(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 785 858 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.03.2021 Bulletin 2021/09

(51) Int Cl.:
B25B 23/00 *(2006.01)* ***B25B 23/12*** *(2006.01)*

(21) Application number: **19193691.3**

(22) Date of filing: **27.08.2019**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Wu, Kun-Lin**
408 Taichung City (TW)

(72) Inventor: **Wu, Kun-Lin**
408 Taichung City (TW)

(74) Representative: **Horak, Michael**
horak. Rechtsanwälte Partnerschaft
Georgstrasse 48
30159 Hannover (DE)

Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) **SCREW DRIVING DEVICE FOR USE WITH IMPACT DRIVER**

(57) A screw driving device for use with an impact driver includes a driving axle (12, 12a) that includes a driving end (14) for coupling to and being driven by the impact driver and a receptacle end (44, 44a) including an annular wall (64, 64a); a hollow clutch sleeve (16, 16a) that includes a top end, a bottom end, and a central channel (40) that receives the driving axle (12, 12a), the central channel (40) having a top end having a size that is defined for passage of the driving end (14) of the driving axle (12, 12a) therethrough and preventing the receptacle end (44, 44a) of the driving axle (12, 12a) to pass therethrough; a depth control collar (18) that surrounds the bottom end of the hollow clutch sleeve (16, 16a), the depth control collar (18) including a bottom part (20), the bottom part (20) including a passage that allows the screwdriver bit (22, 22a) to extend therethrough; and a spring (58), which biases the driving axle (12, 12a) toward the driving position.

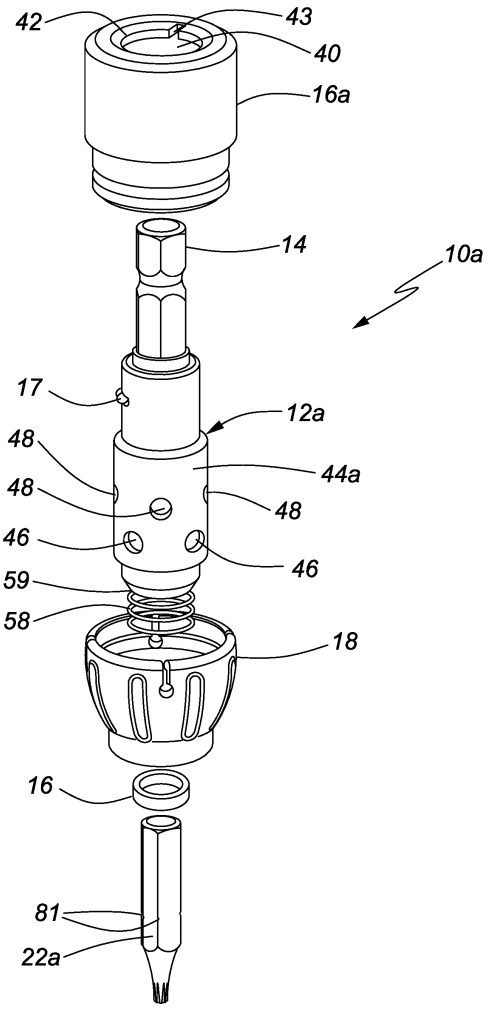

FIG. 3

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a screw driving device, particularly for use with an impact driver.

DESCRIPTION OF THE PRIOR ART

[0002] A device that uses an electrically driven tool (such as an electrical driller or an impact driver) to drive a screw is commonly known in this field. For example, Taiwan Utility Model 098218832 discloses a dual-purpose automatic shut-down device for power transmitting fashion screw driving-in and retracting-out, which operates excellently for driving of electrical drilling for smooth and continuous driving power. However, the construction business trends to use longer and longer screws (bolts), and electrical drillers are not efficient in driving such screws. Thus, a screw driving device that is equipped with an impact driver is used to drive long screws. The impact driver provides an oscillating torque that is required for driving a long screw, while the screw driving device functions to control the depth of the screw penetrating into a workpiece, in order to optimize the retaining strength of the screw.

[0003] However, the oscillation effect caused by the screw driving device and the impact driver might cause a circular bearing of the screw driving device to damage its holding a stem of a screwdriver bit at a driving position. When such a situation occurs, the bearing on longer holds the stem of the screwdriver bit and is no longer rotatable freely at the driving position. Thus, the screwdriver bit must be replaced even before the limit of the service life of the screwdriver bit.

