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(54) **Stud extractor**

(57) A tool is disclosed for gripping and extracting damaged or broken threaded fasteners such as studs or bolts (40, Fig. 3) of a wide range of diameters from a workpiece. The extractor comprises a rotor (20) and a stator (10) and a plurality of teeth (30, Fig. 1). Teeth (30) are individually slidably mounted in a plurality of substantially radial channels (13) in the stator; and are driven inward onto the stud by a stepped camming surface (24) on the rotor. Fig. 6a shows a reversible tool for extracting left-hand threaded studs. This tool is used with a first driving tool (Fig. 6b) comprising a socket wrench adaptor. Fig. 7 shows a tooth (230) with a forward extension (236) allowing the tooth to grip a short protruding section of stud. Ribs or knurling (11) allow the rotor to be manually turned relative to the stator.

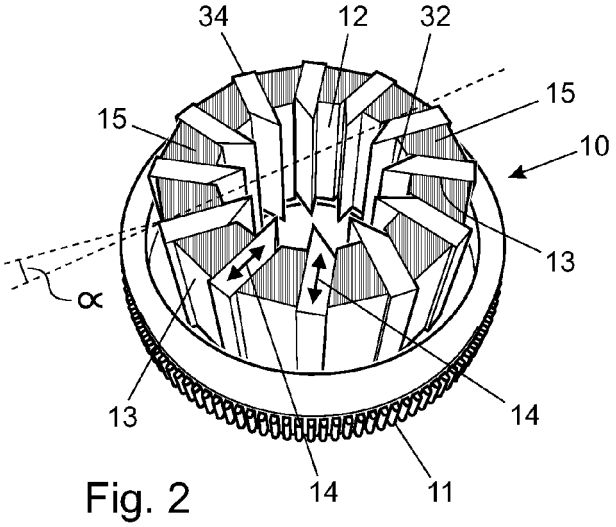

Fig. 2

EP 2 364 816 A2

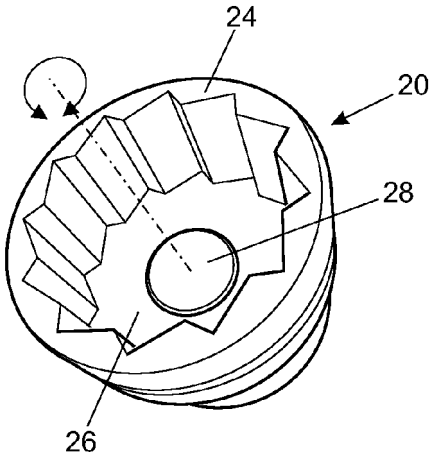

Fig. 3

Description

[0001] The present invention relates to tools for extracting protruding, broken, damaged, or sheared-off threaded fasteners, such as studs, screws, bolt shanks or threaded bars from a work-piece or material in which they have been inserted.

[0002] Various devices have been proposed for removal of the protruding shank of a broken or sheared-off threaded fastener from a hole into which the fastener has been inserted. One known broken bolt extractor requires two holes to be carefully drilled into the end of the stud with the aid of a slip-on guide. Two hardened pins are then inserted into the holes and a tool such as an adjustable spanner can be used to grab the pins and turn the stud out. The device cannot be used with small diameter studs and therefore is not universally applicable. Moreover, the device only works when the end face of the stud is flat and can be accessed by a suitable drilling tool.

[0003] Another known stud extractor comprises a two-piece tool. To use the device, firstly it is necessary to drill a hole in the end of the stud. Then a first piece of the tool having three knurled faces is inserted into the hole. A second piece of the tool comprising a tri-lobed camming tool is then inserted into the first piece and turned so that the camming action forces the knurled faces against the sides of the drilled hole with increasing force until the stud itself begins to rotate. Again, the device cannot be used with small diameter studs and therefore is not universally applicable. Moreover, the device only works when the end face of the stud can be accessed by a suitable drilling tool.

[0004] A further known stud extractor can be driven by a standard wrench. The extractor tool includes a pair of opposing jaws which are cammed into place around the stud to be removed. The tool requires a significant amount of the broken fastener to protrude from the surface to allow the jaws to grip the broken fastener in use. The camming action comes from an elliptical cut-out shape that, when rotated, forces the jaws closed. The gripping force of the stud is increased within increased input torque but the clamping force is not evenly distributed around the circumference of the stud. Moreover, the design of the tool is such that it could only be used with studs having a limited range of diameters.

