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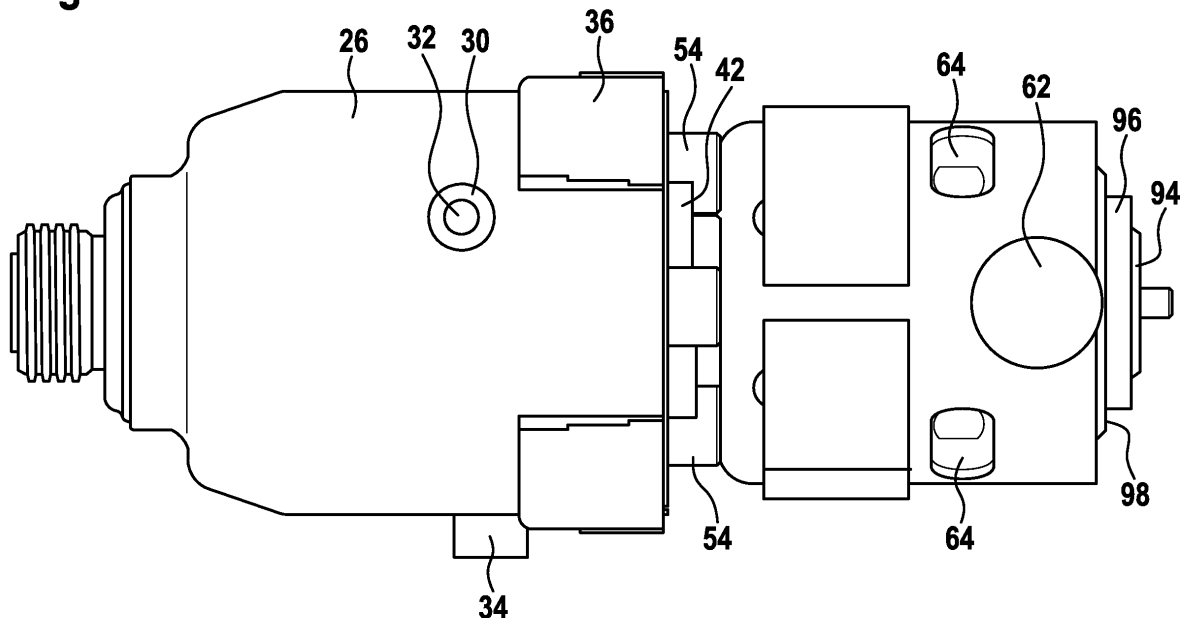
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(54) **Rotary power tool with a gearbox to motor interface that facilitates assembly**

(57) A rotary power tool (10) comprising an output shaft (14) having an axis of rotation (18), a motor (16), a gearbox (24), a first protrusion (82) that is offset from the axis of rotation (18) and protrudes from either one of the motor (16) or the gearbox (24), a first cavity (56) that is offset from the axis of rotation (18) and is within either

one of the motor (16) or the gearbox (24), wherein the first protrusion (82) is substantially within the first cavity (56), and wherein the first cavity (56) is substantially complementary to the first protrusion (82) so that the motor (16) and gearbox (24) cannot substantially rotate relative to each other.

Fig. 2



Description

PRIOR ART

[0001] The invention relates to the interface between a motor and a gearbox in a rotary power tool. Impact drivers are rotary power tools used for high torque driving applications. Particularly in the case of a gearbox which houses not only the gears, but also the impact hammer assembly, the gearbox is preferably securely mounted to the motor to prevent rotation and unnecessary vibration during high torque impacts.

[0002] One type of prior art solution utilizes an indirect coupling, wherein both the gearbox and the motor are secured to the tool housing via brackets or screws. In one such embodiment, the peripheral edge of the gearbox is provided with curved recesses to provide clearance for screws that extend from the motor housing, but the recesses are not sized to correspond to the curvature of the screw heads, do not even partially surround the screw heads, and have no capacity for limiting rotation between the parts. It is also known to provide a direct connection between gearbox and motor via fasteners, although in some cases this necessitates partial disassembly of one or the other part. JP Publication No. 2005-066804-A teaches a direct connection without the use of separate fasteners, disclosing that the gearbox housing can be directly threaded into the motor housing. Each of these prior art methods has drawbacks. Direct connections may complicate assembly and/or increase assembly time. If disassembly is necessary, contamination of the parts such as the gear assembly or the motor armature are possible. Indirect connections with the tool housing may create mechanical and/or thermal stress that leads to wear or damage. It would be useful to have a low-cost and easy to assemble solution for securing the gearbox to the motor.

ADVANTAGES OF THE INVENTION

[0003] A rotary tool is described comprising an output shaft having an axis of rotation, a motor, a gearbox, a first protrusion that is offset from the axis of rotation and protrudes from either one of the motor or the gearbox, a first cavity that is offset from the axis of rotation and is within either one of the motor or the gearbox, wherein the first protrusion is substantially within the first cavity. Only one protrusion and cavity offset from the axis of rotation are necessary to orient the gearbox with the motor, since there is an additional coupling along the rotary shaft of the tool. The limited number of orienting features simplifies assembly. Furthermore no tools are necessary to provide an adequate coupling between the gearbox and the motor.

