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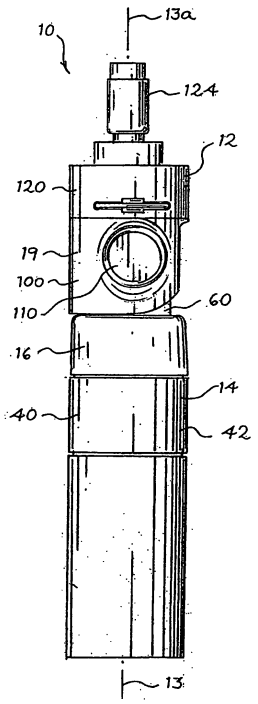
(54) Handheld rotary tool

(57) A rotary tool (10) is provided with a head section (12) that is selectively pivotable at a plurality of positions between an orientation where the head section (12) is in-line with a body section (14) to an orientation where the head section (12) is perpendicular to the body section (14), and where the rotary tool can also swivel about an arc of 360 degrees.

Fig. 1



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Description

BACKGROUND

[0001] The present invention relates to power tools, and in particular to a rotary tool with a head section that can pivot with respect to the body of the tool. Additionally, the present invention relates to a rotary tool with a head section that can rotate with respect to the body section of the tool. The present invention also contemplates a rotary tool having a head section that can pivot and rotate with respect to the body section. The tool of the present invention improves on previous designs because it includes a head section that can pivot and/or rotate with respect to a body section with the motor positioned within the body section. Previous rotary tool designs included a motor that was located within the head section, which caused the head section to be significantly larger than the head section of the present invention, which limited the operability of the previous tools in tight spaces.

SUMMARY OF THE INVENTION

[0002] In a first aspect the present invention provides a rotatable head section comprising (a) a transmission with an input end connected to a rotating member and an output end connected to an output tool; (b) a body section that retains an input end of the transmission and includes a gearbox housing and a longitudinal axis; (c) a sleeve that surrounds a top portion of the gearbox housing and is movable along the gearbox housing; (d) a rotatable cap surrounding the sleeve to selectively cause engagement of the sleeve and the gearbox housing; (e) a head section that houses an output of the transmission, and that is rotatable about the body section along the longitudinal axis of the body section, wherein the head section is prevented from rotating with respect to the body section when the sleeve engages the gearbox housing.

[0003] Preferably the tool further comprises a plurality of flanges that project from the gearbox housing.

[0004] Preferably the sleeve includes a plurality of recesses that accept the plurality of flanges to cause engagement of the sleeve and the gearbox housing.

[0005] Preferably the number of the plurality of recesses is the same as the number of flanges.

[0006] Preferably the number of the plurality of recesses is a positive multiple of the number of flanges.

[0007] Preferably the tool further comprises a cam surface at a bottom end of the sleeve and a corresponding cam surface on the rotatable cap.

[0008] Preferably the tool further comprises further comprising: (a) a plurality of flanges that project from the gearbox housing; (b) a plurality of recesses provided on a bottom surface of the sleeve to accept the plurality flanges; (c) a cam surface at the bottom end of the sleeve; and (d) a cam surface on the rotatable cap, wherein the cap can be rotated to cause engagement between the cam surfaces to cause the recesses in the sleeve to engage the flanges in the gearbox housing.

[0009] Preferably the sleeve is biased away from engagement with the gearbox housing

[0010] In a still further aspect the invention provides a tool operable in at least two positions comprising (a) a transmission with an input end and an output end; (b) a body section with a longitudinal axis including (i) a gearbox housing, (ii) a lock housing that surrounds a top portion of the gearbox housing and that can move along the gearbox housing, (iii) a motor, (iv) a rotatable cap surrounding a bottom portion of the lock housing to selectively cause engagement between the lock housing and the gearbox housing; (c) a head section rotatably connected to the body section to rotate about the longitudinal axis of the body section, with the head section being prevented from rotating with respect to the body section when the lock housing engages the gearbox housing; (d) a pivot housing disposed between the head section and the body section and being pivotably connected to the lock housing about a pivot axis, wherein each of the pivot housing and the lock housing include an aperture; and (e) a block positioned in the lock housing aperture and selectively inserted in the pivot housing aperture to retain the head section in a selected orientation with respect to the body section.

[0011] Advantages of the present invention will become more apparent to those skilled in the art from the following description of the preferred embodiments of the invention that have been shown and described by way of illustration. As will be realized, the invention is capable of other and different embodiments, and its details are capable of modification in various respects. Accordingly, the drawings and description are to be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a side view of one embodiment of the rotary tool, showing the head section of the tool in-line with the body section of the tool of the present invention.

[0013] FIG. 2 is a side view of the tool of FIG. 1, with the head section perpendicular to the body section of the tool.

[0014] FIG. 3 is an exploded view of the tool of FIG. 1, showing the components aligned with the head section in-line with the body section.

[0015] FIG. 4 is an exploded view of the tool of FIG. 1.

[0016] FIG. 5 is a cross-sectional view of the tool of FIG. 1, showing the components of the locking mechanism in the locked position.

[0017] FIG. 6 is a cross-sectional view FIG. 5 in the unlocked position.

[0018] FIG. 7 is a perspective view of a second embodiment of the rotary tool of the present invention, showing the head section of the tool in-line with the body section of the tool.

[0019] FIG. 8 is the view of FIG. 7, showing the head section of the tool perpendicular to the body section of

the tool.

[0020] FIG. 9 is a partial exploded view of the tool of FIG. 7.

[0021] FIG. 9a is a perspective view of the pivot housing.

[0022] FIG. 9b is a perspective view of the second housing cover.

[0023] FIG. 10 is a side view of the pivot housing and the cover section when the head section of the tool is in-line with the body section of the tool.

[0024] FIG. 11 is a side view of the pivot housing, cover section, and middle housing cover when the head section is in-line with the body section of the tool.

[0025] FIG. 12 is a side view of FIG. 10, of the pivot housing and the cover section when the head section is at a first oblique angle with respect to the body section of the tool.

[0026] FIG. 13 is a side view of FIG. 11, of the pivot housing, cover section, and middle housing cover when the head section is at a first oblique angle with respect to the body section.

[0027] FIG. 14 is a side view of FIG. 10, of the pivot housing and the cover section when the head section is at a second oblique angle with respect to the body section.

[0028] FIG. 15 is the view of FIG. 11, of the pivot housing, cover section, and middle housing cover when the head section is at a second oblique angle with respect to the body section.

[0029] FIG. 16 is the view of FIG. 10, of the pivot housing and the cover section when the head section is perpendicular to the body section.

[0030] FIG. 17 is the view of FIG. 11, of the pivot housing, cover section, and middle housing cover when the head section is perpendicular to the body section.

[0031] FIG. 18 is a perspective view of an alternate embodiment of the pivot housing.

[0032] FIG. 19 is a perspective view of tool of FIG. 18, with the lock button removed to show the head section in-line with the body section.

[0033] FIG. 20 is the view of FIG. 19, showing the head section at a forty five degree angle with respect to the body section.

[0034] FIG. 21 is the view of FIG. 19, showing the head section perpendicular to the body section.

[0035] FIG. 22 is an exploded view of the a third embodiment of the handheld rotary tool.

[0036] FIG. 23 is a perspective view of the tool of FIG. 22, showing the gearbox housing connected to the universal joint.

[0037] FIG. 24 is a perspective view of the tool of FIG. 22, showing the lock housing.

[0038] FIG. 25 is a perspective view of the tool of FIG. 22, showing the lock housing.

[0039] FIG. 26 is a perspective view of the tool of FIG. 22, showing the upper swivel cap.

[0040] FIG. 27 is a perspective view of an alternate embodiment of the pivot housing and the lock housing.

DETAILED DESCRIPTION

[0041] Referring now to FIGS. 1-6, a handheld pivotable tool 10 according to the present invention is shown. As an example, the handheld pivotable tool 10 can be a handheld drill or a handheld impact driver. FIGs. 3 and 4 are exploded views of the components of the handheld pivotable tool 10. The handheld pivotable tool 10 has a head section 12 that rotatably moves an output tool or bit. The head section 12 can freely pivot about a body section 14 that is held by a user during operation. The head section 12 may be retained in one position where the longitudinal axis 13a of the head section 12 is aligned along the longitudinal axis 13 of the body section 14. The head section 12 may also be selectively pivoted to positions other than aligned with the longitudinal axis 13. Desirably, the head section 12 can be pivoted about a pivot axis 13b (FIGs. 3 and 4) to a plurality of positions between an orientation where the head section 12 is in-line with the body section 14 and an orientation where the head section 12 is orthogonal to the body section 14. For example, FIG. 20 shows the head section 12 at a 45 degree angle with respect to the body section 14. In other embodiments, the head section 12 can be retained at other angles with respect to the body section 14. The handheld pivotable tool 10 is provided with a locking mechanism 19 to retain the head section 12 in the selected position with respect to the body section 14.

[0042] In embodiments where the handheld pivotable tool 10 is an impact driver, the impact mechanism can either be located inside the body section 14 behind an input end of the transmission or universal joint 80, or in the head section 12 engaging with the output end of the universal joint 80 behind the spindle 124.

[0043] The pivotable handheld pivotable tool 10 includes a carrier 20, a gearbox housing 40, a lock housing 60, a universal joint 80, a pivot housing 100, and a spindle lock housing 120. The locking mechanism 19 includes a lock housing 60, a pivot housing 100, a block 108, and a lock button 110. Apertures 68, 106 formed in the lock housing 60 and the pivot housing 100, respectively, receive the lock button 110 that retains the block 108 within the apertures 68, 106.

[0044] The body section 14 of the handheld rotary tool 10 includes the motor 17, the gearbox 18, the carrier 20, the gearbox housing 40, and the lock housing 60. The body section 14 also retains a rear section 83 of the universal joint 80. In other embodiments, the handheld rotary tool 10 can be formed without a gearbox 18 such that the output spindle 124 rotates at the same angular velocity as the motor shaft 17a. In these embodiments, the output shaft 17a of the motor 17 engages directly with the carrier 20, or similar structure known to those in the art to accept torque from a motor and transfer the torque to the remaining members of the handheld rotary tool 10. In these embodiments, the tool is still formed with a structure similar to the gearbox housing 40. Specifically, the tool in these embodiments includes a structure that in-

cludes at least the shoulder 44 and the neck 46 of the gearbox housing 40 described herein including all of the structure that is discussed below that is a part of the shoulder 44 and the neck 46 of the gearbox housing 40. The term "gearbox housing" is used throughout the specification and claims for the sake of simplicity. It should be understood that the term "gearbox housing" is the name for the structure shown as element 40, but should not be understood to require that the structure 40 enclose and support a speed reduction gearbox nor that the use of a speed reduction gearbox is a required element of the embodiments or the claims.

[0045] It is contemplated to provide a control mechanism within the body section to allow the user to control the output torque of the handheld pivotable tool 10. For example, as shown in FIG. 1, a clutch 16 is included in the body section 14 between the gearbox housing 40 and the lock housing 60 to control the transfer of torque between the gear train 18 and the carrier 20.

[0046] The head section 12 includes a pivot housing 100 and a spindle lock housing 120, which supports a spindle lock mechanism (not shown). The spindle lock housing 120 receives a front section 92 of the universal joint 80. The spindle lock housing 120 further includes an output spindle 124 with a hexagonal collet to accept an output tool (not shown). As is discussed in detail below, the head section 12 is maintained in a selected position with respect to the body section 14 with a connection between the lock housing 60 and the pivot housing 100. The head section further includes a bearing 130, which is mounted on the front section 92 of the universal joint 80, discussed below.