SUMMARY OF THE INVENTION

[0004] Thus, the present invention provides a screw driving device for use with an impact driver, comprising: a driving axle, which includes a driving end for coupling to and being driven by the impact driver and a receptacle end including an annular wall. The annular wall includes multiple radial holes that arranged, at intervals, on a first radial plane of the receptacle end and multiple radial holes arranged, at intervals, on a second radial plane of the receptacle end. The radial holes each retain and hold a clutch bearing for engaging a screwdriver bit at a driving position and disengaging from the screwdriver bit at a clutching position to allow the screwdriver bit to freely rotate relative to the driving axle at the clutching position. Each of the clutch bearings is a cylindrical body that includes a circular external end and a truncated conic end for engaging a screwdriver bit at the driving position. A hollow clutch sleeve includes a top end, a bottom end, and a central channel that receives the driving axle. The central channel has top end having a size that is defined for passage of the driving end of the driving axle therethrough and preventing the receptacle end of the driving axle to pass therethrough. The hollow clutch sleeve is provided with two annular grooves at a bottom end of the central channel. The annular grooves have sizes that are defined to receive outer ends of the clutch bearings arranged on one of a first radial plane and a second radial plane when the driving axle is at the clutching position, so that corresponding inner ends of the clutch bearings are allowed to disengage from the screwdriver bit but are retained in the corresponding radial holes. A depth control collar is coupled to the bottom end of the hollow clutch sleeve. The depth control collar includes a bottom part, and the bottom part includes a passage for the screwdriver bit to extend therethrough. And, a spring is provided for biasing the driving axle toward the driving position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Hereinafter, features of the present invention will be described with reference to the attached drawings, in which:

FIG. 1 is a perspective view showing a screw driving device according to the present invention;
FIG. 2 is an exploded view showing the screw driving device shown in FIG. 1;
FIG. 3 is an exploded view showing a second embodiment of the screw driving device shown in FIG. 1;
FIG. 4 is a cross-sectional view, taken along line 4-4 of FIG. 1, showing the screw driving device of FIG. 2.
FIG. 5 is a cross-sectional view, taken along line 4-4 of FIG. 1, showing the screw driving device of FIG. 3.
FIG. 6 is a close-up view showing a clutch bearing of the screw driving device shown in FIG. 4 or 5;
FIG. 7 is a cross-sectional view showing the screw driving device of FIG. 4 at a clutching position;
FIG. 8 is a cross-sectional view showing the screw driving device of FIG. 5 at a clutching position; and
FIG. 9 is a cross-sectional view showing the screw driving device of FIG. 4 at a locked position for removal of a driven screw.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0006] FIG. 1 is a perspective view showing a screw driving device 10 according to the present invention.

[0007] The screw driving device 10 includes a driving axle 12. The driving axle 12 includes a driving end 14 that is suitable for coupling with and being driven by a handheld electrical impact driver (not shown). The handheld electrical tool belongs to known art.

[0008] A hollow clutch sleeve 16 receives the driving axle 12 therein. A locking projection 17 is formed on a lateral side of the driving axle 12 for locking the screw driving device 10 at a locked position for removing a screw driven thereby.

[0009] Reference is made to FIG. 9 for the following

description. A depth control collar (nose cone) 18 grips a bottom end of the hollow clutch sleeve 16. The depth control collar 18 includes a bottom part 20, and a screwdriver bit 22 is received, by passing through the bottom part, in a bottom end of the driving axle 12.

[0010] Reference is made to FIGS. 4-8 for the following description. When the screw driving device 10 is at a driving position, the screwdriver bit 22 rotates with the driving axle 12; and when the screw driving device 10 is at a clutching position, engagement between the screwdriver bit 22 and the driving axle 12 is released.

[0011] The depth control collar 18 is exchangeable in order to enable variation of a depth of a screw (bolt) driven by the screw driving device 10. If necessary, this can be achieved by adding an extra depth control collar 18 having a different height.