[0004] If the first cavity is substantially complementary to the first protrusion, the motor and gearbox are not able to substantially rotate relative to each other. This stabilizes the interface and limits vibration as well as stress

on the tool housing during impacts that might occur when a hammer assembly or an external object acts on the rotary shaft. The more complementary the coupling, the less rotation and vibration is possible between the two parts.

[0005] Design possibilities are increased by the possibility of locating the first protrusion to either the motor or the gearbox. Naturally the corresponding first cavity should be implemented in the other corresponding part.

[0006] A secure coupling between the motor and gearbox results if both the first protrusion and the first cavity are shaped like a cylinder. Such a shape permits easy axial movement for assembly and disassembly, but also allow the protrusion and cavity to be shaped with little play, so that there is little possible rotation around the axis of rotation of the output shaft.

[0007] If the first protrusion is either the head of a screw or the head of a rivet, these elements can also provide the second function. If either the motor or the gearbox were not of unitary construction, these elements can also secure the motor or the gearbox end cap to the remaining parts of the motor or the gearbox housing. As such, less parts are necessary to accomplish diverse design objectives.

[0008] If the first protrusion is not intrinsic to the motor or to the gearbox, then a single motor or gearbox design can be used to support several different numbers or types of protrusions. This gives greater flexibility in designing multiple different tools with possibly different tolerance requirements or requiring different possible orientations for assembly. It may be advantageous from a cost standpoint to redesign only the shape of the screw or rivet rather than the motor or gearbox. It also would be easier to increase or decrease the number of protrusions and cavities without significant change to the design.

[0009] So that the subassembly including the gearbox and motor can be secured to or oriented with the remainder of the tool, it is useful to provide the gearbox with means for securing or orienting the gearbox to the tool housing. Since the motor is closely coupled with the gearbox, means for separately securing the motor to the tool housing are less necessary.

[0010] It is advantageous if the rotary tool is provided with a second protrusion that is offset from the axis of rotation and protrudes from either one of the motor or the gearbox, as well as with a second cavity that is offset from the axis of rotation and is within either one of the motor or the gearbox, wherein the second protrusion is substantially within the second cavity. Having a second protrusion and cavity coupling may provide further stability to the motor and gearbox interface, so that there is even less vibration.

[0011] In some cases it may be advantageous if there is more than one orientation with which the gearbox may be coupled to the motor. This possibility is realized if the first protrusion can also be positioned in a second cavity while the second protrusion is positioned in the first cavity. If multiple orientations are possible, this should re-

duce the time necessary for manual assembly of the two parts.

[0012] If the first protrusion and second protrusion are substantially identically shaped so that the second protrusion is substantially complementary to the first cavity, then the gearbox to motor interface can be equally stable even in different orientations. The same is true if the first cavity and second cavity are substantially identically shaped so that the second cavity is substantially complementary to the first protrusion.

[0013] Rather than place all the protrusions on either the gearbox or motor, it is also possible to place one or more protrusions on the motor along with one or more protrusions on the gearbox, and also with the corresponding cavities located accordingly, such that the first protrusion and the second cavity are both associated with the same one of either the motor or the gearbox. This may be useful if hybrid shapes are necessary for manufacture or for overcoming other design obstacles.

DRAWINGS

[0014]

Figure 1 is a schematic drawing of a side view of a rotary tool according to the present invention. Features that are located within the tool housing are indicated with dashed lines.

Figure 2 is a side view of a gearbox and motor sub-assembly for a rotary power tool.

Figure 3 is a section view of a gearbox and motor subassembly for a rotary power tool.

Figure 4 is a perspective view of a gearbox for a rotary power tool.

Figure 5 is a perspective view of a motor for a rotary power tool.

Figure 6 is a breakaway section view of a motor for a rotary power tool.

Figure 7 is a projection that defines a cavity for a rotary power tool.

Figure 8 is a screw for a rotary power tool.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] A rotary power tool, or more specifically an impact driver 10, is shown in Fig. 1. Inside a tool housing 12 there is a rotary shaft 14 which is driven indirectly by a motor 16 and which has an axis of rotation 18. The speed and torque output of the motor are modulated by a gear assembly 20. The gear assembly 20 is housed together with an impact hammer assembly 22 in a closed

module gearbox 24. As is well understood by those skilled in the art, the impact hammer assembly 22 normally transmits rotational force to the output shaft 14 but is also capable of providing intermittent impacts to the same output shaft 14 under conditions where high torque is required.

[0016] The motor 16 and gearbox 24 are coupled with each other to form a larger sub-assembly that is shown in greater detail in Figs. 2 and 3. The gearbox 24 has a gearbox housing 26 to which is coupled a gearbox end cap 28. Either metal or plastic would be suitable materials for the gearbox housing 26 and gearbox end cap 28, but both should preferably be constructed of the same type of material. These aspects of the gearbox 24 can be of unitary construction, but separate parts do facilitate manufacture and assembly of the parts.

