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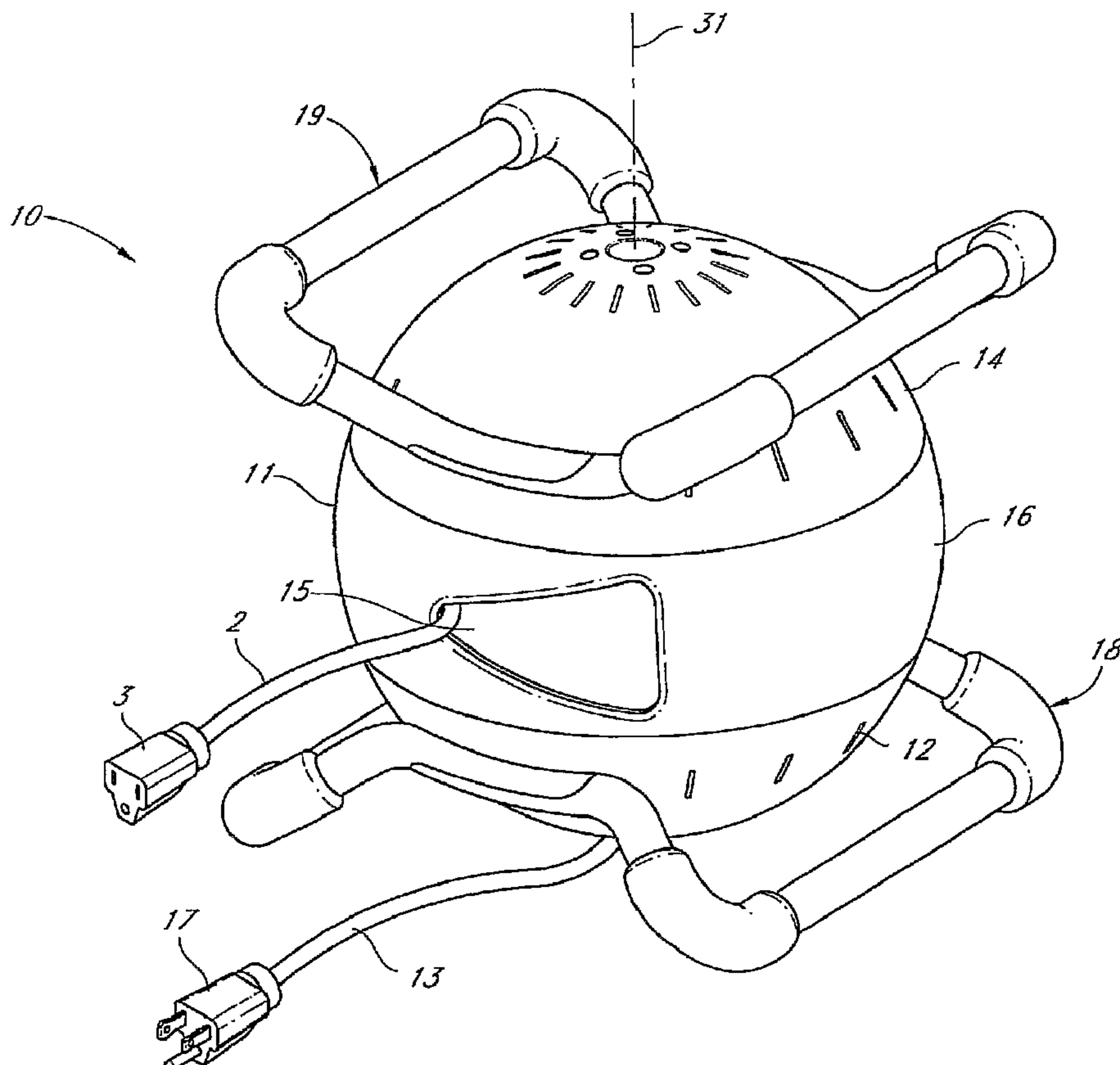
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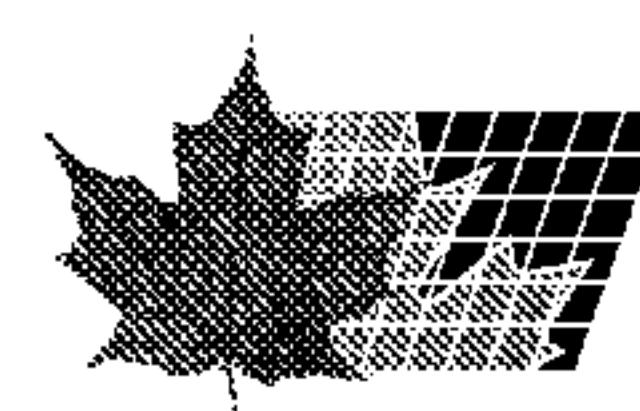
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(54) Titre : ENROULEUR AVEC UN CARTER COMPORTANT UNE OUVERTURE TRIANGULAIRE POUR L'ENTREE  
D'UNE MATIERE LINEAIRE  
(54) Title: REEL WITH HOUSING HAVING TRIANGULAR APERTURE FOR ENTRY OF LINEAR MATERIAL



(57) Abrégé/Abstract:

A reel (10) is provided with a housing (11) having a triangular aperture (15) for entry and removal of linear material (2) wound upon the reel drum (20). The drum (20) has a spool surface (47) onto which a linear material (2) may be wound, the spool surface (47)



## (57) Abrégé(suite)/Abstract(continued):

having two ends. The housing (11) substantially encloses the drum (20), and the drum (20) is rotatable about a drum axis (31) relative to at least a portion of the housing (11). The at least a portion of the housing (11) has a generally triangular aperture (15) sized to receive a linear material (2) wound onto the drum (20). The aperture (15) has a first side (92) oriented generally parallel to the drum axis (31), and second and third sides (94, 96) meeting at a vertex (93) generally midway between opposing ends of the spool surface (47) of the drum (20).

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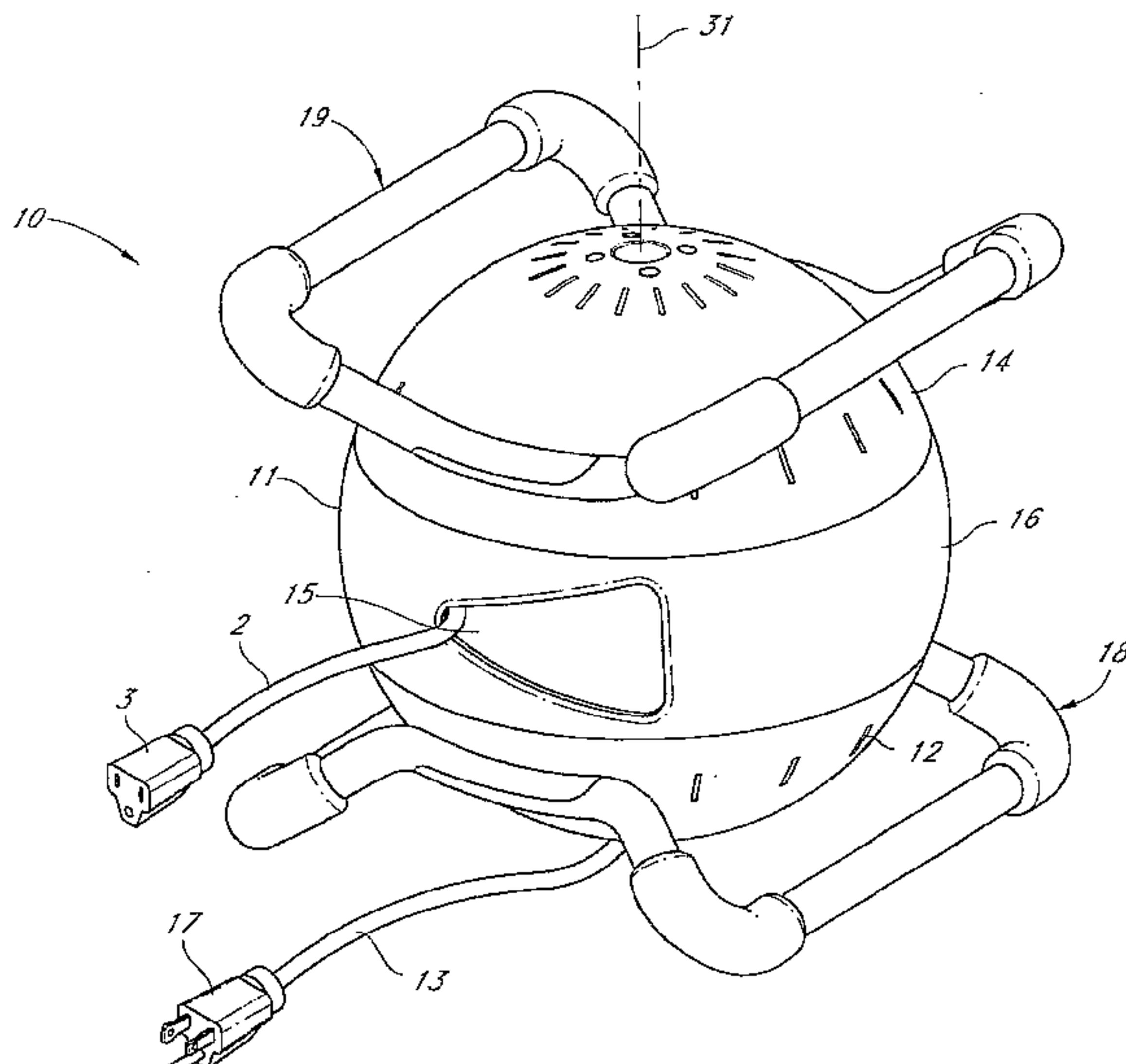
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(54) Title: REEL WITH HOUSING HAVING TRIANGULAR APERTURE FOR ENTRY OF LINEAR MATERIAL