[0005] A number of known stud extractors only grip the stud to be extracted at two or three points around its circumference. This limits the contact area on the stud; and thus may cause the stud to be damaged further, but not necessarily extracted. Stud extractor tools are also known whose stud gripping parts do not extend to the end of the tool adjacent to the workpiece. These tools are of little or no use where there is only a short section of stud protruding from the workpiece, because they cannot get a grip on the short section of protruding stud. Where the extractor teeth do extend to the end of the tool adjacent to the workpiece, they may not be surrounded by a reinforcing ring; which in turn may lead to a lack of rigidity in gripping the stud.

[0006] Accordingly, there is a need in the art for an improved tool for extracting protruding broken or sheared-off studs or fasteners from holes, which can be used with different diameters and lengths of stud; and which can grip the broken stud effectively around its entire circumference. There is also a need for a stud extractor which can be used quickly without requiring the broken stud to be drilled prior to use of the extractor, or several component parts of the extractor to be fitted together prior to each use.

[0007] The above needs are addressed by the present invention which provides a stud extractor comprising: a stator; a rotor; and a plurality of teeth slidably mounted in the stator and movable relative to the stator in a radial direction by rotation of the rotor relative to the stator, or by rotation of the stator relative to the rotor; characterized in that the teeth are individually slidably mounted in a plurality of substantially radial channels in the stator.

[0008] The stator and rotor may be arranged co-axially about a common axis of rotation. Movement of the plurality of teeth in a radial direction includes any movement of the plurality of teeth in a direction which has a component in the radial direction, i.e. any non-tangential movement.

[0009] The stator may have a central aperture in which the stud to be extracted can be inserted. The stator may be annular. The teeth may extend into the central aperture.

[0010] In use, the stud to be extracted may be inserted into the central aperture. The rotor may then be rotated relative to the stator (or the stator rotated relative to the rotor), thus causing the teeth to slide radially inwards and contact the stud. Further rotation of the rotor relative to the stator (or stator relative to the rotor) causes the teeth to grip the stud, until the force exerted by the rotor exceeds that required to turn the threaded stud, and the stud begins to rotate out of the material in which it is embedded. The present invention can be used to extract studs or other damaged threaded fasteners of a wide range of diameters because the teeth are moved radially inwards by the rotor until they impinge upon the stud, whatever diameter the stud may be.

[0011] The stator may include an annular protrusion having a plurality of channels formed therethrough. The annular protrusion may have a circular or regular polygonal shaped cross section. Each channel may be aligned along a different chord of the annular protrusion. Each of the channels may be aligned along chords of equal length such that an angle formed between a) the channel, and b) a diameter of the annular protrusion intersecting a first end of the channel, is the same for each channel. Each chord may be arranged so that it does not pass through the centre of the annular protrusion such that the channels are not aligned with a radius of the annular protrusion. This allows the turning force that can be exerted on the stud to be extracted to be maximised. The channels may be evenly spaced around the circumference of

the protrusion to allow the stud to be gripped with the same force at a plurality of locations around the circumference of the protrusion. Each angle between a channel and a diameter of the protrusion may be an acute angle greater than zero.

[0012] The rotor may include a camming surface. The camming surface may be formed by a plurality of serrations. The camming surface may be arranged to cooperate with the teeth such that rotation of the rotor relative to the stator in a first direction causes the camming surface to push the teeth radially inwards. Rotation of the rotor relative to the stator in a second direction allows the teeth to slide radially outwards.

[0013] The rotor may include a means for cooperation with a driving tool. The means for cooperation may comprise a central aperture. The aperture may, for example, be square for receipt of a standard socket wrench. Alternatively, the means may comprise a plurality of apertures or protrusions circumferentially spaced around a flat face of the rotor, and a first driving tool including a corresponding plurality of protrusions or apertures circumferentially spaced around the first driving tool for cooperation with the plurality of apertures or protrusions spaced around the flat face of the rotor. In this case, the first driving tool may include a central aperture for receipt of a further driving tool, such as a standard socket wrench. The first driving tool may be magnetic, and the rotor may be formed from a ferromagnetic material. Alternatively, the means for cooperating may comprise a plurality of flat surfaces arranged externally around the rotor and/or stator to be gripped by a suitable tool such as a spanner or wrench.

