodiment of the present invention and depicts a cutaway section view orientation direction of FIGURE 25b.

FIGURE 25b illustrates a sectional view of an embodiment of the current invention.

FIGURE 26a illustrates a side view of an embodiment of the present invention and depicts a cutaway section view orientation direction of FIGURE 26b.

FIGURE 26b illustrates a sectional view of an embodiment of the current invention.

5.0 DETAILED DESCRIPTION

The current invention relates to impact protectors, preferably flexible impact protectors, impact protector mountings, and methods for mounting impact protectors.

An impact protector of the invention, under certain embodiments, facilitates the absorption of impact forces. In certain preferred embodiments, an impact protector of the invention absorbs impact forces by allowing a deformation of the protector in one dimension. In certain other preferred embodiments, an impact protector of the invention maintains a lesser deformation in dimensions other than the one in which the protector allowed a deformation. In particularly preferred embodiments, an impact protector of the invention can comprise an impact beam where said impact beam can flex and absorb an impact in one direction, without bending or buckling or substantial bending or buckling in another direction that is perpendicular or substantially perpendicular thereto. In particularly preferred embodiments, an impact protector of the invention can flex and absorb an impact in one direction, without bending or buckling or without substantial bending or buckling in another direction that is perpendicular or substantially perpendicular thereto. This allows the impact protector, in certain embodiments, to be mounted in close proximity to mechanical components, for example, axles, sprockets, and disc brake rotors. The ability of the impact protector to flex and absorb impact in one direction while bending or buckling a lesser amount in a substantially perpendicular direction allows in some embodiments, impact protectors of the current invention to feature large amounts of impact beam flex displacement while maintaining a narrow thickness in a direction perpendicular or substantially perpendicular to the impact beam flex displacement. This can allow an impact protector to fit in a location that otherwise may not allow the physical room for impact protection. Some embodiments of the invention can be designed to share mounting locations with other components, or act as a mounting component for additional components. Some of the many applications where shared mounting of a flexible impact protector and an existing component could be useful would be bicycle, motorcycle, and machinery sprockets, sprocket clusters, and disc brake rotors. Some embodiments of the invention can be designed to use dedicated mounting components. Some of the many applications where dedicated mounting components could be useful are protectors for motorcycle crank cases, transmissions and engines, bicycle, motorcycle, and machinery sprockets, sprocket clusters, and disc brake rotors, and gearboxes for gardening, earthmoving, and snow removal equipment. Some embodiments of the invention can be mounted so that a flexible impact protector moves or rotates with moving or rotating components that they protect. Some embodiments of the invention can be mounted so that a flexible impact

protector moves or rotates with moving or rotating existing components that they protect. Some embodiments of the invention can be mounted so that a flexible impact protector is stationary next to moving or rotating components that they protect. Some embodiments of the invention can be mounted so that a flexible impact protector is stationary positioned beside moving or rotating existing components that they protect. Some embodiments of the invention can be mounted so that a flexible impact protector is stationary next to stationary components that they protect. Some embodiments of the invention can be mounted so that a flexible impact protector is stationary positioned beside stationary existing components that they protect

Impact protector thickness and thickness aspect ratio are discussed. Certain embodiments of the current invention comprise an impact beam, an impact beam axial thickness, a mounting location, a mounting axis, a mounting location axial thickness, and a radial distance. A mounting location axial thickness is the impact protector thickness measured at the mounting axis, parallel to the mounting axis. An impact beam axial thickness is measured at the outer edge of an impact beam, parallel to a mounting axis. A radial distance is measured radially substantially perpendicular from a mounting axis to the outer face or outer edge of an impact beam. In certain embodiments, an impact protector of the invention has a thickness aspect ratio that is measured as the ratio of impact beam axial thickness to radial distance, where an impact protector with an impact beam axial thickness of 1 millimeter (mm), and a radial distance of 10 mm would have an aspect ratio of 0.1:1. Impact protector location and required deflection amounts can constrain design parameters. In certain embodiments, impact protectors of the invention are particularly useful where an impact protector with a narrow thickness is required in order to fit within space constraints. In certain embodiments, an impact protector is a bicycle impact protector, where the impact protector is intended to protect a sprocket, and must fit between existing components such as a pedal and a sprocket. Typically the available width is less than 15 mm, but because a sprocket can have a diameter of 200 mm, an impact protector must have a diameter of at least 200 mm to protect said sprocket. An impact protector may in certain embodiments be attached to an existing component such as a bicycle crankarm with a bolt circle of 104 mm. This would require a radial distance measured perpendicular from a mounting axis and radially to an impact beam of over 48 mm. An impact protector of the current invention designed to meet these space constraints presented would require a thickness aspect ratio of at least 0.3125:1.

In certain embodiments, an impact beam axial thickness is greater than a mounting location axial thickness. In certain embodiments, a mounting location axial thickness is greater than an impact beam axial thickness.. In certain embodiments, an impact beam axial thickness is greater than a radial distance, and has a value of greater than 5:1, or 5.001:1 or higher. In certain preferred embodiments, space constraints require that an impact protector thickness aspect ratio is such that an impact beam axial thickness is less than a radial distance and has a value of less than 5:1, or 4.999:1 or lower.

Design validation is discussed. Due to the structural attributes of a flexible impact protector of the current invention, impact protectors of the invention in certain embodiments are structurally designed through structural analysis. Certain common engineering design practices can help in the design and validation of a suitable component. A useful design practice is a common Finite Element Analysis program such as Cosmos Works Advanced Professional with non-linear analysis, available from Solid Works Corporation, 300 Baker Avenue, Concord, MA 01742 USA, or ALGOR Professional Multiphysics, available from ALGOR, Inc., 50 Beta Drive, Pittsburgh, PA 15238-2932 USA. These finite element analysis software packages can be used by an engineer skilled in the art to help create and optimize flexible impact protectors of the current invention to suit varying applications. Impact force, impact protector stiffness, and impact beam displacement and the amount of impact force output at a mounting location are factors that can be considered in the design validation of an impact protector of the current invention. Impact protectors of the current invention that are intended to absorb lower impact force can have larger impact beam flex displacement than impact protectors that are intended to absorb higher impact force. An impact protector of the current invention can have a ratio of flex in one direction to bending or buckling in a perpendicular or substantially perpendicular direction which can be measured over 1,000:1. For example, if an impact protector of the current invention has a measured displacement in the direction of an impact force of 100 mm, and a displacement in a substantially perpendicular direction 0.1 mm, the ratio of flex in one direction to flex in a substantially perpendicular direction will be 1000:1.

Impact protector mounting of the current invention is discussed. Methods of the current invention, in certain embodiments, comprise mounting an impact protector using an impact protector mounting according to the invention. An impact protector

mounting of the invention, under certain embodiments, facilitates the absorption of impact forces. In certain preferred embodiments, an impact protector mounting of the invention transmits force from an impact protector to a frame structure. In certain other preferred embodiments, an impact protector mounting of the invention directs impact force from an impact protector to a frame structure without intermediately transferring force through a drivetrain component such as a bottom bracket, axle, axle bearings, or crank arm. In certain embodiments, an impact protector mounting of the invention attaches an impact protector to a frame structure. In certain embodiments, an impact protector mounting of the invention attaches an impact protector to a mounting plate. In certain embodiments, an impact protector mounting of the invention attaches a mounting plate to a frame structure. In certain embodiments, these attachments are bolted connections. In certain embodiments, these attachments are splined connections. A spline can be any series of projections and groves manufactured so as to allow the projections and grooves to fit together and inhibit movement in one or more degrees of freedom. In certain preferred embodiments, an impact protector mounting of the invention uses multiple connections to locate an impact protector to a frame structure. In certain other preferred embodiments, these connections are bolted connections. In certain preferred embodiments, an impact protector mounting of the invention uses multiple connections to locate an impact protector to a mounting plate which uses multiple connections to locate to a frame structure. In certain other preferred embodiments, these connections are bolted connections. In certain other preferred embodiments, these connections are splined connections. In certain preferred embodiments a mounting plate is attached to a frame structure without contact to a drivetrain component. In certain preferred embodiments, a mounting plate is located to a frame structure via mounting plate location features where said mounting plate does not directly contact a drivetrain component. In certain preferred embodiments, a mounting plate is designed to prevent deformation of a mounting plate under impact. Because impacts can be significant, in certain embodiments, protection of a bottom bracket or drivetrain component is necessary. In certain preferred embodiments, impact force is transmitted into a frame structure via a fastened connection. In certain preferred embodiments, mounting tabs comprise mechanical features used to accept mounting plate fasteners so as to locate a mounting plate to a frame structure. In certain embodiments, a deformable adaptor can comprise mounting tabs. In certain

embodiments, a mounting plate can be attached to a deformable adaptor. In certain other embodiments, a deformable adaptor can be a removable part that can be replaced if damaged. In certain other embodiments, a deformable adaptor can be located to a frame structure via a bolted and or splined connection. In certain embodiments, use of a deformable adaptor can be advantageous where mounting plate location features are not present and where fragile existing drivetrain components such as a bottom bracket are present. In certain embodiments, a deformable adaptor can take the place of or be positioned next to a bottom bracket spacer. In certain embodiments, a deformable adaptor can be bolted to a frame member via a bottom bracket, where a bottom bracket flange positions a deformable adaptor in relation to a frame structure. In certain embodiments, a deformable adaptor can comprise mounting tabs and a deformable structure. In certain embodiments, a deformable adaptor can be used to position a mounting plate while at the same time protecting a bottom bracket from impact. In certain embodiments, a deformable adaptor can bend or otherwise deform so as to absorb impact force that could otherwise be transferred to a bottom bracket and cause damage to said bottom bracket. In particularly preferred embodiments, an impact protector mounting of the invention shares components with a bicycle chain guide or chain retention system. This allows the impact protector mounting, in certain embodiments, to be mounted in close proximity to mechanical components, for example, axles, sprockets, chain guide parts, and crank arms. Some embodiments of the invention can be designed to share mounting locations with other components, or act as a mounting component for additional components such as chain guide sliders, rollers, idlers, or guides. An additional component could be called a chain guide feature, or chain guide component, or chain guide part. In certain embodiments, an impact protector mounting of the current invention separates an impact protector component from a chain guide component so as to reduce the effect of impact at an impact protector on chain guiding performance. In certain embodiments, an impact protector mounting of the current invention combines an impact protector component with a chain guide component so as to reduce cost of the system. In certain other embodiments, a chain guide component and impact protector feature could be a single manufactured part with specific features so as to lessen the effect of impact at an impact protector on chain guiding performance. In certain embodiments, an impact protector could be combined with a chain guide component so that an impact beam can deflect while a chain guide component

deflects a lesser amount. In certain embodiments, an impact protector could be combined with a chain guide component so that an impact beam and chain guide component can deflect upon impact. In certain embodiments, an impact protector could be combined with a chain guide component so that an impact beam and chain guide component can deflect separately upon impact. In certain embodiments, a chain guide component could have a different distance from a bicycle chainring as an impact protecting feature so as to keep a chain guide component closer to a sprocket, and an impact protector feature further away from a sprocket. In certain embodiments, a chain guide component could have a different distance measured parallel to a mounting axis from a bicycle chainring as an impact protecting feature so as to keep a chain guide component closer to a sprocket, and an impact protector feature further away from a sprocket. In some embodiments, an impact protector and a mounting plate could be multiple manufactured units. In some embodiments, an impact protector, a mounting plate, and a chain guide component could be multiple manufactured parts. In some embodiments, an impact protector and a mounting plate could be a single manufactured unit. In some embodiments, an impact protector, a mounting plate, and a chain guide component could be a single manufactured part. In some embodiments, an impact protector, a mounting plate, and a chain guide component could be fastened together so as to allow for independent adjustment in one degree of freedom. Independent adjustment of an impact protector, mounting plate, or chain guide component can allow for fitment of a unit to a wider range of applications with a lesser number of manufactured parts, lowering manufactured cost. In some embodiments, an impact protector, a mounting plate, and a chain guide component could be fastened together so as to allow for independent adjustment in two degrees of freedom. In some embodiments, an impact protector, a mounting plate, and a chain guide component could be fastened together so as to allow for independent adjustment in three degrees of freedom. In certain embodiments, a mounting plate could comprise multiple parts so as to allow for adjustable support for chain guide components. Some of the many applications where shared mounting of an impact protector and an existing component could be useful would be bicycle, motorcycle, and machinery sprockets, sprocket clusters, and disc brake rotors. Some embodiments of the invention can be designed to act as a dedicated impact protector mounting component. Some of the many applications where dedicated mounting components could be useful are protectors for motorcycle crank cases, transmissions

and engines, bicycle, motorcycle, and machinery sprockets, sprocket clusters, and disc brake rotors, and gearboxes for gardening, earthmoving, and snow removal equipment. Some embodiments of the invention locate an impact protector in a fixedly next to moving or rotating components that it protects.

The Figures in this disclosure use the following numbers and terms: mounting location (1); inner beam (2); impact beam (3); flexure (4); side flexure thickness (5); axial flexure thickness (6); mounting axis (7); leading edge (8); trailing edge (9) ; flexure attachment radii (10); impact beam flexure (11); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact beam flexure connector (15); impact area one (16); impact area two (17); inner impact beam flexure transition (18); transition top edges (19); inner edge (20); damping element (21); mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); chain guide part locating feature (26) chain guide part mounting arm (27); frame structure (28); bottom bracket (29); bottom bracket flange (30); bottom bracket spindle (31); mounting tab (32); impact protector (33); mounting plate fastener (34); impact protector fastener (35); section line A-A (36); bottom bracket spacer (37); deformable adaptor.

The singular of a term used herein is meant to include the plural and vice versa, unless the opposite is indicated or apparent from the context.

Figure 1 presents a design for a flexible impact protector according to certain embodiments of the current invention via a two-dimensional side view. Shown in figure 1 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4). A protector as shown in Figure 1 could be attached to a mounting component via mounting locations (1). A design for a protector as shown in Figure 1 is suited for, but not limited to, use as a sprocket protector or a disc brake protector where a flexible impact protector shares mounting locations 1 with a sprocket or brake rotor. An impact is mitigated by a flexible impact protector by allowing components of a flexible impact protector to flex and temporarily, partially, or fully absorb impact energy. The current invention as shown in Figure 1 allows for impact to be received at an impact beam 3 and for that impact to be mitigated through the combined movement of flexures 4, the impact beam 3, and an inner beam 2. The inner beam 2 additionally acts as a structural support for the base of the flexures 4. The flexures 4 shown in Figure 1 use a variable area design. This variable area design is shown more closely in Figure 2.

Figure 2 shows a cutaway three-dimensional close up view of elements that comprise a protector according to certain embodiments of the current invention. Shown in figure 2 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4); side flexure thickness (5); axial flexure thickness (6); axial mounting axis (7); leading edge (8); trailing edge (9); flexure attachment radii (10).

A protector as shown in Figure 2 could be attached to a mounting component via mounting locations 1, and allows for impact to be received at an impact beam 3 and for that impact to be mitigated through the combined movement of flexures 4, the impact beam 3, and an inner beam 2. The inner beam 2 additionally acts as a structural support for the base of the flexures 4. The flexures 4 shown in Figure 2 use a variable area design with multiple curves. This variable area design can be defined dimensionally by taking measurements of the thickness of the flexure 4 in the side view and front view. The simplest way to obtain these measurements are to measure a side flexure thickness 5, and a perpendicular axial flexure thickness 6 using a vernier caliper or other precision measuring tool. The side flexure thickness 5 should be measured perpendicular to a leading edge 8 from a point on the leading edge to a point on the trailing edge 9. The axial flexure thickness 6 can be found at a parallel to the axial mounting axis 7. The two perpendicular length measurements are multiplied together by the standard method to obtain an area measurement. More complex flexure cross sections using shaped that can not be easily measured by the simple method can be measured by other area measuring equations such as those found in common mathematics textbooks. Comparative area measurements can be taken at a plane that is defined as parallel with an axial mounting axis 10 and perpendicular to the leading edge 8 at and coincident with a point lying within the physical constraints of the leading edge 8. By varying the cross sectional area of the flexure 4 at different locations on the flexure 4, stresses within the flexible impact protector can be kept at levels below the material yield strength so that impacts result in temporary deformation. Because stresses within the flexible impact protector are kept below the yield strength of the material that it is built from, after an impact has passed, the flexible impact protector will return to its original shape. The flexible impact protector of Figures 1 and 2 shows flexure attachment radii 10 at the intersection points between the flexures 4, inner beam 2, and impact beam 3. In the embodiment of the invention shown in figures 1 and 2, the flexure attachment radii 10 should be

kept at a minimum in radius in order to allow the flexure 4 to deflect and maintain the desired stress levels.

Figure 3 shows a flexible impact protector of Figures 1 and 2 in an impacted state. Shown in figure 3 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4).

It is illustrated in Figure 3 that the impact beam 3 has received an impact and has deflected away from that impact. The flexures 4 remain attached to the impact beam 3, and flex to allow the impact beam 3 movement in at least one degree of freedom. The inner area of the flexures 4 remain attached and supported by the inner beam 2. The relative locations of the mounting locations 1 do not change in relation to each other between the non-impacted and impacted state. The inner beam 2 does not exhibit substantial deformation in comparison to the impact beam 3.

Figure 4 shows a three dimensional non-impacted view of the flexible impact protector shown in figures 1, 2, and 3. Shown in figure 4 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4); leading edge (8); trailing edge (9).

Figure 5 presents an impact protector according to certain other embodiments of the current invention via a two-dimensional side view. Shown in figure 5 are the following: mounting location (1); impact beam flexure (11); mounting beam flexure (12).

A protector as shown in Figure 5 could be attached to a mounting component via mounting locations 1, and allows for impact to be received at an impact beam flexure 11 and for that impact to be mitigated through the combined movement of the impact beam flexure 11, and mounting beam flexures 12. By maintaining geometry that will allow a deflection at the impact beam flexure 11 upon receipt of an impact force, stresses within the flexible impact protector can be kept at levels below the material yield strength so that impacts result in temporary deformation. Because stresses within the flexible impact protector are kept below the yield strength of the material that it is built from, after an impact has passed, the flexible impact protector will return to its original shape. The flexible impact protector of Figure 5 shows flexure attachment radii 10 at the intersection points between the impact beam flexure 11, and mounting beam flexures 12. In the embodiment of the invention shown in figure 5, the flexure attachment radii 10 should be kept at a minimum in radius in

order to allow the impact beam flexure 11, and mounting beam flexures 12 to deflect and maintain the desired stress levels.

Figure 6 shows the flexible impact protector of Figure 5 in an impacted state. It is clearly illustrated in Figure 5 that the impact beam 3 has received an impact and has deflected away from that impact. The impact beam flexure 11 remains attached to the mounting beam flexures 12, and that the impact beam flexure 11 and mounting beam flexures 12 flex simultaneously to allow the impact beam flexure 11 movement in at least one degree of freedom. The relative locations of the mounting locations 1 do not change in relation to each other between the non-impacted and impacted state.

Figure 7 shows a three dimensional non-impacted view of the flexible impact protector shown in Figures 5 and 6. Shown in figure 7 are the following: mounting location (1); impact beam flexure (11); mounting beam flexure (12).

Figure 8 presents an impact protector according to certain other embodiments of the current invention via a two-dimensional side view. Shown in figure 8 are the following: mounting location (1); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact beam flexure connector (15); impact area one (16); impact area two (17); inner impact beam flexure transition (18); transition top edges (19); inner edge (20).

A protector as shown in Figure 8 could be attached to a mounting component via mounting locations 1, and allows for impact to be received at impact area one 16 on an outer impact beam flexure 13 and for that impact to be mitigated through the combined movement of the outer impact beam flexure 13, inner impact beam flexure 14, impact beam flexure connector 15, and mounting beam flexures 12. By maintaining geometry that will allow a deflection at the outer impact beam flexure 13 upon receipt of an impact force, stresses within the flexible impact protector can be kept at levels below the material yield strength so that impacts result in temporary deformation. Because stresses within the flexible impact protector are kept below the yield strength of the material that it is built from, after an impact has passed, the flexible impact protector will return to its original shape. The flexible impact protector of Figure 8 shows corners that make the impact beam flexure transition 18 between the inner impact beam flexure 14, and the mounting beam flexure 12. These corners are shaped to allow an even stress distribution in the inner impact beam flexure 13 and mounting beam flexure 12. Additionally, if an impact of sufficient magnitude is received at the impact area two 17, the inner edge 20 of the outer impact

beam flexure 13 can flex to come in contact with the transition top edges 19 of the inner impact beam flexure transition 18 to provide a progressively stiffening impact resistance.