(57) **Abstract:** A reel (10) is provided with a housing (11) having a triangular aperture (15) for entry and removal of linear material (2) wound upon the reel drum (20). The drum (20) has a spool surface (47) onto which a linear material (2) may be wound, the spool surface (47) having two ends. The housing (11) substantially encloses the drum (20), and the drum (20) is rotatable about a drum axis (31) relative to at least a portion of the housing (11). The at least a portion of the housing (11) has a generally triangular aperture (15) sized to receive a linear material (2) wound onto the drum (20). The aperture (15) has a first side (92) oriented generally parallel to the drum axis (31), and second and third sides (94, 96) meeting at a vertex (93) generally midway between opposing ends of the spool surface (47) of the drum (20).

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PATENT

**REEL WITH HOUSING HAVING TRIANGULAR APERTURE FOR ENTRY OF  
LINEAR MATERIAL**

**CLAIM FOR PRIORITY**

**[0001]** This application claims priority under 35 U.S.C. § 119(e) to Provisional Patent Application No. 60/775,629, filed February 21, 2006.

**INCORPORATION BY REFERENCE**

**[0002]** The present application incorporates by reference the entire disclosure of U.S. Patent Application Publication No. US 2006-0266605 A1.

**BACKGROUND OF THE INVENTION**

**Field of the Invention**

**[0003]** The present invention relates generally to reels for winding and unwinding linear material, and specifically to apparatuses and methods for improving the uniformity of wound material and ease of unwinding.

**Description of the Related Art**

**[0004]** A reel typically comprises a cylindrical reel drum onto which a flexible linear material (such as cord, hose, etc.) is wound. The drum ordinarily rotates about a central axis to wind or unwind (also referred to herein as “spooling” and “unspooling”) the linear material with respect to the cylindrical drum surface. Some reels include housings that protect the drum and spooled linear material from the environment. The housing may include an opening or aperture through which the linear material extends, so that it may be pulled from the housing and subsequently retracted back into the housing. Rotation of the drum can be motorized or manual, such as by a hand crank or other like device.

**[0005]** Some reel housings have a portion that includes the linear material aperture and is movable with respect to the remainder of the housing, thereby permitting a user to change the position from which the linear material is pulled from the reel. For example, U.S. Patent No. 6,279,848 to Mead discloses a cylindrical reel drum that rotates about a horizontal axis and is enclosed within a spherical housing comprising upper and

lower semispherical shell portions. The upper shell portion includes a guide aperture for the spooled linear material and is linked to the drum. The upper shell portion and drum together rotate about a vertical central axis with respect to the lower shell portion. This permits a user to pull the linear material out of the housing through the guide aperture, and move around the reel with the guide aperture following the radial position of the user. The upper shell portion and drum form a unit that is freely rotatable (about the vertical axis) with respect to the lower shell portion, through 360° and more.

**[0006]** Another example of a reel housing having a portion that includes a linear material aperture and is movable with respect to the remainder of the housing is shown and described in U.S. Patent Application Publication No. US 2006-0266605 A1. That reference discloses a spherical reel housing comprising lower, intermediate, and upper housing portions, an internal vertical spindle member fixed with respect to the lower and upper housing portions, and a drum rotatable on the spindle member and surrounded by the intermediate housing portion. In that reference, the intermediate housing portion includes a linear material aperture and is also rotatable, independently of the drum, about the spindle member.

**[0007]** A variety of reels, particularly non-motorized reels, include spring return mechanisms for automatically spooling the linear material. Typically, a coil of flat spring steel stock is provided with one end secured to the reel drum and the other end secured to a spindle on which the drum rotates. For example, U.S. Patent No. 6,273,354 to Kovacik et al. discloses such a reel. Such reels are often provided with a ratchet and pawl mechanism (or similar apparatus) for permitting the user to initiate rewinding of the reel by a slight tug on the linear material.

#### SUMMARY OF THE INVENTION

**[0008]** In one aspect, the present invention provides a reel comprising a drum and a housing substantially enclosing the drum. The drum has a spool surface onto which a linear material may be wound, the spool surface having two ends. The drum is rotatable about a drum axis relative to at least a portion of the housing. The at least a portion of the housing has a generally triangular aperture sized to receive a linear material wound onto the drum. The aperture has a first side oriented generally parallel to the drum axis, and second and third sides meeting at a vertex generally midway between opposing ends of the spool surface of the drum.

**[0009]** In another aspect, the present invention provides a method comprising rotating a drum about a drum axis to wind a linear material onto a spool surface of the drum or unwind the linear material from the spool surface of the drum. During the step of rotating the drum, the linear material is drawn through a generally triangular aperture in a housing substantially enclosing the drum, the drum being rotatable about the drum axis with respect to a portion of the housing that includes the aperture. The aperture has a first side oriented generally parallel to the drum axis, and second and third sides meeting at a vertex generally midway between opposing ends of the spool surface of the drum.

**[0010]** In another aspect, the present invention provides a reel comprising a drum and a housing substantially enclosing the drum. The drum has a spool surface onto which a linear material may be wound, and is rotatable about a drum axis relative to at least a portion of the housing. The at least a portion of the housing has a generally triangular aperture sized to receive a linear material wound onto the drum.

**[0011]** In other aspect, the present invention provides a method comprising rotating a drum about a drum axis to wind a linear material onto a spool surface of the drum or unwind the linear material from the spool surface of the drum. During the step of rotating the drum, the linear material is drawn through a generally triangular aperture in a housing substantially enclosing the drum, the drum being rotatable about the drum axis with respect to a portion of the housing that includes the aperture.

**[0012]** For purposes of summarizing the invention and the advantages achieved over the prior art, certain objects and advantages of the invention have been described above and as further described below. Of course, it is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objects or advantages as may be taught or suggested herein.

**[0013]** All of these embodiments are intended to be within the scope of the invention herein disclosed. These and other embodiments of the present invention will become readily apparent to those skilled in the art from the following detailed description of the preferred embodiments having reference to the attached figures, the invention not being limited to any particular preferred embodiment(s) disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1 is a perspective view of a reel according to one embodiment of the present invention.

[0015] Figure 2 is an exploded top perspective view of the reel of Figure 1.

[0016] Figure 3 is an exploded bottom perspective view of the reel of Figure 1.

[0017] Figure 4 is a top perspective view of the reel of Figure 1, with the upper housing portion removed.

[0018] Figure 5 is a bottom perspective view of the drum of the reel of Figure 1.