[0047] The carrier 20 is provided within the body section 14 and is enclosed within the gearbox housing 40 (along with portions of the gear train 18). The carrier 20 is disc-shaped with a plurality of posts 22 extending from the rear surface of the discs and a hollow cylinder 24 extending from the front surface. Each of the posts 22 are preferably inserted into a center aperture of a planet gear 18a that is included within a planetary gear train 18. Therefore, the carrier 20 rotates along with the rotation of the planet gears, which rotate about an internal sun gear 18b, normally attached to an output shaft 17a of a motor 17. The planetary gear train 18 may include multiple stages. Therefore, the carrier 20 rotates within the body section 14 based on the rotation of the motor 17. The carrier 20 is retained within a body section 42 of the gearbox housing 40, with the front surface of the carrier located in close vicinity to the rear surface of the body section 42. When the carrier 20 is in this position, the hollow cylinder 24 extends into a shoulder portion 44 of the gearbox housing 40.

[0048] The hollow cylinder 24 of the carrier 20 is formed with an aperture 25 through which the rear end 83 of the rear section 82 of the universal joint 80 is inserted. Preferably, the aperture 25 and rear end 83 are formed to prohibit relative rotation between the two when the end 83 is inserted into the aperture 25. The aperture 25 and the rear end 83 may have complementary shapes. In some embodiments, the rear end 83 and the aperture 25 are each formed as a "D" or a similar shape to prevent relative rotation between the universal joint 80 and carrier 20. Upstream of the carrier 20, the rear section 82 of the universal gear is rotationally supported by a needle roller bearing 26 that is housed within the shoulder portion 44 of the gearbox housing 40. Additionally, the rear section 82 of the universal joint 80 can be rotationally supported by a bushing 27. The universal joint 80 therefore accepts the torque transferred to the carrier 20 by the motor 17 and the gear train 18 and allows the torque to be transferred to the head section 12.

[0049] The gearbox housing 40 is formed from three sections, the body section 42, the shoulder 44, and the neck 46. The body section 42 is formed with the largest circumference and is formed to house or at least partially enclose the front end of the motor 17, the gear train 18, and the carrier 20, with the hollow cylinder 24 of the carrier 20 extending into the shoulder 44.

[0050] The neck 46 of the gearbox housing 40 extends from the front end of the shoulder 44 along the same axis as the shoulder 44 and body section 42. The rear section 82 of the universal joint extends from its connection with the carrier within the shoulder 44 into the neck 46. The neck 46 preferably includes a U-shaped cutout 48 formed along one side of the neck 46 that extends from the forward surface of the neck 46 toward, but not reaching, the shoulder 44. The universal joint 80 is positioned with respect to the neck 46 such that a center section 88 of the universal joint 80 pivots from a position where the center section 88 is in line with the rear section 82 of the universal joint 80 to a position where the center section 88 is at an oblique angle with respect to the rear section 82. When the center section 88 is not positioned along the same line as the rear section 82, the center section 88 extends through the U-shaped cutout 48. In other embodiments, other structures to movably support the rear section 83 of the universal joint 80 may be used.

[0051] The neck 46 additionally includes two through holes 50 that are along the same axis on the walls of the neck 46. The holes 50 are positioned to accept a press fit connector 54 with the lock housing 60 to mount the lock housing 60 onto the neck 46, which prevents any relative motion between the lock housing 60 and the gearbox housing 40. When the lock housing 60 is connected to the neck, the bottom surface of the lock housing 60 rests on a ledge 45 between the shoulder and the neck 46.

[0052] The lock housing 60 includes a U-shaped aperture 64 that is substantially the same shape and in the same location as the U-shaped aperture 48 in the neck 46. Similar to the U-shaped aperture 48 in the gearbox housing 40, the U-shaped aperture 64 in the lock housing 60 provides an opening to allow the center section 88 of the universal joint 80 to extend through the circumference of the lock housing 60. The lock housing 60 also includes a round projection 66 that extends from the outer circum-

ference of the lock housing 60. The projection 66 has a centerline that is perpendicular to a plane that bisects the U-shaped aperture 64. Preferably, the centerline of the projection 66 is along the pivot axis 13b that the head section 12 pivots with respect to the body section 14. The projection 66 includes a recess 68 (or aperture) that blindly extends into the projection 66. The recess 68 has a shape to receive a portion of the block 108, as further described below. The lock housing 60 has a second projection 70 that extends along the same axis as the projection 66 and extends from the opposite external surface of the lock housing 60. The second projection 70 is round and is preferably the same height as the projection 66.

[0053] In other embodiments, the lock housing 60 can be formed integral with the gearbox housing 40. In this embodiment, the neck 46 of the gearbox housing 40 is formed in the shape of the lock housing 60, including the projection 66 with the recess 68 and the opposite second projection 70. In embodiments where the gearbox housing 40 also forms the lock housing 60, the U-shaped aperture 48 in the neck 46 is integral with the U-shaped aperture 64 in the lock housing.

[0054] As noted above, the universal joint 80 includes three sections, a rear section 82, a center section 88, and a front section 92. The rear section 82 is mounted to the carrier 20 with an end 83 having a shape complementary to the aperture 25 in the carrier 20 to cause the rear section 82 to rotate with the rotation of the carrier 20. Each of the sections 82, 88, 92 are connected together with pins 85 and a center hub (not shown). The pins 85 and the center hub allow the transfer of torque from the rear section 82 to the center section 88, and from the center section 88 to the front section 92, so the front section 92 rotates when the rear section 82 rotates. The pins 85 and the center hub also allow relative pivoting with respect to each of the sections. While the rear section 82 is constrained from pivoting with respect to the body section 14 by the connection between the rear section 82 and the carrier 20, the center section 88 can pivot with respect to the rear section 82. Similarly, the front section 92 can pivot with respect to the center section 88. Also, as discussed above, the U-shaped apertures in the neck 46 of the gearbox housing 40 and the lock housing 60 (48, 64) permit clearance for the center section 88 and the front section 92 to pivot within the tool. This pivoting motion of the center and front sections 88, 92 allows the head section 12 to pivot with respect to the body section 14 along the pivot axis 13b.

[0055] The front section 92 of the universal joint 80 may be integrally formed with a spindle lock housing 120 or the two components may be formed separately and attached together by structure that is known to those of skill in the art. The spindle lock housing 120 is rotatably supported by a bearing 130 that is mounted within the pivot housing 100.

[0056] As best seen in FIG. 3, the pivot housing 100 is formed from at least two clamshell halves. The pivot housing 100 surrounds the rear portion 126 of the spindle lock housing 120, as well as the universal joint 80, the lock housing 60, and a portion of the neck 46 of the gearbox housing 40. When assembled, in this embodiment, the pivot housing 100 is generally cylindrical, with a removed section 102 that corresponds to the U-shaped apertures 48, 64 in the neck 46 and lock housing 60, respectively. The removed section 102 provides clearance between the pivot housing 100 and the components that form the body section 14 so that the head section 12 can pivot with respect to the body section 14.

[0057] The pivot housing 100 includes a recessed section 104 along an outer surface of the pivot housing 100. The recessed section 104 may have any suitable shape, but in one embodiment, it is circular. A centerline of the recessed section 104 is perpendicular to a plane that bisects the removed section 102. Preferably, the centerline of the recessed section 104 is positioned co-linear with the pivot axis 13b when the pivot housing 100 is positioned with respect to the lock housing 60. An aperture 106 is formed in the recessed section 104 with the center of the aperture 106 being along the centerline of the recessed section 104. In some embodiments (shown in FIGs. 3 and 4), the aperture 106 is formed in a cross shape, with four legs 107 radiating from the centerline and perpendicular to each other. In other embodiments (shown in FIGs. 18-21) the aperture 106 is formed with eight legs 107 radiating from the centerline and at a forty-five degree angle from the neighboring legs 107. In either embodiment, the legs 107 may have the same length. The recessed section 104 further includes a plurality of holes 112 along the periphery of the aperture 106. The holes 112 may be rectangular.

[0058] In another embodiment shown in FIG. 27, the aperture 106 may be replaced with an arcuate track 106a with a center point of the arcuate track 106a located at the pivot axis 13b. In this embodiment, the recess 68 on the lock housing 60 is formed at the same distance R from the pivot axis 13b as the radius R of the arcuate track 106a, such that the recess 68 is in line with the track 106a throughout the range of motion of the head section 12 with respect to the body section 14.

[0059] It is contemplated that the aperture can be formed with a structure other than four or more legs. Desirably, the aperture will have a shape complementary to the shape of the lock block 108, as described below and also will have a shape to permit a plurality of selective discrete orientations of the head section 12 with respect to the body section 14. In other embodiments of the lock block 108, the aperture 106, and the recess 68 can be formed of alternate, non-circular, shapes such that when the lock block 108 engages both the aperture 106 and the recess 68, the head section 12 cannot pivot with respect to the body section 14. For example, the lock block 108, aperture 106, and the recess 68 can each be formed as a square, a triangle, a pentagon, a hexagon, etc.

[0060] The pivot housing 100 additionally includes a hollow, circular projection 118 that extends from the inner surface of the pivot housing 100 toward the centerline of

the pivot housing 100. The circular projection 118 extends along the same centerline as the aperture 106 and is formed with an inner diameter slightly larger than the second projection 70 that extends from the lock housing 60. When the pivot housing 100 is assembled to surround the lock housing 60, the connection between the second projection 70 of the lock housing 60 and the circular projection 118 of the pivot housing 100 provides a stable rotational connection between the pivot housing 100 and the lock housing 60.

[0061] As best shown in FIG. 3, a lock block 108 is provided with a shape complementary to that of recess 68 of the lock housing 60. In one embodiment, the lock block 108 is formed as a cross, or a plus symbol (+), with four arms 109 that extend from the center of the lock block 108 and are perpendicular to each other. The height of the lock block 108 is slightly smaller than the length of the projection 68 from the lock housing 60 and is the same depth as the recess 68 of the lock housing 60. When the handheld pivotable tool 10 is assembled, the lock block 108 is inserted into the aperture 106 of the pivot housing 100 and further into the recess 68 of the lock housing 60. A spring 116 (FIGs. 5 and 6) is provided between the bottom of the recess 68 in the lock housing 60 and the bottom of the lock block 108, to bias the lock block 108 upwards away from the bottom of the recess 68 in the lock housing 60.

[0062] Normally, as shown in FIG. 5, the spring 116 biases the lock block 108 into a position where the top portion of the lock block 108 extends into the aperture 106 within the pivot housing 100 and the bottom portion of the lock block 108 extends into the recess 68 within the pivot housing 60. In this situation, the pivot housing 100 cannot rotate or move with respect to the lock housing 60 because the arms 109 of the lock block 108 are inserted within the four of the mutually perpendicular legs 107 of the aperture 106 in the pivot housing 100, as well as within the legs 69 of the recess 68 of the lock housing 60.

[0063] In the embodiments shown in FIGs. 3 and 4, with a cross-shaped aperture 106 on the pivot housing 100, the pivot housing 100 (and output tool) can be retained in a position where it is along the same line as the body section 14 of the handheld pivotable tool 10 (FIG. 3) and in a position where the pivot section 100 (and output tool) is perpendicular to the body section 14 of the handheld pivotable tool 10 (FIG. 4). In the embodiments shown in FIGs. 18-21, the aperture 106 in the pivot housing is formed with eight legs 107, the pivot housing 100 (and output tool) can be retained in a position where the pivot housing 100 is either along the same line as the body section 14 (FIG. 19), at a forty-five degree angle to the body section 14 (FIG. 20), or perpendicular to the body section 14 (FIG. 21).

[0064] The lock block 108 is moveably retained in its position inserted within at least the recess 68 of the lock housing (and when biased upward by the spring 116 within the aperture 106 of the pivot housing) by a lock button 110. The lock button 110 includes a center projection 110a (best shown in FIGs. 5 and 6) that is sized to fit within the center of the aperture 106 in the pivot housing 100. The lock button 110 also includes a plurality of legs 111 that extend in the same direction as the center projection 110a that are inserted into the plurality of apertures 112 in the recessed section 104 of the pivot housing 100. The legs 111 each preferably include outwardly facing tabs 111a that maintain the legs 111 inserted within the apertures 112.