Figure 9 shows the flexible impact protector of Figure 8 in an impacted state. Shown in figure 8 are the following: mounting location (1); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact beam flexure connector (15); impact area one (16); inner impact beam flexure transition (18).

It is illustrated in Figure 9 that the outer impact beam 13 has received an impact and has deflected away from that impact. The impact in Figure 9 is shown at impact area one 16 for illustrative purposes. Impact area one 16 lies on the outer impact beam 13, between two mounting locations 1. The outer impact beam flexure 13 remains attached to the inner impact beam flexure 14 via an impact beam flexure connector 15. The inner impact beam flexure 14 is connected to the mounting beam flexures 12, through inner impact beam flexure transitions 18. The outer impact beam flexure 13, inner impact beam flexure 14, inner impact beam flexure transitions 15, and mounting beam flexures 12 flex simultaneously to allow the outer impact beam flexure 13 movement in at least one degree of freedom. The relative locations of the mounting locations 1 do not change in relation to each other between the non-impacted and impacted state.

Figure 10 shows a three dimensional non-impacted view of the flexible impact protector shown in Figures 8 and 9. Shown in figure 10 are the following: mounting location (1); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact beam flexure connector (15).

Figure 11 presents an impact protector according to certain other embodiments of the current invention via a two-dimensional side view. Shown in Figure 11 are the following: mounting location (1); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact area one (16); impact area two (17); inner impact beam flexure transition (18); transition top edges (19); inner edge (20).

A protector as shown in Figure 11 would be attached to a mounting component via mounting locations 1, and allows for impact to be received at impact area one 16 on an outer impact beam flexure 11 and for that impact to be mitigated through the combined movement of the impact beam flexure 11, outer impact beam

flexure 13, inner impact beam flexure 14, and mounting beam flexures 12. By maintaining geometry that will allow a deflection at the outer impact beam flexure 13 upon receipt of an impact force, stresses within the flexible impact protector can be kept at levels below the material yield strength so that impacts result in temporary deformation. Because stresses within the flexible impact protector are kept below the yield strength of the material that it is built from, after an impact has passed, the flexible impact protector will return to its original shape. The flexible impact protector of Figure 11 shows corners that make the impact beam flexure transition 18 between the inner impact beam flexure 14, and the mounting beam flexure 12. These corners are shaped to allow an even stress distribution in the inner impact beam flexure 13 and mounting beam flexure 12. Additionally, if an impact of sufficient magnitude is received at the impact area two 17, the inner edge 20 of the outer impact beam flexure 13 can flex to come in contact with the transition top edges 19 of the inner impact beam flexure transition 18 to provide a progressively stiffening impact resistance.

Figure 12 shows the flexible impact protector of Figure 11 in an impacted state. Shown in Figure 11 are the following: mounting location (1); impact beam flexure (11); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact area one (16); inner impact beam flexure transition (18).

It is illustrated in Figure 12 that impact beam flexure 11 has received an impact and has deflected away from that impact. The impact in Figure 12 is shown at impact area one 16 for illustrative purposes. Impact area one 16 lies on the impact beam flexure 11, between two mounting locations 1. The outer impact beam flexure 13 remains attached to the inner impact beam flexure 14 via an impact beam flexure 11. The inner impact beam flexure 14 is connected to the mounting beam flexures 12, through inner impact beam flexure transitions 18. The outer impact beam flexure 13, inner impact beam flexure 14, impact beam flexure 11, and mounting beam flexures 12 flex simultaneously to allow an impact beam flexure 11 movement in at least one degree of freedom. The relative locations of the mounting locations 1 do not change in relation to each other between the non-impacted and impacted state.

Figure 13 shows a three dimensional non-impacted view of the flexible impact protector shown in Figures 11 and 12. Shown in figure 13 are the following: mounting

location (1); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact beam flexure connector (15).

Figure 14 presents an impact protector according to certain other embodiments of the current invention via a two-dimensional side view. Shown in figure 1 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4).

A protector as shown in Figure 14 could be attached to a mounting component via mounting locations 1. The design for a protector as shown in Figure 14 is suited for, but not limited to, use as a sprocket or disc brake protector where the flexible impact protector shares mounting locations 1 with a sprocket or brake rotor. An impact is mitigated by the flexible impact protector by allowing the components of the flexible impact protector to flex and temporarily, partially, or fully absorb the energy of an impact. The invention as shown in Figure 14 allows for impact to be received at an impact beam 3 and for that impact to be mitigated through the combined movement of flexures 4, and an impact beam 3. Flexures 4 meet at their bases to act as structural supports for additional flexures. The bases of the flexures form an area to act as a mounting location 1.

Figure 15 shows the flexible impact protector of Figure 14 in an impacted state. Shown in figure 3 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4).

It is illustrated in Figure 15 that the impact beam 3 has received an impact and has deflected away from that impact. The flexures 4 remain attached to the impact beam 3, and flex to allow the impact beam 3 movement in at least one degree of freedom. The inner areas of the flexures 4 remain attached to each other and isolate a mounting location 1 from impact. The relative locations of the mounting locations 1 do not change in relation to each other between the non-impacted and impacted state.

Figure 16 shows a three dimensional non-impacted view of the flexible impact protector shown in figures 1, 2, and 3. Shown in Figure 16 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4); leading edge (8); trailing edge (9).

Figure 17 presents an impact protector according to certain other embodiments of the current invention via a two-dimensional side view. Shown in figure 17 are the following: mounting location (1); inner beam (2); impact beam (3); damping elements (21).

A protector as shown in Figure 17 could be attached to a mounting component via mounting locations 1. The design for a protector as shown in Figure 17 is suited for, but not limited to, use as a sprocket or disc brake protector where the flexible impact protector mounts stationary or moving next to a component that it is intended to protect. An impact is mitigated by the flexible impact protector by allowing the components of the flexible impact protector to temporarily, partially, or fully absorb the energy of an impact. The invention as shown in Figure 17 allows for impact to be received at an impact beam 3 and for that impact to be mitigated through the combined movement of the impact beam and a damping elements 21. The inner beam 2 additionally acts as a structural support for the damping elements 21.

Figure 18 shows the impact protector of Figure 17 in an impacted state. Shown in figure 15 are the following: mounting location (1); inner beam (2); impact beam (3); damping elements (21).

It is illustrated in Figure 18 that the impact beam 3 has received an impact and has deflected away from that impact. The damping elements 21 remain supported relative to the impact beam 3 and flex to allow the impact beam 3 movement in at least one degree of freedom. The inner area of the damping elements 21 remain attached and supported by the inner beam 2. The relative locations of the mounting locations 1 do not change in relation to each other between the non-impacted and impacted state. The inner beam 2 does not exhibit substantial deflection in comparison to the impact beam 3.

Figure 19 presents an impact protector according to certain other embodiments via a two-dimensional side view of the current invention. Shown in figure 11 are the following: mounting location (1); inner beam (2); impact beam (3); flexure (4).

A protector as shown in Figure 19 could be attached to a mounting component via mounting locations 1. The design as shown in Figure 19 is suited for, but not limited to, use as a sprocket or disc brake protector where the flexible impact protector mounts stationary or moving next to a component that it is intended to protect. An impact is mitigated by the flexible impact protector by allowing the components of the flexible impact protector to flex and temporarily, partially, or fully absorb the energy of an impact. The invention as shown in Figure 19 allows for impact to be received at an impact beam 3 and for that impact to be mitigated through the combined movement of flexures 4, the impact beam 3, and an inner beam 2. The

inner beam 2 additionally acts as a structural support for the base of the flexures 4. The flexures 4 shown in Figure 19 use a variable area design.

Figure 20 presents an impact protector according to certain other embodiments via a two-dimensional side view of the current invention. Shown in figure 20 are the following: mounting location (1); impact beam flexure (11); mounting beam flexure (12).

A protector as shown in Figure 20 could be attached to a mounting component via mounting locations 1, and allows for impact to be received at an impact beam flexure 11 and for that impact to be mitigated through the combined movement of the impact beam flexure 11, and mounting beam flexures 12. By maintaining geometry that will allow a deflection at the impact beam flexure 11 upon receipt of an impact force, stresses within the flexible impact protector can be kept at levels below the material yield strength so that impacts result in temporary deformation. Because stresses within the flexible impact protector are kept below the yield strength of the material that it is built from, after an impact has passed, the flexible impact protector will return to its original shape. The flexible impact protector of Figure 20 shows flexure attachment radii 10 at the intersection points between the impact beam flexure 11, and mounting beam flexures 12. In the embodiment of the invention shown in Figure 20, the flexure attachment radii 10 should be kept at a minimum in radius in order to allow the impact beam flexure 11, and mounting beam flexures 12 to deflect and maintain the desired stress levels.

Figure 21a presents a design under certain other embodiments of the invention via a two-dimensional side view of the current invention. Shown in figure 21 are the following: mounting location (1); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact beam flexure connector (15); impact area one (16); impact area two (17); inner impact beam flexure transition (18); transition top edges (19); inner edge (20).

A protector as shown in Figure 21a could be attached to a mounting component via mounting locations 1, and allows for impact to be received at impact area one 16 on an outer impact beam flexure 13 and for that impact to be mitigated through the combined movement of the outer impact beam flexure 13, inner impact beam flexure 14, impact beam flexure connector 15, and mounting beam flexures 12. By maintaining geometry that will allow a deflection at the outer impact beam flexure 13 upon receipt of an impact force, stresses within the flexible impact protector can be

kept at levels below the material yield strength so that impacts result in temporary deformation. Because stresses within the flexible impact protector are kept below the yield strength of the material that it is built from, after an impact has passed, the flexible impact protector will return to its original shape. The flexible impact protector of Figure 21a shows corners that make the impact beam flexure transition 18 between the inner impact beam flexure 14, and the mounting beam flexure 12. These corners are shaped to allow an even stress distribution in the inner impact beam flexure 13 and mounting beam flexure 12. Additionally, if an impact of sufficient magnitude is received at the impact area two 17, the inner edge 20 of the outer impact beam flexure 13 can flex to come in contact with the transition top edges 19 of the inner impact beam flexure transition 18 to provide a progressively stiffening impact resistance.

Figure 21b presents an impact protector under certain other embodiments of the invention via a two-dimensional side view of the current invention. Shown in Figure 21b are the following: mounting location (1); mounting beam flexure (12); outer impact beam flexure (13); inner impact beam flexure (14); impact beam flexure connector (15); impact area two (17); inner impact beam flexure transition (18); transition top edges (19); inner edge (20).

A protector as shown in Figure 21b could be attached to a mounting component via mounting locations 1, and allows for impact to be received at impact area one 16 on an outer impact beam flexure 11 and for that impact to be mitigated through the combined movement of the impact beam flexure 11, outer impact beam flexure 13, inner impact beam flexure 14, impact beam flexure connector 15, and mounting beam flexures 12. By maintaining geometry that will allow a deflection at the outer impact beam flexure 13 upon receipt of an impact force, stresses within the flexible impact protector can be kept at levels below the material yield strength so that impacts result in temporary deformation. Because stresses within the flexible impact protector are kept below the yield strength of the material that it is built from, after an impact has passed, the flexible impact protector will return to its original shape. The flexible impact protector of Figure 21b shows corners that make the impact beam flexure transition 18 between the inner impact beam flexure 14, and the mounting beam flexure 12. These corners are shaped to allow an even stress distribution in the inner impact beam flexure 13 and mounting beam flexure 12. Additionally, if an impact of sufficient magnitude is received at the impact area two 17, the inner edge 20

of the outer impact beam flexure 13 can flex to come in contact with the transition top edges 19 of the inner impact beam flexure transition 18 to provide a progressively stiffening impact resistance.

Figure 22 illustrates the application of damping material flexible impact protector shown in Figure 1. Damping material 22 (shown in black) is applied in open areas between flexures 4, an impact beam 3, and a support beam 2. Damping material 22 does not have to be applied in all open areas to be effective.

Figure 23a presents a design for an impact protector locating mounting plate according to certain embodiments of the current invention via a two-dimensional side view. Shown in figure 23a are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25).

A mounting plate 22 as shown in Figure 23a could be attached to a frame structure via mounting plate location features 24. An impact protector can be located to the mounting plate 22 via impact protector location features 23, an impact protector mounting as shown in Figure 23a is suited for, but not limited to, use to locate an impact protector where the mounting plate 22 locates to a frame structure using multiple mounting plate location features 24.

Figure 23b presents a design for an impact protector locating mounting plate according to certain embodiments of the current invention via a two-dimensional side view. Shown in figure 23b are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); chain guide part location feature (26); chain guide part mounting arm (27).

A mounting plate 22 as shown in Figure 23b could be attached to a frame structure via mounting plate location features 24. An impact protector can be located to the mounting plate 22 via impact protector location features 23. An impact protector mounting as shown in Figure 23b can be designed to share mounting locations with other components, or act as a mounting component for additional components such as chain guide sliders, rollers, idlers, or guides. Chain guide part locating features 26 are illustrated in figure 23b, and are supported by chain guide part mounting arms 27. An impact protector mounting as shown in Figure 23b is suited for, but not limited to, use to locate an impact protector and chain guide parts where the mounting plate 22 locates to a frame structure using multiple mounting plate location features 24.

Figure 24a shows a three-dimensional view of elements that comprise an impact protector mounting according to certain embodiments of the current invention. Shown in figure 24a are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); frame structure (28); bottom bracket (29); bottom bracket flange (30); bottom bracket spindle (31); mounting tab (32); impact protector (33); mounting plate fastener (34); impact protector fastener (35).

It is illustrated in figure 24a that a mounting plate 22 is located to a frame structure 28 via mounting plate location features 24. Mounting tabs 32 can be part of a frame structure 28. Mounting tabs 32 can provide receptacles for mounting plate fasteners 34. Mounting plate fasteners 34 attach a mounting plate 22 to a frame structure 28, and mounting plate fasteners 34 are positioned at a distance away from each other so as to provide a greater mechanical advantage to impede free movement of a mounting plate 22 in relation to a frame structure 28. A bottom bracket 29 comprises a bottom bracket spindle 31 and a bottom bracket flange 30. A bottom bracket spindle 31 can rotate inside the bottom bracket 29 in one degree of freedom. A bottom bracket 29 can be attached to a frame structure 28 via a threaded or press fit or tapered or clamped connection. A bottom bracket flange 30 positions a bottom bracket 29 in a direction substantially perpendicular to a bottom bracket spindle 31 rotation axis, and in relation to a frame structure 28. A bottom bracket spindle 31 can be in some embodiments supported by bearings which allow rotation of a bottom bracket spindle 31 that are in turn supported by a bottom bracket 29. Bearings can be supported by a bottom bracket 29 so that the bearings are substantially inside or outside the envelope of a frame structure 28. A mounting plate 22 comprises mounting plate location features 24, a drivetrain clearance hole 25, and one or more impact protector location features 23. A drivetrain clearance hole 25 allows sufficient clearance between a bottom bracket 29 and mounting plate 22 so as to reduce mechanical interaction between the bottom bracket 29 and mounting plate 22 that could damage the bottom bracket 29 during an impact. An impact protector 33 locates to a mounting plate 22 via one or more impact protector location features 23. One or more impact protector fasteners 35 can be used to fasten an impact protector 33 to a mounting plate 22. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28. A mounting plate 22 meditates the

transmission of force from an impact protector 33 to a frame structure 28 without transmitting force into or through a bottom bracket 29.

Figure 24b shows a three-dimensional view of elements that comprise an impact protector mounting according to certain embodiments of the current invention. Shown in figure 24b are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); chain guide part location feature (26); chain guide part mounting arm (27); frame structure (28); bottom bracket (29); bottom bracket flange (30); bottom bracket spindle (31); mounting tab (32); impact protector (33); mounting plate fastener (34); impact protector fastener (35).

It is illustrated in figure 24b that a mounting plate 22 is located to a frame structure 28 via mounting plate location features 24. Mounting tabs can be part of a frame structure 28. Mounting tabs 32 can provide receptacles for mounting plate fasteners 34. Mounting plate fasteners 34 attach a mounting plate 22 to a frame structure 28, and mounting plate fasteners 34 are positioned at a distance away from each other so as to provide a greater mechanical advantage to impede free movement of a mounting plate 22 in relation to a frame structure 28. A bottom bracket 29 comprises a bottom bracket spindle 31 and a bottom bracket flange 30. A bottom bracket spindle 31 can rotate in relation to a bottom bracket 29 in one degree of freedom. A bottom bracket 29 can be attached to a frame structure 28 via a threaded or press fit or tapered or clamped connection. A bottom bracket flange 30 positions a bottom bracket 29 in a direction substantially perpendicular to a bottom bracket spindle 31 rotation axis, and in relation to a frame structure 28. A bottom bracket spindle 31 can be in some embodiments supported by bearings which allow rotation of a bottom bracket spindle 31 that are in turn supported by a bottom bracket 29. Bearings can be supported by a bottom bracket 29 so that the bearings are substantially inside or outside the envelope of a frame structure 28. A mounting plate 22 comprises mounting plate location features 24, a drivetrain clearance hole 25, and one or more impact protector location features 23. A drivetrain clearance hole 25 allows sufficient clearance between a bottom bracket 29 and mounting plate 22 so as to reduce mechanical interaction between a bottom bracket 29 and mounting plate 22 that could damage a bottom bracket 29 during an impact. An impact protector 33 locates to a mounting plate 22 via one or more impact protector location features 23. One or more impact protector fasteners 35 can be used to fasten an impact protector

33 to a mounting plate 22. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28 without transmitting force into or through a bottom bracket 29. An impact protector mounting as shown in Figure 24b can be designed to share mounting locations with other components, or act as a mounting component for additional components such as chain guide sliders, rollers, idlers, or guides. Chain guide part locating features 26 are illustrated in figure 24b, and are supported by chain guide part mounting arms 27.

Figure 25a shows a two-dimensional view of elements that comprise an impact protector mounting according to certain embodiments of the current invention. Shown in figure 25a are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); frame structure (28); bottom bracket (29); bottom bracket flange (30); bottom bracket spindle (31); mounting tab (32); impact protector (33); mounting plate fastener (34); impact protector fastener (35); section line A-A (36).

It is illustrated in figure 25a that a mounting plate 22 is located to a frame structure 28 via mounting plate location features 24. Mounting tabs 32 can be part of a frame structure 28. Mounting tabs 32 can provide receptacles for mounting plate fasteners 34. Mounting plate fasteners 34 attach a mounting plate 22 to a frame structure 28, and mounting plate fasteners 34 are positioned at a distance away from each other so as to provide a greater mechanical advantage to impede free movement of a mounting plate 22 in relation to a frame structure 28. A bottom bracket 29 comprises a bottom bracket spindle 31 and a bottom bracket flange 30. A bottom bracket spindle 31 can rotate inside the bottom bracket 29 in one degree of freedom. A bottom bracket 29 can be attached to a frame structure 28 via a threaded or press fit or tapered or clamped connection. A bottom bracket flange 30 positions a bottom bracket 29 in a direction substantially perpendicular to a bottom bracket spindle 31 rotation axis, and in relation to a frame structure 28. A bottom bracket spindle 31 can be in some embodiments supported by bearings which allow rotation of a bottom bracket spindle 31 that are in turn supported by a bottom bracket 29. Bearings can be supported by a bottom bracket 29 so that the bearings are substantially inside or outside the envelope of a frame structure 28. A mounting plate 22 comprises mounting plate location features 24, a drivetrain clearance hole 25, and one or more impact protector location features 23. A drivetrain clearance hole 25 allows sufficient

clearance between a bottom bracket 29 and mounting plate 22 so as to reduce mechanical interaction between the bottom bracket 29 and mounting plate 22 that could damage the bottom bracket 29 during an impact. An impact protector 33 locates to a mounting plate 22 via one or more impact protector location features 23. One or more impact protector fasteners 35 can be used to fasten an impact protector 33 to a mounting plate 22. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28 without transmitting force into or through a bottom bracket 29. Section line A-A 36 is used to create a sectional view, section A-A illustrated in figure 25b.