[0019] Figure 6 is a front view of a triangular aperture according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTOverview

[0020] Embodiments of the present invention provide a reel comprising a reel drum substantially enclosed within a housing having a portion with a triangular aperture for receiving and guiding linear material onto a spool surface of the drum as the drum rotates relative to the housing about a drum axis. In some embodiments, the housing portion having the triangular guide aperture is also rotatable about the drum axis, relative to the drum. In some embodiments, the rotatable housing portion having the triangular guide aperture is also rotatable, about the drum axis, with respect to one or more other portions of the housing. In other words, the drum and housing portion with the triangular guide aperture are preferably independently rotatable with respect to the remainder of the housing. In preferred embodiments, the housing portion with the triangular guide aperture is freely rotatable through at least 360°, and preferably any fraction or multiple thereof, with respect to a remainder of the housing. In preferred embodiments, the reel is adapted to spool electrical cord. However, skilled artisans will appreciate that reels of the present invention can spool other types of linear materials, such as hoses, ropes, and the like.

[0021] Reels that employ a drum that rotates about a vertical axis are susceptible to the problem of non-uniform winding. In other words, the linear material wound upon the drum tends to form a non-uniform spool. This is because the linear material tends to wind upon the lower portion of the drum, due to the effects of gravity.

The present inventors have discovered that this tendency is reduced significantly by a linear material guide or housing aperture that is located generally midway between opposing ends of the spool surface of the drum. During winding, a guide or aperture so positioned causes the linear material to wind more evenly on the spool surface. However, when the direction of drum rotation is reversed, the centrally located guide or aperture can substantially impede or slow down the process of unwinding the linear material, due to the restrictive position and size of the aperture relative to the length of the spool. In many cases, the linear material tends to become stuck or immovable during unwinding.

**[0022]** As used herein, the terms “winding” and “spooling” refer to the process of rotating the drum in a direction to accumulate the linear material onto the spool surface of the drum, and “unwinding” and “unspooling” refer to the process of retracting the linear material from the drum, which involves rotating the drum in the opposite direction.

**[0023]** The present invention addresses this problem by providing a reel having a housing with a generally triangular guide aperture for the linear material. A first vertex of the triangular aperture is preferably located generally midway between the ends of the spool surface of the drum. The first vertex points in the direction in which the linear material is wound so that, during winding, the linear material tends to slide against the first vertex. Thus, during winding, the linear material is guided onto the drum from a position generally midway between the opposing ends of the spool surface, advantageously producing more even and uniform winding as explained above. The side of the triangular aperture that is opposite the first vertex is preferably oriented substantially parallel to the drum’s axis of rotation and has a length preferably large enough to significantly improve the ease of unwinding. During unwinding, the linear material is free to slide against the full length of this side of the triangle, advantageously reducing the likelihood of the linear material getting stuck.

#### Exemplary Reel

**[0024]** In order to provide a fuller understanding of the invention, the following paragraphs describe an exemplary reel and reel housing that are particularly suited to having a triangular aperture as taught herein. While the illustrated reel 10 is an electrical cord reel, triangular apertures of the invention can be provided for reels adapted

to wind different types of linear materials. Further details of the illustrated reel 10 are shown and described in U.S. Patent Application Publication No. US 2006-0266605 A1.

[0025] Figure 1 shows a reel 10 comprising a housing 11 enclosing a rotatable reel drum 20 (Figures 2, 3, and 5) onto which a flexible linear material 2 can be spooled. In the illustrated embodiment, the linear material 2 comprises an electrical cord with a female plug connector 3, as known in the art. The housing 11 comprises a first or lower housing portion 12, a second or upper housing portion 14, and a middle housing portion 16 interposed therebetween. In the illustrated embodiment, the housing portions 12, 14, and 16 collectively form a substantially spherical shape. However, the housing 11 can have other shapes, giving due consideration to the goal of collectively substantially surrounding and preferably enclosing the drum 20. The reel 10 also includes a first or lower support structure 18 mounted to the lower housing portion 12, as well as a second or upper support structure 19 mounted to the upper housing portion 14. The lower support structure 18 is configured to support the reel 10 on a lower support surface. In a preferred embodiment, the reel is capable of operating upside down, and the upper support structure 19 is also configured to support the reel 10 on a lower support surface. As explained in further detail below, the middle housing portion 16 includes a triangular aperture 15 through which the linear material 2 can extend.

[0026] As mentioned above, in a preferred embodiment the reel 10 is adapted to spool electrical cord 2. Preferably, the reel 10 provides electrical power to the cord 2 from an external electrical power outlet. In the embodiment of Figure 1, the reel 10 includes an electrical cable 13 that extends out of a lower opening (not shown) of the lower housing portion 12. The cable 13 preferably includes a standard electrical plug 17 that is adapted to plug into a standard electrical power outlet. The cable 13 preferably provides power to the electrical cord 2 spooled on the reel 10. While the illustrated connectors 3 and 17 are respectively female and male, these "genders" can be reversed.

[0027] Figures 2 and 3 are exploded top and bottom views, respectively, of the reel 10. The reel 10 includes a spindle member 22 having a first end 24 and a second end 26 (Figure 4). The first end 24 is connected to, and preferably integrally formed with, the lower housing portion 12. In this embodiment, the spindle member 22 is configured to extend through an opening 28 (Figure 5) in the drum 20 so that the drum is rotatable about a spindle axis 31 (also referred to herein as a "drum axis") defined by the spindle member 22. Preferably, the opening 28 is sized to closely receive the spindle member 22.

The spindle member 22 is also configured to extend through an opening 30 (Figure 4) of the middle housing portion 16. Preferably, the opening 30 is sized to closely receive the spindle member 22. In one embodiment, the spindle member 22 has a lower larger diameter portion for a close fit with the opening 28 of the drum 20, and an upper smaller diameter portion for a close fit with the opening 30 of the middle housing portion 16, it being understood that the opening 28 is larger than the opening 30. In another embodiment, the openings 28 and 30 are approximately the same size, and the spindle member 22 has a substantially uniform diameter. Skilled artisans will appreciate that other configurations of the spindle member 22 and openings 28 and 30 are possible, keeping in mind the goal of permitting both the middle housing portion 16 and drum 20 to rotate with respect to the spindle member 22 and independently with respect to each other.

**[0028]** With reference to Figures 2-4, the upper housing portion 14 is preferably adapted to connect to the second end 26 of the spindle member 22 when the member 22 extends through the drum 20. Preferably, the upper housing portion 14 and the spindle member 22 are detachably secured to one another so that they cannot rotate with respect to each other. In the illustrated embodiment, the upper housing portion 14 includes four through-holes 32 sized and configured to receive screws 34 (Figure 4) that are in turn adapted to screw into threaded holes 36 in the second end 26 of the spindle member 22. Skilled artisans will appreciate that any of a wide variety of means can be employed for detachably securing the upper housing portion 14 to the spindle member 22.

**[0029]** The reel 10 thus permits the middle housing portion 16 and drum 20 to rotate freely about the spindle member 22 and independently with respect to each other. In order to assist or facilitate the rotation of the drum 20 and/or middle housing portion 16, rotation-assistance elements such as ball bearings, rollers, and the like may (but need not) be provided at interfaces between the housing portions 12 and 16, between the housing portions 14 and 16, between the middle housing portion 16 and the drum 20, between the lower housing portion 12 and the drum 20, between the spindle member 22 and the drum 20, and/or between the spindle member 22 and the middle housing portion 16. Also, tracks or other guide means can be provided to control the relative movement of these members. Lubricants can also be used to reduce friction at these interfaces.

**[0030]** With continued reference to Figures 2 and 3, each of the upper and lower housing portions 12 and 14 preferably includes an annular wall 39 and a plurality of radial ribs 37 for added strength. Alternative configurations for internal walls and ribs are

also possible, keeping in mind the goal of improving the strength and rigidity of the housing portions 12, 14. In other embodiments, the housing portions 12 and 14 do not have any internal members for added strength.