[0017] Various means are provided for orienting and securing the gearbox housing 26 within the rotary tool housing 12. For example, each side of the gearbox housing 26 has a ring-shaped protrusion 30 defining a cavity 32 which is in turn threaded for accommodating a fastener, such as a screw (not shown). Furthermore, a U-shaped protrusion 34 extends from the bottom side of the gearbox 24. Even without a fastening element, the U-shaped protrusion 34 can be used to orient or secure the gearbox with respect to ribs or comparable features (not shown) that form a part of the tool housing 12. The gearbox housing 26 is also provided with elevated ridges 36 stretching across particular arcs along its circumference. These may also be used to orient the gearbox with complementary structures in the tool housing 12. The shape and location of these securing means is customized to conform with the shape of the rotary tool housing 12. For tool housings with different shapes, alternative means or locations for these means may be equally effective in orienting and/or fastening the gearbox 24.

[0018] The gearbox end cap 28 actually surrounds the gear assembly 20. It also provides a seat for a ball bearing 38 that stabilizes a jackshaft 40 which transmits the output of the gear assembly 20 to the impact hammer assembly 22. The ball bearing 38 is seated within a ring-shaped shelf 42 that protrudes out of the main face 44 of the end cap 28. The gearbox end cap 28 is provided with several flanges 46 around its perimeter which cooperate with corresponding recesses 48 within the gearbox housing 26 to orient the gearbox end cap 28. The flanges 46 prevent relative rotation of the gearbox end cap 28 and the gearbox housing 26. The gearbox end cap 28 does not need to be fastened to the gearbox housing 26 and instead is maintained in position via an axial force that compresses the entire assembly within the tool housing 12.

[0019] Within the space surrounded by the ring-shaped shelf 42, the main face 44 of the end cap 28 is provided with a central ring-shaped protrusion 50 defining a central orifice 52 (see Fig. 4). Intersecting both the ring-shaped shelf 42 and the central ring-shaped protrusion 50 are four smaller ring-shaped projections 54, each

defining a cavity 56.

[0020] The motor 16 also has a motor housing 58 and a motor end cap 60 which may be of unitary construction as illustrated in Fig. 5 or comprised of separate parts which potentially facilitates manufacture and assembly of the motor 16.

[0021] Two laterally positioned brush covers 62 extend from the motor housing 58 through cavities (not shown) in the tool housing 12 for access to the brushes (not shown). Each of four oblong cavities 64 provides a path for air to enter and/or exit the motor housing 58. Although they are not illustrated, channels formed by ribs in the tool housing 12 can interact with and/or insert into the cavities 64, although in doing so they do not by themselves provide significant structural stability. Instead they mostly serve as a guide for channelling air to and from the motor 16.

[0022] The motor end cap 60 is also provided with four more oblong cavities 66 for providing additional air paths. A ring-shaped extension 68 seats a bearing 70 that supports a motor shaft 72 that extends from the motor 16. Motor shaft 72 is connectable via an interference press-fit to a pinion gear 74 that meshes with planetary gears 76 in the gearbox assembly 20.

[0023] Screws 78 or alternatively rivets 80 (see Fig. 6) with preferably cylinder-shaped screw heads 82 or rivet heads 84 are secured to the motor end cap 60. Both screws 78 or rivets 80 can potentially be used to fasten motor end cap 60 to the motor housing 58 if these parts were not of unitary construction. However, the screw heads 82 or rivet heads 84 primarily serve a role as protrusions for cooperating with cavities 56 as will be described below.

[0024] No tools are required for forming a subassembly comprised of the motor 16 and the gearbox 24. To do so, pinion gear 74 is meshed with planetary gears 76 while ring-shaped extension 68 is interference press-fit into the orifice 52 defined by ring-shaped protrusion 50.

[0025] Since the gears 74, 76 are free to rotate and ring-shaped protrusion 68 is circular, these elements would allow assembly of the motor 16 to the gearbox 24 in any orientation over the full 360 degrees. However, the possible orientations between the motor 16 and the gearbox 24 are more limited since each of the two screw heads 82 or rivet heads 84 are inserted into cavities 56 so that they are substantially within these cavities.

[0026] In the illustrated embodiment, the screw heads 82 are completely within the cavities 56. However it is possible in alternative embodiments to provide cavities 86 that are not fully enclosed (see Fig. 7). That is, they may result from a C-shaped projection 88 that does not define a fully enclosed cavity. Also the screw heads 82 or rivet heads 84 might also not be cylinder-shaped, but instead be a generally cylinder-shaped screw head 90 with one or more extensions 92 deviating from that shape (see Fig. 8). If such a screw head 90 were found within cavity 86, the protrusion would be considered to be substantially within the cavity 86.

[0027] In the first illustrated example, since there are four cavities 56, there are actually four possible orientations. Only two of these are practical, however, since the brush covers 62 are preferably found on the same lateral face as the ring-shaped protrusions 30 for assembly into the tool housing 12.

[0028] The number of cavities 56 and the number of screw heads 82 or rivet heads 84 acting as protrusions is preferably chosen in consideration of the desired orientation options. For example, provided that each cavity 56 and each protrusion is symmetrical in shape and provided they are symmetrically provided on the respective end caps, a single cavity or protrusion permits assembly of the motor 16 and gearbox 24 in only one possible orientation. Two permit two orientations, while three permit three, and so on.