Figure 25b shows a two-dimensional sectional view, section A-A of elements that comprise an impact protector mounting according to certain embodiments of the current invention. Shown in figure 25b are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); frame structure (28); bottom bracket (29); bottom bracket flange (30); bottom bracket spindle (31); mounting tab (32); impact protector (33); mounting plate fastener (34); impact protector fastener (35); bottom bracket spacer (37).

Figure 25b illustrates a sectional view, section A-A, as defined by section line A-A 36 shown in figure 25a. Figure 25b is used to show clearly that a mounting plate 22 is separated from mechanical contact with a bottom bracket 29. It is illustrated in figure 25b that a mounting plate 22 is located to a frame structure 28. Mounting tabs 32 can be part of a frame structure 28. Mounting tabs 32 can provide receptacles for mounting plate fasteners 34. Mounting plate fasteners 34 attach a mounting plate 22 to a frame structure 28, and mounting plate fasteners 34 are positioned at a distance away from each other so as to provide a greater mechanical advantage to impede free movement of a mounting plate 22 in relation to a frame structure 28. A bottom bracket 29 comprises a bottom bracket spindle 31 and a bottom bracket flange 30. A bottom bracket spindle 31 can rotate inside the bottom bracket 29 in one degree of freedom. A bottom bracket 29 can be attached to a frame structure 28 via a threaded or press fit or tapered or clamped connection. A bottom bracket flange 30 positions a bottom bracket 29 in a direction substantially perpendicular to a bottom bracket spindle 31 rotation axis, and in relation to a frame structure 28. A bottom bracket spacer 37 is positioned between a bottom bracket flange 30 and frame structure 28. A bottom bracket spacer can be used to act as a washer for spacing and ease of assembly

purposes. A bottom bracket spindle 31 can be in some embodiments supported by bearings which allow rotation of a bottom bracket spindle 31 that are in turn supported by a bottom bracket 29. Bearings can be supported by a bottom bracket 29 so that the bearings are substantially inside or outside the envelope of a frame structure 28. A drivetrain clearance hole 25 allows sufficient clearance between a bottom bracket 29 and mounting plate 22 so as to reduce mechanical interaction between the bottom bracket 29 and mounting plate 22 that could damage the bottom bracket 29 during an impact. An impact protector 33 locates to a mounting plate 22. One or more impact protector fasteners 35 can be used to fasten an impact protector 33 to a mounting plate 22. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28 without transmitting force into or through a bottom bracket 29.

Figure 26a shows a two-dimensional view of elements that comprise an impact protector mounting according to certain embodiments of the current invention. Shown in figure 26a are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); frame structure (28); bottom bracket (29); bottom bracket flange (30); bottom bracket spindle (31); mounting tab (32); impact protector (33); mounting plate fastener (34); impact protector fastener (35); section line A-A (36); deformable adaptor (38).

It is illustrated in figure 26a that a mounting plate 22 is located to a frame structure 28 via mounting plate location features 24. A deformable adaptor 38 is shown. A deformable adaptor 38 can have a bending strength or stiffness lower than a mounting plate 22 so as to allow the deformable adaptor 38 to deform at a lower force than a mounting plate 22. A deformable adaptor 38 is positioned in relation to a frame structure 28 where a bottom bracket flange 30 locates a deformable adaptor 38 in relation to a frame structure 28 and can be a removable part that can be replaced if damaged. A deformable adaptor 38 can be further located to a frame structure 28 via a bolted and or splined connection. A deformable adaptor 38 is used to position a mounting plate 22, so that said deformable adaptor 38 can bend or otherwise deform so as to absorb impact force that could otherwise be transferred to a bottom bracket 29 and cause damage to said bottom bracket 29. Mounting tabs 32 can be part of a deformable adaptor 38. A deformable adaptor 38 can provide receptacles for mounting plate fasteners 34. Mounting plate fasteners 34 attach a mounting plate 22

deformable adaptor 38, which is located to a frame structure 28. Mounting plate fasteners 34 are positioned at a distance away from each other so as to provide a greater mechanical advantage to impede free movement of a mounting plate 22 in relation to a frame structure 28, and to allow for clearance for deformation of the deformable adaptor 38. A bottom bracket 29 comprises a bottom bracket spindle 31 and a bottom bracket flange 30. A bottom bracket spindle 31 can rotate inside the bottom bracket 29 in one degree of freedom. A bottom bracket 29 can be attached to a frame structure 28 via a threaded or press fit or tapered or clamped connection. A bottom bracket flange 30 positions a bottom bracket 29 in a direction substantially perpendicular to a bottom bracket spindle 31 rotation axis, and in relation to a frame structure 28. A bottom bracket spindle 31 can be in some embodiments supported by bearings which allow rotation of a bottom bracket spindle 31 that are in turn supported by a bottom bracket 29. Bearings can be supported by a bottom bracket 29 so that the bearings are substantially inside or outside the envelope of a frame structure 28. A mounting plate 22 comprises mounting plate location features 24, a drivetrain clearance hole 25, and one or more impact protector location features 23. A drivetrain clearance hole 25 allows sufficient clearance between a bottom bracket 29 and mounting plate 22 so as to reduce mechanical interaction between the bottom bracket 29 and mounting plate 22 that could damage the bottom bracket 29 during an impact. An impact protector 33 locates to a mounting plate 22 via one or more impact protector location features 23. One or more impact protector fasteners 35 can be used to fasten an impact protector 33 to a mounting plate 22. A mounting plate 22 and deformable adaptor 38 meditate the transmission of force from an impact protector 33 to a frame structure 28. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28 while using a deformable adaptor 38 to reduce the impact force transmitted through a bottom bracket 29. Section line A-A 36 is used to create a sectional view, section A-A illustrated in figure 26b.

Figure 26b shows a two-dimensional sectional view, section A-A of elements that comprise an impact protector mounting according to certain embodiments of the current invention. Shown in figure 26b are the following: mounting plate (22); impact protector location feature (23); mounting plate location feature (24); drivetrain clearance hole (25); frame structure (28); bottom bracket (29); bottom bracket flange (30); bottom bracket spindle (31); mounting tab (32); impact protector (33); mounting

plate fastener (34); impact protector fastener (35); bottom bracket spacer (37); deformable adaptor (38).

Figure 26b illustrates a sectional view, section A-A, as defined by section line A-A 36 shown in figure 26a. Figure 26b is used to show clearly that a mounting plate 22 is separated from mechanical contact with a bottom bracket 29. A deformable adaptor 38 is shown. A deformable adaptor 38 can have a bending strength or stiffness lower than a mounting plate 22 so as to allow the deformable adaptor 38 to deform at a lower force than a mounting plate 22.It is illustrated in figure 26b that a mounting plate 22 is located to a frame structure 28 via mounting plate location features 24. A deformable adaptor 38 is positioned in relation to a frame structure 28 where a bottom bracket flange 30 locates a deformable adaptor 38 in relation to a frame structure 28 and can be a removable part that can be replaced if damaged. A deformable adaptor 38 can be further located to a frame structure 28 via a bolted and or splined connection. A deformable adaptor 38 is used to position a mounting plate 22, so that said deformable adaptor 38 can bend or otherwise deform so as to absorb impact force that could otherwise be transferred to a bottom bracket 29 and cause damage to said bottom bracket 29. Mounting tabs 32 can be part of a deformable adaptor 38. A deformable adaptor 38 can provide receptacles for mounting plate fasteners 34. Mounting plate fasteners 34 attach a mounting plate 22 to a deformable adaptor 38, which is located to a frame structure 28. Mounting plate fasteners 34 are positioned at a distance away from each other so as to provide a greater mechanical advantage to impede free movement of a mounting plate 22 in relation to a frame structure 28, and to allow for clearance for deformation of the deformable adaptor 38. A bottom bracket 29 comprises a bottom bracket spindle 31 and a bottom bracket flange 30. A bottom bracket spindle 31 can rotate inside the bottom bracket 29 in one degree of freedom. A bottom bracket 29 can be attached to a frame structure 28 via a threaded or press fit or tapered or clamped connection. A bottom bracket flange 30 positions a bottom bracket 29 in a direction substantially perpendicular to a bottom bracket spindle 31 rotation axis, and in relation to a frame structure 28. A bottom bracket spacer 37 is positioned between a bottom bracket flange 30 and frame structure 28. A bottom bracket spacer can be used to act as a washer for spacing and ease of assembly purposes. A bottom bracket spindle 31 can be in some embodiments supported by bearings which allow rotation of a bottom bracket spindle 31 that are in turn supported by a bottom bracket 29. Bearings can be supported by a bottom bracket

29 so that the bearings are substantially inside or outside the envelope of a frame structure 28. A drivetrain clearance hole 25 allows sufficient clearance between a bottom bracket 29 and mounting plate 22 so as to reduce mechanical interaction between the bottom bracket 29 and mounting plate 22 that could damage the bottom bracket 29 during an impact. An impact protector 33 locates to a mounting plate 22. One or more impact protector fasteners 35 can be used to fasten an impact protector 33 to a mounting plate 22. A mounting plate 22 and deformable adaptor 38 meditate the transmission of force from an impact protector 33 to a frame structure 28. A mounting plate 22 meditates the transmission of force from an impact protector 33 to a frame structure 28 while using a deformable adaptor 38 to reduce the impact force transmitted through a bottom bracket 29.

According to certain embodiments, an impact protector of the invention is designed in a manner so as to promote absorption of impacts by allowing a temporary deformation of material in one degree of freedom, while maintaining relatively less deformation in other degrees of freedom. As an impact takes place, the impact protector can flex and absorb the impact in one direction, without bending or buckling substantially in a perpendicular direction. In certain embodiments, this capability can allow the impact protector to be mounted in close proximity to mechanical components such as axles, sprockets, and disc brake rotors. In certain embodiments, this property is accomplished by engineering a structure so that its stiffness in relation to the impact is less in the direction that it is planned to deflect, and higher in relation to the impact in a direction that it is deemed desirable to limit deflection. In certain embodiments, a flexible element, or multiple flexible elements can be used to facilitate deflection in a tactical direction or directions. A flexible element can be a feature which is specifically designed to allow deflection in a prescribed manner. An impact protector according to certain preferred embodiments of the invention has a lesser stiffness in the direction of impact than the stiffness perpendicular to the impact direction when measured at a static state. In certain preferred embodiments, an impact protector of the invention does not buckle, or only to an acceptable degree depending on the special arrangements, in a direction that is perpendicular or substantially perpendicular to the impact and parallel or substantially parallel to the direction of the object or objects being protected. Under certain preferred embodiments, an impact protector of the current invention is capable of deflecting away from impacts. Under certain other embodiments, a protector of the invention has a shape that is designed to

protect a component or structure of interest, for example, by taking into account the location of impact loads, or the magnitude of impact loads, or its deformed shape after impact, or the space requirements in its application (with and without impact), or the mounting requirements present in its application, or the structural requirements of its mounting requirements present in its application, or several or all of these aspects. Sharp or non-radiused edges should be avoided in a flexible impact protector of the invention to avoid stress concentrations, but in some applications, sharp or non-radiused edges may be desirable for one or more of the requirements disclosed herein. Many types of these structures are outlined within the body of this document.

Physical layouts of flexible impact protectors of the current invention are discussed. A flexible impact protector of the invention can be built in varying forms. Some flexible impact protectors of the invention can be used in applications where they rotate with a component that is to be protected. Flexible impact protectors that fit into this category can offer 360 degree or less impact protection. Flexible impact protectors of the invention that offer 360 degree protection can be circular or non-circular in shape generally depending on the specific impact locations and magnitudes, and protection need requirements. In some applications, 360 degree flexible impact protectors of the current invention can be made up of areas that display more flexibility in some areas of the 360 degree profile than other areas of the 360 degree profile. Non-circular flexible impact protectors of the current invention can have a C-shape or can be part of a circle, part of an ellipse, part of a string of varying radiuses, a string of straight lines and radiuses, or a string of straight lines.

Several flexible impact protector designs of the invention shown in the figures herein are compared. A flexible impact protector of the current invention like one shown for example in Figures 1, 2, 3, 4, 14,15, 16, and 19 can comprise a series of flexures to support an impact beam. Certain embodiments of the invention can comprise flexures, impact areas, and support areas. A flexible impact protector of the current invention like the examples shown in Figures 5, 6, 7, and 20 can combine a flexible impact beam and mounting beam flexures. Certain embodiments of the invention can comprise combined flexures and impact areas, and combined support and mounting areas. Because of this combining of flexures and impact or mounting areas, the possibility for fewer elements is present. A flexible impact protector of the current invention like the examples shown in Figures 8, 9, 10, 11, 12, 13, 21a, and 21b can combine some of the features of both the design of Figure 1 through 4, and

the design of Figures 5 through 7. Certain embodiments of the invention can comprise combined flexure and impact areas, and in certain embodiments can give the benefit of less variation in impact mitigating stiffness at different impact areas around the protector as compared to other embodiments. A flexible impact protector of the current invention like examples shown in Figures 17 and 18 can use elastomer, rubber, springs, or other flexible elements to support an impact beam. Certain embodiments of the invention can comprise multiple elements consisting of a springing or damping element or elements, impact areas, and support areas.

Certain embodiments of the invention are exemplified in Figures 1, 2, 3, 4, 14, 15, 16, and 19, which can be engineered to allow for significant deflection under a relatively light impact. This design could be manufactured by CNC machining from a plate of material or an injection molded blank, or it could be manufactured as a fully injection molded part. It could also be manufactured by stamp forming, casting, forging, laser cutting, waterjet cutting or other processes suitable for cutting or forming metals, woods, or plastics. Of the three single part designs presented, this design may be more expensive to produce due to its more complex geometry.

Certain embodiments of the invention are exemplified in Figures 5, 6, 7, and 20 are shown. Examples of these embodiments can be designed to provide deflection under impact in a simple to manufacture and therefore cost effective part. This design could be manufactured by CNC machining from a plate of material or an injection molded blank, or it could be manufactured as a fully injection molded part. It could also be manufactured by stamp forming, casting, forging, laser cutting, waterjet cutting or other processes suitable for cutting or forming metals, woods, or plastics.

Certain embodiments of the invention are exemplified in Figures 8, 9, 10, 11, 12, 13, 21a, and 21b are shown. Examples of these embodiments can be designed to provide deflection under impact in a simple to manufacture and therefore cost effective part. This design could be manufactured by CNC machining from a plate of material or an injection molded blank, or it could be manufactured as a fully injection molded part. It could also be manufactured by stamp forming, casting, forging, laser cutting, waterjet cutting or other processes suitable for cutting or forming metals, woods, or plastics.

Certain embodiments of the invention are exemplified in Figures 17 and 18. Examples of these embodiments can be engineered to allow for significant deflection under a relatively light impact. A stiffer impact beam and support beam could cradle

elastomer, rubber, springs, or other flexible elements to support an impact beam. This could allow for an abrasion resistant metal outer impact beam, with the impact benefits of a one-piece flexure design. An example of this type could be manufactured by CNC machining from material or an injection molded blanks, or it could be manufactured as an assembly of fully injection molded parts. It could also be manufactured by stamp forming, casting, forging, laser cutting, waterjet cutting or other processes suitable for cutting or forming metals, woods, or plastics. Of the four designs presented, this design may be the most expensive to produce due to its more complex assembly nature and higher part count.

The use of curved flexures or flexible elements is preferred over the use of non-curved flexible elements. Curved flexible elements allow for the possibility of extension between the anchor areas of the flexure in addition to the bending and flexing capability. Non-curved flexible elements can bend and flex, but do not offer any flexure length extension. Straight flexures can be used with or without mounting areas that are designed to allow for some amount of length extension through mounting area deformation.

The designs presented herein are examples of the many forms that flexible impact protectors of the invention can take. In certain preferred embodiments, an impact protector of the invention and as exemplified herein may also comprise damping materials, or added damping materials, to augment impact mitigation as shown in Figure 22. These damping materials could be attached to the flexible impact protectors so that an impact would cause the impact protector to deflect away from an impact, while at the same time using energy through damping material. This damping material could have the additional benefit of adding extra stiffness in a direction perpendicular, or substantially perpendicular, to an impact. Common damping materials like foams and rubbers could easily be used to augment function of flexible impact protectors of the invention.

Mounting and attachment of flexible impact protectors of the current invention is discussed further. Some embodiments of the invention can be designed to share mounting locations with other components. Some of the many applications where shared mounting of a flexible impact protector and an existing component could be useful would be bicycle, motorcycle, and machinery sprockets, sprocket clusters, and disc brake rotors. Some embodiments of the invention can be designed to use dedicated mounting components. Some of the many applications where embodiments

using dedicated mounting components could be useful are bicycle drivetrains, motorcycle drivetrains, electric bike drivetrains, scooter drivetrains, motorcycle crank case, transmission and engine protectors, bicycle, motorcycle, and machinery sprockets, sprocket clusters, and disc brake rotors, and gearbox protectors for gardening, earthmoving, and snow removal equipment. Some embodiments of the invention can be mounted so that a flexible impact protector moves or rotates with moving or rotating components that they protect. Some embodiments of the invention can be mounted so that a flexible impact protector is stationary next to moving or rotating components that they protect. Impact protector mountings of the invention can be facilitated by many possible mechanical devices. The simplest and most economical mounting arrangement will typically be but is not limited to a bolted connection. A bolted mounting arrangement could consist of bolts or fasteners that attach an impact protector to a mounting plate so that the mounting axes are in a parallel perpendicular, or angled plane or planes to the impact force. A bolted mounting arrangement could consist of bolts or fasteners that attach a mounting plate to a frame structure so that the mounting axes are in a parallel or perpendicular plane to the impact force. A bolted mounting arrangement could likewise consist of bolts or fasteners that attach an impact protector to a mounting plate so that the mounting axes are not in a parallel or perpendicular plane to the impact force. A bolted mounting arrangement could likewise consist of bolts or fasteners that attach a mounting plate to a frame structure so that the mounting axes are not in a parallel or perpendicular plane to the impact force. Any combination of other attachments and fasteners could be used to facilitate mounting. Additionally, bosses or embossed mounting locations could allow for a mechanical interface between an impact protector and a mounting plate. Other fastener augmenting mechanical interfaces could be in the form of circular or non-circular holes with complementing mechanical features on both a mounting plate and impact protector. Additionally, bosses or embossed mounting locations could allow for a mechanical interface between a mounting plate and an frame structure. Other fastener augmenting mechanical interfaces could be in the form of circular or non-circular holes with complementing mechanical features on both a mounting plate and frame structure.

A flexible impact protector of the current invention in certain embodiments is mounted to a mounting component using a bolted connection, multiple bolts, one bolt, two bolts, three bolts, four bolts, five bolts, six bolts, seven bolts, eight bolts,

chainring bolts, chainring nuts, T-nuts, a bolt and nut combination, bolt and nut combinations, screws, threads, a threaded connection, rivets, pop-rivets, aircraft rivets, pins, split pins, alignment pins, alignment studs, studs, bushings, splines, keys, keyways, a machined spline, wave splines, a mounting bracket, an intermediate mounting bracket, a mounting support, a flexible impact protector support, a mounting receptacle, a boss, an embossed interface, a non-circular mounting hole.