[0014] The rotor may include means for limiting radial movement of the teeth. The means for limiting radial movement may comprise a central protrusion. Movement of each tooth may be limited when an inner surface of each tooth contacts the central protrusion of the rotor. The central protrusion may be positioned on an inner face of an internal cut-out of the rotor.

[0015] The rotor may be annular and have a central aperture. In this case, the stator may also include a means for connecting a driving tool to the stator. The means may comprise a plurality of apertures or protrusions circumferentially spaced around a flat face of the stator, and a first driving tool including a corresponding plurality of protrusions or apertures circumferentially spaced around the first driving tool for cooperation with the plurality of apertures or protrusions spaced around the flat face of the stator. In this case, the first driving tool may include a central aperture for receipt of a further driving tool, such as a standard socket wrench. The first driving tool may be magnetic, and the stator may be formed from a ferromagnetic material. Consequently, the stud extractor could be used to remove both left and right handed threaded studs by connecting the first driving tool to one of the stator and the rotor and positioning the stud to be gripped in the central aperture of the other of the stator and the rotor.

[0016] The stator and/or the rotor may be knurled and include a plurality of grooves around an outer surface thereof which form a gripping surface. The plurality of grooves allow the user to grip the stator and/or the rotor and initially rotate the stator or rotor relative to the other of the stator or rotor in order to position the extractor on the stud and lightly grip the stud to be extracted.

[0017] The teeth may be chamfered. In particular the teeth may be generally rectangular and have a chamfered gripping edge directed towards a central axis of the extractor. The chamfered edge may further include an extension which extends in a direction parallel to the central axis. The length of the extension may be chosen such that a portion of each tooth is flush with a flat surface of the stator and/or rotor. This allows the tool to be used to grip a stud which has minimal length protruding from the material in which it is embedded. Alternatively, the length of the extension may be chosen such that a portion of each tooth extends beyond the flat surface of the stator or rotor.

[0018] The rotor may be connected to the stator. The connection between the stator and the rotor may be formed by one of the stator and the rotor including a circumferential channel, and the other of the stator and the rotor including a portion of reduced diameter which fits within the circumferential channel. Consequently, the stud extractor may consist of a single, integral or self-contained unit.

[0019] The rotor and stator may be formed from forged and machined steel. The teeth may be formed from steel plate with at least one machined chamfer.

[0020] The stud extractor may include biasing means for applying a uniform resilient biasing force against the teeth, so as to ensure the teeth remain centred within the stator and rotor, thus aiding the application of the extractor to the broken fastener. The teeth may be resiliently biased towards the centre of the rotor so that the extractor could be fitted around the broken fastener one-handed.

[0021] Embodiments of the present invention will now be described in detail by way of example only, with reference to the following Figures in which:

Figures 1 a), b) and c) show three perspective views of a first embodiment of a stud extractor according to the present invention;

Figure 2 shows the stator and teeth of the embodiment of Figure 1;

Figure 3 shows the rotor of the embodiment of Figure 1;

Figure 4 shows a cut-away view of a portion of the embodiment of Figure 1;

Figures 5 a) and b) show two perspective views of the embodiment of Figure 1 when in use;

Figure 6 a) shows a perspective view of a second embodiment of a stud extractor according to the present invention;

Figure 6 b) shows a perspective view of a driving tool for use with the embodiment of Figure 6 a); and

Figure 7 shows a perspective view of a third embodiment of a stud extractor according to the present invention with an exploded view of a tooth of the stud extractor.

[0022] Figures 1 a), b) and c) show a stud extractor according to a first embodiment of the invention. The stud extractor comprises a stator 10, a rotor 20, and a plurality of teeth 30. The teeth 30 are slidably mounted in the stator 10 and are free to move in a substantially radial manner inwards and outwards. The teeth 30 are movable relative to the stator 10 in a substantially radial direction by rotation of one of the rotor 20 and the stator 10 relative to the other of the rotor 20 and the stator 10. Figure 1 shows the extractor in its unused state, with the teeth 30 in their most radially retracted position. In the embodiment shown in Figure 1, the extractor includes twelve teeth. However, an extractor according to the present invention may include any number of teeth greater than or equal to three; but preferably greater than or equal to six.

[0023] The stator 10 includes a knurled gripping portion comprising a plurality of grooves 11 which allow the user to grip and rotate the stator 10 relative to the rotor 20 by hand. The stator 10 and rotor 20 are arranged about a common axis of rotation. The stator 10 includes a central aperture 12 into which the stud 40 to be extracted is inserted (see Figure 5). The stator 10 is generally annular and the teeth 30 can slide in a substantially radial direction so that they extend into the central aperture 12.