**[0031]** In the disclosed embodiments, the upper and lower support structures 18 and 19 are (but need not be) substantially similar. Accordingly, only the lower support structure 18 is described in detail herein. With reference to Figures 2 and 3, the lower support structure 18 preferably comprises two mounting portions 40 and two handle portions 38. The illustrated mounting portions 40 comprise elongated tubular members that are configured to be mounted on opposing sides of the lower housing portion 12. Skilled artisans will appreciate that the mounting portions 40 can alternatively have non-tubular shapes. In a preferred embodiment, the lower housing portion 12 includes recesses 42 that are sized and shaped to receive the mounting portions 40. The mounting portions 40 can be secured (preferably detachably) to the lower housing portion 12 by any of a wide variety of means, such as by screws, nut and bolt combinations, and the like. For example, the illustrated mounting portions 40 include vertical internally threaded stubs 41 that fit snugly into corresponding recesses 43 inside the recesses 42. The recesses 43 are configured to receive screws for creating a detachable connection between the mounting portions 40 and the lower housing portion 12. The mounting portions 40 can be curved to conform more closely to the semispherical shape of the lower housing portion 12, providing a more stable and secure connection.

**[0032]** The illustrated handle portions 38 are positioned generally on opposing sides of the lower housing portion 12 and are substantially parallel to one another. In the illustrated embodiment, the handle portions 38 comprise elongated tubular members oriented generally perpendicular to the spindle member 22 and positioned so as to maintain a lower extreme of the lower housing portion 12 at least slightly above the lower support surface. The handle portions 38 are preferably sized and shaped to allow a person to grip them directly with his or her hands. Each mounting portion 40 preferably has one end coupled to an end of one of the handle portions 38 and another end coupled to an end of the other of the handle portions 38. Each end of the handle portions 38 is preferably coupled to only one of the mounting portions 40. The end portions of the illustrated mounting portions 40 extend downward and outward from a central portion that mounts to the recess 42 of the lower housing portion 12.

[0033] In a preferred embodiment, the lower support structure 18 further comprises four coupling members 44, each of which couples one of the ends of one of the handle portions 38 to one of the ends of one of the mounting portions 40. In the illustrated embodiment, the coupling members 44 contact the lower support surface, while the handle portions 38 and mounting portions 40 do not. The illustrated coupling members 44 comprise elbow-shaped tubular members.

[0034] As mentioned above, the upper support structure 19 is preferably substantially similar to the lower support structure 18. Accordingly, the illustrated support structure 19 preferably includes handle portions 38, mounting portions 40 adapted to mount within recesses 42 of the upper housing portion 14, and coupling members 44, substantially as described above. The handle portions 38 of either support structure 18, 19 can advantageously be used to conveniently grip onto and move the reel 10. Preferably, the support structures 18, 19 are configured to prevent the housing 11 (e.g., housing portions 12, 14, and 16) from contacting a generally flat support surface regardless of the orientation of the reel 10. For example, the illustrated support structures 18, 19 prevent the housing 11 from contacting the ground even if the reel 10 is turned onto its side. In this configuration, the support structures more effectively protect the housing 11 from damage. In other embodiments, the upper support structure 19 is configured differently or can even be omitted from the reel 10. It will be appreciated that a wide variety of different types of support structures 18, 19 can be used without departing from the scope of the invention.

[0035] Figures 2, 3, and 5 show a preferred embodiment of the reel drum 20. The illustrated drum 20 comprises a substantially cylindrical member 46 having a spool surface 47 onto which linear material can be spooled, a first end plate 48 at one end of the member 46, and a second end plate 50 at the other end of the member 46. The cylindrical member 46 and end plates 48 and 50 preferably rotate in unison together about the spindle member 22. The cylindrical member 46 and end plates 48 and 50 can be formed integrally as a single unitary piece or can be formed separately and secured together. The middle housing portion 16 encircles the drum 20 and preferably rotates about the spindle member 22 independently of the drum 20. The triangular aperture 15 is preferably positioned near the surface of a cylindrical member 46, so as to direct the linear material onto the drum 20 during spooling.

[0036] With reference to Figures 3 and 5, the lower housing portion 12 is preferably adapted to house a motor 51 that drives the reel drum 20 through a gear reduction assembly. In the illustrated embodiment, the motor 51 is housed within the spindle member 22. The motor 51 is inserted into an opening 52 in the underside of the lower housing portion 12. A motor cover 54 can be provided to support the motor 51 and/or close and possibly seal the opening 52 to protect the motor and gears from dust and debris. For ease of illustration, the gear reduction is not shown in the drawings. However, skilled artisans will understand that the gear reduction may comprise any suitable number of gears assembled to convert the motor rotational output into rotation of the drum 20 about the drum axis 31. For example, as shown in Figures 3 and 5, the gear reduction can effect rotation of the drum 20 by rotating a ring gear 58 comprising an annular wall on the bottom side of the end plate 48, with teeth facing radially inward from the annular wall. In the illustrated embodiment, the annular wall is part of a ring-shaped piece 70 that is secured to the bottom side of the end plate 48. In other embodiments, the piece 70 can be formed integrally with the end plate 48. Further details of a preferred configuration of the gear reduction are set forth in U.S. Patent Application Publication No. US 2006-0266605 A1.

[0037] Thus, the motor 51 produces rotation of the drum 20 about the spindle member 22. As seen in Figure 3, in the preferred embodiment the motor 51 is upside down (i.e., its output faces downward). However, it will be appreciated that the motor 51 can be oriented other than as shown. Skilled artisans will also understand that a variety of different types of motors and gear reduction assemblies can be employed without departing from the scope of the invention.

[0038] In use, a user can unwind the linear material 2 from the drum 20 by pulling the material out through the triangular aperture 15 of the middle housing portion 16. In doing so, the drum 20 begins to rotate with respect to the upper and lower housing portions 12, 14 and the spindle member 22. The middle housing portion 16 is also freely rotatable, and its rotational position may vary because the aperture 15 will tend to follow the radial direction in which the user pulls the linear material 2. As the user moves around the reel 10 holding a portion of the linear material that is withdrawn from the housing 11, the middle housing portion 16 freely rotates to allow the aperture 15 to follow the radial direction of the withdrawn linear material. In this manner, the freely rotatable middle housing portion 16 facilitates using the linear material within a larger area. For

example, the reel 10 can be placed centrally within a room or outdoor area (e.g., on the ground or mounted to a ceiling) and the linear material can be relatively easily withdrawn toward any direction or portion of the room or area. When the user wishes to spool the linear material onto the drum 20, the user can switch on the motor 51 accordingly. The resultant rotation of the drum 20 causes the linear material to be pulled back into the housing 11 through the aperture 15 of the middle housing portion 16.

**[0039]** During spooling, the middle housing portion 16 may tend to rotate along with the drum 20, due to friction therebetween. This can cause the linear material to swing around the reel 10, which can result in harm to surrounding persons or objects. Preferably, the reel 10 includes a mechanical and/or electrical mechanism to rotationally lock the middle housing portion 16 with respect to the upper and lower housing portions 12, 14 during spooling. With reference to Figure 3, the illustrated embodiment includes a solenoid device 62 secured to the lower housing portion 12. The solenoid device 62 is electrically operable, as well known in the art, to cause a piston stem 64 to extend in and out of an outer opening of its housing. The stem 64 is sized and shaped to slide into any one of a ring of indentations 66 provided on the inner surface of the middle housing portion 16. The indentations 66 can have any of wide variety of shapes and sizes, keeping in mind the goal of permitting the solenoid stem 64 to stop the middle housing portion 16 from rotating by entering one of the indentations 66. When the stem 64 enters one of the indentations 66, it "locks" the middle housing portion 16. In other words, the extended stem 64 prevents the middle housing portion 16 from rotating with respect to the upper and lower housing portions 12, 14. An electronic control system can be provided to actuate the solenoid device 62 (i.e., cause the stem 64 to extend) when the motor 51 is switched to a spooling operation, and to retract the solenoid device 62 (i.e., cause the stem 64 to retract into its housing) when the motor 51 is switched off or to a powered unspooling operation.