[0065] Normally, as shown in FIG. 5, when no inward force is applied to the button 110, the biasing force of the spring 116 pushes the lock block 106 outward to contact the center projection 110a of the lock button 110. As discussed above, in this position, the lock block 108 extends within the aperture 106 in the pivot housing 100 and the recess 68 in the lock housing 60, to prevent relative motion between the head section 12 and the body section 14. As shown in FIG. 6, when the lock button 110 is pushed inward, the center projection 110a urges the lock block 108 inward against the biasing force of the spring 116 until it no longer is inserted within the aperture 106 in the pivot housing 100. In this orientation, the pivot housing 100 (and the head section 12) is free to pivot with respect to the body section 14 of the handheld pivotable tool 10. When the lock button 110 is released, the spring 116 urges the lock block 108 (and the lock button 110) outward until the lock block 108 again is inserted within the aperture 106 in the pivot housing 100 to retain the pivot housing 100 and head section 12 in the selected position with respect to the body section 14.

[0066] If the pivot housing 100 is not either in-line, at a forty-five degree angle (in embodiments shown in FIGs. 18-21), or perpendicular with respect to the body section 14 the lock block 108 will not enter the aperture 106 in the pivot housing due to the specific shapes of the lock block 108 and aperture 106 in the pivot housing 100. The tool can be pivoted until it reaches one of these positions to allow the lock block 108 to again move into the aperture 106.

[0067] In the embodiment shown in FIG. 27, and as partially discussed above, an arcuate slot 106a is provided instead of the aperture 106 on the pivot housing 100, and the lock button 110 is formed with legs 111 that ride within tracks 113 in the pivot housing 100. The lock button 110 has a projection (not shown in FIG. 27 but similar to the projection 110a shown in FIGs. 5 and 6) that engages the top portion of the lock block 108. The lock block 108 is sized so that it can be inserted into enlarged portions 106b at predetermined positions on the arcuate slot 106a (i.e. positions where the head section 12 will be retained with respect to the body section 14). FIG. 27 shows the enlarged portions 106b formed at the extreme ends of the arcuate slot 106a. In other embodiments, the arcuate slot 106a can include enlarged portions 106b at other positions within the arcuate slot 106a. To change the orientation of the head section 12 with respect to the body section 14, the lock button 110

is pressed against the biasing force of the spring 116, so that the lock block 108 moves out of engagement with the arcuate slot 106a, to allow the head section 12 to be pivoted with respect to the body section. When the tool is in the required orientation, the lock button 110 is released and the lock block again engages the arcuate slot 106a within the pivot housing to retain the tool in the selected orientation.

[0068] A second embodiment of the handheld pivotable tool 10 is shown in FIGs. 7-17. This handheld pivotable tool 10 includes all of the structure discussed in the embodiment shown in FIGs. 1-6 (and 18-21) above, including the structure that encloses and protects the internal components of the lock housing 60, pivot housing 100, and universal joint 80 throughout the range of motion of the head section 12 with respect to the body section 14. This embodiment however, includes a second housing cover 140 and a cover piece 160. The embodiments shown in FIGs. 7-17 include a pivot housing 100 that has a spherical profile, instead of the cylindrical pivot housing 100 shown in FIGs. 1-6. The structure disclosed below can be modified to include the second housing cover 140 and cover piece 160 in embodiments where the pivot housing 100 has a cylindrical profile. Similarly, the embodiments shown in FIGs. 1-6 and discussed above can be modified to form the pivot housing 100 with a spherical profile, as shown in FIGs. 18-21.

[0069] The second housing cover 140 is formed from two clamshell halves (a slotted piece 142 and a unslotted piece 144) that are connected together to surround a majority of the lock housing 60 and allow the motion of the universal joint 80 discussed above for the head section 12 to pivot with respect to the body section 14. The second housing cover 140 is surrounded by the pivot housing 100. The clamshell halves of the second housing cover 140 are connected along a plane that is perpendicular to the plane formed by the edges of the clamshell halves of the pivot housing, and also extends through a centerline of the body section 14 of the handheld pivotable tool 10.

[0070] As best seen in FIG. 9, the second housing cover 140 forms two circular holes 141, 143 with the centerline of each extending through the plane formed by the connection between the clamshell halves of the second housing cover 140. The holes 141, 143 are positioned to allow the projections 66, 70 of the lock housing 60 to extend through. The second housing cover 140 further includes a bottom aperture 148a, which is sized to allow the second housing cover 140 to surround the lock housing 60 and a top aperture 148b. The top aperture 148b is sized to allow the second housing cover 140 to surround the lock housing 60, and also to allow the universal joint 80 to pivot with respect to the body section 14.

[0071] The cover section 160 is formed as a curved plate and is inserted between the second housing cover 140 and the pivot housing 100 to cover any exposed regions of either the lock housing 60 or the universal joint 80 during the range of motion of the handheld pivotable tool 10. The motion of the cover section 160 is constrained by the internal structure of the pivot housing 100 and the external structure of the second housing cover 140. Specifically, as shown in FIG. 9a, the pivot housing 100 is formed with interior sidewalls 208 that are formed with an arcuate slot 210. The arcuate slot 210 has an arc length greater than the ninety degree range of motion of the head section 12 of the tool. The slot 210 includes a first face 212 and a second face 214. (The opposite clamshell half of the pivot housing 100 has a similar arcuate slot with a first and second face, not shown). When the handheld pivotable tool 10 is assembled, the cover section 160 rides within the arcuate slot 210 and its range of motion is partially determined by the positions of the first face 212 and the second face 214.

[0072] The slotted piece 142 of the second housing cover 140 includes apair of top faces 152 and a pair of bottom faces 154 (best shown in FIG. 9b). The top and bottom faces 152, 154 are formed at the intersection between a top and bottom section 145, 146 near the edges where the slotted piece 142 contacts the edge of the unslotted piece 144. The top and bottom sections 145, 146 are formed at a first diameter, and the middle section 147 (in the region between the edge sections) is formed with a second, smaller diameter. When the handheld pivotable tool 10 is assembled, the cover piece 160 rides on the middle section 147 of the slotted piece 142 of the second housing cover 140 the range of motion of the cover section 160 is also determined by the top and bottom faces 152, 154 of the second housing cover 140.

[0073] FIG. 10 shows the cover section 160 positioned within the pivot housing 100 when the head section 12 is in-line with the body section 14. FIG. 11 shows the cover section 160 assembled with the second housing cover 140 and the pivot housing 100 in the same position. As seen in FIG. 10, the bottom edge 164 of the cover section 160 contacts the first face 212 of the pivot housing 100. As seen in FIG. 11, the top edge 165 of the cover section 160 contacts the top face 152 of the second housing cover 140. These contact points retain the cover section 160 in the required position to protect the internal components of the handheld pivotable tool 10.

[0074] FIG. 12 shows the cover section 160 with respect to the pivot housing 100 when head section 12 is pivoted to an intermediate position between a position where the head section 12 is in-line with the body section 14 and a position where they are perpendicular to each other. FIG. 13 shows the cover section 160 with respect to the second housing cover 140 and the pivot housing 100 in the same orientation. In intermediate orientations of the head section 12 with respect to the body section 14, the cover section 160 does not contact either the first or second faces 212, 214 of the pivot housing 100 or the top or bottom faces 152, 154 of the second housing cover 140. Therefore, the cover section 160 is free to move with respect to both the second housing cover 140 and the pivot housing 100 as constrained by the faces, and the cover section 160 will cover the internal components

of the handheld pivotable tool 10 regardless of the position of the cover section 160.

[0075] FIG. 14 shows the cover section 160 with respect to the pivot housing 100 when the head section 12 is at an approximate 65 degree angle with respect to the body section 14. FIG. 15 shows the cover section 160 with respect to the second housing cover 140 and the pivot housing 100 in the same orientation. As shown in FIG. 14, the top edge 165 of the cover section 160 contacts the second face 214 of the arcuate slot 210 of the pivot housing 100. As shown in FIG. 15, neither the top nor the bottom edges 165, 164 of the cover section 160 contacts the top or bottom faces 152, 154 of the second housing cover 140. Therefore, with additional pivoting of the head section 12 with respect to the body section 14, the cover section 160 will move counter-clockwise (as seen in the view of FIG. 14) closer to the position where its bottom edge 164 engages the bottom face 154 of the second housing cover 140.

[0076] FIG. 16 shows the cover section 160 with respect to the pivot housing 100 when the head section 12 is perpendicular to the body section 14. FIG. 17 shows the cover section 160 with respect to the second housing cover 140 and the pivot housing 100 in the same orientation. As shown in FIG. 17 the bottom edge 164 of the cover section 160 is engaged with the bottom face 154 of the second housing cover 140.

[0077] A third embodiment of the handheld pivotable tool 10 is shown in FIGs. 22-26. In this embodiment, the head section 12 rotates with respect to the longitudinal axis of the body section 14. The position of the spindle lock housing (not shown in FIGs. 22-26, the spindle lock housing in this embodiment is similar to that shown in described in previous embodiments) and the pivot housing 100, however can be modified (as shown in FIG. 22) so the output shaft is offset from the center of the pivot housing 100 because of the formation of the universal joint 80 with three sections. This offset positioning allows the output tool (not shown) to be operated in tight spaces. For example, because the spindle is positioned closer to one outside surface of the head section 12, the handheld pivotable tool 10 can be operated to drill a hole or insert a fastener located closer to a wall than would be possible if the spindle was positioned at the center of the pivot housing 100.

[0078] In this embodiment, the gearbox housing 40 is formed as a separate member from the lock housing 60. The gearbox housing 40 is slightly altered as discussed herein (although it is modified in a way that will not hinder performance of the embodiments discussed above). As shown in FIG. 23, the top surface 45 of the shoulder 44 includes a plurality of flanges 324 that project upwards into the neck 46 of the gearbox housing 40. The flanges 324 may be equally spaced around the circumference of the gearbox housing 40. Preferably, the gearbox housing 40 includes four flanges 324 spaced ninety degrees apart. In some embodiments, the flanges 324 can be formed as rectangular blocks, in other embodiments, the flanges 324 can be formed as different shapes. The shoulder 44 also includes two grooves 352 around the circumference of the shoulder 44 that accept two retaining rings 350, which are discussed below.

[0079] The lock housing 60 is also slightly modified from the structure discussed above (although it is modified in a way that will not hinder performance of the embodiments discussed above). In embodiments that do not include structure to allow the head section 12 to pivot with respect to the body section 14, a cylindrical sleeve is provided that surrounds the neck 46 of the gearbox housing 40 and can move axially about the gearbox housing 40. This sleeve is formed with the structure of the lock housing 60 disclosed specifically with this embodiment. For simplicity, only the lock housing 60 is discussed here (and shown in the figures), but the reference to the lock housing 60 should be interpreted to also refer to a sleeve with the specific structure discussed herein.

[0080] The lock housing 60 includes a cam surface 310 (best shown in FIG. 25) formed around the outer surface of the lock housing 60. The cam surface 310 is formed as an inclined plane that wraps around a substantial portion of the circumference of the lock housing 60 starting at the bottom edge. As shown in FIG. 24, the lock housing 60 also includes a plurality of recesses 316 formed on the bottom edge. Desirably, the recesses 316 are equally spaced at uniform positions around the inner circumference of the lock housing 60. The recesses 316 are sized and positioned to engage the flanges 324 when the lock housing 60 engages the upper surface of the shoulder 44 of the gearbox housing 40. In one embodiment, the lock housing 60 includes twice the number of recesses 316 than the number of flanges 324 formed in the gearbox housing 40. In other embodiments, the lock housing 60 can have the same number of recesses 316 as flanges 324, or a greater number of recesses 316 to flanges 324.