[0024] The rotor 20 includes a central square aperture 22 for connecting a driving tool, such as a socket wrench, to the rotor. The square aperture may be sized for a standard socket wrench, for example a 1/4", 3/8", 1/2", 3/4", or 1" socket drive.

[0025] Figure 2 shows the stator 10 and teeth 30 of the stud extractor. The teeth 30 are slidably mounted in a plurality of channels 13 in the stator 10 which provide a guide for the movement of the teeth 30. The arrows 14 show the directions of movement of two of the teeth during operation. The stator 10 includes an annular protrusion 15 in which the plurality of channels 13 are formed. The annular protrusion 15 has a regular polygonal shaped cross section. Each channel 13 is aligned along a different chord of the annular protrusion 15. Each of the channels 13 are aligned along chords of equal length such that an angle α between each channel 13, and a diameter of the annular protrusion 15 intersecting a first end of the channel 13, is the same for each channel 13. None of the chords pass through the centre of the annular protrusion 15 so that the channels 13 are not aligned with a radius of the annular protrusion 15. The channels 13 are evenly spaced around the circumference of the protrusion 15.

[0026] The teeth 30 are chamfered so as to provide a surface such as an edge with which to engage and grip the stud or other such fastener to be removed. In particular, the teeth 30 are generally rectangular and have a chamfered gripping edge 32 directed towards the central axis of the extractor. The teeth also have a chamfered edge 34 directed away from the central axis of the extractor. Edge 34 is chamfered to engage accurately with the rotor 20 and its camming surface 24. The gripping edge 32 and chamfered edge 34 are shown in detail in Figure 7.

[0027] Figure 3 shows the rotor 20 of the stud extractor. The rotor 20 includes a camming surface 24. The camming surface 24 is positioned in an internal cut-out 26 of the rotor 20. The camming surface 24 is serrated and, in use, is arranged to cooperate with the teeth 30 such that rotation of the rotor 20 relative to the stator 10 in a first direction causes the camming surface 24 to urge the teeth 30 radially inwards. Rotation of the rotor 20 relative to the stator 10 in a second direction opposite to the first direction allows the teeth 20 to slide radially outwards. It should be noted that the reversible arrow of rotation of Figure 3 is shown rotating around a central axis of the rotor, and hence of the stud extractor.

[0028] The rotor 20 also includes a central protrusion 28 for limiting radial movement of the teeth 30 and preventing the teeth from falling out of the extractor. The central protrusion 28 is positioned on an inner face of the internal cut-out 26 of the rotor 20. Movement of each tooth 30 is limited when an inner surface of the chamfered edge 32 of each tooth 30 contacts or impinges upon the central protrusion 28 of the rotor 20.

[0029] Figure 4 shows how the stator 10 and rotor 20 are connected to one another. The connection between the stator 10 and the rotor 20 is formed by providing the rotor with a circumferential channel 29, and the stator 10 with a portion 16 of reduced diameter which fits within the circumferential channel 29.

[0030] In the embodiment shown in Figure 4, the rotor 20 and stator 10 are formed from forged and machined steel, whilst the teeth 30 are formed from steel plate with machined chamfers 32, 34 at each end. Once the teeth 30 have been placed within the stator 10, the rotor 20 and the stator 10 are pushed or pressed together and the top most section of the stator 10 material is pressed or swaged onto the circumferential channel 29 or groove on the rotor 20 to form the reduced diameter portion 16.

[0031] Figure 5 shows how the stud extractor of Figure 1 is used. In use, the stud 40 to be extracted is inserted into the central aperture 12 of the stator 10. The user then attaches a tool such as a ratchet wrench or similar into the central aperture 22 of the rotor, and hand tightens the teeth 30 onto the surface of the stud 40 by gripping the stator 10 using the grooves 11 and rotating the stator 10 clockwise (when looking end on to the stud). This process causes the teeth 30 to slide radially inwards until they contact the surface of the stud or bolt 40. Alternatively, the user may hold the stator 10 stationary against the work-piece and rotate the rotor 20 in an anti-clockwise direction relative to the stator 10. The user then further tightens the grip of the teeth 30 by rotating the rotor 20 anti-clockwise relative to the stator 10 (in the direction of

the arrow 42) using the wrench until the teeth 30 impinge upon and grip the stud 40, the force exerted by the rotor exceeds that required to turn the threaded stud, and the stud 40 begins to rotate with the extractor out of the material or work-piece in which it is embedded. If the force of the teeth 30 impinging upon the material of the stud 40 is sufficiently high, the teeth 30 may cut into the material of the stud 40, further increasing the level of grip the extractor has on the stud 40. The grip exerted by the teeth 30 tightens with increasing input torque from the operator thus maximising the operational success of the tool. Furthermore, the movement of the teeth 30 and operation of the extractor allow the extractor to be used on a range of stud or bolt diameters without significantly reducing its effectiveness.