[0012] For such a purpose, the depth control collar 18 has an axial slit 24 formed in a top edge thereof to allow a lip 26 of the depth control collar 18, which projects inwards, to disengage and separate from a recess 28 that is of a corresponding shape formed in the hollow clutch sleeve 16 (see for example FIG. 4).

[0013] FIG. 2 is an exploded view of the screw driving device 10 shown in FIG. 1.

[0014] The driving end 14 of the driving axle 12 extends through a central channel 40 formed in the hollow clutch sleeve 16. The central channel 40 has a top part that is extended inward to form a stop 42. The stop has a size that is designed to allow passage of the driving end 14 of the driving axle 12, but preventing a receptacle end 44 of the driving axle 12 to pass. The stop 42 is formed with a locking gap 43 that allows the locking projection 17 to pass therethrough in order to retain the screw driving device at the locked position, and this will be further described below with reference to FIG. 9.

[0015] Multiple radial holes 46 are arranged to penetrate through the receptacle end 44 of the driving axle 12 and respectively receive and holds clutch bearings 50 (see FIGS. 4-6). In the embodiment, three radial holes 46 that are spaced from each other by 120 degrees are arranged on a radial planar surface. The clutch bearings 50 are engageable with the screwdriver bit 22 at the driving position of the screw driving device, this being described below with reference to FIGS. 4, 5, and 6, such that the screwdriver bit 22 is rotatable in unison with the screw driving device 10.

[0016] When the screw driving device 10 is at the clutching position, the clutch bearings 50 and the screwdriver bit 22 are separated and disengaged from each other, this being described below with reference to FIGS. 7 and 8, such that the screwdriver bit is not related to the rotation of the screw driving device 10 in order to control a depth of the screw driven by the screw driving device 10.

[0017] A helical spring 58 has a top end positioned on a bottom end 59 of the driving axle 12, and the helical spring 58 has a bottom end engaging an interior bottom surface of the depth control collar 18, as shown in FIGS. 4 and 5. The helical spring 58 biases the driving axle 12 toward the driving position of the screw driving device 10.

[0018] An annular magnet 60 is received and retained in a receptacle 62 formed in the bottom part 20 of the depth control collar 18 (see FIGS. 4 and 5). The magnet 60 magnetically attracts a steel screw (not shown) disposed on the screwdriver bit 22 so as to hold the screw on the screwdriver bit 22, until the screw is driven by the screw driving device 10.

[0019] FIG. 3 is an exploded view showing a different embodiment, which is designated with reference 10a, for the screw driving device 10 shown in FIG. 1. The embodiment 10a is identical to the embodiment 10 described above with reference to FIG. 2, except a driving axle 12a has a receptacle end 44a that is longer than the receptacle end 44 of the driving axle 12.

[0020] The clutch sleeve 16a is, correspondingly, longer than the clutch sleeve 16, and the screwdriver bit 22a is also correspondingly longer than the screwdriver bit 22 shown in FIG. 2. The extra lengths of the receptacle end 44a, the hollow clutch sleeve 16a, and the screwdriver bit 22a allow the receptacle end 44a of the hollow clutch sleeve 12a to accommodate multiple radial holes 48. Each of the radial holes 48 similarly accommodates one clutch bearing 50, this being described below with reference to FIGS. 5 and 8.

[0021] In the embodiment, the radial holes 46 are arranged on a first radial plane and spaced from each other by 120 degrees, and the radial holes 48 are arranged on a second radial plane that is located above the first radial plane and spaced from each other by 120 degrees. Each of the radial holes 46 is spaced from any one of the radial holes 48 adjacent thereto by 60°.

[0022] FIG. 4 is a cross-sectional view of the screw driving device 10 shown in FIG. 2 by taking along a line 4-4 of FIG. 1, wherein the screwdriver bit 22 is put in rotation with the rotation of the driving axle 12.

[0023] The receptacle end 44 of the driving axle 12 includes an annular wall 64. The annular wall 64 is arranged to form a receptacle 66 that receives and retains the screwdriver bit 22 therein. The annular wall 64 is penetrated through by the multiple radial holes 46 (only one of which is shown in the cross-sectional view, however, as noted above, there are generally three such radial holes 46).