[0029] It may be desirable, however to make the cavities 56 and/or protrusions asymmetrical in shape or distribution, so that the number of possible orientations is further limited, even though there may be multiple cavities 56 or protrusions.

[0030] The cylinder-shaped screw heads 82 or rivet heads 84 preferably slide into the cylinder-shaped cavities 56 just like a piston in a combustion engine. Consistent with this analogy, there is very little play between the two parts, so the cavities 56 are very effective in orienting the screw heads 82 or rivet heads 84 to permit little rotational movement between the motor 16 and gearbox 24.

[0031] During assembly, the ring-shaped shelf 42 serves as a blocking member to prevent unintentional mating of the screw heads 82 with the space in-between the various protrusions 54.

[0032] During assembly of the tool, the subassembly of motor 16 and gearbox 24 is inserted into the tool housing 12. The end bell 94 of the motor 16 helps to orient the subassembly and an O-ring 96 is provided in the space between the motor end face 98 and the tool housing 12, so that the entire subassembly is compressed in the axial direction. This compression maintains the positioning of the screw heads 82 or rivet heads 84 into cavities 56, so that there can be no relative rotation between the motor 16 and gearbox 24. As mentioned earlier, this axial force also keeps the gearbox end cap 28 positioned in the gearbox housing 26.

[0033] In an alternative that is not illustrated, the screw or rivet heads plus the corresponding cavities can take on a conic shape rather than a cylindrical shape. This may facilitate assembly in so far as the angled surfaces of the cavity might help to orient the protrusions for insertion into the cavities when the parts are assembled. However, there is less room for mismatch between the depth of the cavity and the protrusions measured in the axial direction. With the cylindrical design, even with tolerance errors, the motor 16 and gearbox 24 are well-stabilized against relative rotation.

Claims

1. A rotary power tool comprising:

an output shaft (14) having an axis of rotation (18);
 a motor (16);
 a gearbox (24);
 a first protrusion (82) that is offset from the axis of rotation (18) and protrudes from either one of the motor (16) or the gearbox (24);
 a first cavity (56) that is offset from the axis of rotation (18) and is within either one of the motor (16) or the gearbox (24);

wherein the first protrusion (82) is substantially within the first cavity (56);

characterized in that the first cavity (56) is substantially complementary to the first protrusion (82) so that the motor (16) and gearbox (24) cannot substantially rotate relative to each other.

2. A rotary power tool according to any one of the preceding claims, **characterized in that** the first protrusion (82) protrudes from the motor (16) and the first cavity (56) is within the gearbox (24).
3. A rotary power tool according to any one of the preceding claims, **characterized in that** the first protrusion (82) is shaped substantially like a cylinder.
4. A rotary power tool according to any one of the preceding claims, **characterized in that** the first cavity (56) is shaped substantially like a cylinder.
5. A rotary power tool according to any one of the preceding claims, **characterized in that** the first protrusion (82) is also means for securing a motor or gearbox end cap (60) to a motor or gearbox housing (58).
6. A rotary power tool according to any one of the preceding claims, **characterized in that** the gearbox (24) is provided with means (30, 34, 36) for securing the gearbox (24) to a tool housing (12).
7. A rotary power tool according to any one of the preceding claims, **characterized in that** it further comprises:

a second protrusion (82) that is offset from the axis of rotation (18) and protrudes from either one of the motor (16) or the gearbox (24);
 a second cavity (56) that is offset from the axis of rotation (18) and is within either one of the motor (16) or the gearbox (24);

wherein the second protrusion (82) is substantially

within the second cavity (56).

8. A rotary power tool according to claim 7, **characterized in that** the first protrusion (82) can also be positioned in the second cavity (56) while the second protrusion (82) is positioned in the first cavity (56).
9. A rotary power tool according to one of claims 7 or 8, **characterized in that** the first protrusion (82) and second protrusion (82) are substantially identically shaped so that the second protrusion (82) is substantially complementary to the first cavity (56).
10. A rotary power tool according to one of claims 7 through 9, **characterized in that** the first cavity (56) and second cavity (56) are substantially identically shaped so that the second cavity (56) is substantially complementary to the first protrusion (82).
11. A rotary power tool according to any one of claims 7 through 10, **characterized in that** the first protrusion (82) and the second cavity (56) are both associated with the same one of either the motor (16) or the gearbox (24).
12. A rotary power tool according to any one of the preceding claims, **characterized in that** the first protrusion (82) is a screw head (82) from a screw (78) that is threaded into either one of the motor (16) or the gearbox (24).
13. A rotary power tool according to any one of claims 1 through 11, **characterized in that** the first protrusion (84) is a rivet head (84) from a rivet (80) that is attached onto either one of the motor (16) or the gearbox (24).