[0032] It will be appreciated that the extractor of the present invention may be used to grip the head of a damaged fastener such as a nut whose surface has been damaged or rounded-off.

[0033] Figure 6 shows a second embodiment of a stud extractor according to the present invention. The stator 110 and teeth 130 of this embodiment are the same as those of the first embodiment except that the stator 110 further includes a plurality of indentations (not shown) that are the same as the indentations 121 formed in the rotor 120 and described below.

[0034] The embodiment of Figure 6 can be used in both a clockwise and an anti-clockwise direction, so that it has the capability to remove both clockwise threaded and anti-clockwise threaded fasteners. The rotor 120 is annular and includes a central aperture 122 passing all the way through the rotor 120. Consequently, in use, the stud to be extracted can be inserted into either end of the extractor, i.e. into the rotor 120, or into the stator 110, depending on the direction of the thread of the stud.

[0035] Both the rotor 120 and the stator 110 can be rotated by hand and include a knurled or milled gripping surface formed by a plurality of grooves 111, 123. The gripping surface allows the user to initially rotate the stator or rotor relative to the other of the stator or rotor in order to position the extractor on the broken fastener and cause the teeth 130 to lightly grip the broken fastener before commencing extraction.

[0036] The rotor 120 includes a means for connecting a driving tool 150 to the rotor 110. The means comprises a plurality of apertures or indentations 121 circumferentially spaced around a flat face of the rotor 120. The stator also includes a plurality of indentations or apertures circumferentially spaced around a flat face of the stator 110 for connecting a driving tool 150 to the stator. The indentations 121 are shown as having a circular cross section. However, the indentations may have any suitable cross section.

[0037] A driving tool 150 can be connected to either the rotor 120 or the stator 110 of the device to allow the device to function in either direction of rotation. The driving tool 150 acts as an adaptor between the stud extractor and a standard drive such as a 3/8" socket drive and includes a central aperture 152 for receipt of a further driving tool such as a socket drive. The driving tool 150 includes a plurality of protrusions 151 circumferentially spaced around the tool 150. These protrusions 151 correspond to and cooperate with the plurality of indentations 121 on the rotor 120 and the plurality of indentations (not shown) on the stator 110. In the example shown, the driving tool 150 is magnetic, and the stator and rotor are formed from a ferromagnetic material so that the driving tool uses magnetic attraction to hold itself in place during operation and storage.

[0038] Consequently, the stud extractor of Figure 6 can be used to remove both left and right handed threaded fasteners by connecting the first driving tool 150 to one of the stator 110 and the rotor 120 and positioning the stud to be gripped in the central aperture of the other of the stator 110 and the rotor 120.

[0039] Figure 7 shows a third embodiment of a stud extractor according to the present invention. The stud extractor of Figure 7 is the same as that of Figure 1 except that the teeth 230 are stepped so that the chamfered edge 232 includes an extension 236 which allows each tooth 230 to extend in a direction parallel to the central axis. The length of the extension is chosen to be equal to a thickness of a front face of the stator 210 so that the extension 236 of each tooth 230 is flush with the front face of the stator 210. The extractor tool of Figure 7 can be used with shorter protruding stud lengths of fastener than the embodiment of Figure 1.

[0040] It will of course be understood that the present invention has been described by way of example, and that modifications of detail can be made within the scope of the invention as defined by the following claims.

Claims

1. A stud extractor comprising:

a stator (10);
a rotor (20); and
a plurality of teeth (30) slidably mounted in the stator (10) and movable relative to the stator in a radial direction by rotation of the rotor (20) relative to the stator (10), or by rotation of the stator (10) relative to the rotor (20);
characterized in that the teeth (30) are individually slidably mounted in a plurality of substantially radial channels (13) in the stator.