A mounting component to receive the flexible impact protector of the current invention in certain embodiments could comprise a bolted connection, multiple bolts, one bolt, two bolts, three bolts, four bolts, five bolts, six bolts, seven bolts, eight bolts, chainring bolts, chainring nuts, T-nuts, a bolt and nut combination, bolt and nut combinations, screws, threads, a threaded connection, rivets, pop-rivets, aircraft rivets, pins, split pins, alignment pins, alignment studs, studs, bushings, splines, keys, keyways, a machined spline, wave splines, a mounting bracket, an intermediate mounting bracket, a mounting support, an impact protector support, a mounting plate, a mounting receptacle, a boss, an embossed interface, a non-circular mounting hole, a drivetrain clearance hole, a drivetrain clearance area, a bottom bracket clearance area, a bottom bracket clearance slot, a drivetrain clearance slot, a bottom bracket clearance feature, a drivetrain clearance feature, a fusible link, a fusible adaptor, a deformable adaptor, a deformable link, a bendable link, an impact absorbing link, a rigid mounting, a flexible mounting, rubber mounting, a bicycle crank arm, chainring tabs, a chainring, a chainwheel, a bicycle chain guide, a bicycle chain retention system, a chain guide back plate, a chain guide boomerang, a bicycle chain guide mounting plate, ISCG mounting tabs, ISCG05 mounting tabs, a disc brake rotor, a disc brake rotor mount, a brake drum, a mounting plate, an engine crankcase, an electric motor, a transmission case, an axle, a rim.

A flexible impact protector or impact protector mounting of current invention in certain embodiments is useful to protect an existing component. In certain embodiments, an existing component could comprise for example, a sprocket, a chainwheel, a bottom bracket, an axle, a structural component, a bicycle frame, a disc brake rotor, a disc brake caliper, a drum brake, a motorcycle frame, an ATV frame, an off-road vehicle frame, an engine, a motor, a transmission, a gearbox, a sequential gearbox, a flywheel, a lawnmower deck, a lawnmower, a snowblower, a plow frame, a plow, garden equipment, brush clearing equipment, construction equipment, a cart, an electronics enclosure, a boat keel, a boat hull, a watercraft hull.

A flexible impact protector of the current invention in certain embodiments comprises a mounting location, a rigid mounting, a flexible mounting, an inner beam, an impact beam, a flexure, flexures, identical flexures, varying flexures, similar flexures, dissimilar flexures, a straight flexure, straight flexures, a c-shaped flexure, c-shaped flexures, an S-shaped flexure, S-shaped flexures, a circular flexure, circular flexures, an elliptical flexure, elliptical flexures, a constant radius flexure, constant radius flexures, a varying radius flexure, varying radius flexures, a crescent shaped flexure, crescent shaped flexures, a tapered flexure, tapered flexures, a side flexure thickness, a constant side flexure thickness, a variable side flexure thickness, multiple side flexure thicknesses, an axial flexure thickness, a constant axial flexure thickness, a variable axial flexure thickness, multiple axial flexure thicknesses, a mounting axis, mounting axes, a leading edge, leading edges, a trailing edge, trailing edges, flexure attachment radii, constant radius flexure attachment radii, varying radius flexure attachment radii, an impact beam flexure, impact beam flexures, a mounting beam flexure, mounting beam flexures, an outer impact beam flexure, outer impact beam flexures, an inner impact beam flexure, inner impact beam flexures, an impact beam flexure connector, impact beam flexure connectors, an impact area, multiple impact areas, an inner impact beam flexure transition, inner impact beam flexure transitions, an outer impact beam flexure transition, outer impact beam flexure transitions, a transition top edge, transition top edges, an inner edge, inner edges, a bolted connection, multiple bolts, one bolt, two bolts, three bolts, four bolts, five bolts, six bolts, seven bolts, eight bolts, chainring bolts, a bolt and nut combination, bolt and nut combinations, screws, threads, a threaded connection, splines, keys, keyways, a machined spline, wave splines, a mounting bracket, an intermediate mounting bracket, a single part, multiple parts, a single element, multiple elements, a single material, multiple materials, a composite of multiple materials, a metal, a plastic, an elastomer, a thermoplastic elastomer (TPE), a thermoplastic rubber (TPR), damping, springs, damping elements, fluid, an abrasion resistant surface, joints, connections, interconnections, interlocking components, halves, quarters.

An impact protector of the current invention, in certain embodiments comprises an impact beam which can flex and absorb an impact in one direction, without substantial bending or buckling in another direction that is substantially perpendicular thereto. A ratio of flex in one direction to bending or buckling in a perpendicular or substantially perpendicular direction can be measured as less than

10,000:1, 1000:1, 100:1, 80:1, 60:1, 40:1, 20:1, 10:1, 9:1, 8:1, 7:1, 6:1, 5:1, 4:1, 2.5:1, 2:1, 1.5:1, 1.25:1, 1.1:1, 1.05:1. A ratio of flex in one direction to bending or buckling in a perpendicular or substantially perpendicular direction can be measured as greater than 10,000:1, 1000:1, 100:1, 80:1, 60:1, 40:1, 20:1, 10:1, 9:1, 8:1, 7:1, 6:1, 5:1, 4:1, 2.5:1, 2:1, 1.5:1, 1.25:1, 1.1:1, 1.05:1, 1:1. An impact protector of the current invention, in certain embodiments, can comprise a thickness aspect ratio where thickness aspect ratio is calculated as impact beam axial thickness versus radial distance. A thickness aspect ratio can be measured as less than 0.001:1, 0.01:1. 0.05:1 0.1:1, 0.2:1, 0.3:1, 0.4:1, 0.5: 1, 0.6:1, 0.7:1, 0.8:1, 0.9:1, 0.99:1, 1:1, 2:1, 3:1, 4:1, 5:1, 10:1, 20:1.

A flexible impact protector of the current invention is manufactured, for example, by or from CNC machining, machining, turning, injection molding, machining of injection molded parts, CNC machining of injection molded parts, drilling, tapping, drilling injection molded parts, tapping injection molded parts, bonding, gluing, friction welding, welding, TIG welding, MIG welding, arc welding, plasma welding, laser welding, friction stir welding, resistance welding, stamping, forging, casting, cutting, waterjet cutting, laser cutting, sawing, torch cutting, flame cutting, annealing, heat treating, plastic, metal, aluminum, steel, stainless steel, titanium, ceramic, metal matrix, composite, fibrous composite, carbon fiber, fiberglass, kevlar, blended fibers, elastomers, elastomer, TPR, TPE, polyurethane, foam, damping foam, urethane, elastomer and metal composites, elastomer and plastic composites, elastomer and fibrous composite composites, springs, coil spring, torsion spring, a hard outer ring, an anti friction impact beam.

A chain guide component of the current invention in certain embodiments comprises chain guide sliders, rollers, idlers, guides, pulleys, bearings, a chain guide slider, a mounting arm, a roller mounting arm, a slider mounting arm, a movable mounting arm, a fixed mounting arm, a bolt, a bolt hole, a threaded hole, an adjustment slot

The present invention is not to be limited in scope by the specific embodiments described herein, which are intended as single illustrations of individual aspects of the invention, and functionally equivalent methods and components are within the scope of the invention. Indeed, various modifications of the invention, in addition to those shown and described herein, will become apparent to those skilled in the art from the foregoing description. Such modifications are intended to fall within

the scope of the appended claims. Throughout this application the singular includes the plural and the plural includes the singular, unless indicated otherwise. All cited publications, patents, and patent applications are herein incorporated by reference in their entirety.

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What is claimed is:

1. An impact protector comprising an impact beam, a flexible element and a mounting location wherein said impact beam is able to deflect in a direction parallel to an impact force while maintaining less deflection in a direction perpendicular to said impact force.

2. The impact protector of claim 1, wherein said impact protector is mounted so that the impact protector moves with a component the impact protector protects.

3. The impact protector of claim 2, wherein said impact protector comprises a thickness aspect ratio of less than 5:1.

4. The impact protector of claim 1, wherein said impact protector is mounted so that the impact protector is stationary relative to a component the impact protector protects.

5. The impact protector of claim 4, wherein said impact protector comprises a thickness aspect ratio of less than 5:1.

6. The impact protector of claim 1, wherein said impact beam comprises a ratio of flex in one direction to bending or buckling in a perpendicular direction which can be measured as greater than 2:1.

7. The impact protector of claim 1, wherein said impact beam comprises a ratio of flex in one direction to bending or buckling in a perpendicular direction which can be measured as greater than 5:1.

8. The impact protector of claim 5, wherein said impact protector is attached to a mounting plate, said mounting plate comprising mounting plate location features, wherein said mounting plate does not directly contact a drivetrain component.

9. The impact protector of claim 8, wherein said mounting plate is attached to a frame structure.

10. The impact protector of claim 8, wherein said mounting plate is attached to a deformable adaptor.

11. An impact protector mounting comprising a frame structure, an impact protector, a mounting plate, wherein said mounting plate does not directly contact a drivetrain component.

12. The impact protector mounting of claim 11, wherein said impact protector is mounted so that the impact protector is stationary relative to a component the impact protector protects, and wherein said mounting plate is attached to a frame structure.

13. The impact protector mounting of claim 11, wherein said impact protector is mounted so that the impact protector is stationary relative to a component the impact protector protects, and wherein said mounting plate is attached to a deformable adaptor.

14. The impact protector mounting of claim 11, wherein said impact protector is mounted so that the impact protector is stationary relative to a component the impact protector protects, and wherein said impact protector comprises a chain guide component.

15. The impact protector mounting of claim 14, wherein said impact protector comprises an impact beam and wherein said impact beam has a different distance from a sprocket than from a chain guide component.

16. The impact protector mounting of claim 11, wherein said impact protector is mounted so that the impact protector is stationary relative to a component the impact protector protects, and wherein a single part comprises said mounting plate and said impact protector.

17. The impact protector mounting of claim 11, wherein said impact protector is mounted so that the impact protector is stationary relative to a component the impact protector protects, and wherein said mounting plate and said impact protector are separate parts.

18. The impact protector mounting of claim 11, wherein said mounting plate comprises multiple parts.

19. The impact protector mounting of claim 18, wherein said mounting plate allows for independent adjustment in one degree of freedom.

20. The impact protector mounting of claim 18, wherein a single part comprises a part of said mounting plate and said impact protector.