[0081] The handheld pivotable tool 10 also includes a swivel cap 330 formed from an upper cap 342 and a lower cap 332, as best seen in FIG. 22. The swivel cap 330 is rotatably connected to the shoulder 44 of the gearbox housing 40 with two retaining rings 350 placed above and below the lower cap 332 and tightened to engage each of the grooves 352 in the shoulder 44. As shown in FIG. 26, the upper cap 342 has a cam surface 344 that opposes the cam surface 310 on the lock housing 60. The cam surface 344 of the upper cap 342 is formed on the lower surface of the upper cap 342.

[0082] When the handheld pivotable tool 10 is assembled, the upper cap 342 is positioned such that it is above the cam surface 310 of the lock housing 60, which allows the cam surface 344 on the upper cap to engage the cam surface 310 on the lock housing 60. The upper and lower caps 342, 332 are connected with fasteners (not shown) that extend through holes in the respective caps 342, 332 so that the upper cap 342 and the lock housing 60 are positioned with respect to the gearbox housing 40. FIGs. 7-9 show the upper and lower swivel caps 342, 332 po-

sitioned on the handheld rotary tool 10 with respect to the lock housing 60 and the gearbox housing 40. A spring 336 (best seen in FIG. 22) is provided within the swivel cap 330 between the lower cap 332 and the lower surface 315 of the lock housing 60 to push the lock housing upwards away from the lower cap 332.

[0083] In operation, rotation of the swivel cap 330 moves the lock housing 60 with respect to the gearbox housing 40. For example, when the swivel cap is rotated clockwise the cam surface 344 of the upper cap 342 engages the cam surface 310 of the lock housing, which forces the lock housing 60 downward against the biasing force of the spring 336. With sufficient clockwise rotation, the lock housing 60 is moved far enough downward so that the flanges 324 of the gearbox housing 40 are inserted into the recesses 316 of the lock housing. Because the flanges 324 are positioned within the recesses 316, the lock housing 60 and the head section 12 are selectively positioned and cannot rotate with respect to the body section 14.

[0084] When the swivel cap 330 is rotated in the counter-clockwise direction with respect to the body section 14, the lock housing 60 moves upward due to the biasing force of the spring and releases the engagement between the cam surfaces 310, 344. The upward movement of the lock housing 60 causes the flanges 324 to disengage the recesses 316 of the lock housing 60, so that the lock housing 60 and the head section 12 can rotate with respect to the body section 14. When the head section 12 is in the desired orientation with respect to the body section 14, the swivel cap 330 is rotated clockwise to engage the flanges 324 with the recesses 316 in the lock housing, which prevents rotation of the head section 12 with respect to the body section 14.

[0085] Alternatively, other structures that are known to those of skill in the art can be used to selectively secure the lock housing 60 to the gearbox housing 40 to prevent the head section 12 from rotating with respect to the body section 14 when the head section 12 is in a position selected by the user.

[0086] Each of the embodiments discussed above may include a clutch 16 that allows the maximum output torque of the torque to be selected by the user. Clutch designs that are known by those of skill in the art may be used in conjunction with these embodiments to allow selection of a maximum output torque of the tool. Additionally, a suitable clutch design, for use with the handheld pivotable tool 10 is described in U.S.S.N. 11/090,947, which is fully incorporated herein by reference.

[0087] It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting, and that it be understood that it is the following claims, including all equivalents, that are intended to define the scope of this invention.

Claims

1. A tool with a rotatable head section comprising:

(a) a transmission with an input end connected to a rotating member and an output end connected to an output tool;
(b) a body section that retains an input end of the transmission and includes a gearbox housing and a longitudinal axis;
(c) a sleeve that surrounds a top portion of the gearbox housing and is movable along the gearbox housing;
(d) a rotatable cap surrounding the sleeve to selectively cause engagement of the sleeve and the gearbox housing;
(e) a head section that houses an output of the transmission, and that is rotatable about the body section along the longitudinal axis of the body section, wherein the head section is prevented from rotating with respect to the body section when the sleeve engages the gearbox housing.

2. The tool of claim 2 further comprising a plurality of flanges that project from the gearbox housing.

3. The tool of claim 2 wherein the sleeve includes a plurality of recesses that accept the plurality of flanges to cause engagement of the sleeve and the gearbox housing.

4. The tool of claim 3 wherein the number of the plurality of recesses is the same as the number of flanges.

5. The tool of claim 2 or 3 wherein the number of the plurality of recesses is a positive multiple of the number of flanges.

6. The tool of any one of any preceding claim further comprising a cam surface at a bottom end of the sleeve and a corresponding cam surface on the rotatable cap.

7. The tool of claim 1 further comprising:

(a) a plurality of flanges that project from the gearbox housing;
(b) a plurality of recesses provided on a bottom surface of the sleeve to accept the plurality flanges;
(c) a cam surface at the bottom end of the sleeve; and
(d) a cam surface on the rotatable cap, wherein the cap can be rotated to cause engagement between the cam surfaces to cause the recesses in the sleeve to engage the flanges in the gearbox housing.

8. The tool of claim 7 wherein the sleeve is biased away from engagement with the gearbox housing.

9. A tool operable in at least two positions comprising:

(a) a transmission with an input end and an output end;
(b) a body section with a longitudinal axis including:

(i) a gearbox housing,
(ii) a lock housing that surrounds a top portion of the gearbox housing and that can move along the gearbox housing,
(iii) a motor,
(iv) a rotatable cap surrounding a bottom portion of the lock housing to selectively cause engagement between the lock housing and the gearbox housing;

(c) a head section rotatably connected to the body section to rotate about the longitudinal axis of the body section, with the head section being prevented from rotating with respect to the body section when the lock housing engages the gearbox housing;
(d) a pivot housing disposed between the head section and the body section and being pivotably connected to the lock housing about a pivot axis, wherein each of the pivot housing and the lock housing include an aperture; and
(e) a block positioned in the lock housing aperture and selectively inserted in the pivot housing aperture to retain the head section in a selected orientation with respect to the body section.

Fig. 1

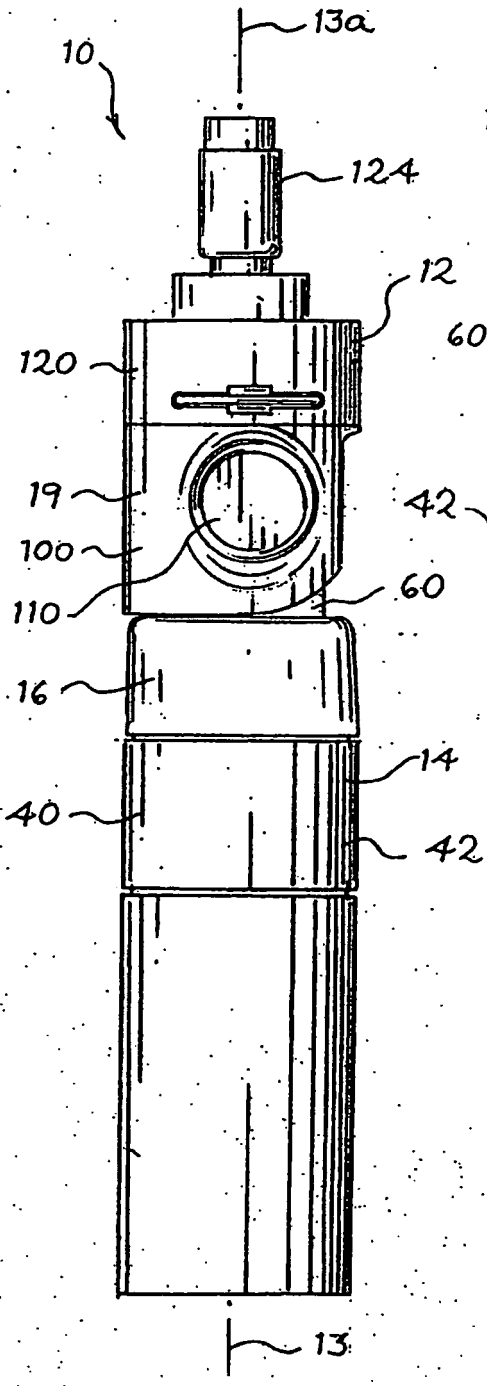
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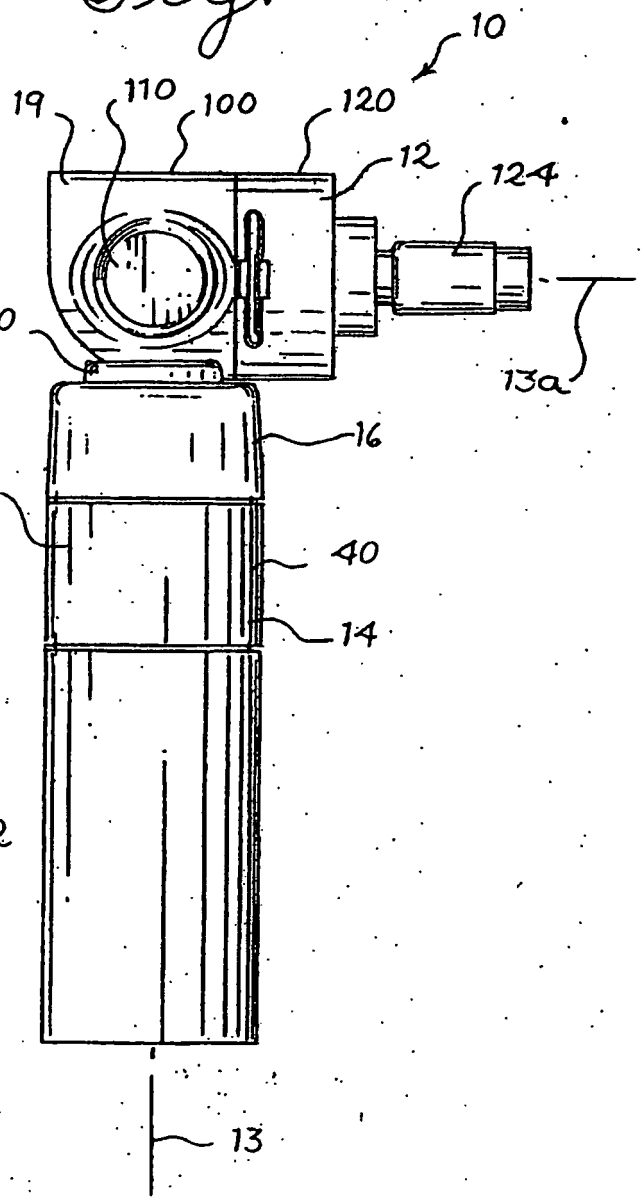
Fig. 2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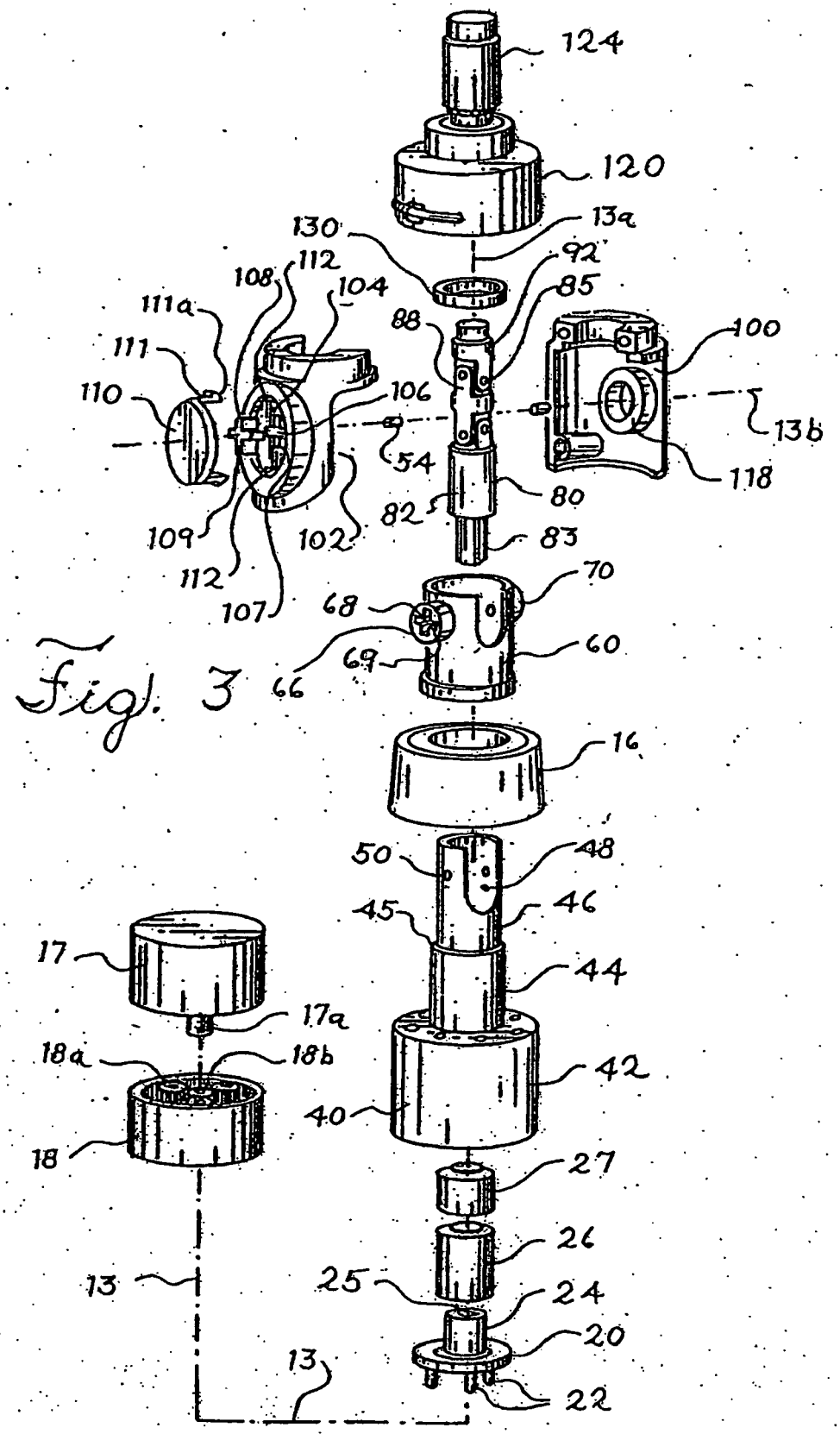
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Fig. 3