[0024] When the screw driving device 10 is at the driving position so illustrated, the radial holes 46 receive the clutch bearings 50 to engage planar surfaces of a hexagonal configuration of the screwdriver bit 22, and also enabling disengagement and detachment of the screwdriver bit 22 at the clutching position shown in FIG. 7. The hollow clutch sleeve 16 is provided with an annular groove 72 at a bottom end of the central channel 40, and the annular groove 72 has a size that is arranged to receive and accommodate the clutch bearings 50 when the screw driving device 10 is at the clutching position, so that the clutch bearings 50 are detached from the screwdriver bit 22 but are retained in the radial holes 46.

[0025] Frictional fitting with a ball bearing 74 disposed

on an axial hole 76 for supporting a top end of the screwdriver bit 22 allows the screwdriver bit 22 to keep in a stationary condition and also allows for free rotation of the driving axle 12 when the screw driving device 10 is at the clutching position, this being described below with reference to FIG. 7.

[0026] A retention ring 78 that is held in a radial recess 80 in an end of the receptacle 66 is engageable with a notch 81 formed on the screwdriver bit 22 to retain, in a removable manner, the screwdriver bit 22 in the receptacle 66.

[0027] FIG. 5 is a cross-sectional view, taken along line 4-4 of FIG. 1, showing the screw driving device of FIG. 3 at the driving position, wherein the screwdriver bit 22 is put in rotation with the rotation of the driving axle 12.

[0028] The receptacle end 44a of the driving axle 12a includes an annular wall 64a. The annular wall 64a is arranged to form a receptacle 66a that receives and retains the screwdriver bit 22a. The annular wall 64a is penetrated by the multiple radial holes 46, 48 (only one of each of which is shown in the cross-sectional view, however, as noted above, there are generally three such radial holes 46 and three such radial holes 48).

[0029] The radial holes 46 respectively hold the clutch bearings 50a, and when the screw driving device 10a is at the driving position as illustrated, the radial holes 48 respectively hold the clutch bearings 50b, and the clutch bearing 50b are respectively engageable with planar surfaces of a hexagonal configuration of the screwdriver bit 22a, and also disengageable and separated from the screwdriver bit 22a at the clutching position shown in FIG. 8.

[0030] The hollow clutch sleeve 16a is provided with two annular grooves 72a, 72b at a bottom end of the central channel 40. The two annular grooves 72a, 72b have sizes that are arranged to receive and accommodate corresponding clutch bearings 50a, 50b when the screw driving device 10a is at the clutching position, so that the clutch bearings 50a, 50b are detached from the screwdriver bit 22a but are retained in the corresponding radial holes 46, 48.

[0031] Frictional fitting with a ball bearing 74 disposed on an axial hole 76 for supporting a top end of the screwdriver bit 22a allows the screwdriver bit 22a and also allows for free rotation of the driving axle 12a when the screw driving device 10a is at the clutching position, this being described below with reference to FIG. 8.

[0032] A retention ring 78 that is held in a radial recess 80 in an end of the receptacle 66 is engageable with a notch 81 formed on the screwdriver bit 22 to retain, in a removable manner, the screwdriver bit 22 in the receptacle 66.

[0033] FIG. 6 is a close-up view showing one of the clutch bearings 50 of the screw driving device shown in FIG. 4 or 5.

[0034] All clutch bearings 50, 50a, 50b are of the same size and shape. In an embodiment, the clutch bearing 50 is a cylindrical body that includes a truncated conic internal end 52 and a circular external end 54. The cylindrical body has a total length that is designated at "a". The circular external end 54 has a length that is designated at "b" and is one quarter of the total length, namely1/4a (or 0.25a). A cylindrical middle 56 has a length that is designated at "c" and is one half of the total length, namely 1/2a (or 0.5a). The truncated conic internal end 52 has a length of 1/4a (or 0.25a). The cylindrical middle 56 has a diameter that is 1a (or 1.0a). The truncated conic end 52 has a planar surface 57 having a diameter that is designated at "e" and is 3/4a (or 0.75a). The circular external end 54 has a radius that is designated at "r" and is 1/2a (or 0.5a). In an embodiment, the clutch bearing 50 has a length of 4 mm and a diameter of 4mm; the cylindrical middle has a length of 2 mm. The circular external end has a radius of 2 mm, and the circular external end 54 has a length of 1 mm. The truncated conic internal end 52 has a length of 1 mm, and the planar surface 57 has a diameter of 3 mm. It is noted that the two ends of the clutch bearing 50 can both be truncated cone in shape.