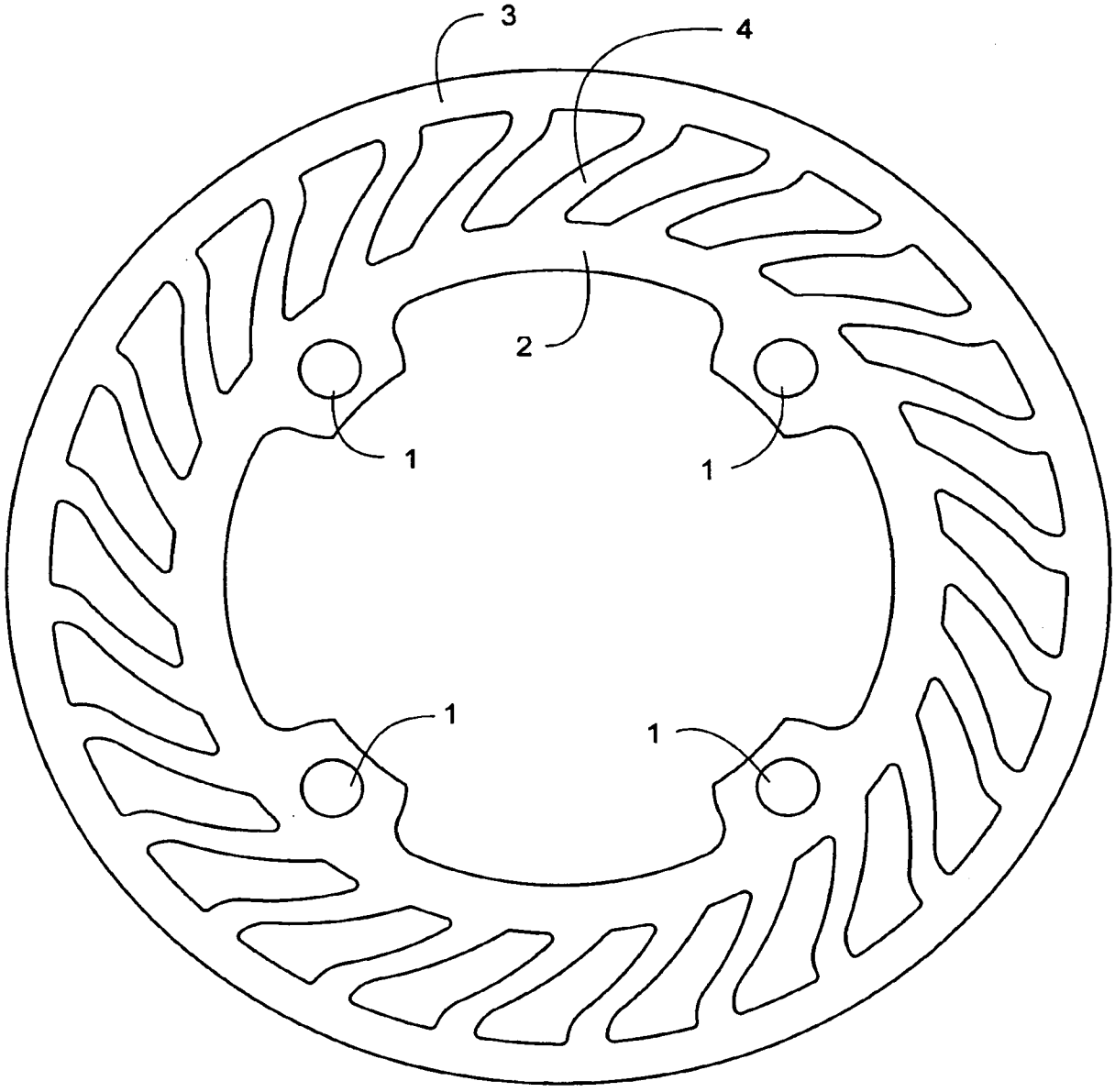


FIGURE 1

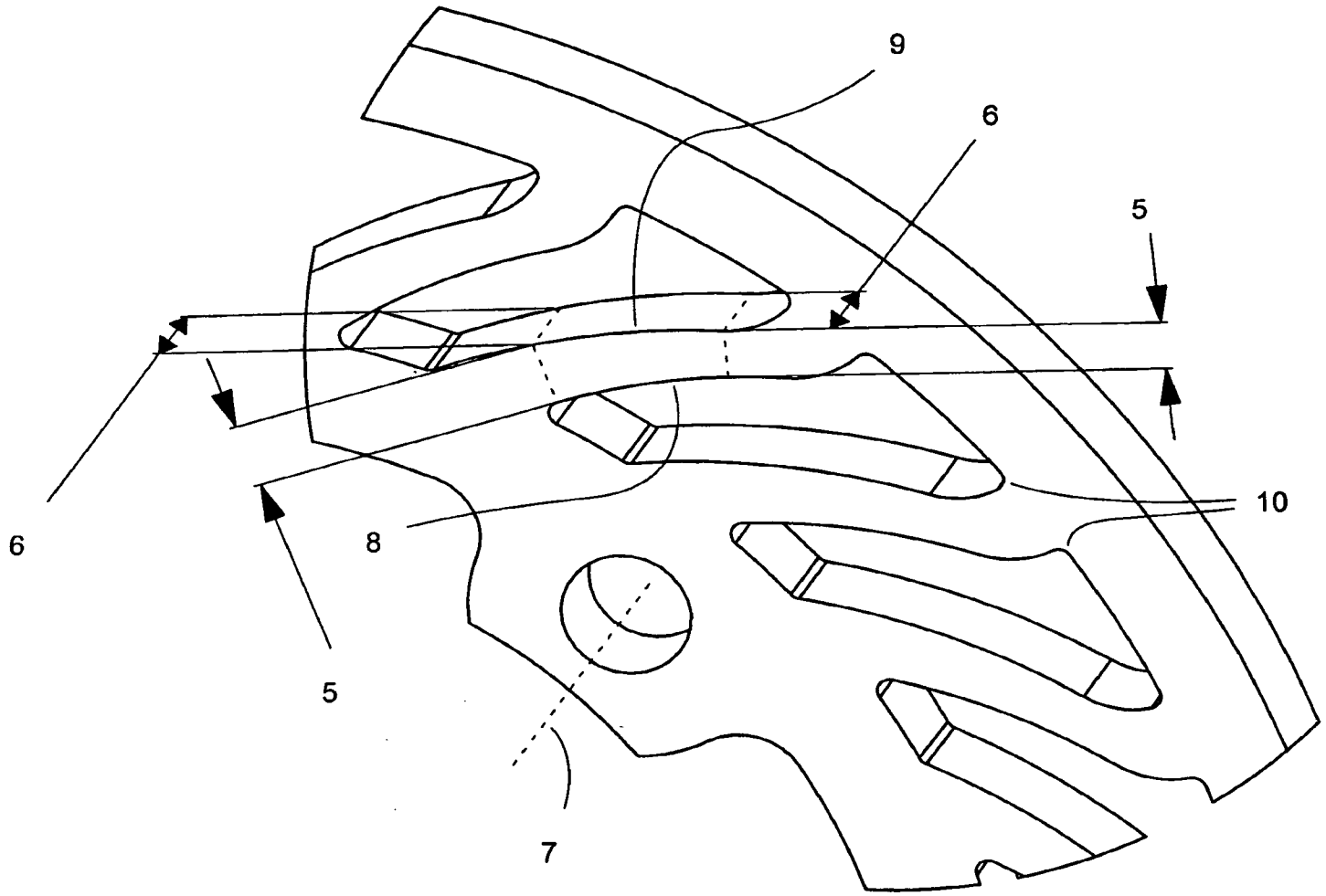


FIGURE 2

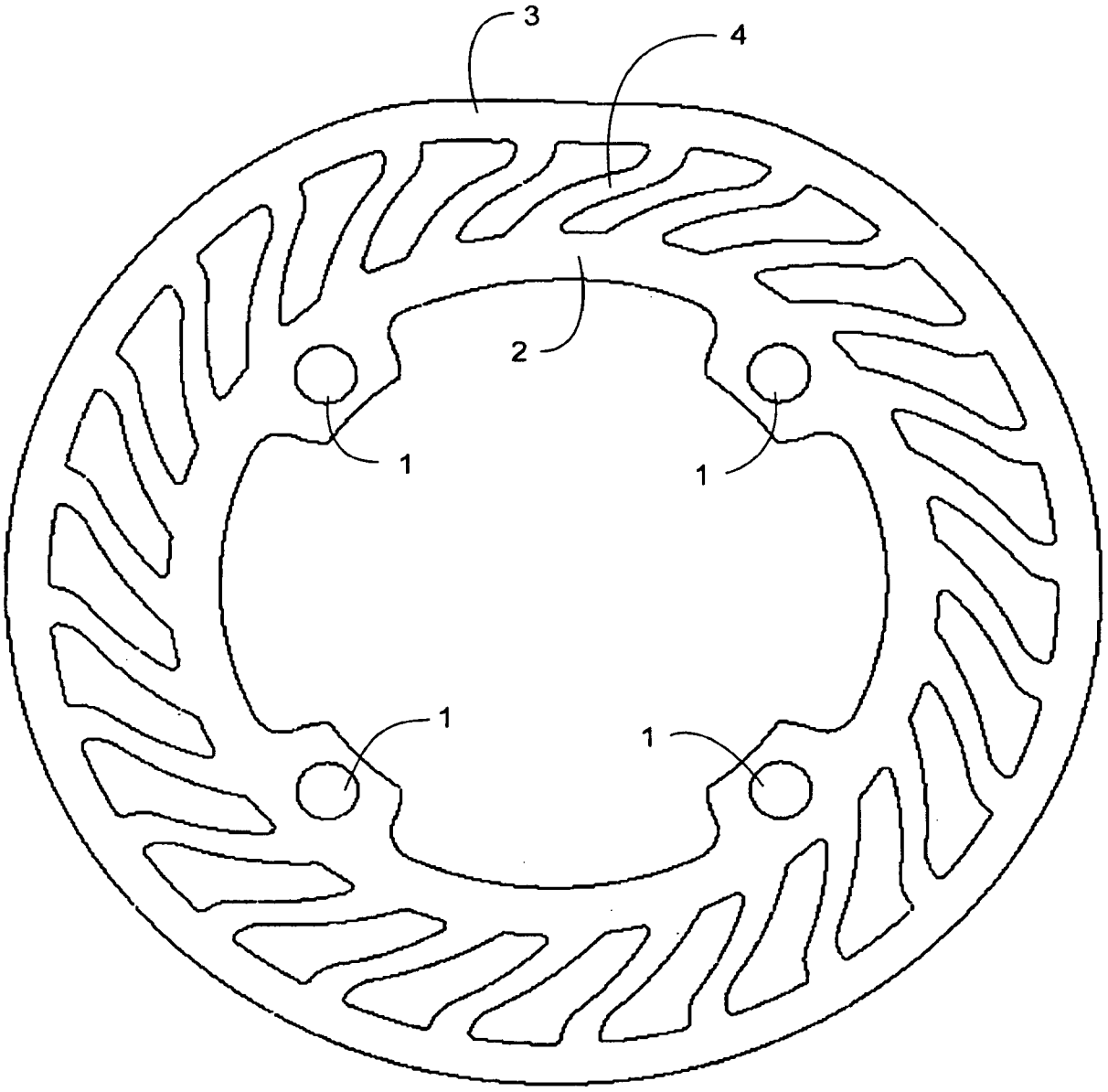


FIGURE 3

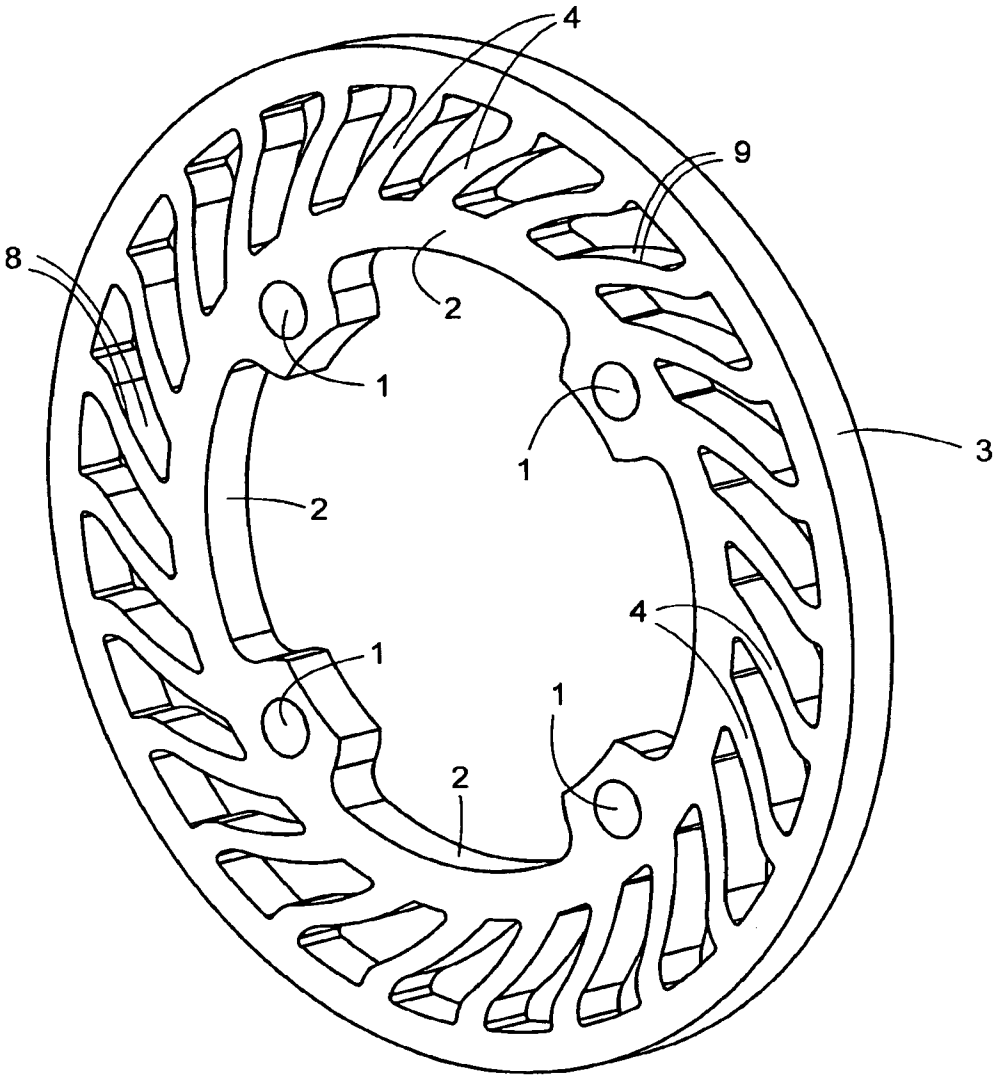


FIGURE 4

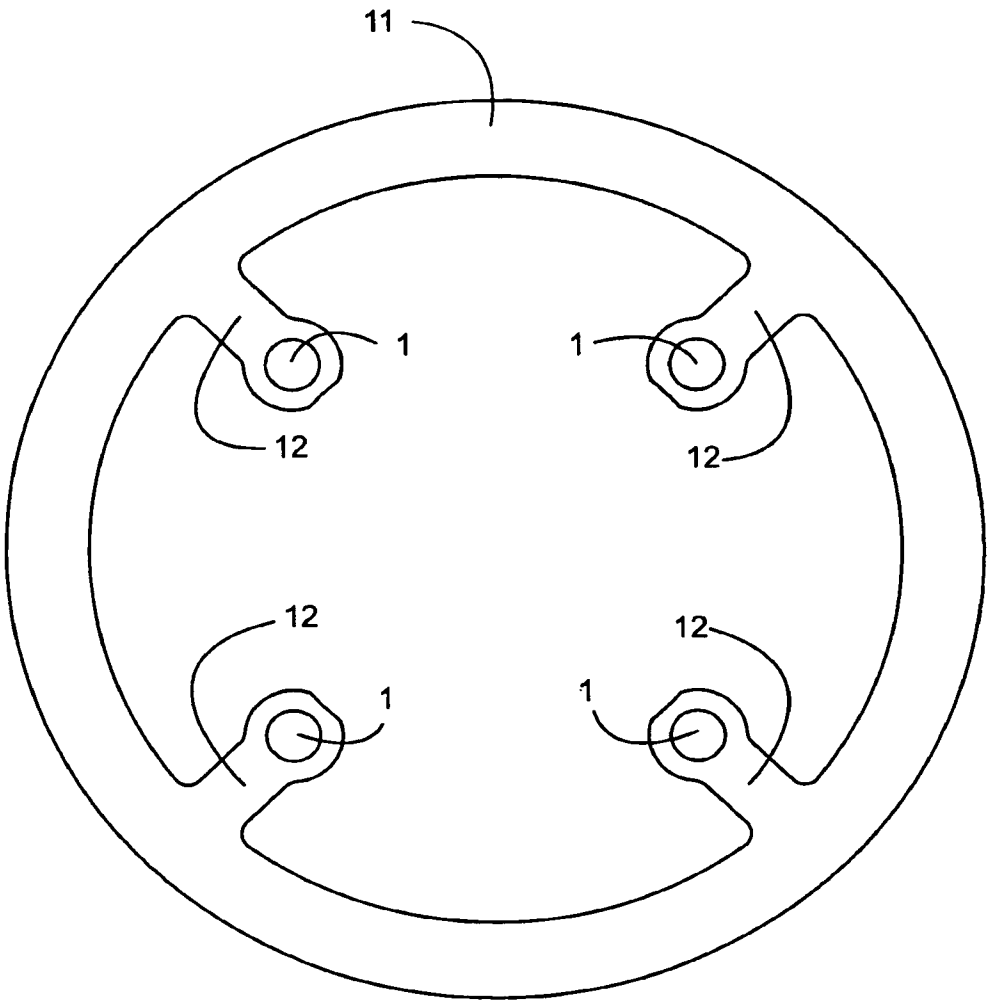


FIGURE 5

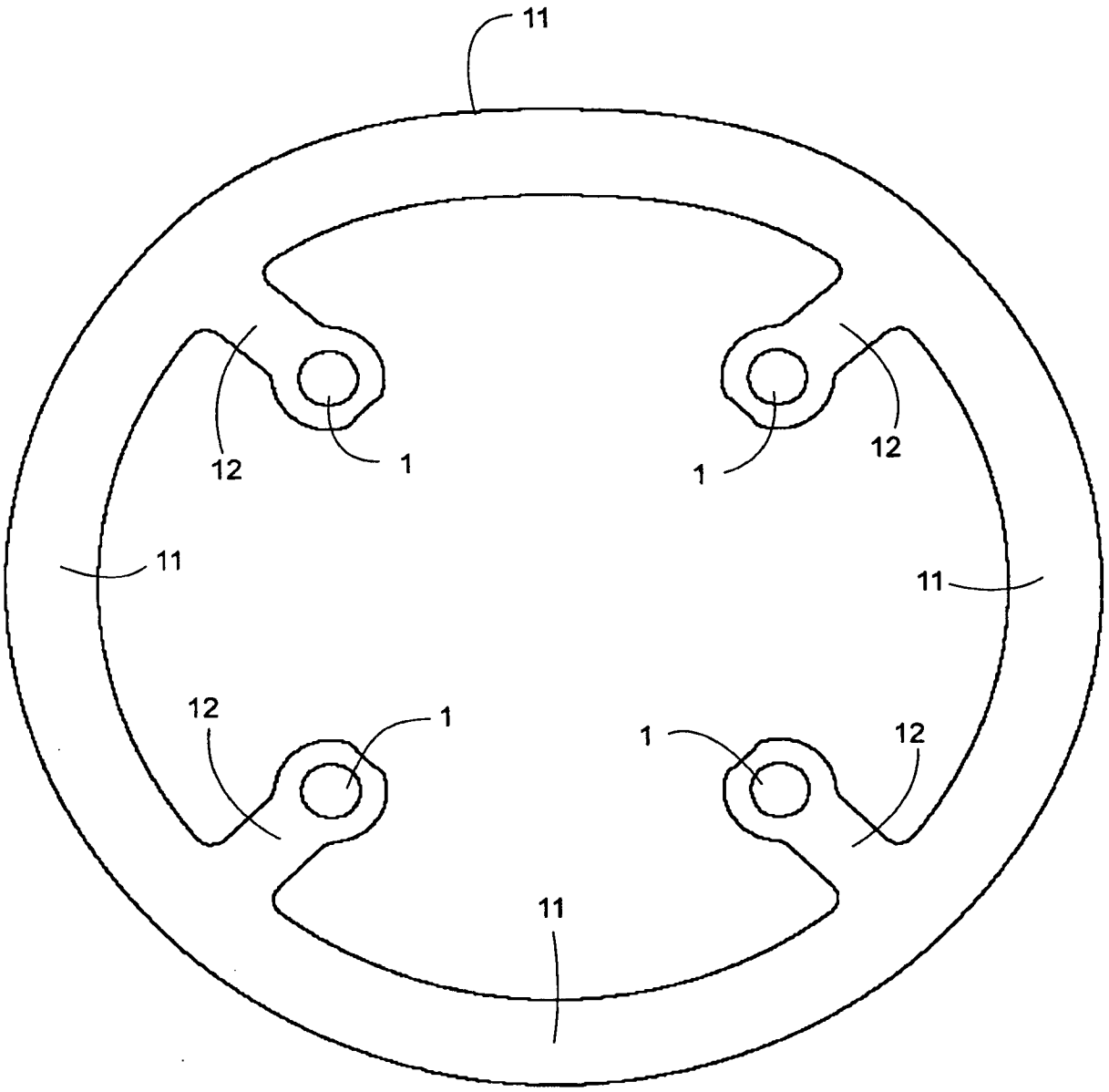


FIGURE 6

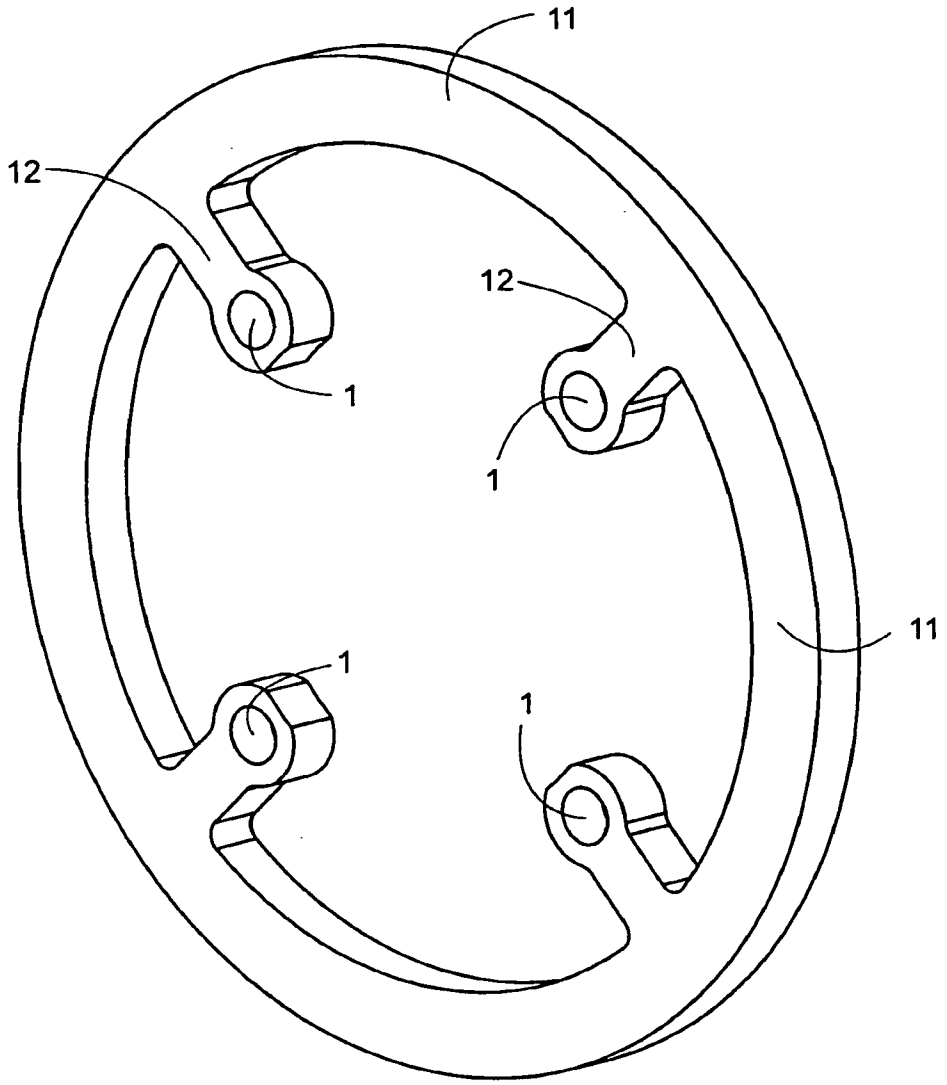


FIGURE 7

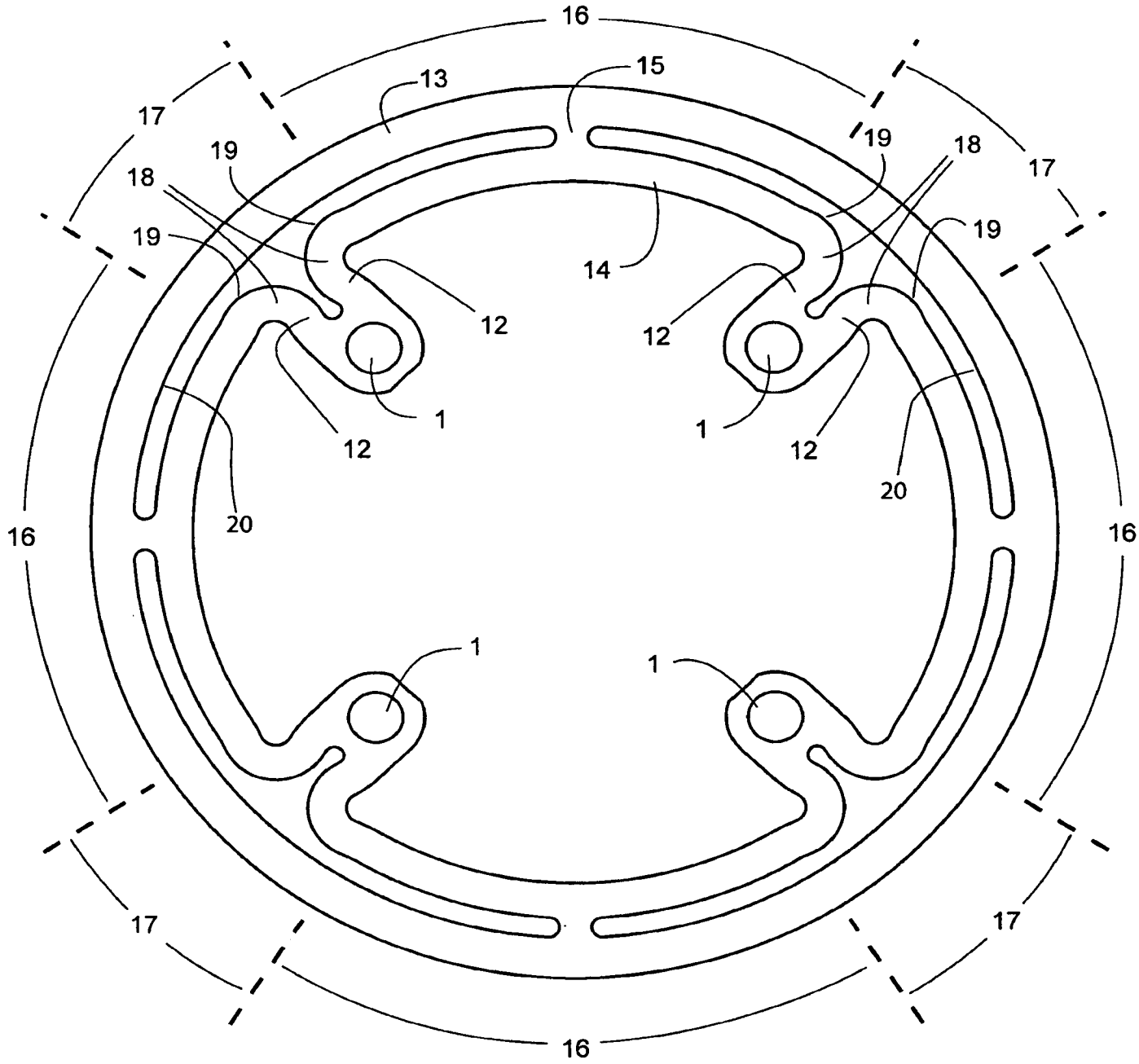

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FIGURE 8