**[0040]** In a preferred embodiment, the illustrated electrical cord reel 10 is adapted to provide electrical power to an electrical cord 2 wound on the drum 20, the cord 2 being operable to deliver power to an external device. Accordingly, the reel 10 can include suitable means for enabling a power connection between the cord 13 (Figure 1) and the wound cord 2, as known in the art. For example, the bottom of the end plate 48 of the drum 20 can include electrically conductive rings 78 (Figure 5), also referred to as "slip rings," adapted to contact electrical brushes (not shown) that are in turn in electrical

communication with the cord 13. Further, the drum 20 can be configured to provide an electrical connection between the slip rings 78 and a power connector (not shown) on the drum 20, to which the wound cord 2 is connected. Further details of a preferred configuration for providing electrical power to the wound cord 2 are provided in U.S. Patent Application Publication No. US 2006-0266605 A1.

### Triangular Aperture

**[0041]** Figure 6 shows the triangular aperture 15, in accordance with a preferred embodiment of the invention. As mentioned above, the middle housing portion 16 includes a generally triangular aperture 15 sized to receive a linear material (in the illustrated embodiment, the electrical cord 2) wound onto the drum 20. The aperture 15 has a first side 92, a second side 94, and a third side 96. The first side 92 is preferably oriented generally parallel to the drum axis 31 (Figure 2). The first side 92 and second side 94 meet at a vertex 97. The first side 92 and third side 96 meet at a vertex 95. The second side 94 and the third side 96 meet at a vertex 93.

**[0042]** The vertex 93 is preferably positioned generally midway between opposing ends of the spool surface 47 of the drum 20. For example, in the illustrated embodiment, the vertex 93 is preferably positioned generally midway between inner surfaces of the end plates 48 and 50. The aperture 15 is advantageously sized and oriented so that, during winding, the linear material 2 tends to translate against the vertex 93. Preferably, a locking apparatus or mechanism (such as the solenoid device 62 described above) is provided to positionally lock the middle housing portion 16 while the linear material 2 is being wound onto the drum 20, so that the vertex 93 remains fixed with respect to the rotating drum.

**[0043]** During unwinding of the linear material 2, the middle housing portion 16 is preferably unlocked with respect to the housing portions 12, 14, allowing the housing portion 16 to rotate in a direction that would ease the retraction of the linear material. As a result, the linear material 2 is free to retract through a portion of the triangular aperture 15 other than just the vertex 93 (in Figure 6, any portion of the aperture 15 to the right of the vertex 93). Advantageously, a larger vertical dimension of the aperture 15 is available for retracting the linear material 2, resulting in significant improvements in the ease of retraction of the linear material. Also, the novel triangular

shape of the aperture 15 allows for a greater amount of linear material 2 to be spooled into the housing 11, such as an increase of about 25%.

[0044] In a preferred embodiment, the vertices 93, 95, and 97 are rounded, with a radius preferably equal to or greater than that of the linear material 2. Such rounded vertices are preferred over sharp vertices because the latter would involve heightened stress concentrations in the middle housing portion 16. Also, the thickness of the middle housing portion 16 is preferably increased along the edges or sides 92, 94, 96 of the aperture 15, to provide increased strength for withstanding loads imposed against such edges by the taught linear material 2 during winding or unwinding.

[0045] Skilled artisans will appreciate that the ease with which the linear material 2 can be unwound from the reel 10 depends upon the length of the first side 92 of the triangular aperture 15 relative to the length of the drum 20. The first side 92 extends across preferably at least 35%, more preferably at least 50%, more preferably at least 60%, more preferably at least 80%, and even more preferably at least 95% of a length of the spool surface 47 of the drum 20. It will also be appreciated that the ease with which the linear material can be unwound depends upon the extent to which the first side 92 of the triangular aperture 15 is centered with respect to the length of the drum 20. In this regard, a distance  $y$  between (1) a plane 102 that is parallel to the drum axis 31 (Figure 1) and that extends through a center 98 of the first side 92, and (2) a plane 104 that is perpendicular to the drum axis 31 and that extends through a center of a length of the spool surface 47 of the drum 20, is preferably less than 20%, more preferably less than 10%, and even more preferably less than 5% of the length of the spool surface. In the illustrated embodiment of Figure 6, the plane 104 is below the center 98 of the length of the first side 92 of the aperture 15; however, it will be appreciated that the plane 104 could be above or directly level with the center 98.

[0046] Skilled artisans will understand that the advantages of providing the triangular aperture 15 are achieved when the aperture "points" in the correct direction. In particular, the linear material 2 is preferably wound in a direction in which the vertex 93 points. For example, in the orientation of Figure 6, the linear material 2 is preferably wound in a clockwise direction (viewing the reel and aperture 15 of Figure 6 from above) about the drum. In other words, the linear material 2 is preferably wound in a direction so that, during winding of the linear material onto the drum, the linear material tends to slide against the vertex 93.

[0047] Skilled artisans will also appreciate that the ease of retraction of the linear material depends also upon the shape of the triangular aperture 15. In a preferred embodiment, the aperture 15 is shaped substantially like an isosceles triangle and the second side 94 and third side 96 are oriented with respect to one another at an angle preferably within 20-50°, more preferably within 25-45°, and even more preferably within 30-40°. Other possible ranges include 25-55°, 30-50°, and 35-45°.

[0048] Skilled artisans will also appreciate that the ease of retraction of the linear material also depends upon the size of the aperture 15 relative to that of the drum 20. The spool surface 47 of the drum 20 is preferably cylindrical and the distance between the vertex 93 and the first side 92 is preferably within 40-300%, more preferably within 60-200%, more preferably within 75-150%, and even more preferably within 85-125% of a diameter of the spool surface 47. In one embodiment, the distance between the vertex 93 and the first side 92 is about the same as the diameter of the spool surface. Other suitable ranges for said angle are 70-130%, 85-115%, and 95-105% of the diameter of the spool surface 47.

[0049] Although the invention has been disclosed in the context of certain embodiments and examples, it will be understood by those skilled in the art that the invention extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses and obvious modifications and equivalents thereof. Accordingly, the invention is not intended to be limited by the specific disclosures of preferred embodiments herein.

WHAT IS CLAIMED IS:

1. A reel comprising:
  - a drum onto which a linear material may be wound, the drum having two ends; and
    - a housing substantially enclosing the drum, the housing comprising a first housing portion and a second housing portion, the drum being rotatable about a drum axis relative to the second housing portion, the second housing portion being rotatable with respect to the first housing portion about the drum axis, the second housing portion having a generally triangular aperture sized to receive a linear material wound onto the drum, the aperture having a first side oriented generally parallel to the drum axis, and second and third sides meeting at a vertex generally midway between the ends of the drum.
2. The reel of Claim 1, wherein the aperture has rounded vertices.
3. The reel of Claim 1, wherein the first side of the aperture extends across at least 50% of a length of the drum.
4. The reel of Claim 1, wherein a distance between a center of the first side of the aperture and a plane perpendicular to the drum axis and extending through a center of a length of the drum is less than 20% of the length of the drum.
5. The reel of Claim 1, wherein a thickness of the second housing portion is increased along edges of the aperture.
6. The reel of Claim 1, further comprising a linear material at least partially wound upon the drum and extending through the aperture, the linear material being wound in a direction in which the vertex points.
7. The reel of Claim 1, further comprising a linear material at least partially wound upon the drum, the linear material being wound in a direction so that, during winding of the linear material onto the drum, the linear material tends to slide against the vertex.
8. The reel of Claim 1, wherein the triangular aperture is shaped substantially like an isosceles triangle and the second and third sides are oriented at an angle of 20-50° with respect to one another.
9. The reel of Claim 1, wherein the drum is cylindrical and a distance between the vertex and the first side is within 40-300% of a diameter of the drum.

10. The reel of Claim 1, further comprising a mechanism for rotatably locking the first and second housing portions while rotating the drum in a direction to wind linear material thereon.

11. A method comprising:

rotating a drum about a drum axis to wind a linear material onto the drum or unwind the linear material from the drum; and

during said step of rotating the drum, drawing the linear material through a generally triangular aperture in a housing substantially enclosing the drum, the housing comprising a first housing portion and a second housing portion rotatable with respect to the first housing portion about the drum axis, the second housing portion including the aperture, the drum being rotatable about the drum axis with respect to the second housing portion, the aperture having a first side oriented generally parallel to the drum axis, and second and third sides meeting at a vertex generally midway between opposing ends of the drum.