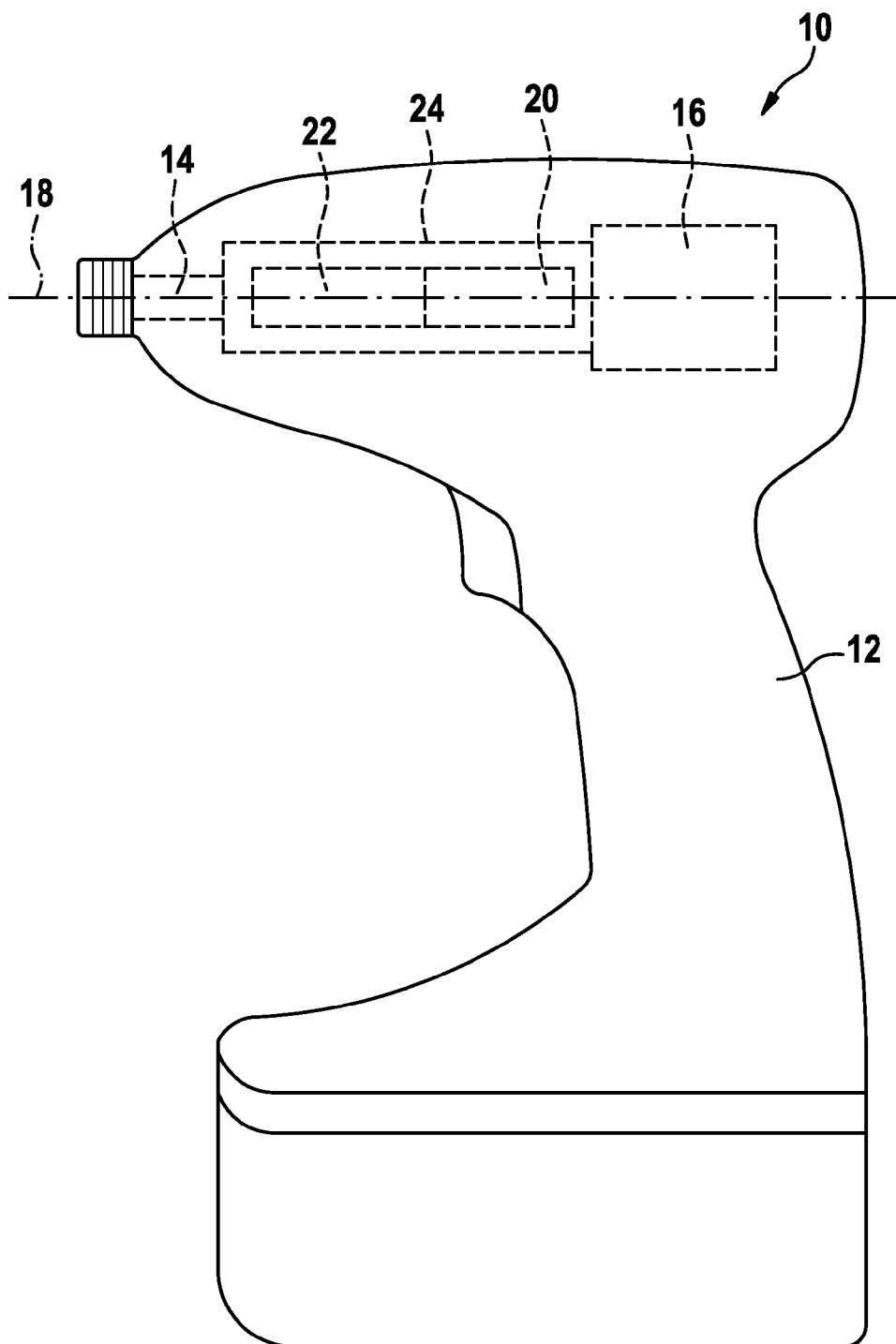


Fig. 1

Fig. 2