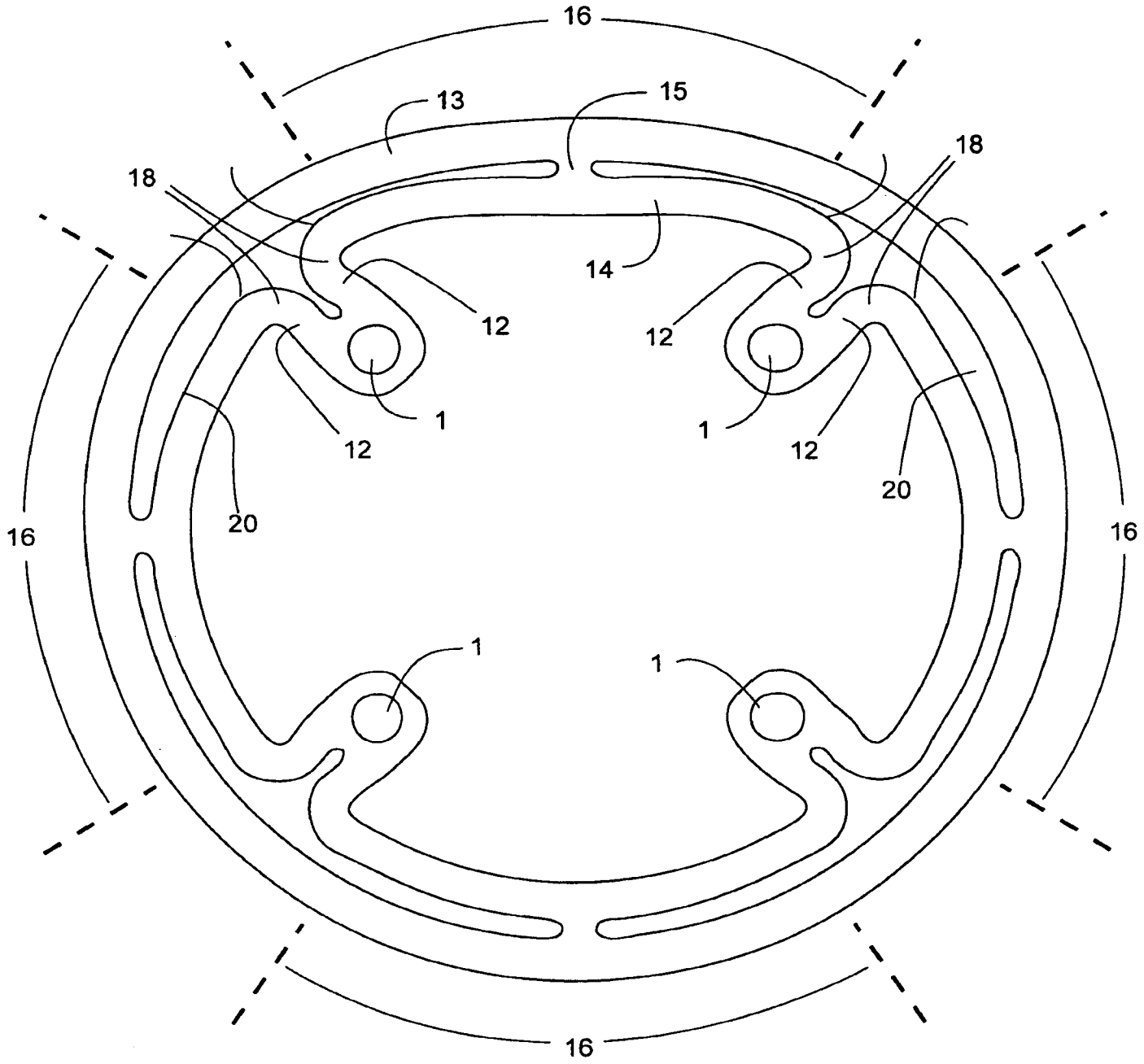


FIGURE 9

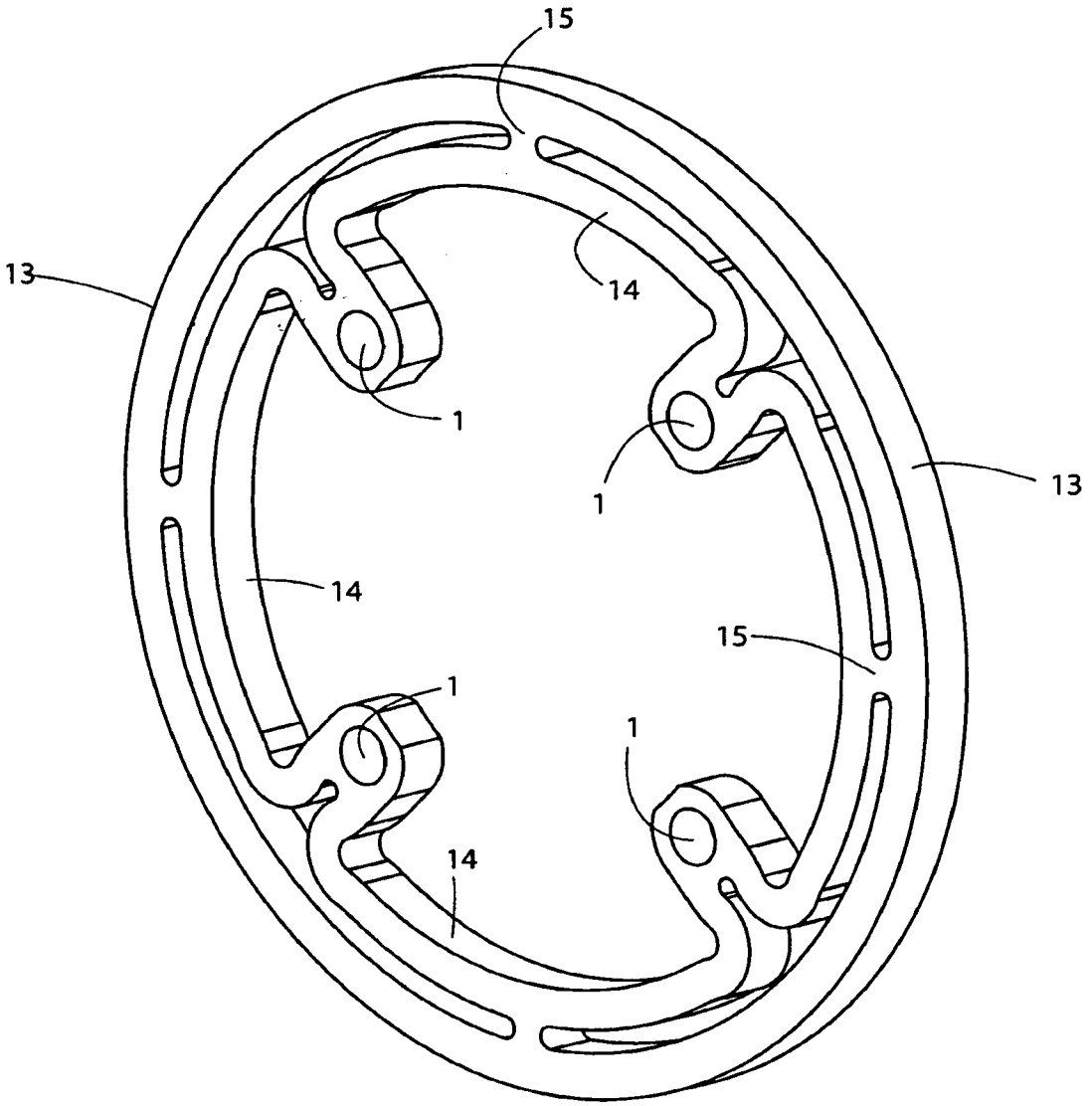


FIGURE 10

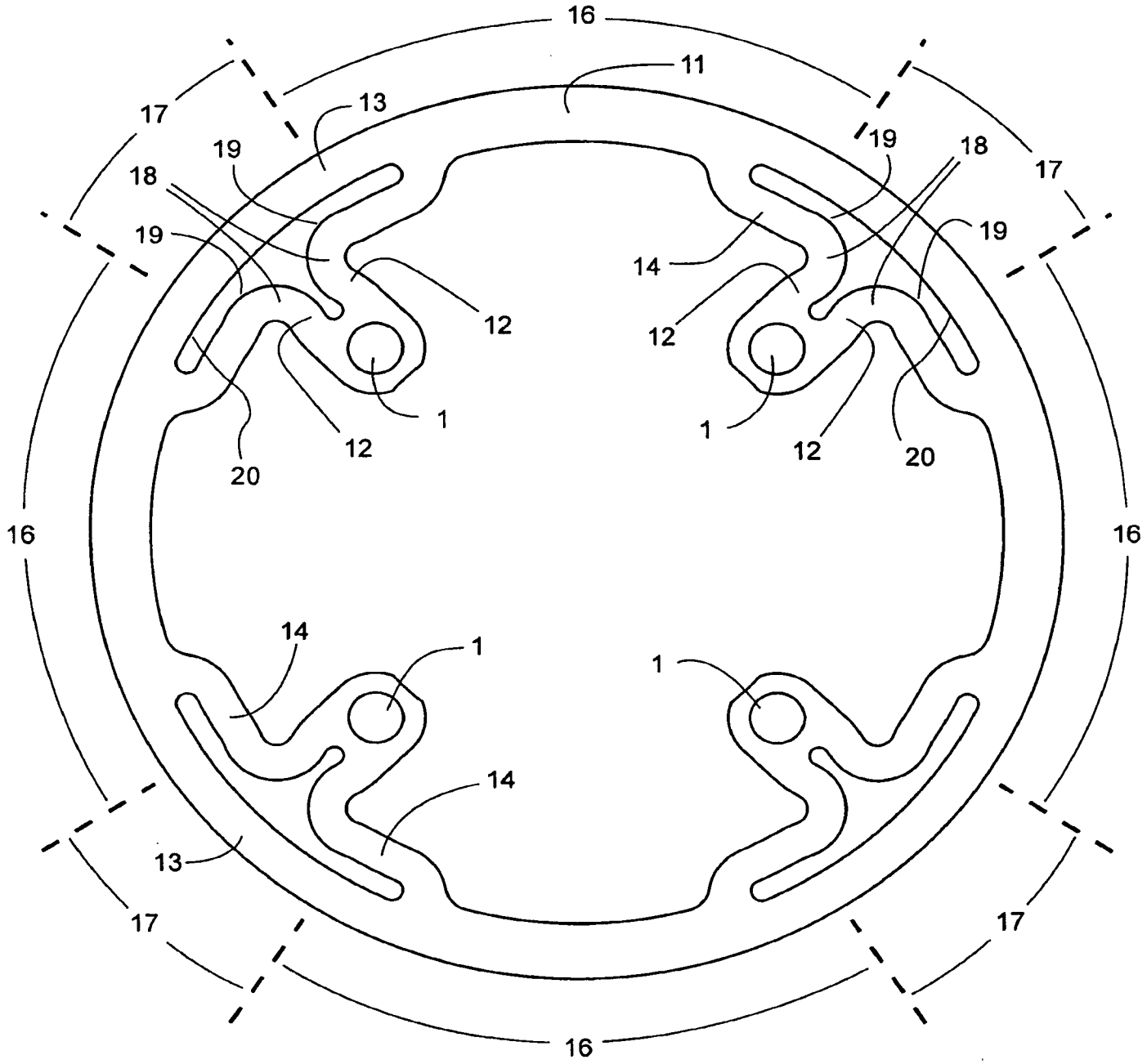

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FIGURE 11

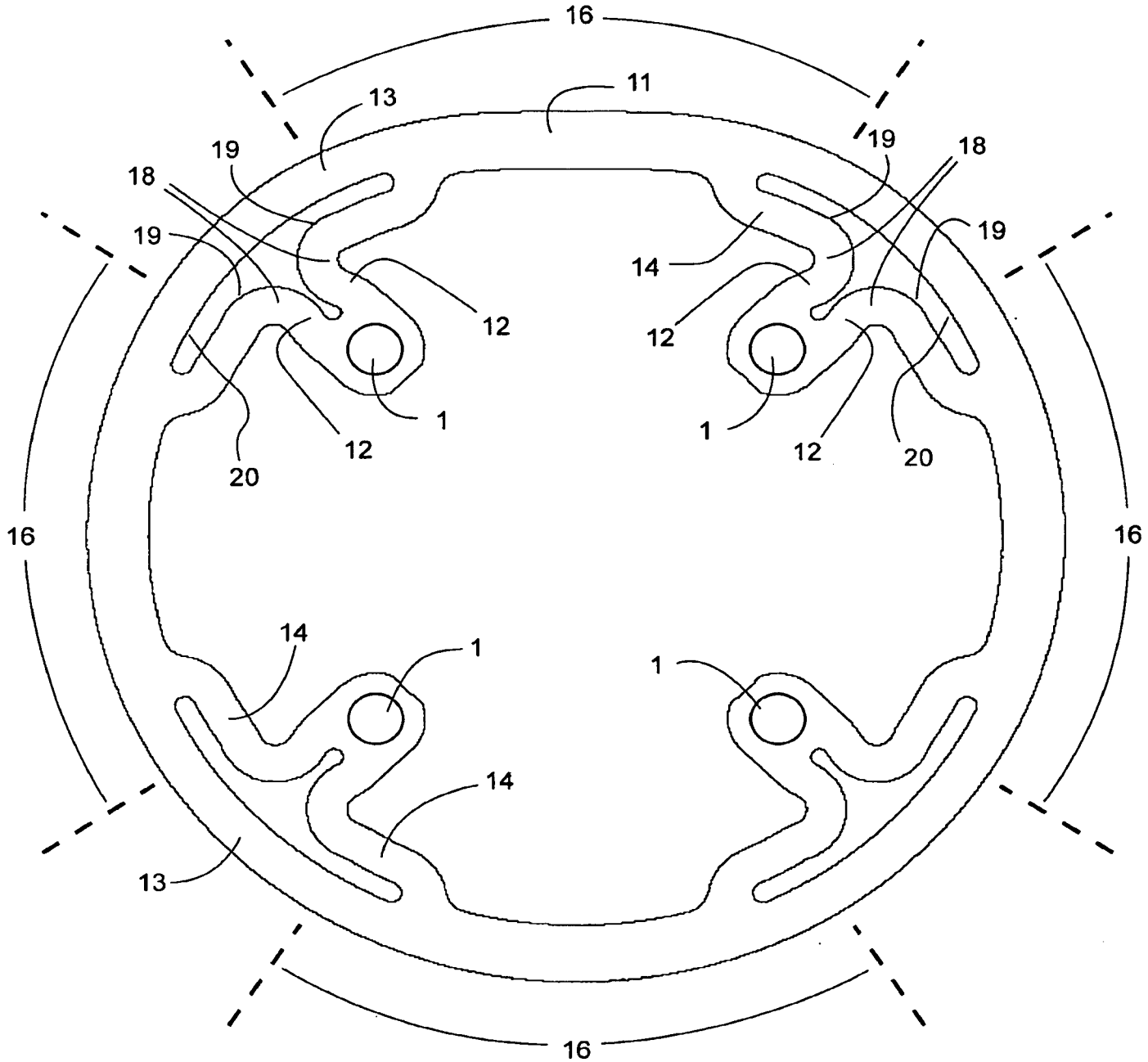


FIGURE 12

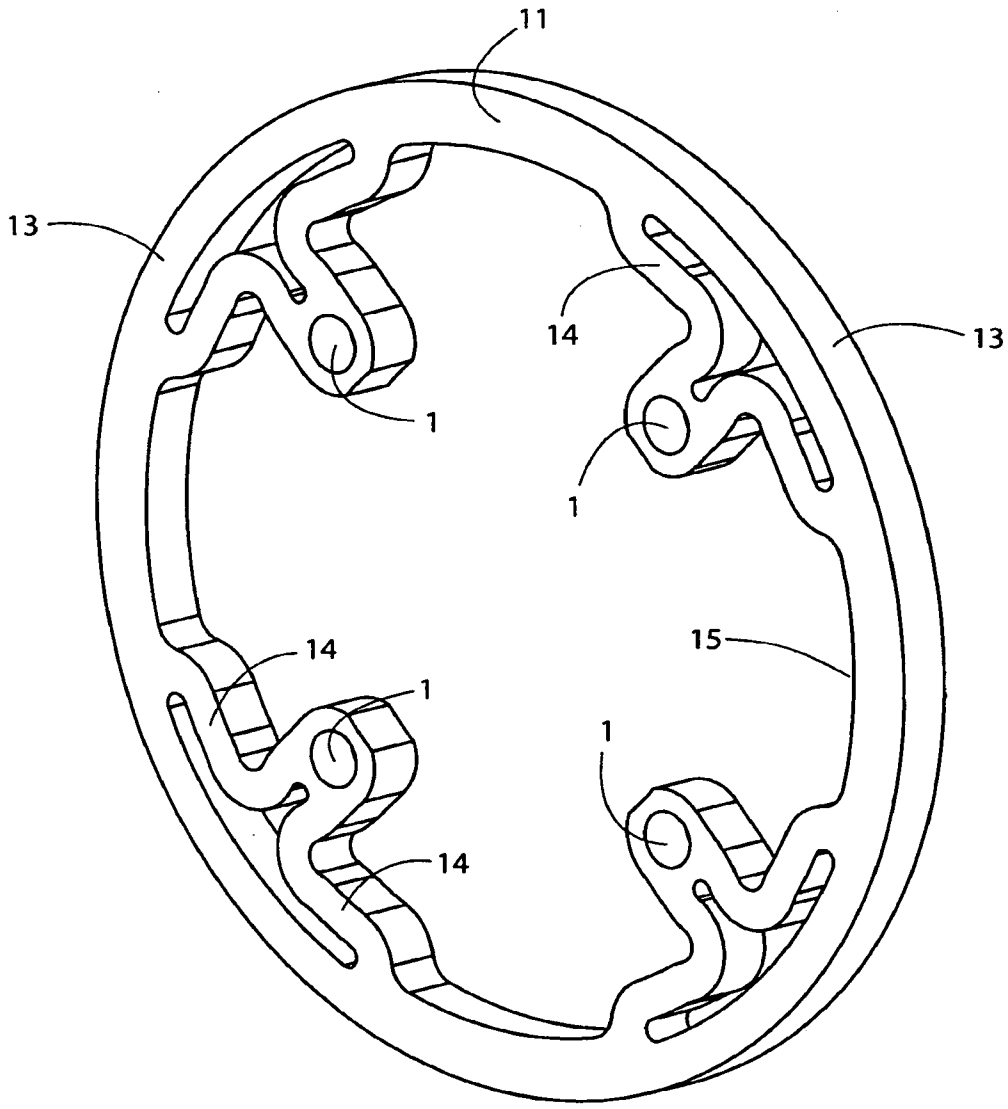


FIGURE 13

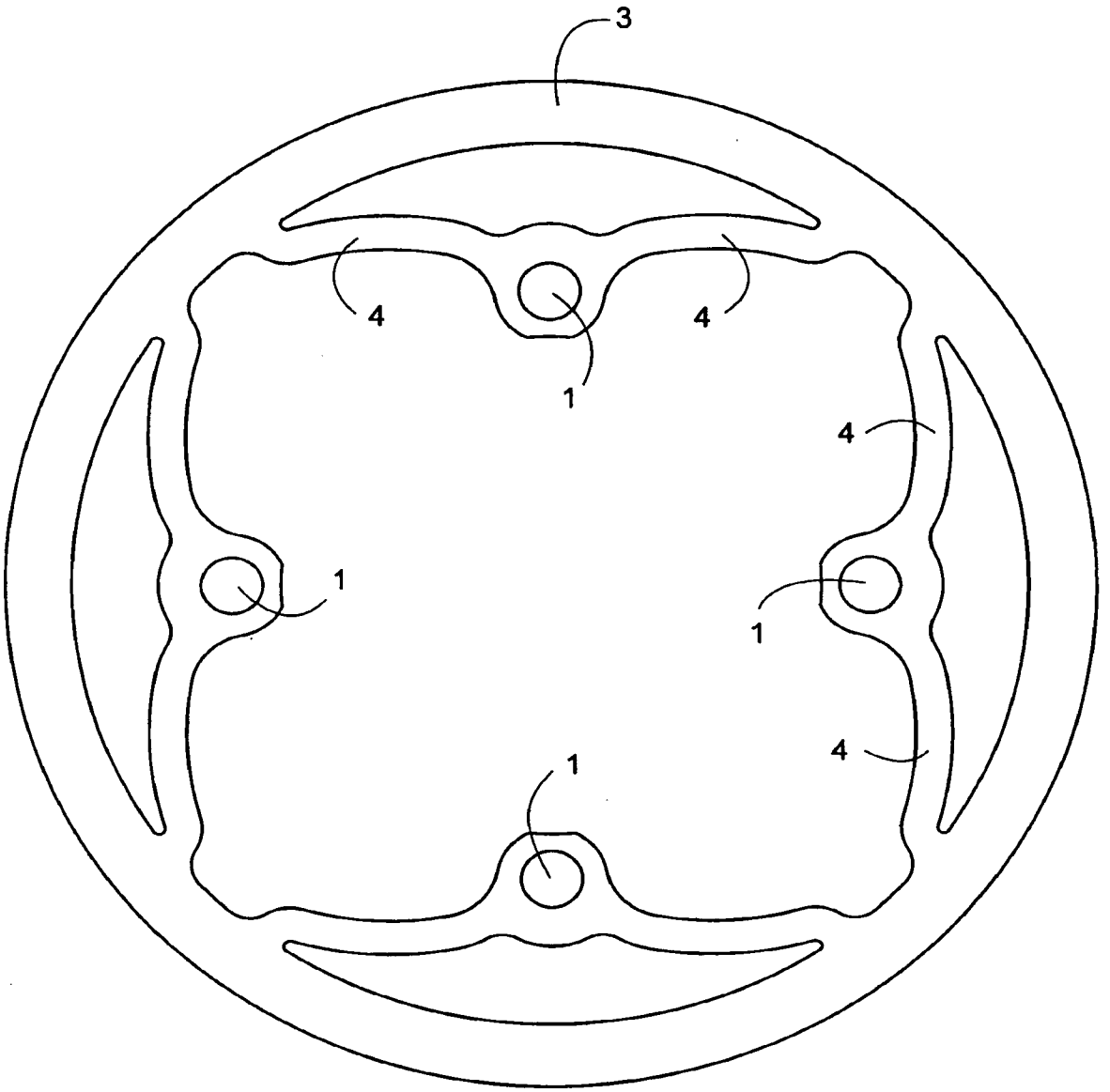


FIGURE 14

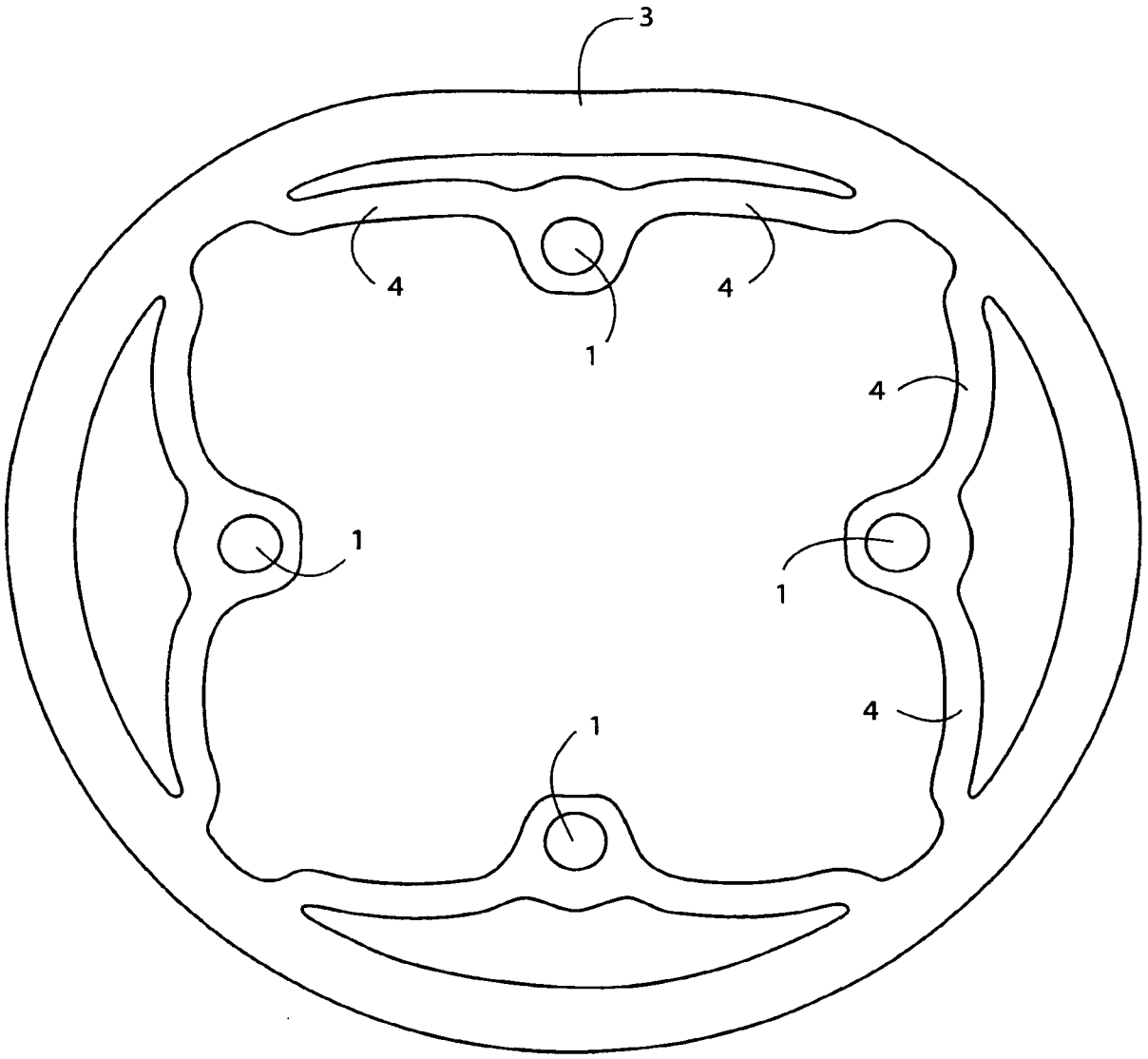