12. The method of Claim 11, further comprising rounding one or more vertices of the aperture.

13. The method of Claim 11, further comprising configuring the aperture so that the first side of the aperture extends across at least 50% of a length of the drum.

14. The method of Claim 11, further comprising positioning the first side of the aperture so that a distance between a center of the first side of the aperture and a plane perpendicular to the drum axis and extending through a center of a length of the drum is less than 20% of the length of the drum.

15. The method of Claim 11, further comprising increasing a thickness of the second housing portion along edges of the aperture.

16. The method of Claim 11, wherein rotating the drum about the drum axis comprises winding the linear material onto the drum in a direction in which the vertex points.

17. The method of Claim 11, wherein rotating the drum about the drum axis comprises causing the linear material to slide against the vertex.

18. The method of Claim 11, further comprising:

shaping the aperture substantially like an isosceles triangle; and

orienting the second and third sides of the aperture at an angle of 20-50° with respect to one another.

19. The method of Claim 11, wherein the drum is cylindrical and a distance between the vertex and the first side is within 40-300% of a diameter of the drum.

20. The method of Claim 11, wherein rotating the drum about the drum axis comprises rotating the drum in a direction to wind the linear material onto the drum, the method further comprising rotatably locking the first and second housing portions during the step of rotating the drum.

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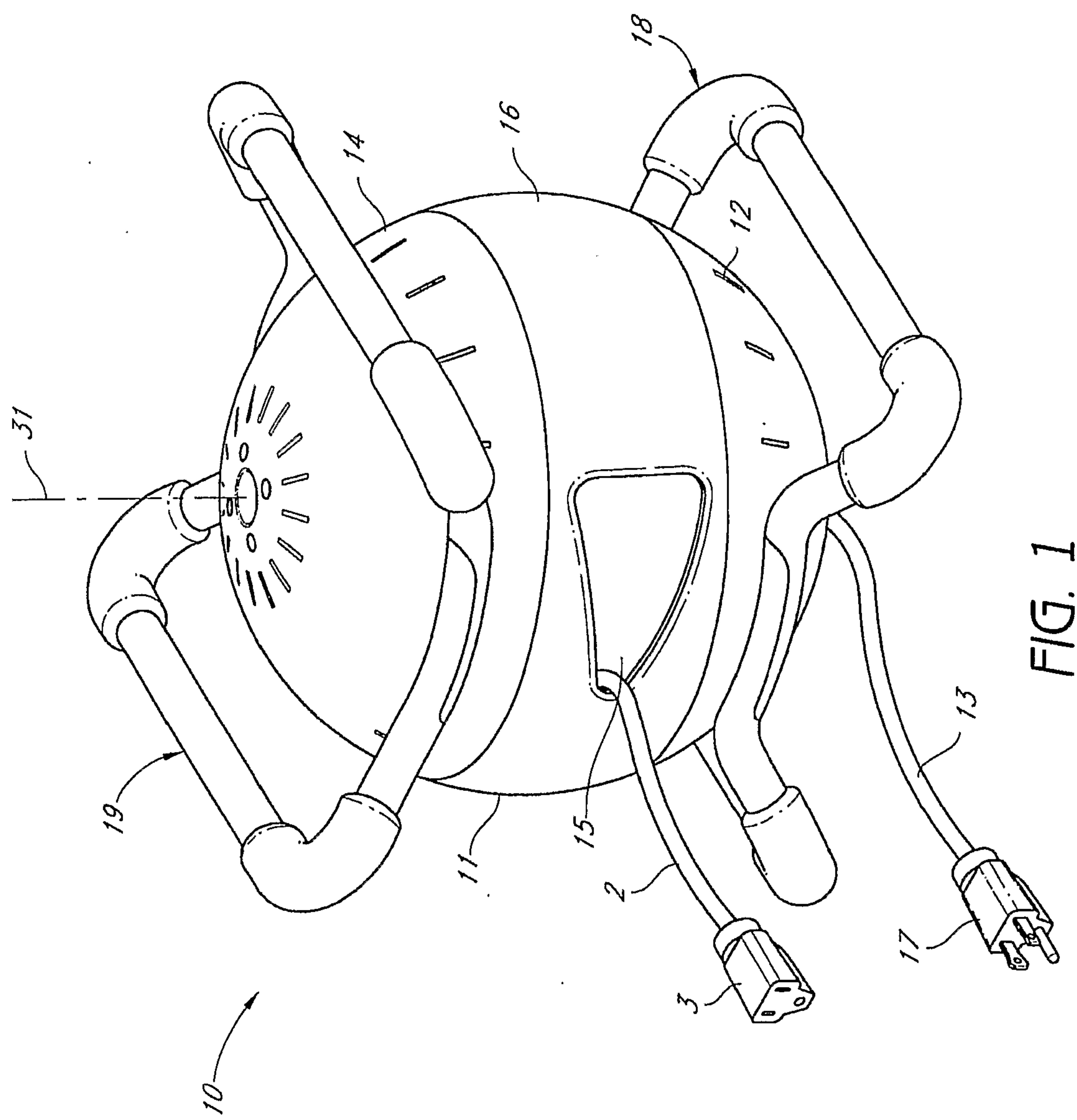