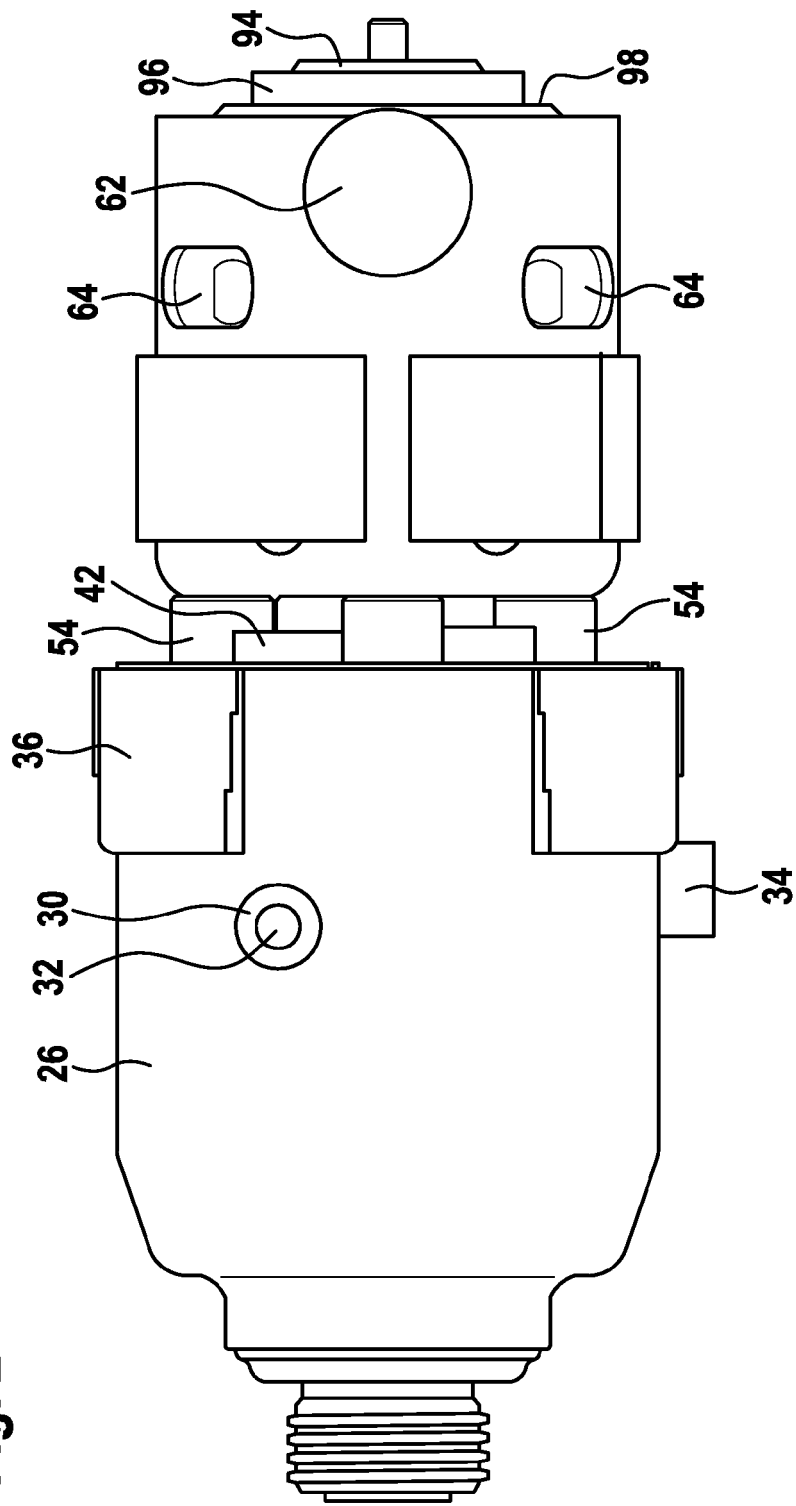
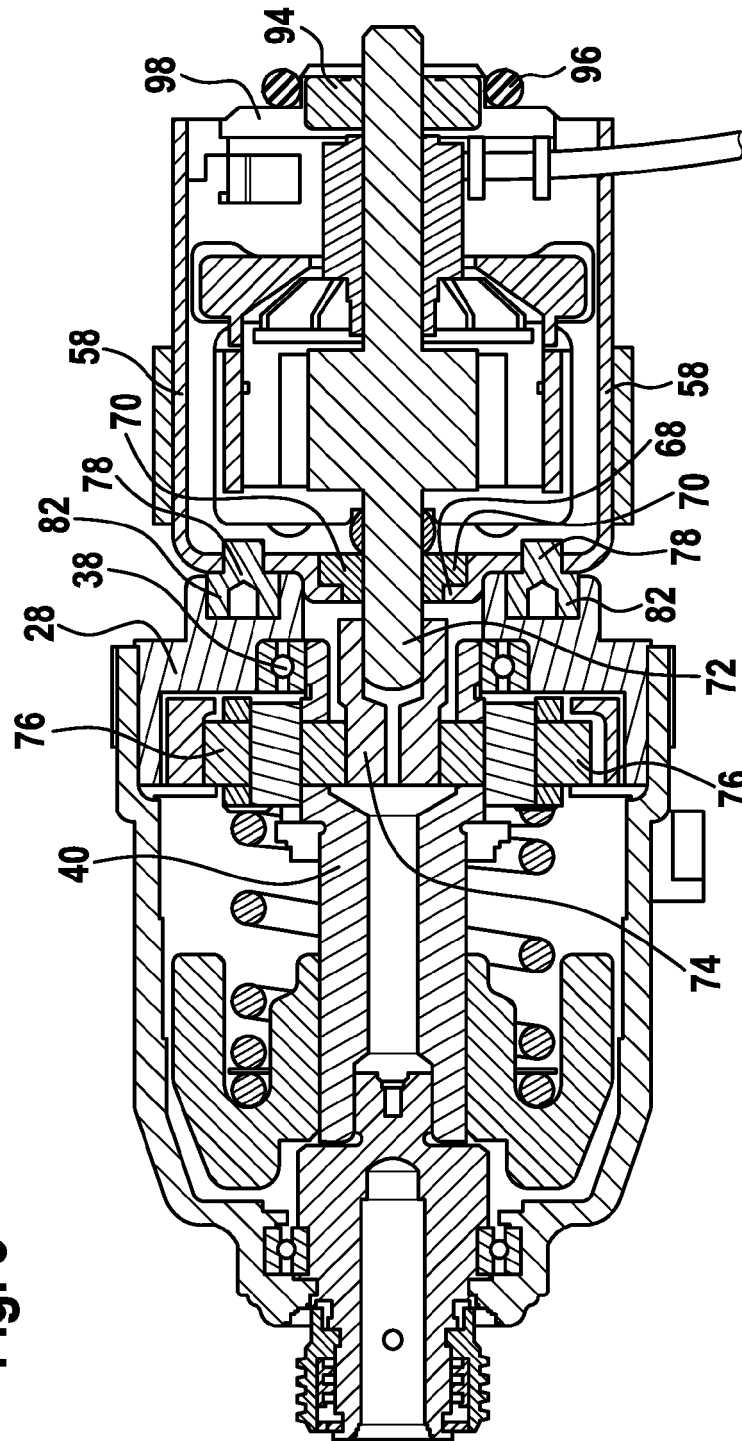