FIGURE 15

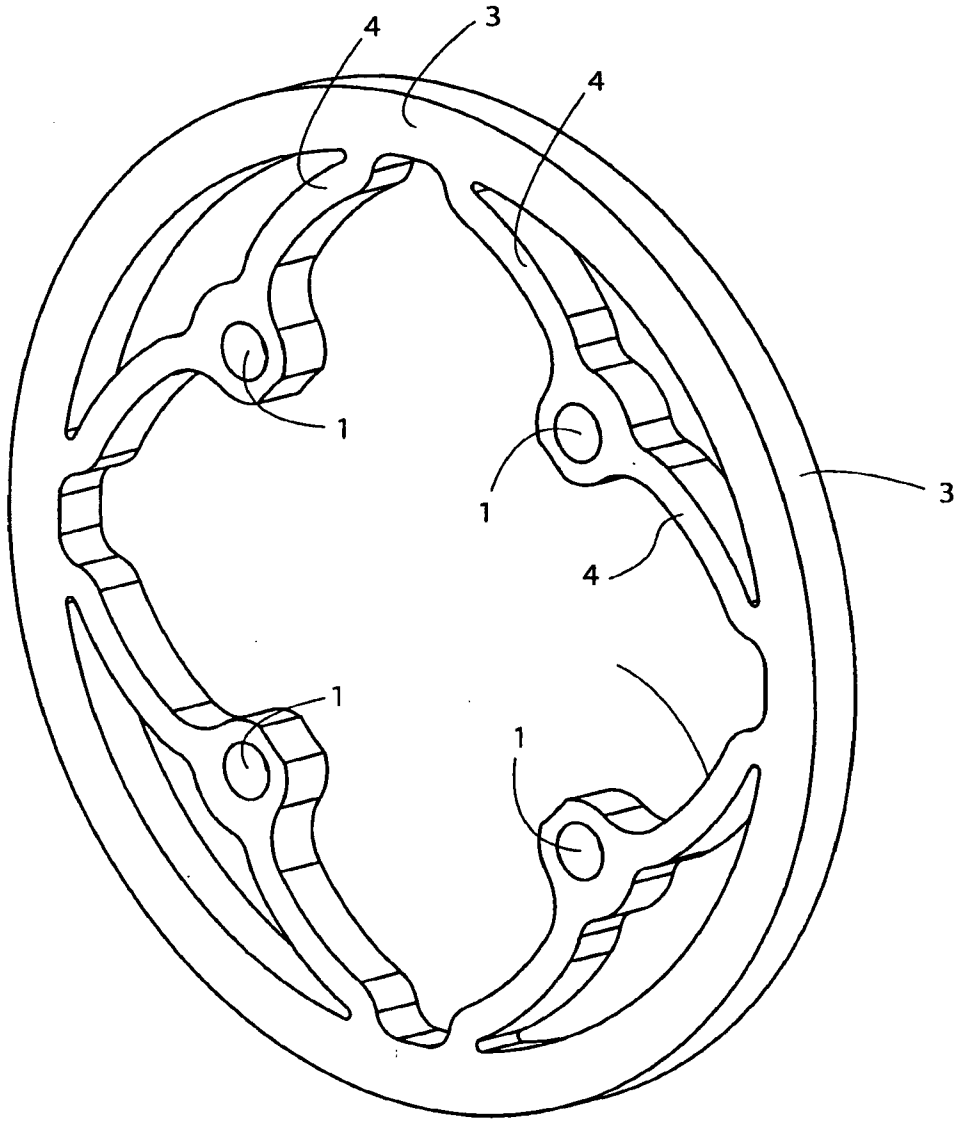


FIGURE 16

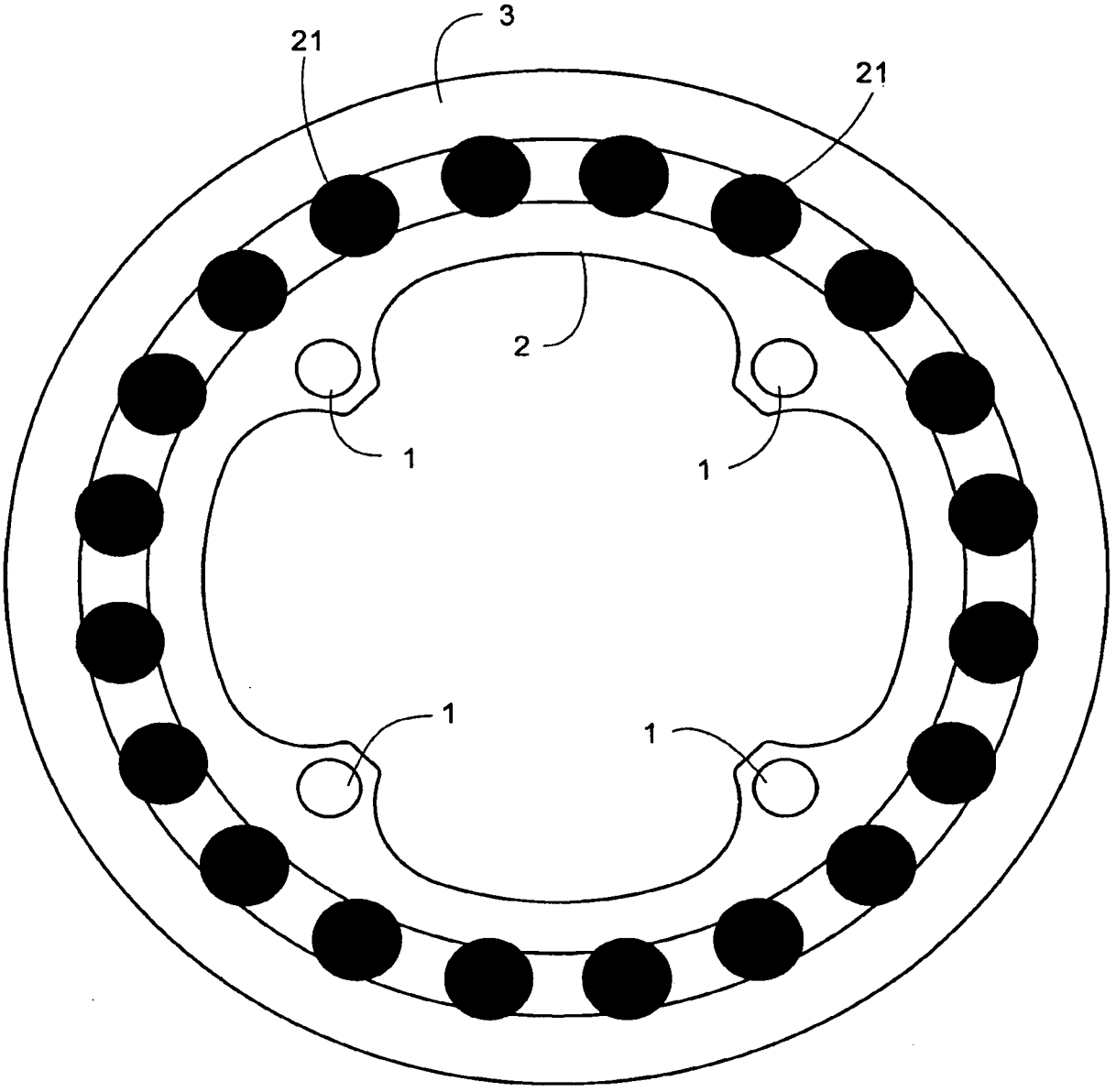


FIGURE 17

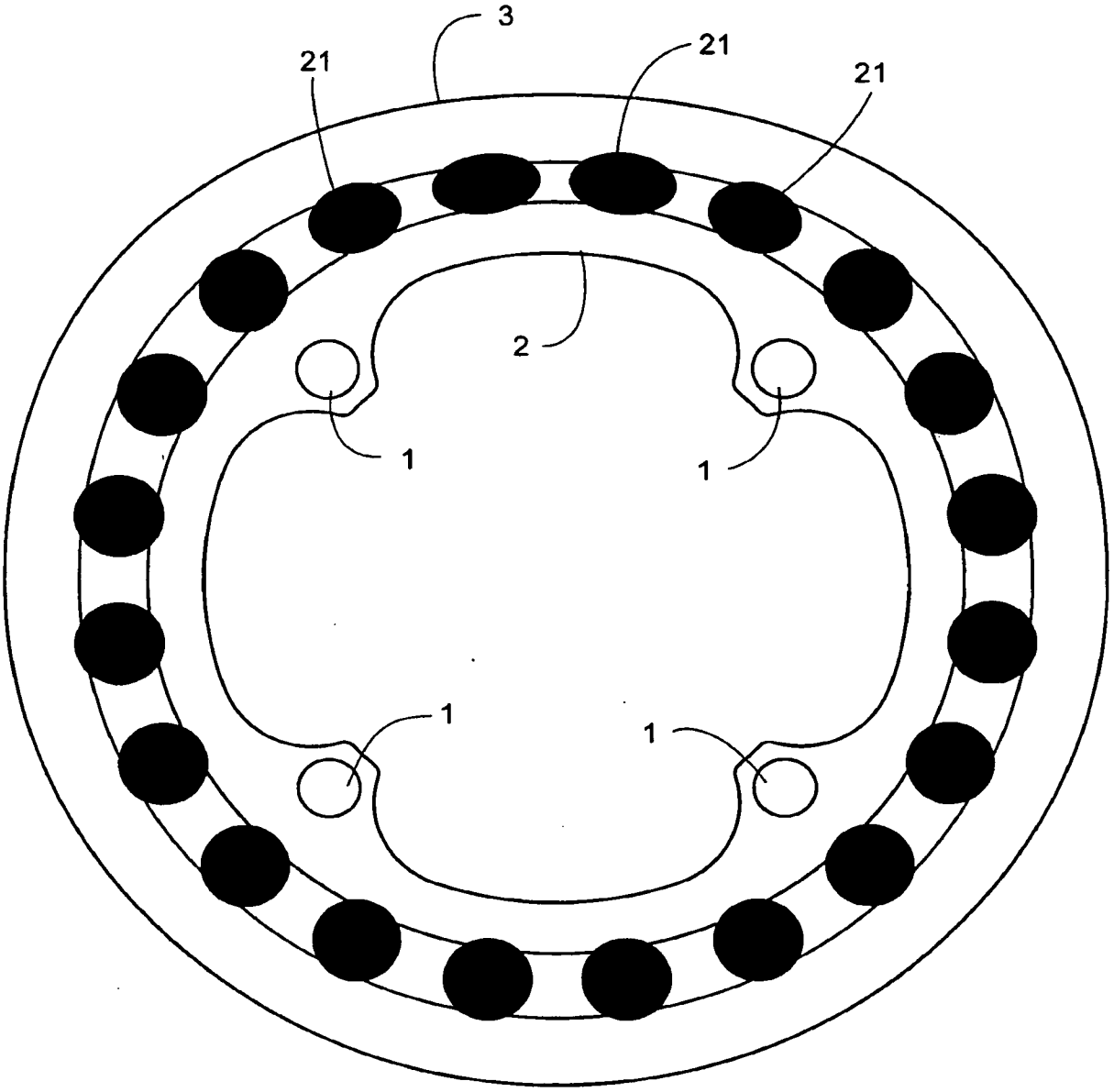


FIGURE 18

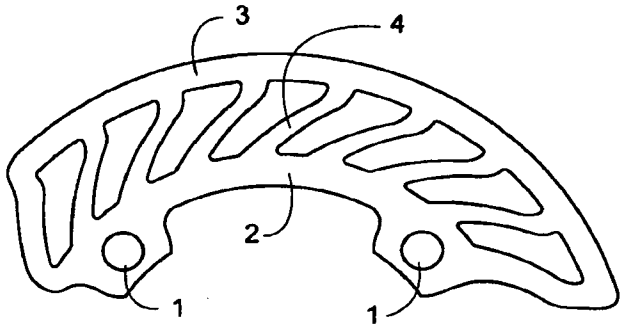


FIGURE 19

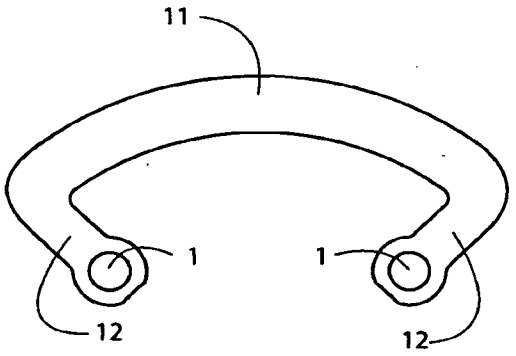


FIGURE 20

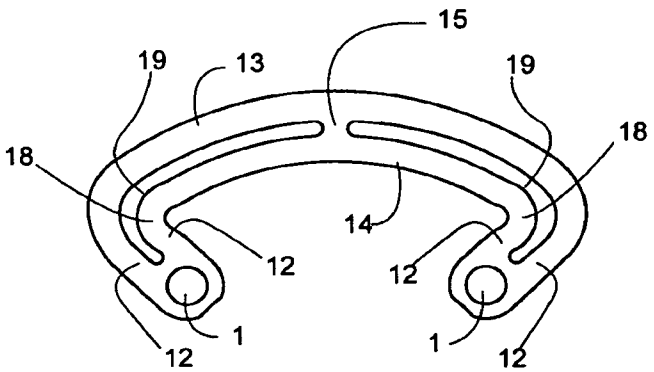


FIGURE 21a

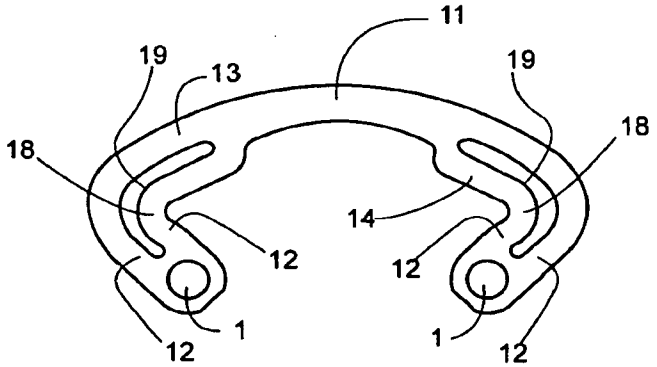


FIGURE 21b

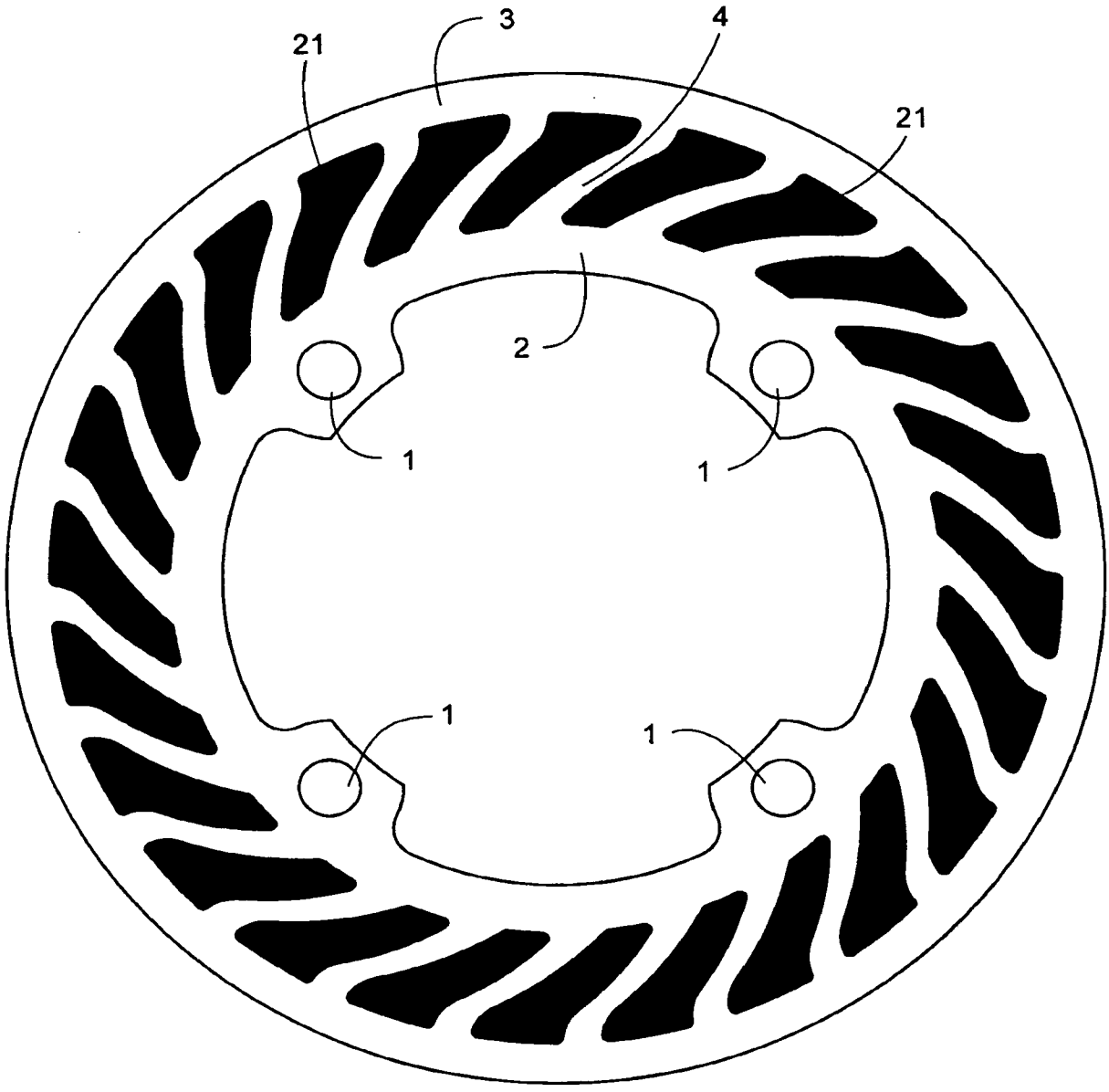


FIGURE 22