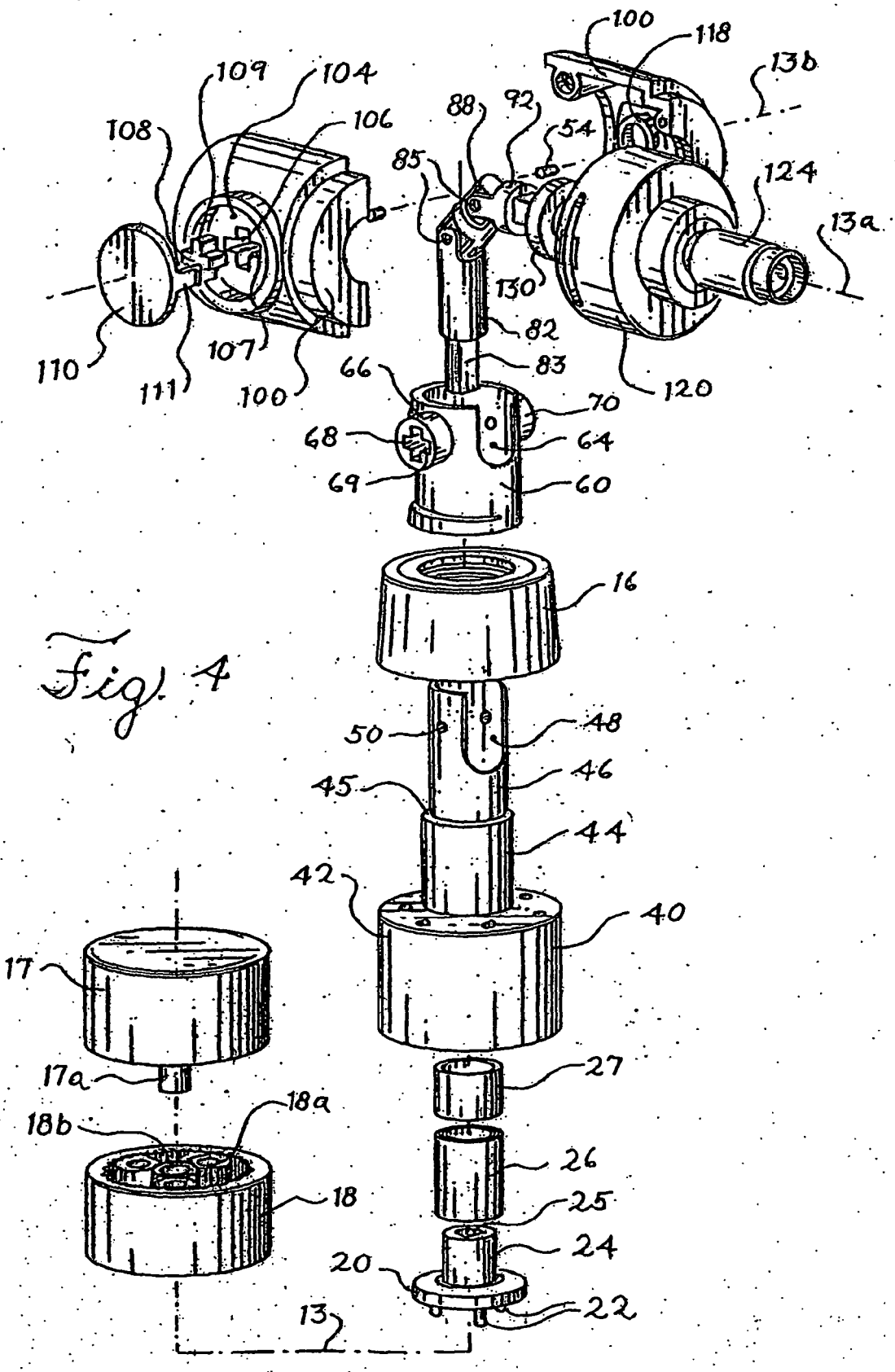
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Fig. 4

Fig. 5

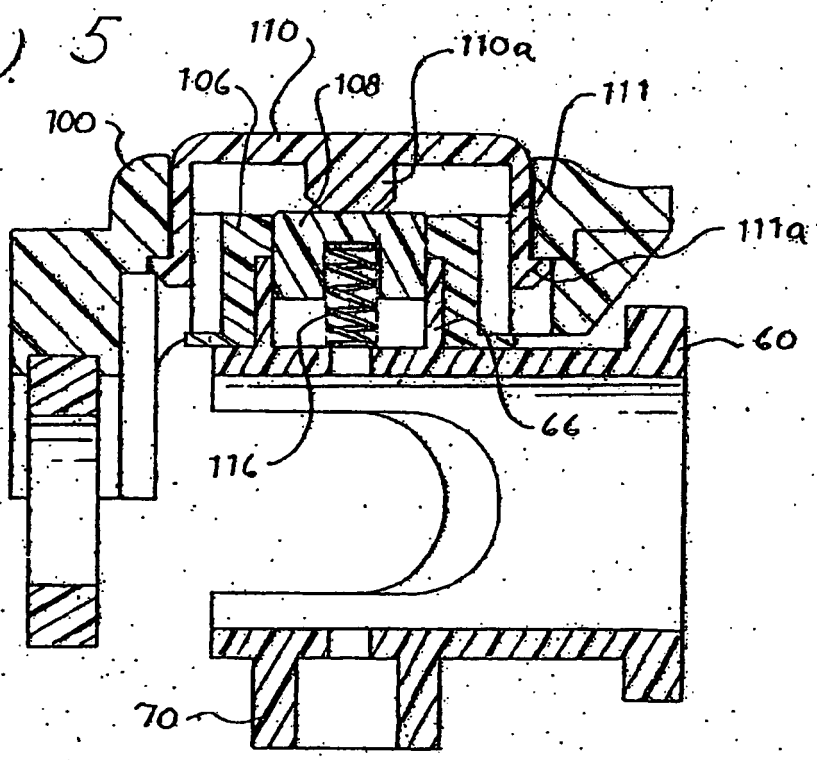
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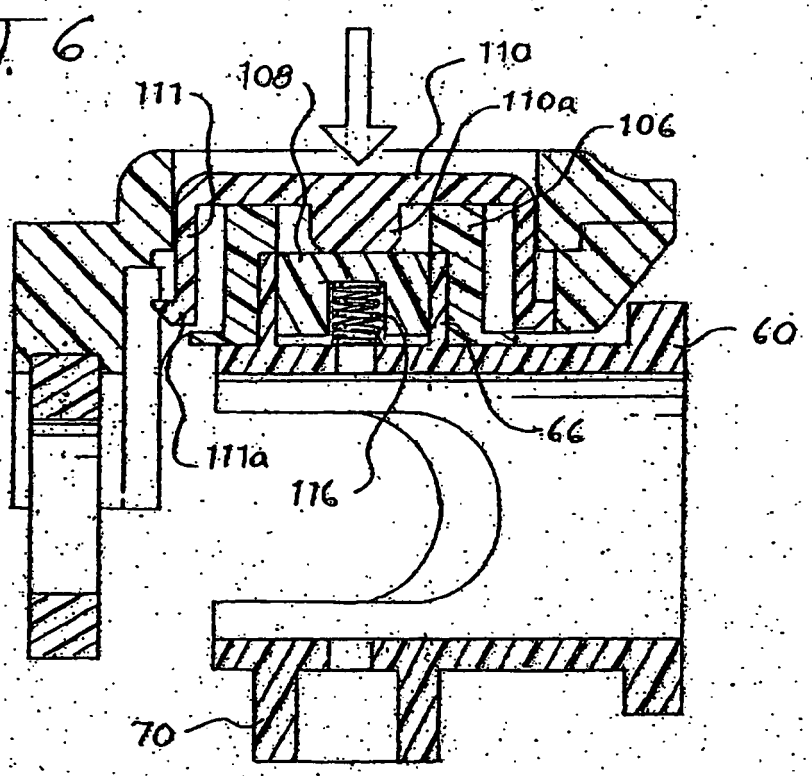
Fig. 6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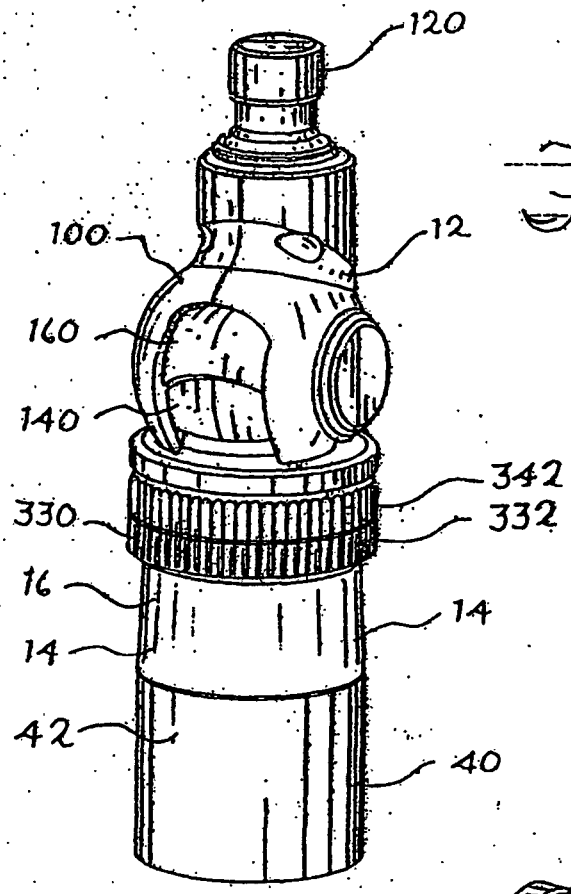
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Fig. 7