Fig. 3



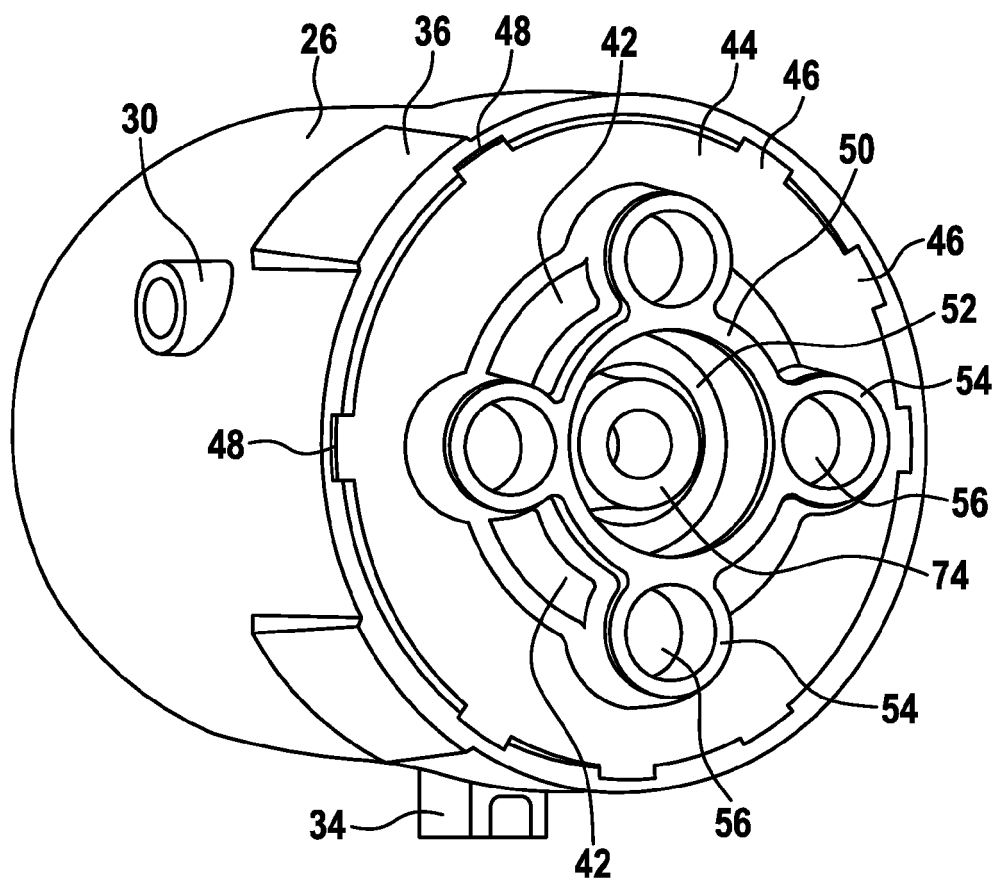


Fig. 4

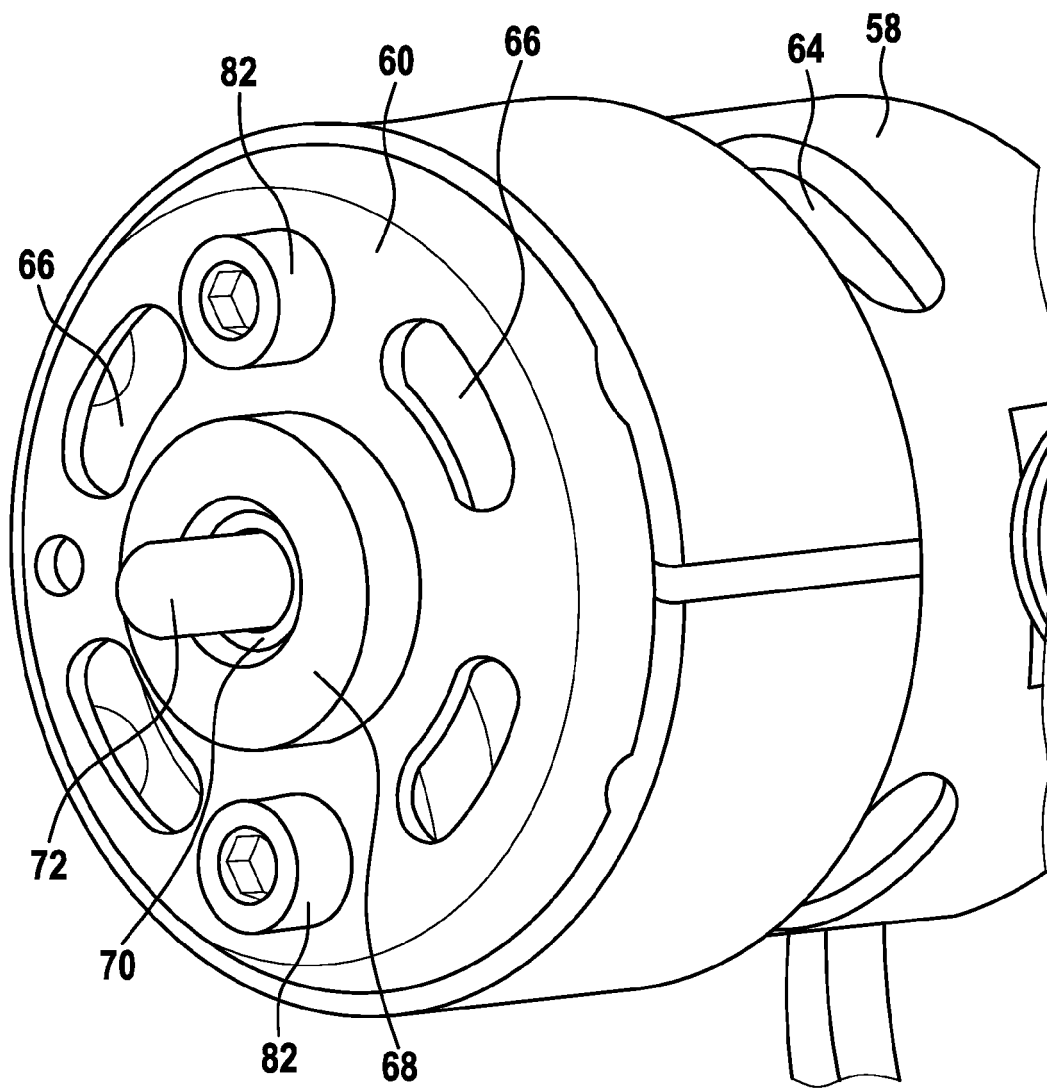


Fig. 5

Fig. 6

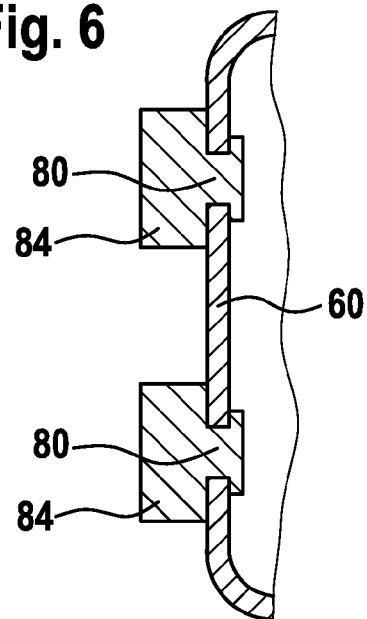


Fig. 7

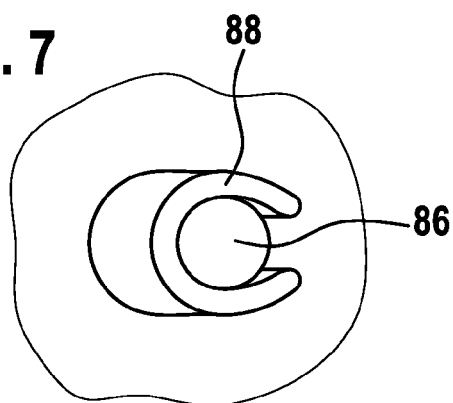
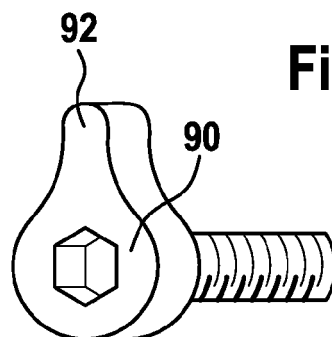


Fig. 8





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 12 4144

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 A	US 5 624 000 A (MILLER PHILIP T [US]) 29 April 1997 (1997-04-29) * column 4, lines 51-58; figures 1-12 * * column 5, lines 29-33 * -----	1-4,6-13 5	INV. B25F5/00 B25F5/02
			TECHNICAL FIELDS SEARCHED (IPC)
			B25F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 April 2008	Examiner Swiderski, Piotr
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EP 07 12 4144

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28-04-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5624000 A	29-04-1997	DE 69530892 D1	03-07-2003
		DE 69530892 T2	26-02-2004
		EP 0698449 A2	28-02-1996
		ES 2194044 T3	16-11-2003
		JP 8052669 A	27-02-1996

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005066804 A [0002]