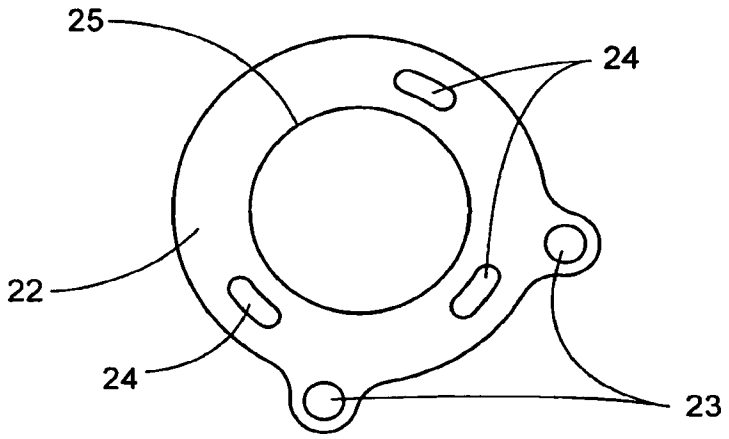


FIGURE 23A

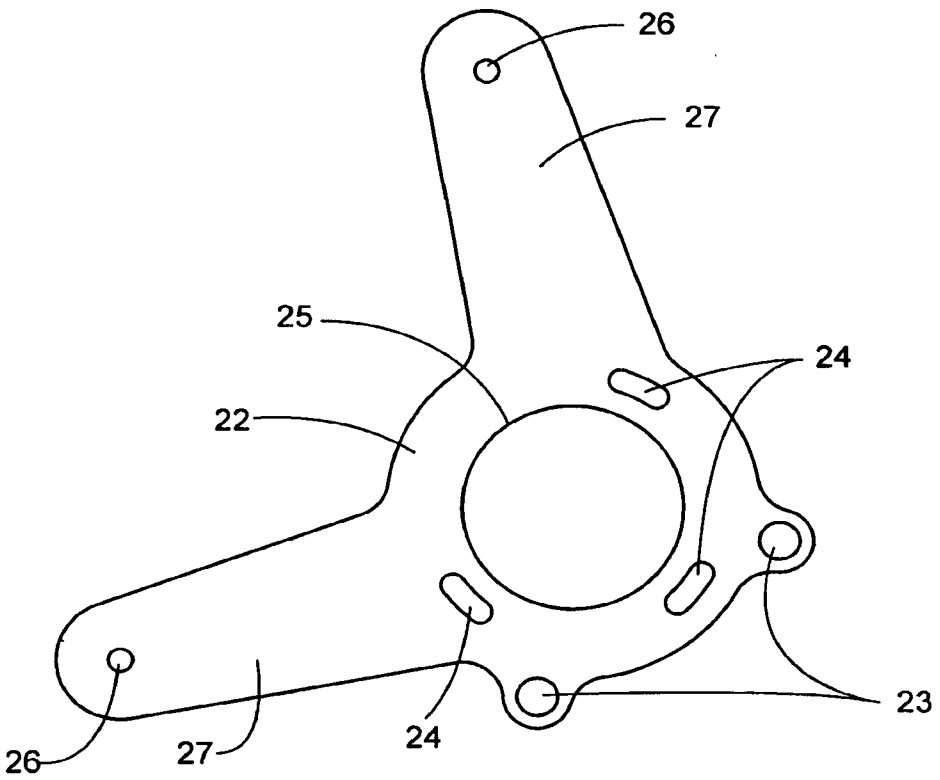


FIGURE 23B

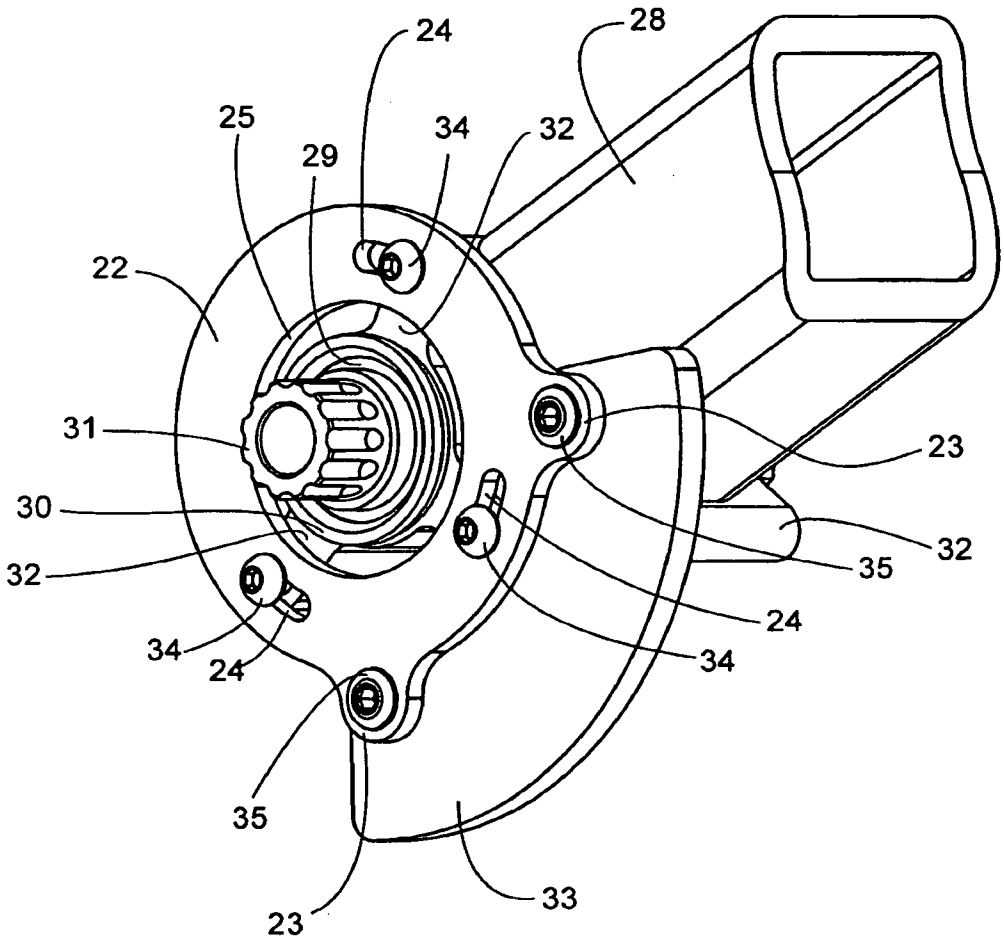


FIGURE 24A

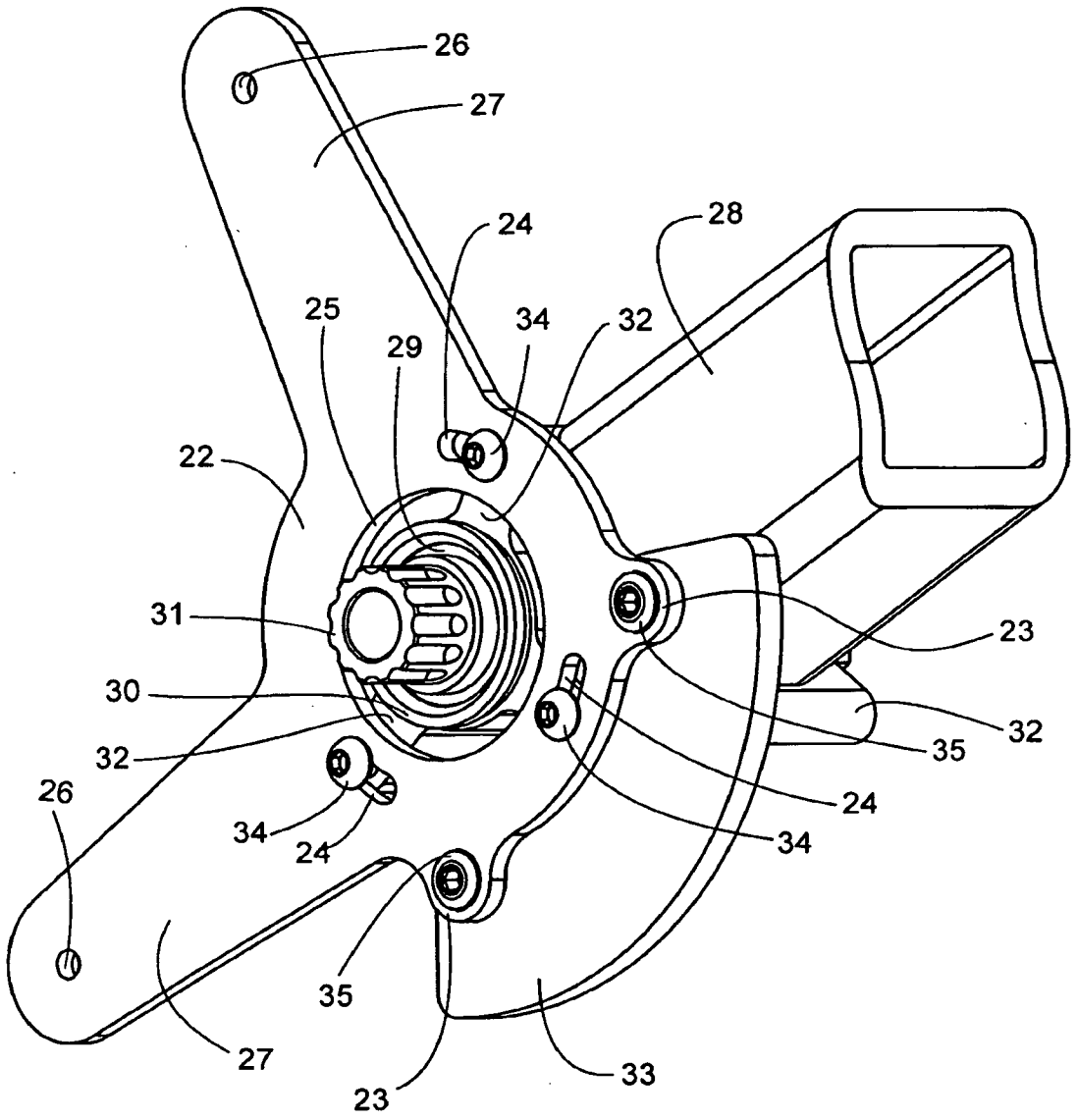


FIGURE 24B

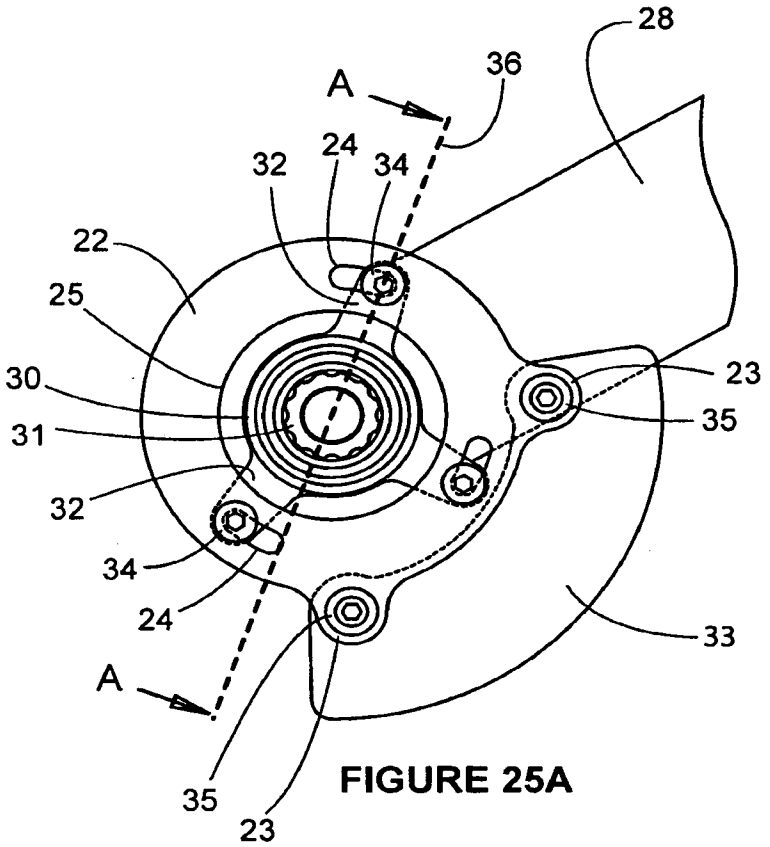


FIGURE 25A

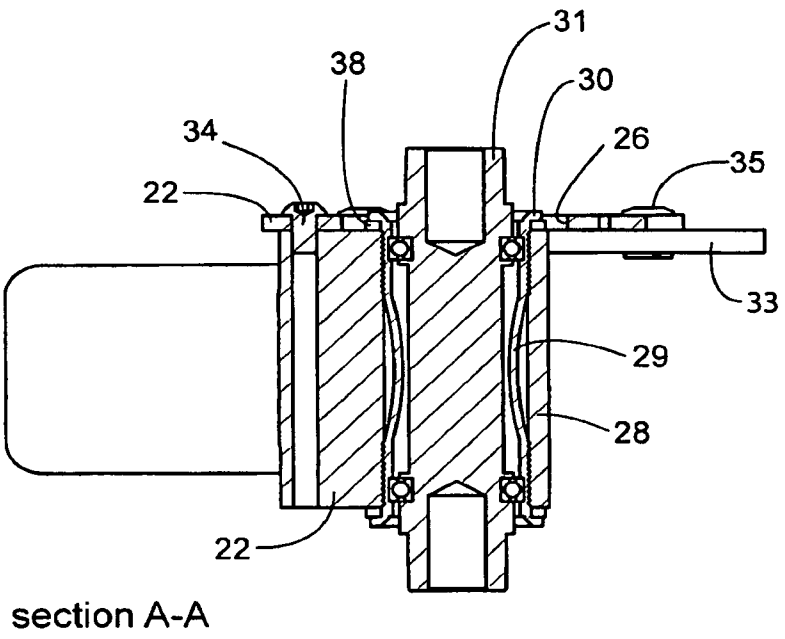


FIGURE 25B

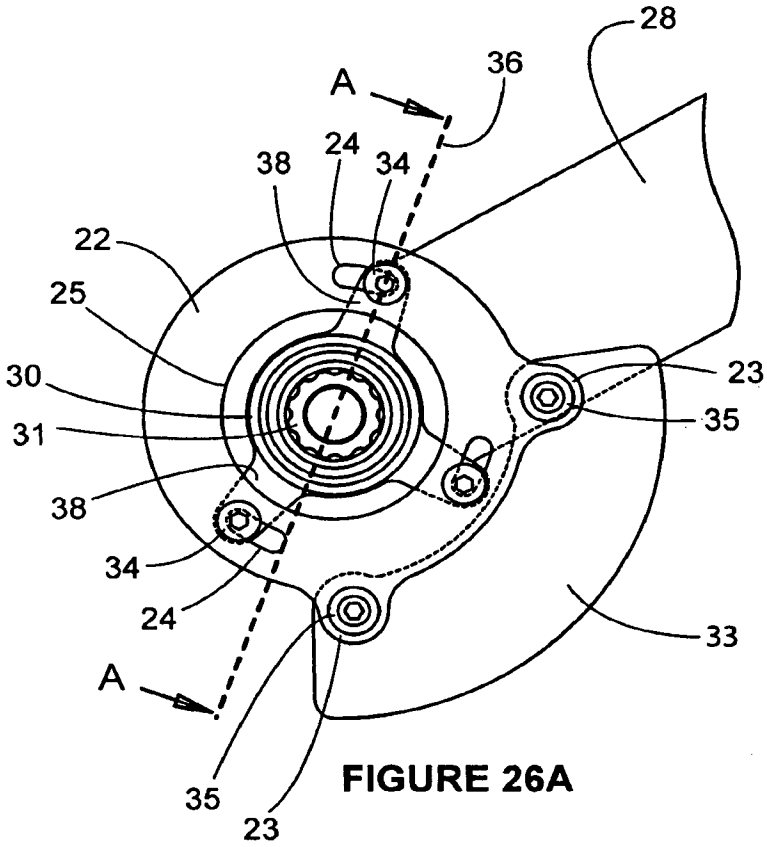
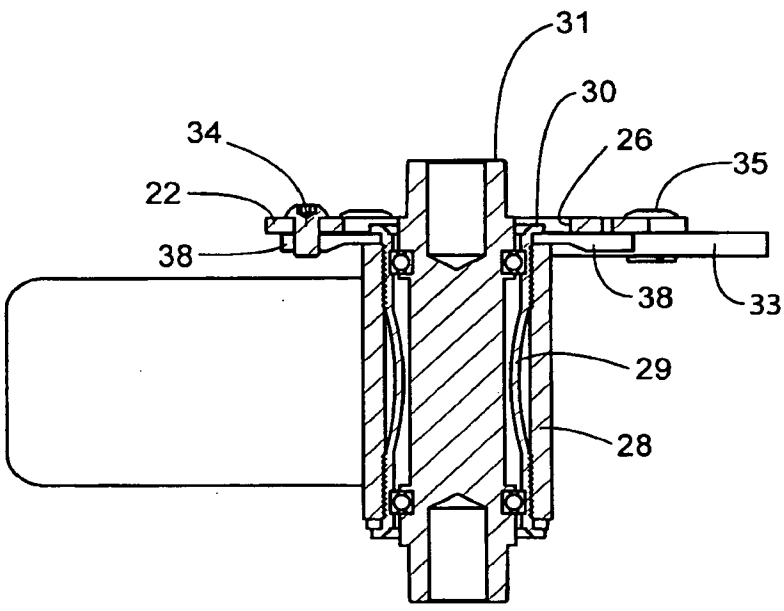


FIGURE 26A



section A-A

FIGURE 26B