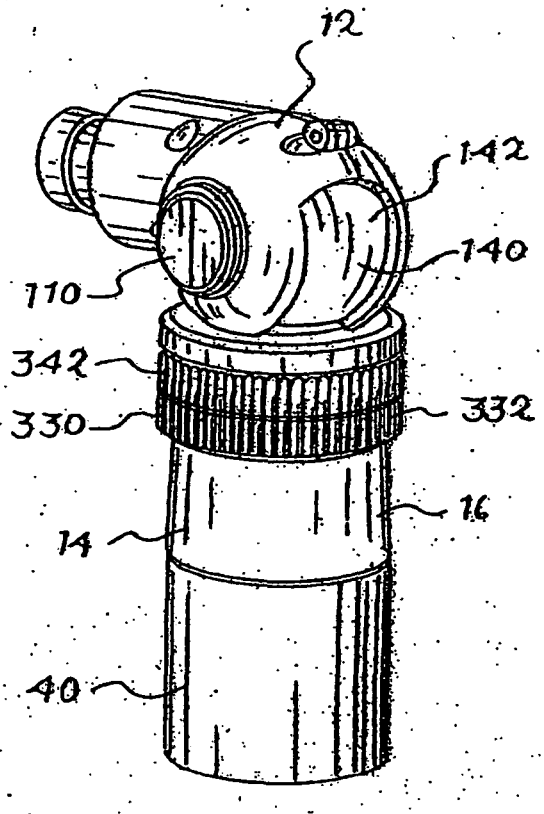
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Fig. 8

Fig. 9

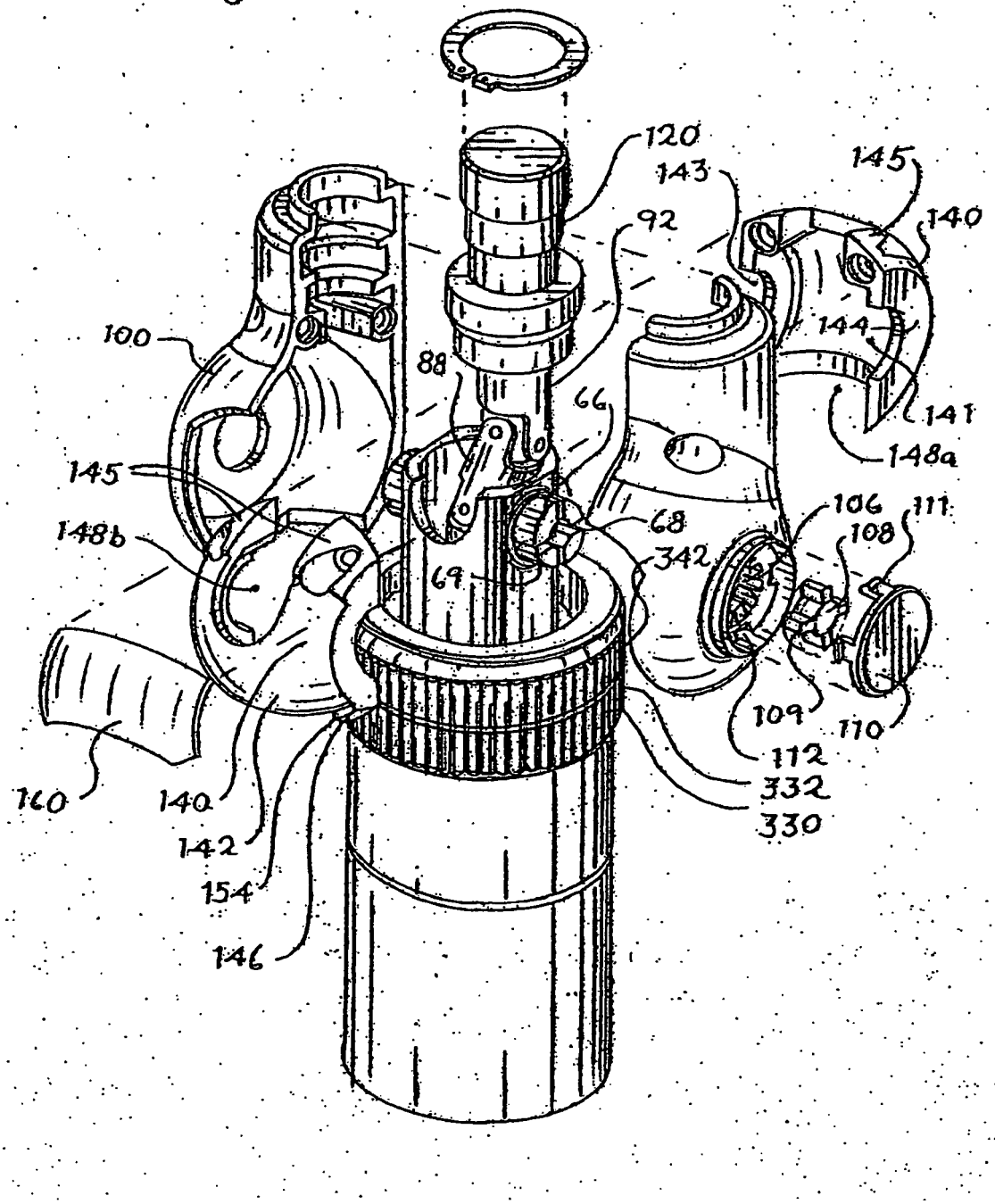
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Fig. 9a

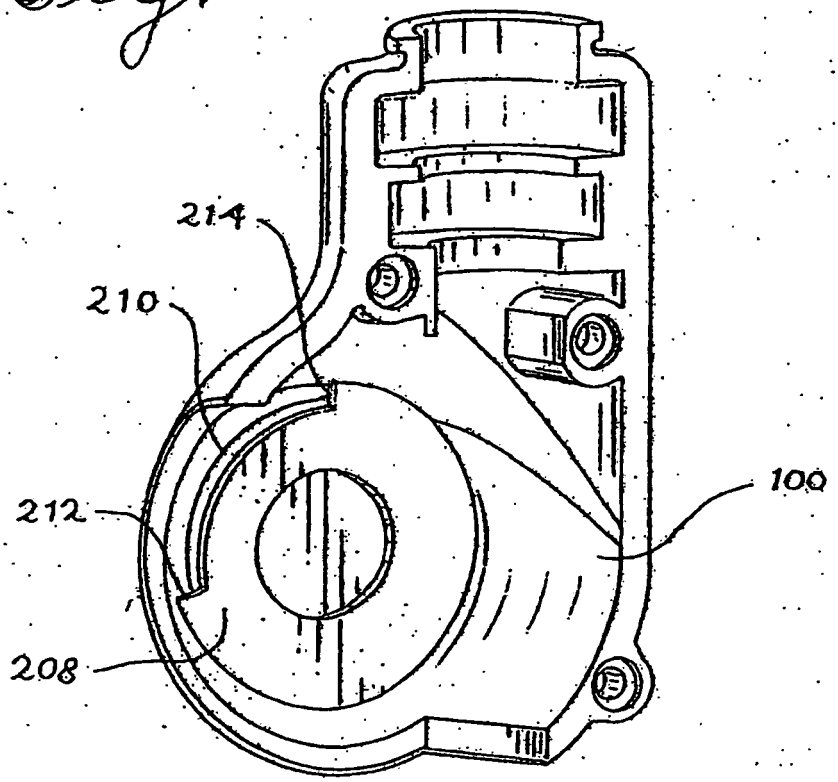
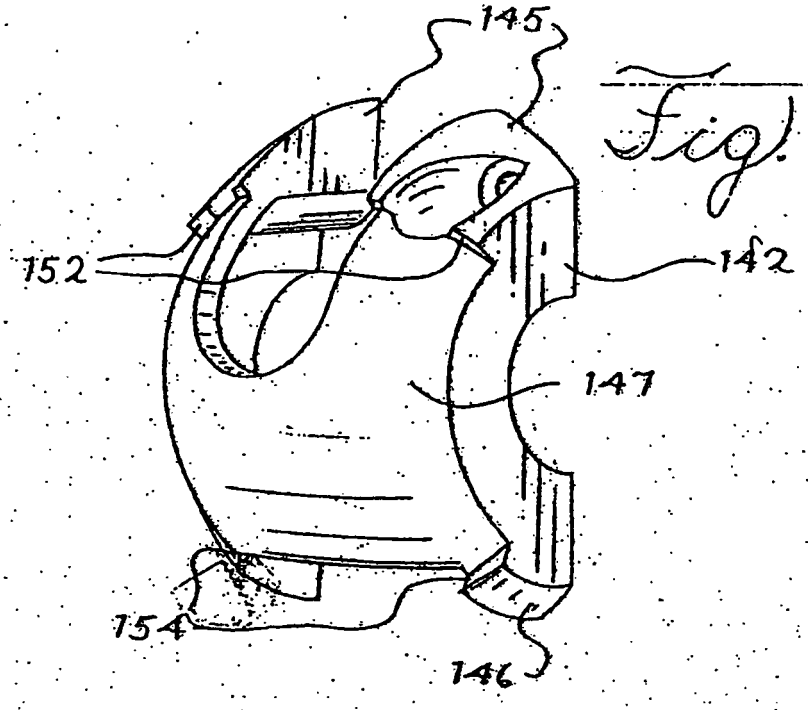