2. The stud extractor of claim 1, wherein the stator (10) includes an annular protrusion (15) having the plurality of channels (13) formed therethrough.

3. The stud extractor of claim 2, wherein the plurality of channels (13) are evenly spaced around the stator (10);
and each of the plurality of channels (13) is aligned

along a different chord of the annular protrusion (15).

4. The stud extractor of claim 3, wherein each channel (13) is at the same angle (α) to a diameter of the protrusion (15) intersecting a first end of said channel (13).

5. The stud extractor of claim 4, wherein the angle (α) between each channel (13) and the corresponding diameter of the protrusion (15) is an acute angle greater than zero.

6. The stud extractor of any preceding claim, wherein the rotor (20) includes a camming surface (24).

7. The stud extractor of claim 6, wherein the camming surface (24) is formed by a plurality of serrations.

8. The stud extractor of any preceding claim, wherein either the rotor (20) or both the rotor (20) and the stator (10) include a plurality of apertures (121) or protrusions (151) circumferentially spaced around a flat face of either the rotor, or the rotor and the stator, for cooperating with a driving tool (150).

9. The stud extractor of claim 8" further including a driving tool (150), wherein the driving tool includes a plurality of protrusions (151) or apertures (121) circumferentially spaced around the first driving tool (150) corresponding to and for cooperation with the plurality of apertures (121) or protrusions (151) spaced around the flat face of the rotor (20) or the rotor (20) and the stator (10).

10. The stud extractor of claim 9, wherein the driving tool (150) is magnetic.

11. The stud extractor of any of claims 1 to 7, wherein the rotor (20) and/or the stator (10) include a plurality of flat surfaces arranged externally therearound for cooperating with a driving tool.

12. The stud extractor of any preceding claim, wherein the rotor (20) includes means for limiting inward radial movement of the teeth (30).

13. The stud extractor of any preceding claim, wherein each of the plurality of teeth (30, 230) includes a chamfered gripping edge (32, 232) directed towards a central axis of the extractor.

14. The stud extractor of claim 13, wherein each chamfered gripping edge (232) includes an extension (236) which extends in a direction parallel to the central axis, such that in use, the extension of each tooth (230) is flush with, or protrudes from, a flat surface of the stator (210) and/or rotor (20) adjacent to a workpiece from which a stud (40) is to be extracted.

15. The stud extractor of claim 14, where each extension (236) is flush with the flat surface of the stator (210) and/or rotor (20), and is surrounded on its radially outer edge by said flat surface.

16. The stud extractor of any preceding claim, further including a biasing means for resiliently biasing the teeth (30, 230) in a radial direction towards a central axis of the stud extractor.

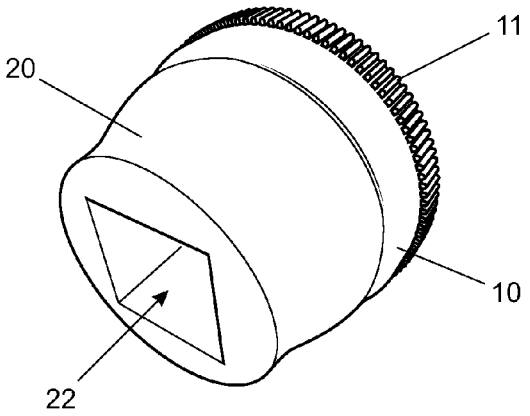

Fig. 1 (a)

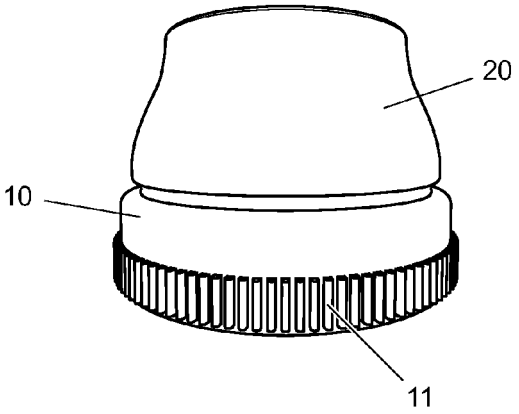

Fig. 1 (b)