[0035] FIG. 7 is a cross-sectional view showing the screw driving device 10 of FIG. 4 at the clutching position. At the clutching position, the screwdriver bit 22 is released from the corresponding clutch bearings 50 that were set in engagement therewith so that the screw 100 is no longer driven by the screw driving device 10.

[0036] When the screw 100 is driven into a working surface 102, the bottom end 20 of the depth control collar 18 is brought into contact with the working surface 102 and the driving axle 12 slides downward to pass through the central channel 40 of the hollow clutch sleeve 16, until the radial holes 46 are in alignment with the annular groove 72 of the hollow clutch sleeve 16 and a force applied by the screwdriver bit 22 set in engagement with a screw driven thereby causes the clutch bearings 50 to move outwards and enter the annular groove 72.

[0037] The clutch bearings 50, once entering the annular groove 72, is no longer kept in engagement with the planar surfaces of the screwdriver bit 22, and the screw driving device 10 is located at the clutching position. Thus, even the driving axle 12 is continuously rotated by the impact driver, the screwdriver bit still keeps stationary and the screw is not driven any more. A depth that the screw is driven into the working surface 102 can thus be controlled by the depth control collar 18.

[0038] When a downward pressing force of the driving axle 12 is released through operation of the impact driver and the screw driving device 10 is removed from the working surface, the helical spring 58 biases upward the driving axle 12, and the screw driving device 10 returns to the driving position shown in FIG. 4. When the screw driving device 10 returns to the driving position, an inclined bottom surface 82 of the annular groove 72 forces each of the clutch bearings 50 to contact with a corresponding one of the planar surfaces of the screwdriver bit 22.

[0039] FIG. 8 is a cross-sectional view showing the screw driving device of FIG. 5 at the clutching position.

At the clutching position, the screwdriver bit 22a is released from each of the clutch bearings 50a, 50b that was set in engagement therewith so that the screw 100 is no longer driven by the screw driving device 10a.

[0040] When the screw 100 is driven into a working surface 102, the bottom part 20 of the depth control collar 18 is brought into contact with the working surface 102, and when the screw 100 is driven to enter the working surface 102, the driving axle 12a slides downward to pass through the central channel 40 of the hollow clutch sleeve 16a, until the radial holes 46, 48 are in alignment with the annular grooves 72a, 72b of the hollow clutch sleeve 16a, and the clutch bearings 50a, 50b corresponding thereto are caused by the screwdriver bit 22a in engagement with the driven screw 100 to move outward and enter the annular grooves 72a, 72b.

[0041] The clutch bearings 50a, 50b, once entering the corresponding annular grooves 72a, 72b, are no longer kept in engagement with the planar surfaces of the screwdriver bit 22a, and the screw driving device 10a is located at a held position. Thus, even the driving axle 12a is continuously rotated by the impact driver, the screwdriver bit 22a still keeps stationary and the screw 100 is not driven any more. A depth that the screw is driven into the working surface 102 can thus be controlled by the depth control collar 18.

[0042] When a downward pressing force of the driving axle 12a is released through operation of the impact driver and the screw driving device 10a is removed from the working surface 102, the helical spring 58 biases upward the driving axle 12a, and the screw driving device 10a returns to the driving position shown in FIG. 5.

[0043] When the screw driving device 10a returns to the driving position, an inclined bottom surface 82a, 82b of each of the annular groove 72a, 72b forces each of the clutch bearings 50a, 50b to contact with a corresponding one of the planar surfaces of the screwdriver bit 22a.

[0044] FIG. 9 is a cross-sectional view showing the screw driving device 10 of FIG. 4 is fixed at a locked position in a reversed direction for removal of a driven screw from a workpiece.

[0045] To set the screw driving device 10 at the driving position in the reversed direction, the locking projection 17 is caused to move downward through the locking gap 43 (see FIG. 2) to resist the force of the helical spring 58, this being described above with reference to FIG. 2. And, further, the hollow clutch sleeve is rotated far enough to have the locking projection 17 caught under the stop 42 at the top end of the hollow clutch sleeve 16.