Fig. 9b



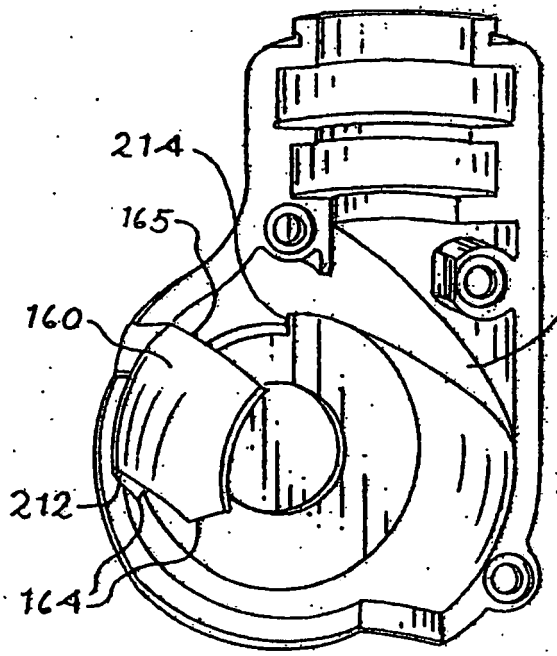


Fig. 10

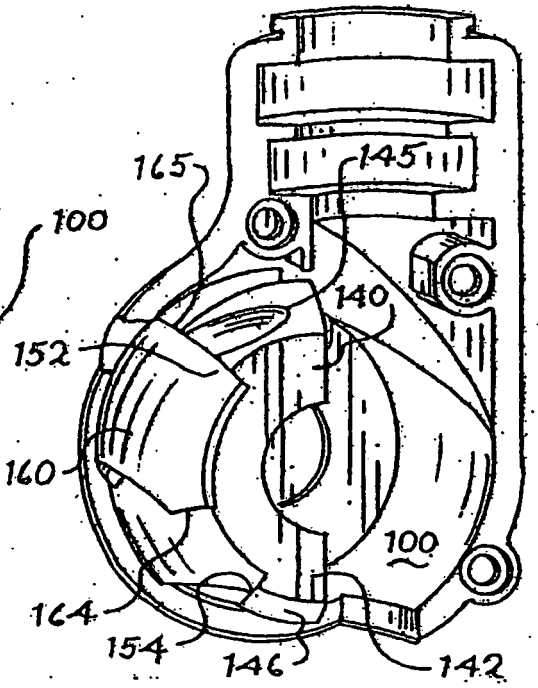


Fig. 11

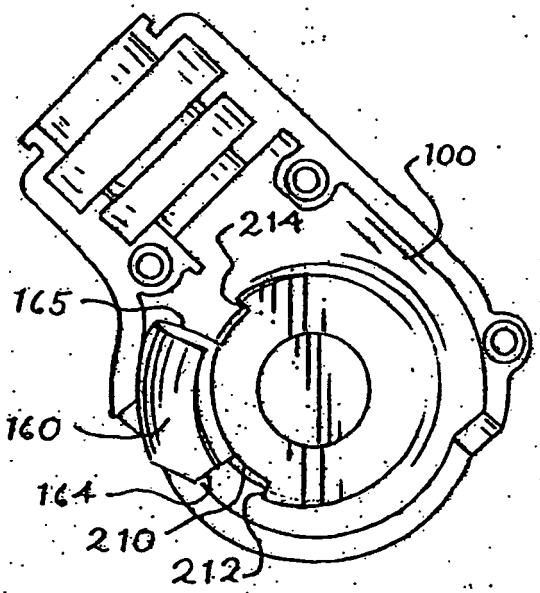


Fig. 12

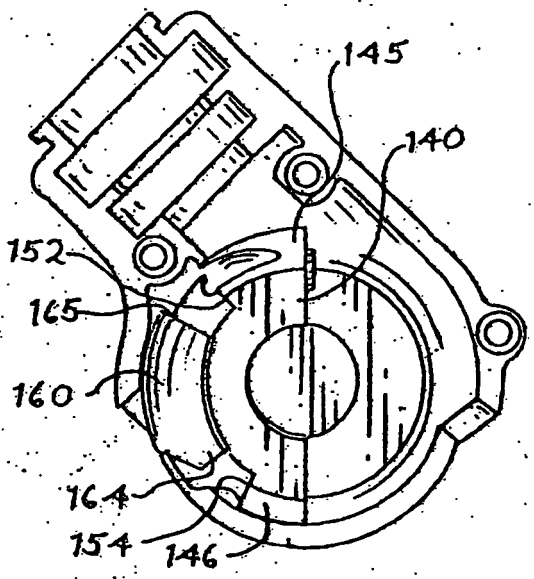
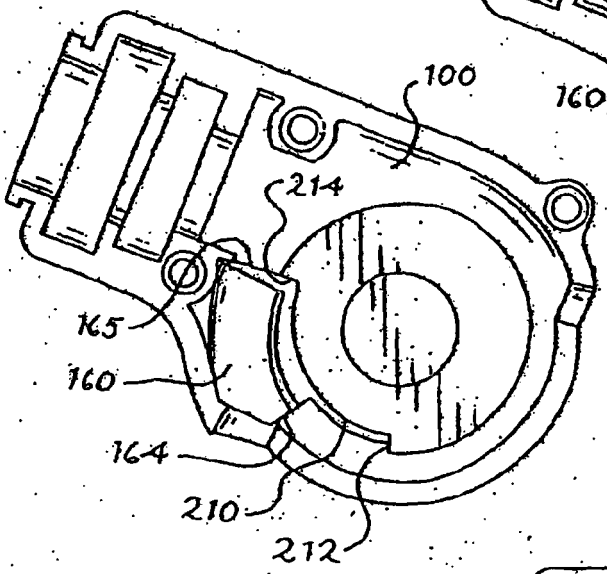


Fig. 13

Fig. 14



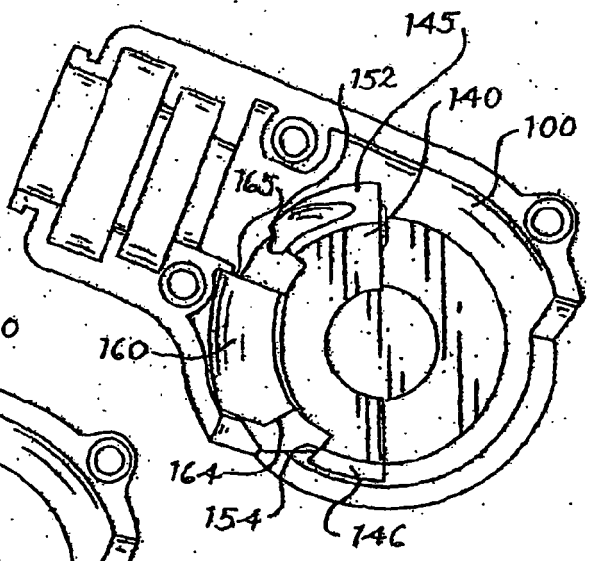
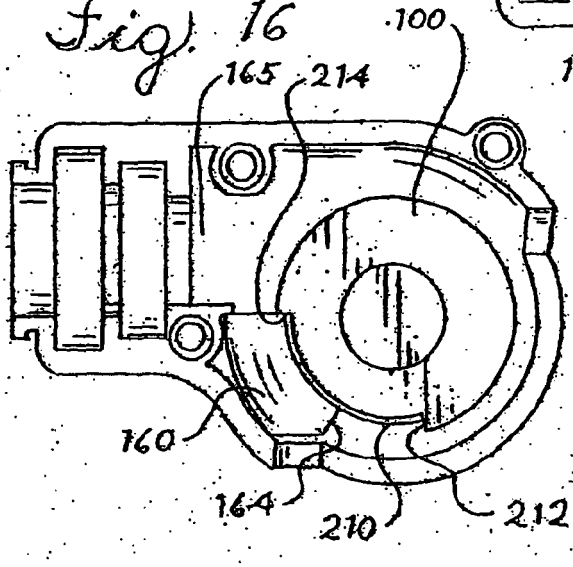


Fig. 15

Fig. 16



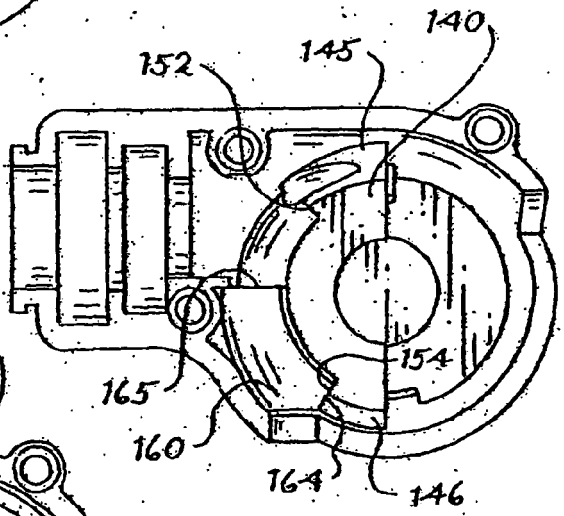


Fig. 17

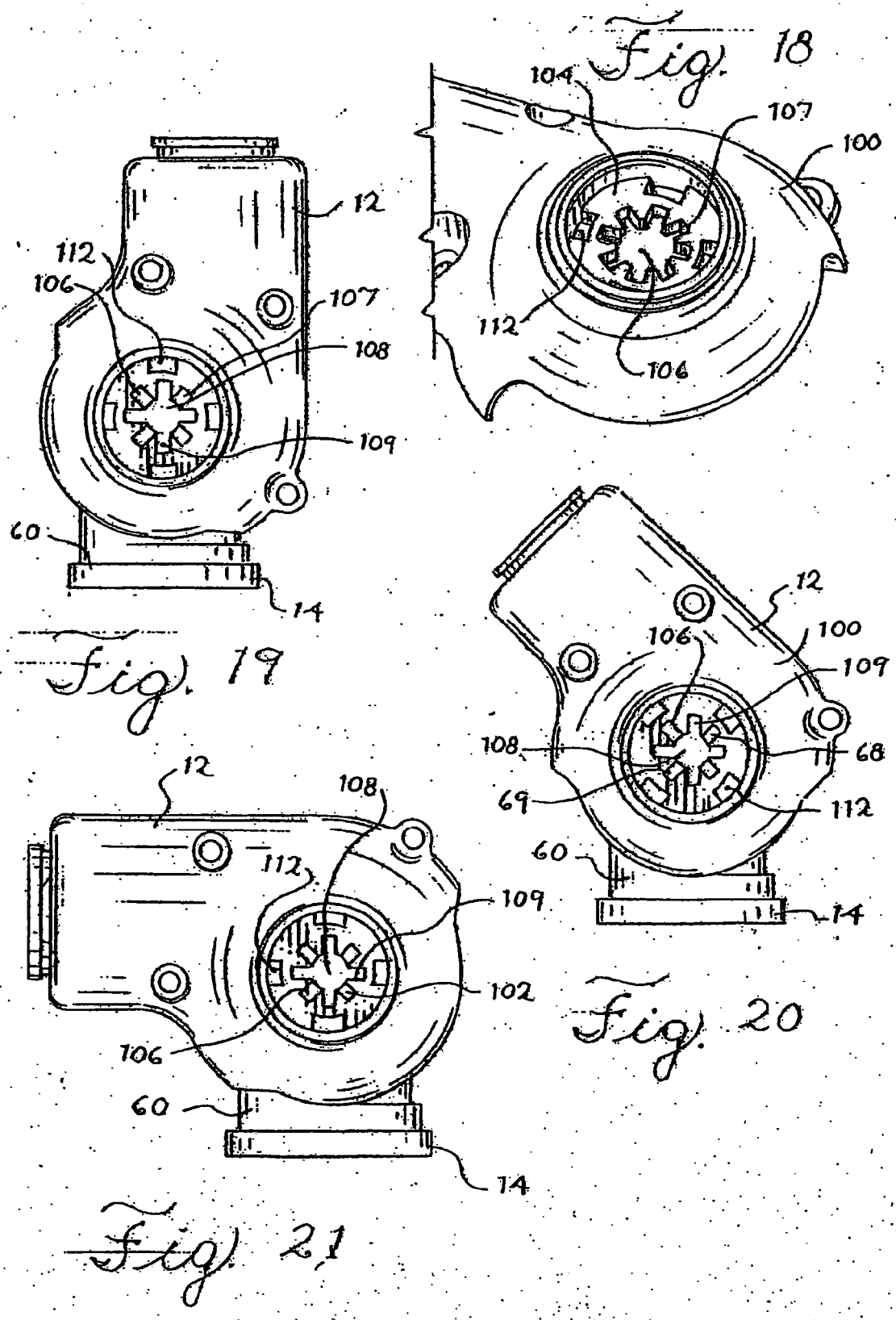

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Fig. 18
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Fig. 21