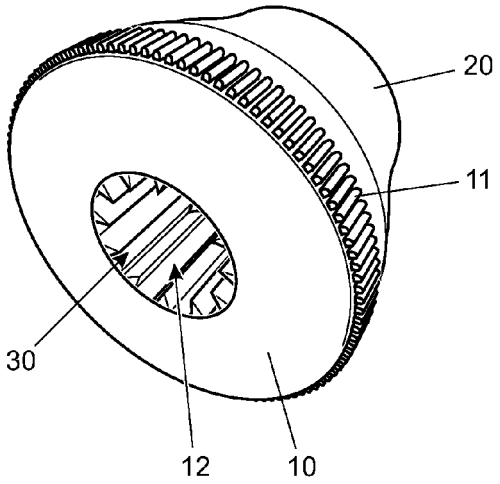

Fig. 1 (c)

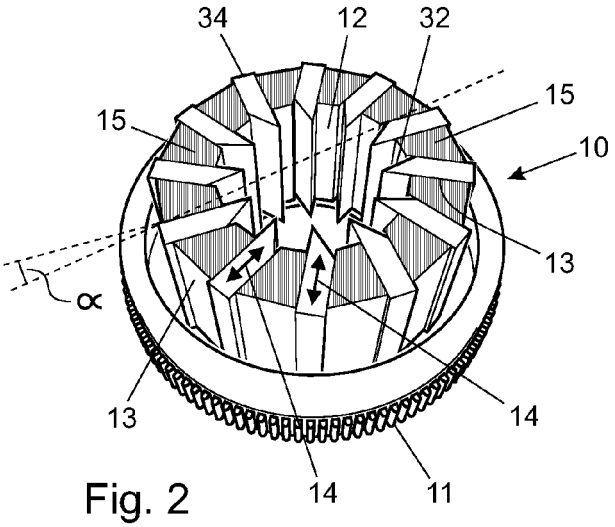

Fig. 2

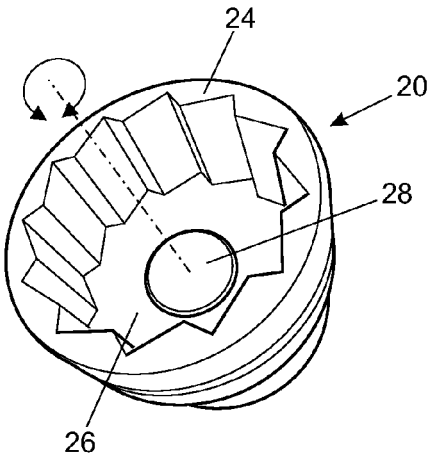

Fig. 3

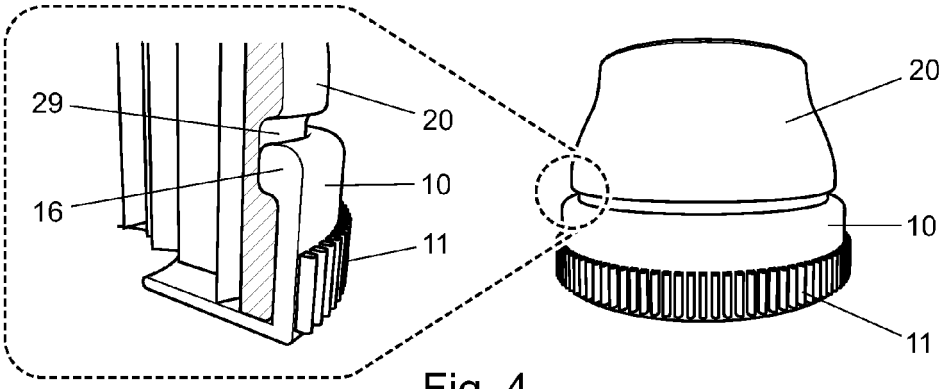

Fig. 4

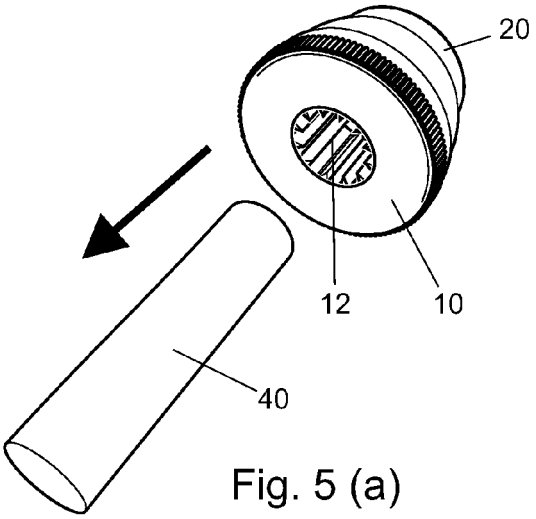

Fig. 5 (a)