[0046] At the driving position in the reversed direction, each of the clutch bearings 50 is set below the annular groove 72 of the hollow clutch sleeve 16 and in engagement with a corresponding one of the planar surfaces of the screwdriver bit 22, so that the rotation of the driving axle 12 made in any direction could make the screwdriver bit rotating in the same direction. The screw driving device 10 could rotate the hollow clutch sleeve 16 back to the driving position shown in FIG. 4, while keeping the driving axle 12 stationary, until the locking projection 17 and the locking gap 43 are in alignment with each other and is pushed upward by the helical spring 58.

[0047] The embodiment of the present invention shown in FIGS. 5 and 8 can be operated in exactly the same way to have the screw driving device 10a fixed at the driving position in the reversed direction.

Claims

1. A screw driving device for use with an impact driver, comprising:

a driving axle (12, 12a), which includes a driving end (14) adapted to couple to and be driven by the impact driver and a receptacle end (44, 44a) including an annular wall (64, 64a), the annular wall (64, 64a) being arranged to form a receptacle (66, 66a) for receiving and retaining a screwdriver bit (22, 22a), the annular wall (64, 64a) including multiple radial holes (46), each of the radial holes (46, 48) receiving and holding a clutch bearing (50, 50a, 50b) for engaging with the screwdriver bit (22, 22a) at a driving position and disengaging from the screwdriver bit (22, 22a) at a clutching position;

a hollow clutch sleeve (16, 16a), which includes a top end, a bottom end, and a central channel (40) that receives the driving axle (12, 12a), the central channel (40) having a top end having a size that is defined for passage of the driving end (14) of the driving axle (12, 12a) therethrough and preventing the receptacle end (44, 44a) of the driving axle (12, 12a) to pass therethrough, the hollow clutch sleeve (16, 16a) having an annular groove (72, 72a, 72b) at a bottom end of the central channel (40), the annular groove (72, 72a, 72b) having a size that that is defined to receive the clutch bearings (50, 50a, 50b) therein when the driving axle (12, 12a) is at the clutching position, so that a truncated conic end (52) of each of the clutch bearings (50) disengages from the screwdriver bit (22, 22a) but retains in a corresponding one of the radial holes (46, 48);

a depth control collar (18), which surrounds the bottom end of the hollow clutch sleeve (16, 16a), the depth control collar (18) including a bottom part (20), the bottom part (20) including a passage that allows the screwdriver bit (22, 22a) to extend therethrough; and

a spring (58), which biases the driving axle (12, 12a) toward the driving position;

characterized in that:

the clutch bearings (50, 50a, 50b) each a cylindrical body that includes the truncated

conic internal end (52) and an circular external end (54) and are arranged to engage with the screwdriver bit (22, 22a) at the driving position and to allow the clutch bearings (50) to move from the clutching position to the driving position, wherein
the cylindrical body has a total length "a" and the circular external end (54) gas a length "b" that is 1/4a, a cylindrical middle (56) having a length "c" that is 1/2 a, the truncated conic internal end (52) having a length "d" that is 1/4a, the cylindrical middle (56) having a diameter that is 1a, the truncated conic end having a planar surface having a diameter "e" that is 3/4a, the circular external end (54) having a radius "r" that is 1/2a, the receptacle end (44) of the driving axle (12) including three radial holes (46) that are spaced from each other by 120 degrees on a radial planar surface of the receptacle end (44), the receptacle end (44a) of the driving axle (12a) including three radial holes (46) arranged on a first radial plane of the receptacle end (44a) and three radial holes (48) arranged on a second radial plane of the receptacle end (44a), the second radial plane being separate from the first radial plane, the hollow clutch sleeve (16a) comprising a first annular groove (72a) and a second annular groove (72b) for receiving the clutch bearings (50a, 50b) retained in the radial holes (46, 48) arranged on the first and second radial planes when the screw driving device (10a) is at the clutching position, a locking projection (17) arranged at one side of the driving axle (12, 12a) above the receptacle end (44, 44a) being operable to fix the screw driving device (10, 10a) at the driving position in a reversed direction in order to remove a driven screw from a workpiece, at least one locking gap (43) formed in the top end of the hollow clutch sleeve (16, 16a) to allow the locking projection (17) to pass therethrough for fixing the screw driving device (10, 10a) at the driving position at the reverse direction, wherein when the locking projection (17) passes through the locking gap (43) and the hollow clutch sleeve (16, 16a) is rotated far enough to have the locking projection (17) caught in the hollow clutch sleeve (16, 16a), an axial slit (24) that is formed in the top end of the depth control collar (18) and is split allows the depth control collar (18) to be removed and replaced by another control collar having a different depth in order to change a depth of a screw being driven into a workpiece, the depth control collar (18) having a bottom part that is smaller than a top part of the depth control collar (18), a corresponding one of the radial holes (46) on the first radial plane being shifted away from each of the radial holes (48) of the second radial plane adjacent thereto by 60 degrees.