FIG. 1

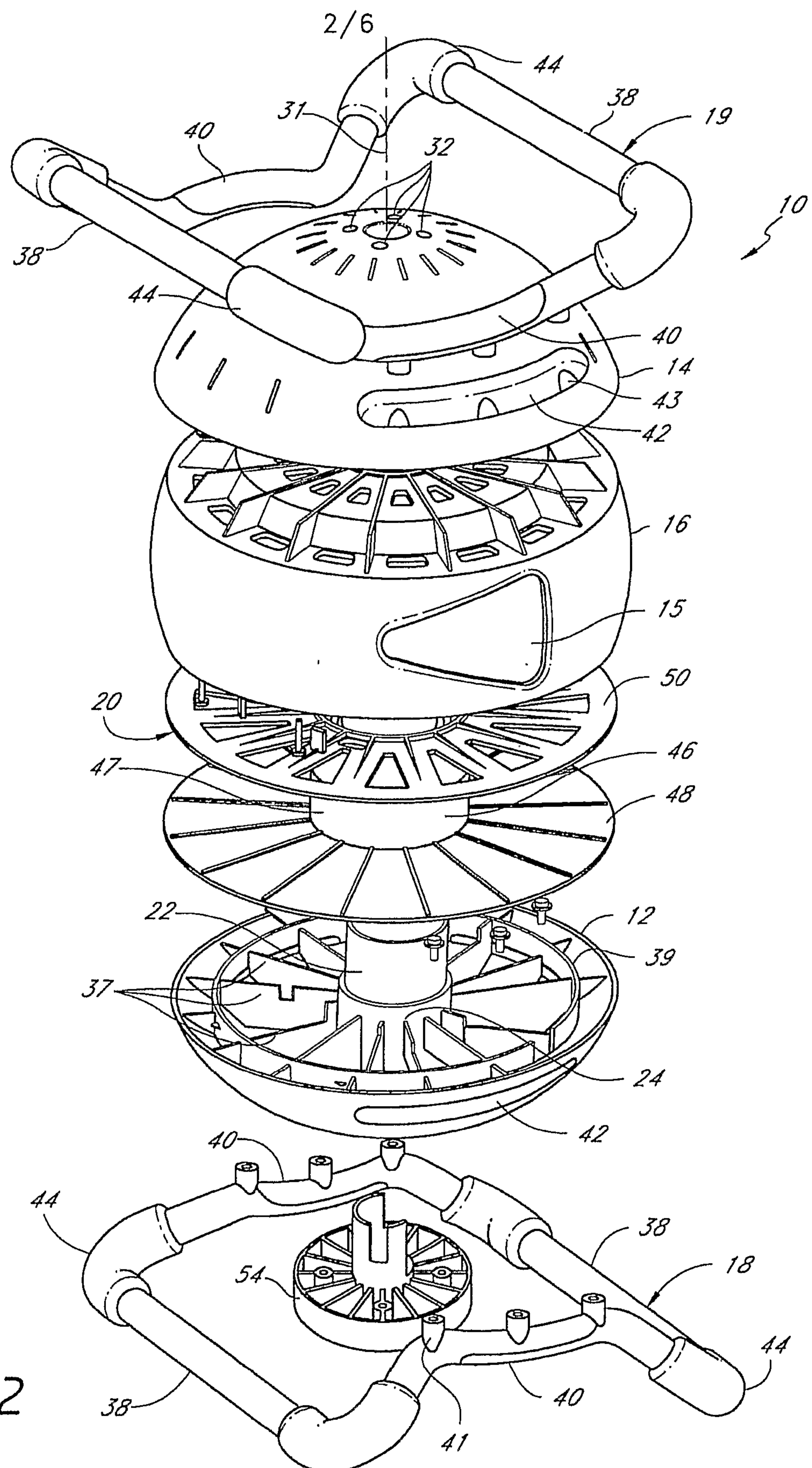
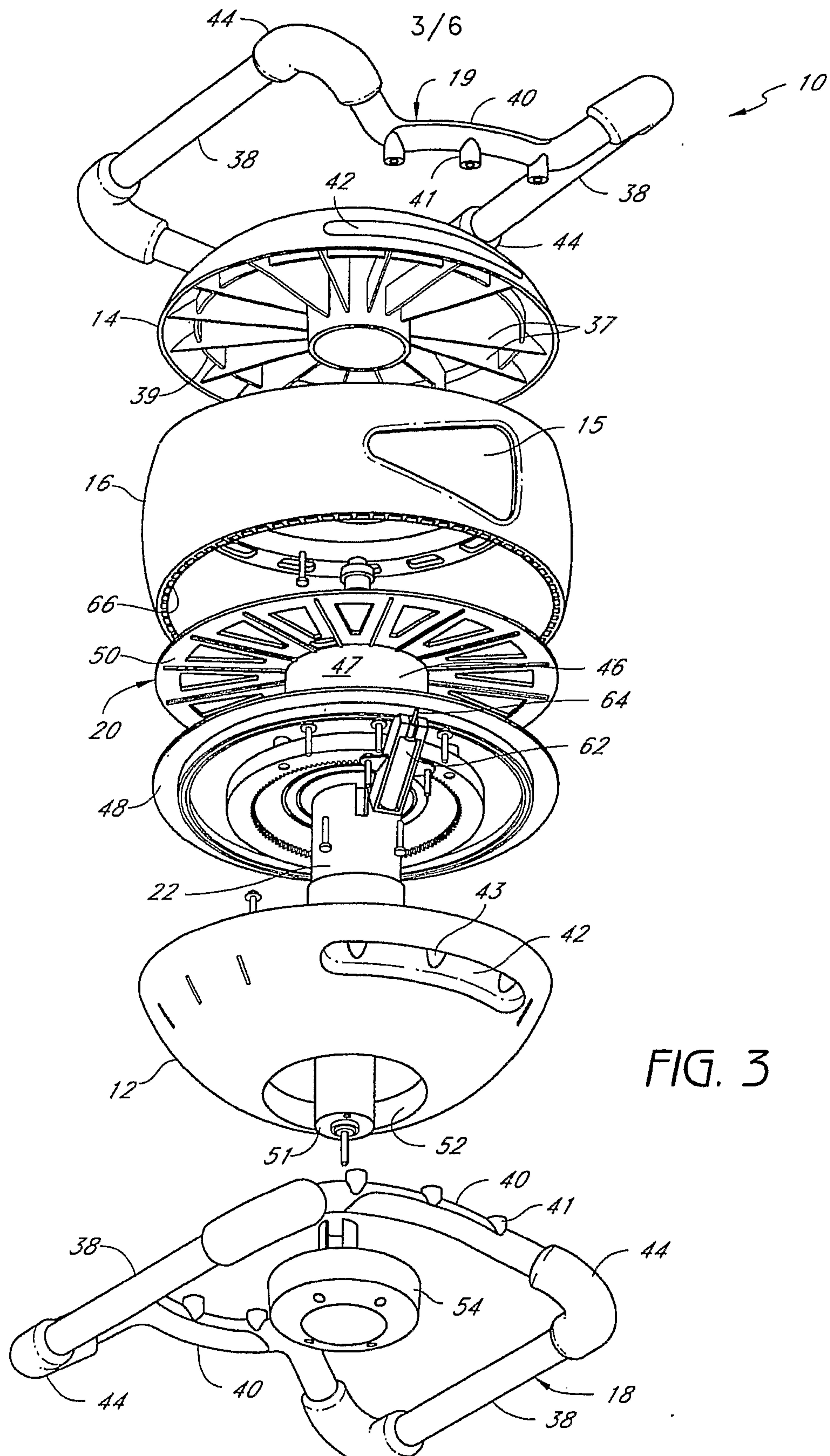