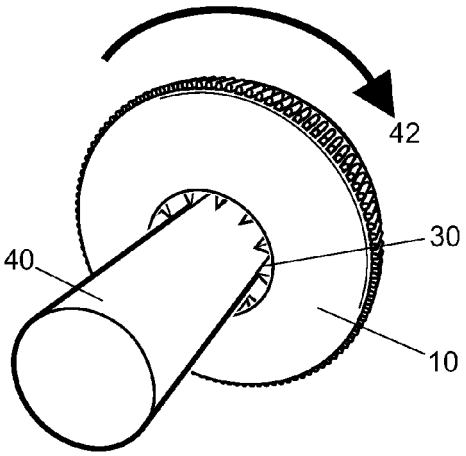

Fig. 5 (b)

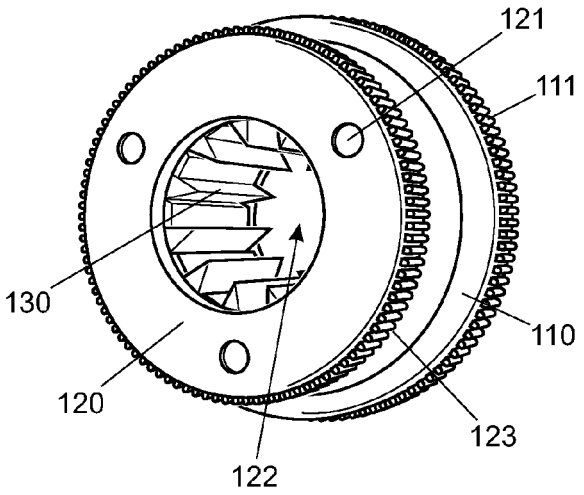

Fig. 6 (a)

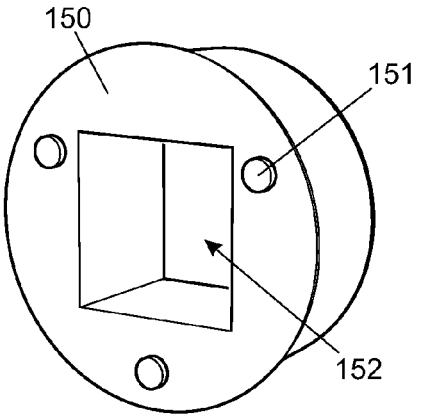

Fig. 6 (b)

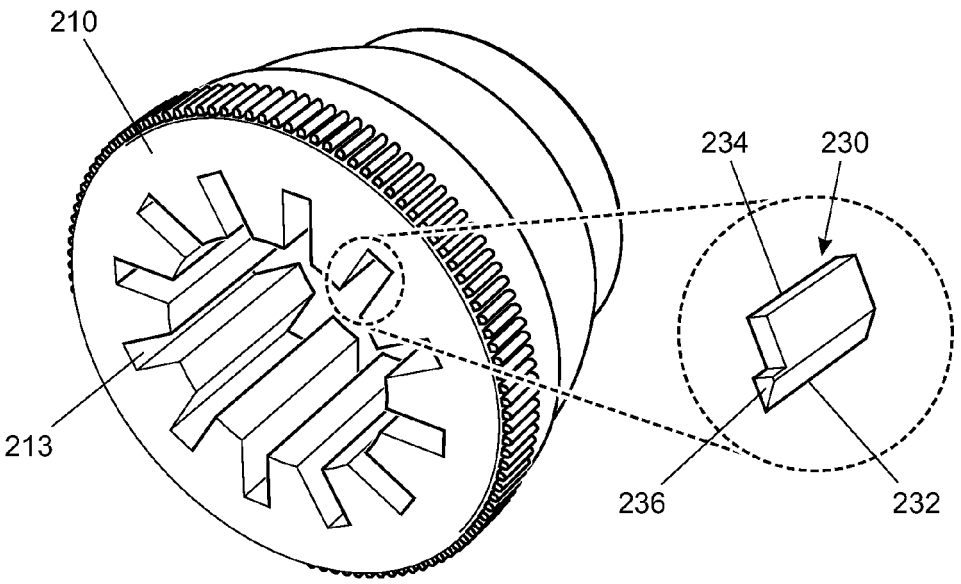

Fig. 7