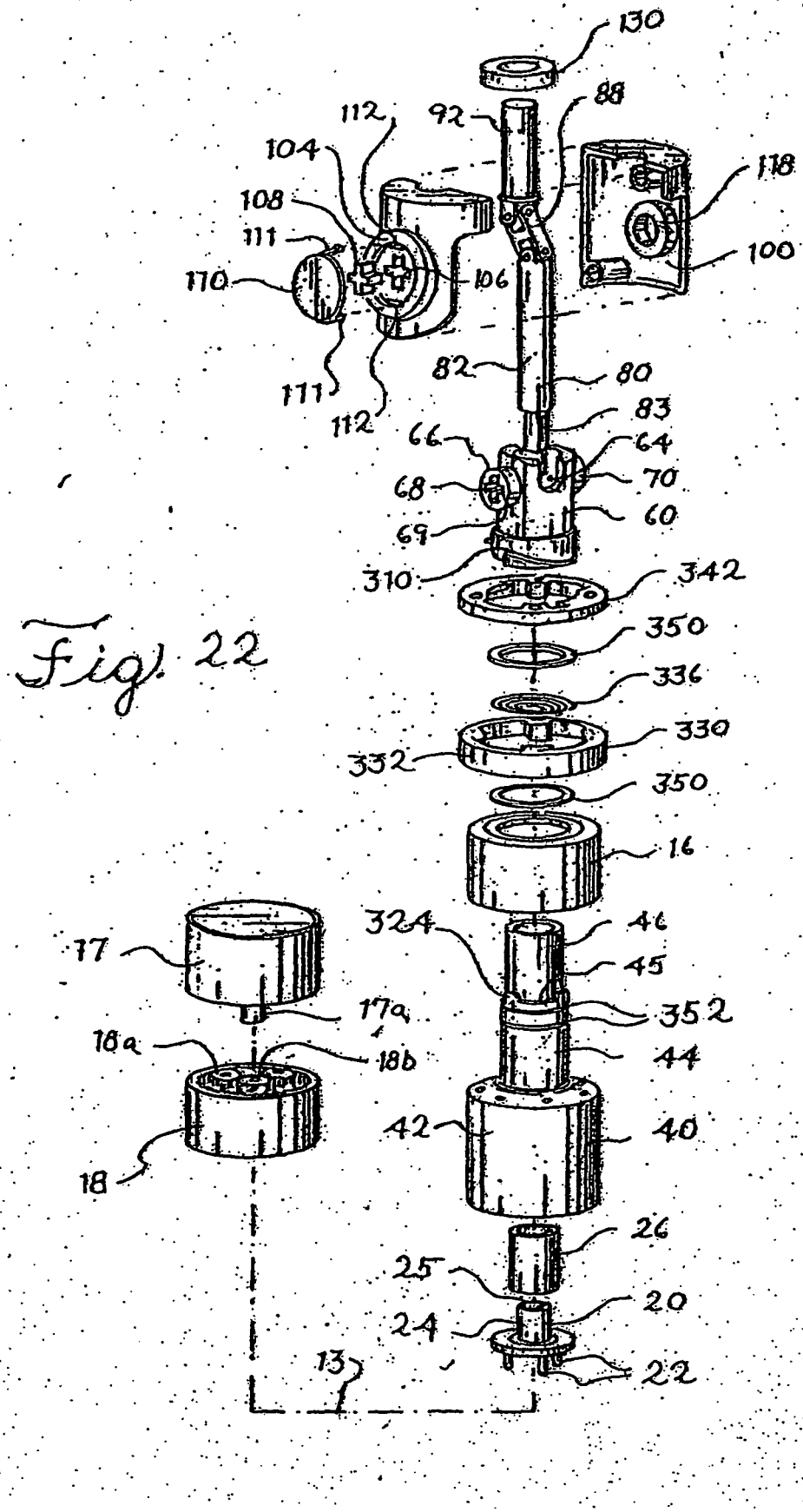
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Fig. 22

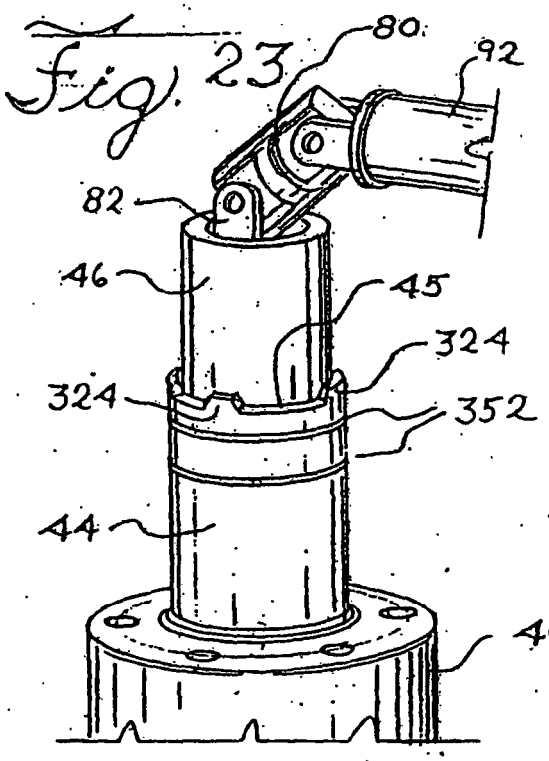

Fig. 23

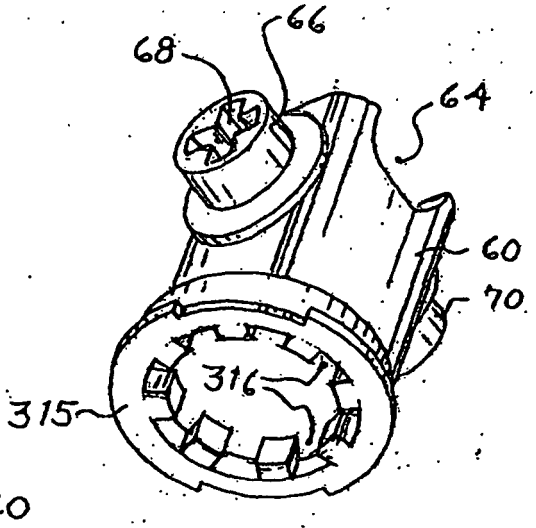

Fig. 24

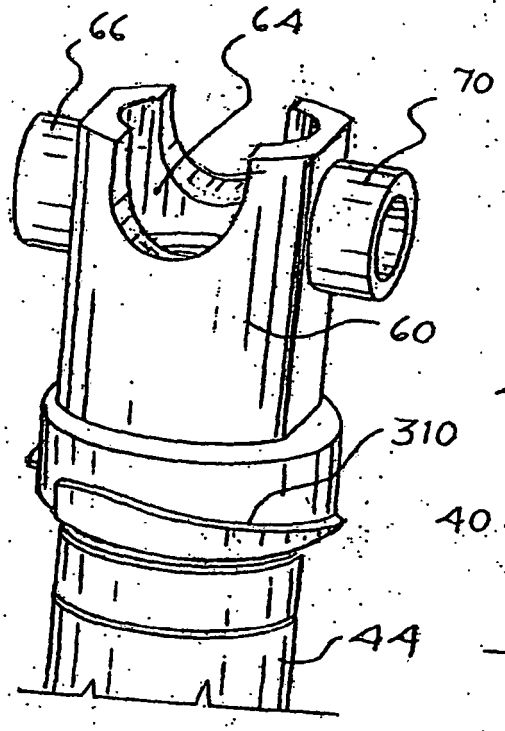

Fig. 25

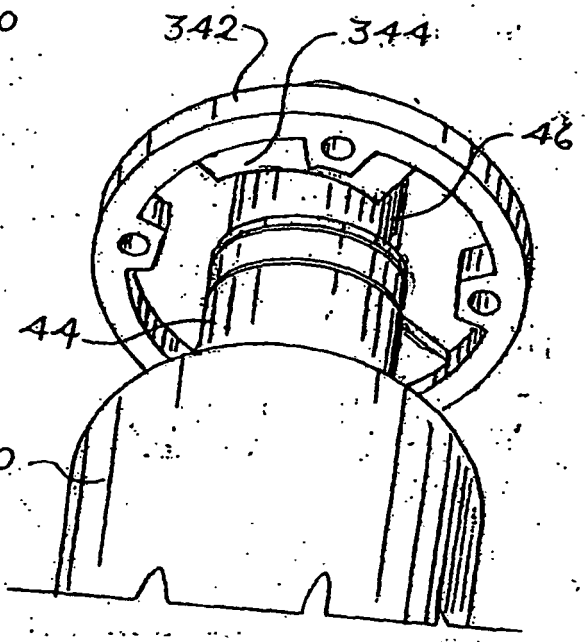

Fig. 26

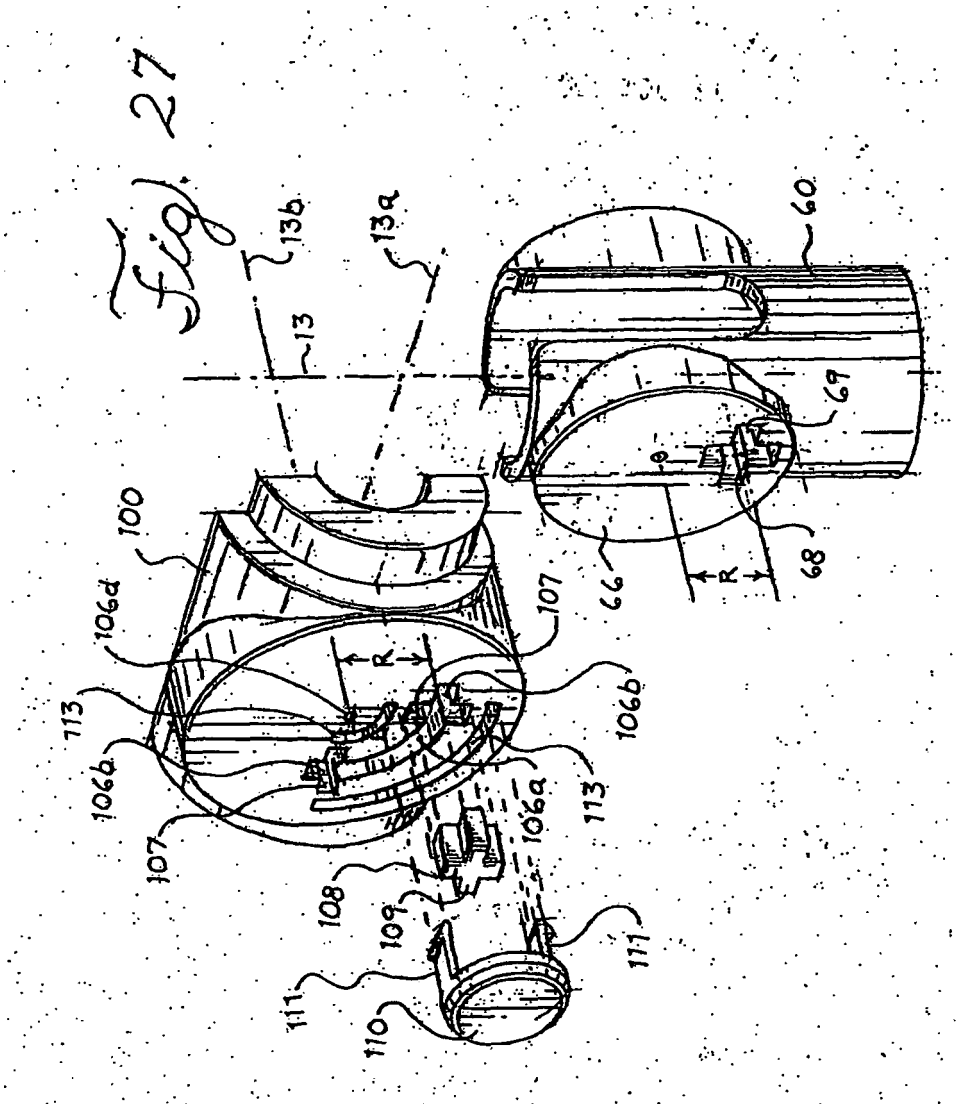
Fig. 27
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Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 01 1023

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2005/070616 A1 (CONCEPT TO REALITY PTY LTD [AU]; BERTANI ROMOLO LORENZO [AU]) 4 August 2005 (2005-08-04) * page 15, line 10 - page 16, line 17; figures * * page 18, lines 11-15,23-27 *	1-5,9	INV. B25F5/02
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Place of search	Date of completion of the search	Examiner
The Hague	3 November 2010	Popma, Ronald

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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