FIG. 2

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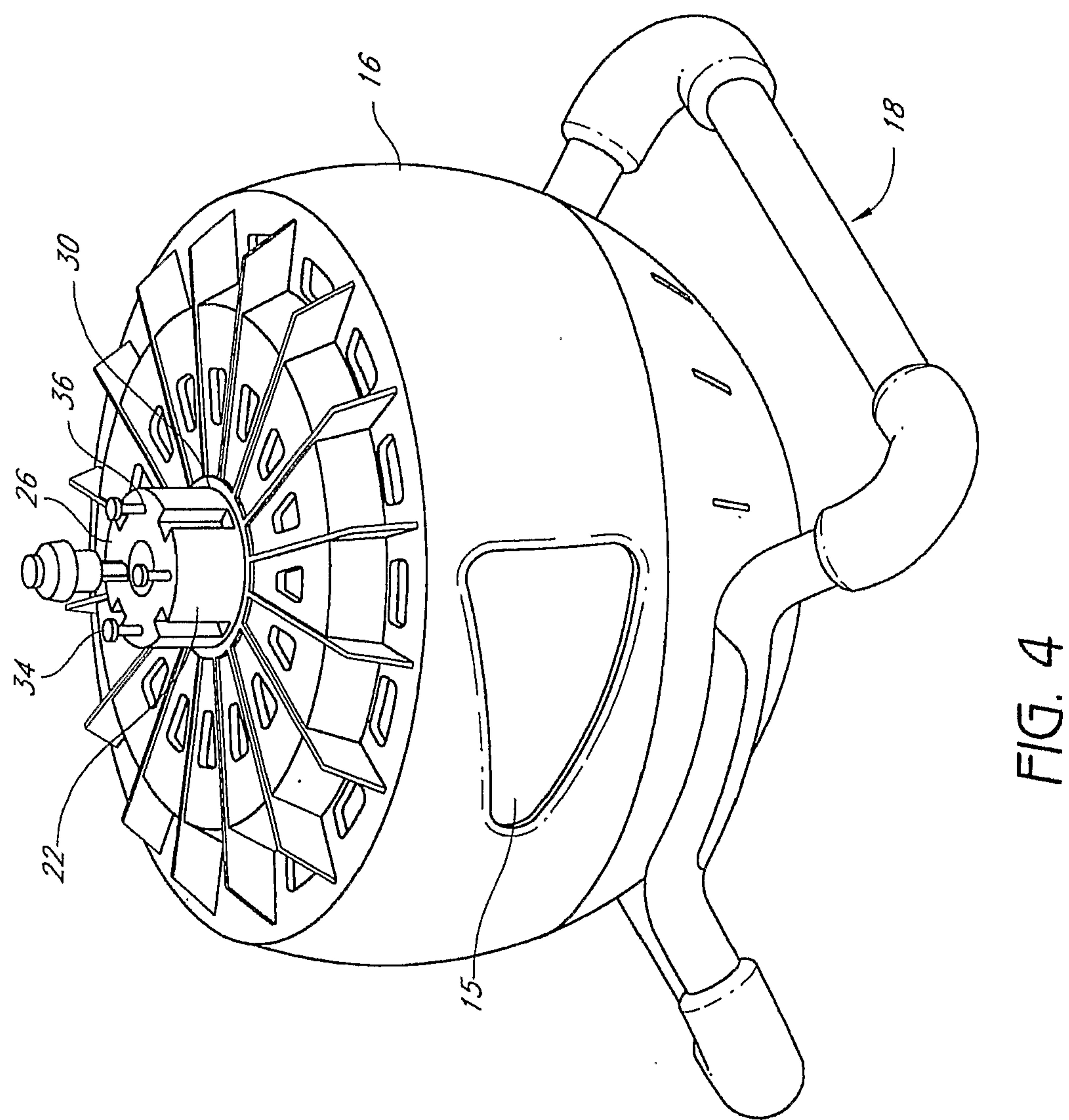
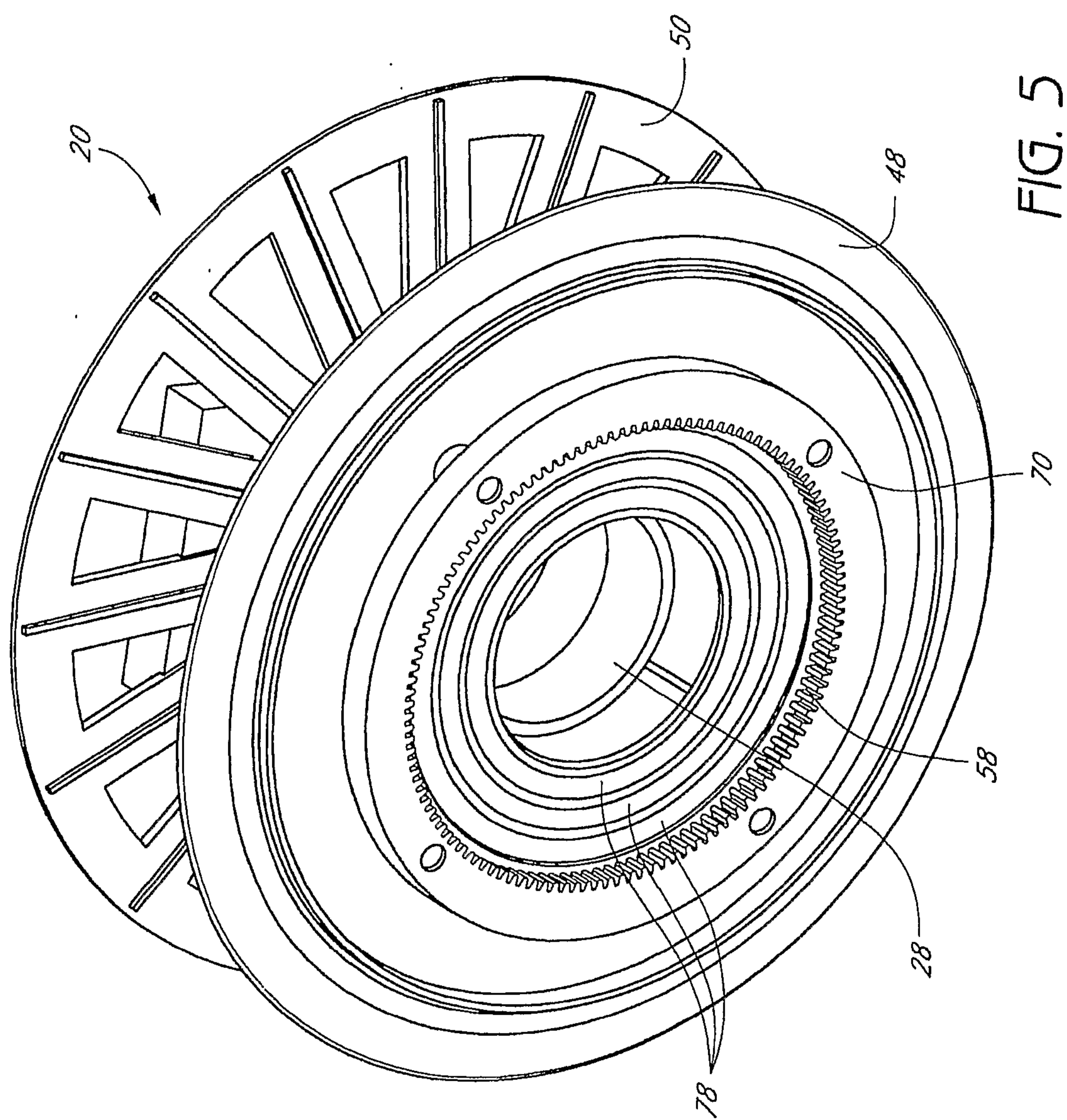


FIG. 4

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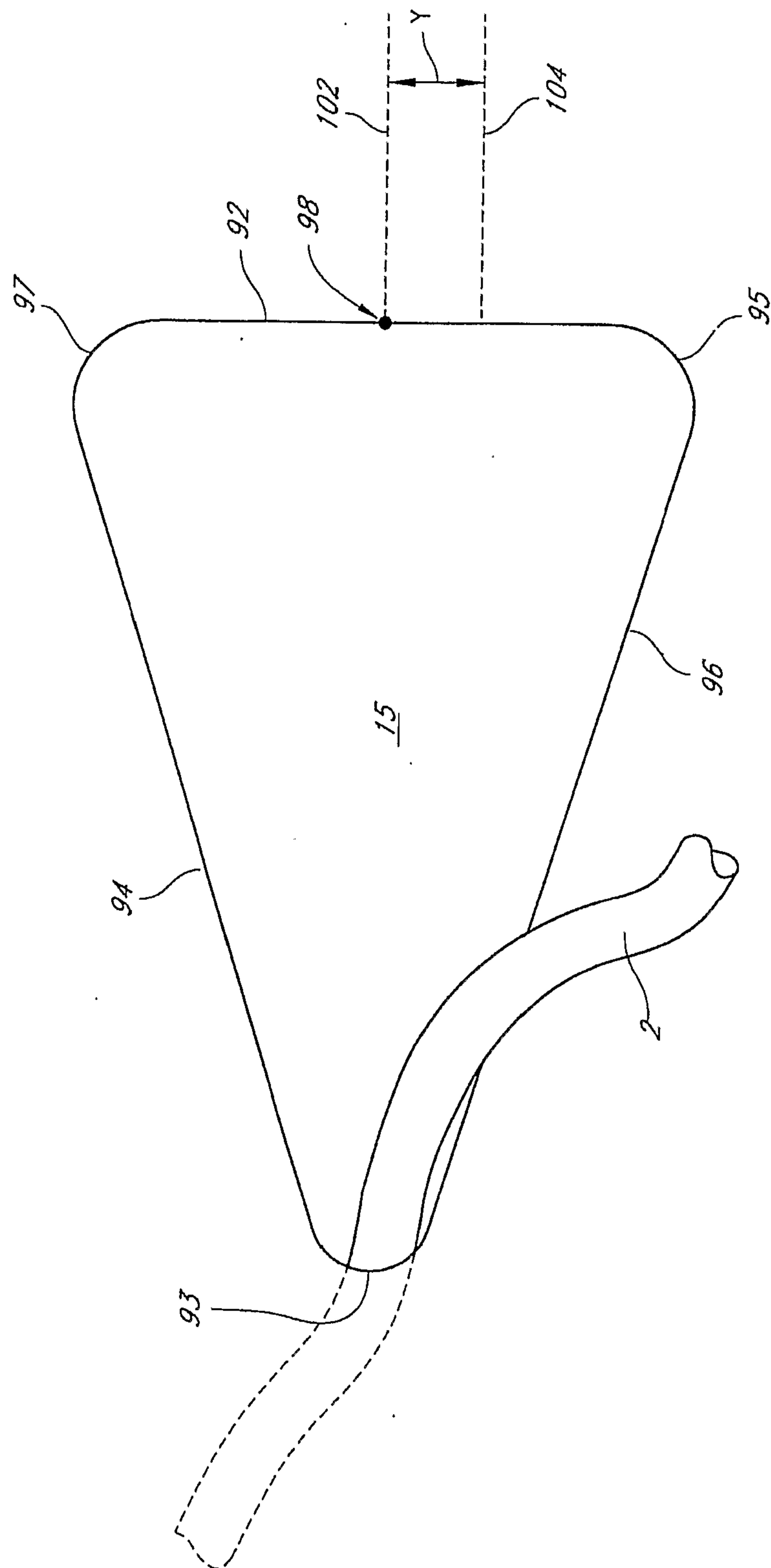


FIG. 6