2. The screw driving device for use with the impact driver according to claim 1, wherein the bottom part of the depth control collar includes an insertion receptacle (62), the insertion receptacle (62) surrounding the channel through which the screwdriver bit (22, 22a) extends, the insertion receptacle (62) receiving and retaining therein an annular magnet (60), so as to hold the bottom end of the screwdriver bit (22, 22a) when the driving axle (12, 12a) is at the driving position, an annular groove (80) formed in a bottom part of the receptacle end (44, 44a) of the driving axle (12, 12a), the annular groove (80) receiving a retention ring (78) in engagement with the screwdriver bit (22, 22a) to hold, in a releasable manner, the screwdriver bit (22, 22a) in the receptacle end (44, 44a) of the driving axle (12, 12a), the depth control collar (18) including an axial slit (24) formed in an edge of the top part thereof to allow the depth control collar (18) to detach from the hollow clutch sleeve (16, 16a) so that the depth control collar (18) is removed from the hollow clutch sleeve (16, 16a).

Amended claims in accordance with Rule 137(2) EPC.

1. A screw driving device for use with an impact driver, comprising:

a driving axle (12, 12a), which includes a driving end (14) adapted to couple to and be driven by the impact driver and a receptacle end (44, 44a) including an annular wall (64, 64a), the annular wall (64, 64a) being arranged to form a receptacle (66, 66a) for receiving and retaining a screwdriver bit (22, 22a), the annular wall (64, 64a) including multiple radial holes (46, 48), each of the radial holes (46, 48) receiving and holding a clutch bearing (50, 50a, 50b) for engaging with the screwdriver bit (22, 22a) at a driving position and disengaging from the screwdriver bit (22, 22a) at a clutching position;
a hollow clutch sleeve (16, 16a), which includes a top end, a bottom end, and a central channel (40) that receives the driving axle (12, 12a), the central channel (40) having a top end having a size that is defined for passage of the driving end (14) of the driving axle (12, 12a) therethrough and preventing the receptacle end (44, 44a) of the driving axle (12, 12a) to pass there-

through, the hollow clutch sleeve (16, 16a) having an annular groove (72, 72a, 72b) at a bottom end of the central channel (40), the annular groove (72, 72a, 72b) having a size that that is defined to receive the clutch bearings (50, 50a, 50b) therein when the driving axle (12, 12a) is at the clutching position, so that a truncated conic end (52) of each of the clutch bearings (50) disengages from the screwdriver bit (22, 22a) but retains in a corresponding one of the radial holes (46, 48);

a depth control collar (18), which surrounds the bottom end of the hollow clutch sleeve (16, 16a), the depth control collar (18) including a bottom part (20), the bottom part (20) including a passage that allows the screwdriver bit (22, 22a) to extend therethrough; and

a spring (58), which biases the driving axle (12, 12a) toward the driving position;

wherein the clutch bearings (50, 50a, 50b) are each a cylindrical body that includes the truncated conic internal end (52) and an circular external end (54) and are arranged to engage with the screwdriver bit (22, 22a) at the driving position and to allow the clutch bearings (50) to move from the clutching position to the driving position, and

the cylindrical body has a total length "a" and the circular external end (54) has a length "b" that is 1/4a, a cylindrical middle (56) having a length "c" that is 1/2 a, the truncated conic internal end (52) having a length "d" that is 1/4a, the cylindrical middle (56) having a diameter that is 1a, the truncated conic end having a planar surface having a diameter "e" that is 3/4a, the circular external end (54) having a radius "r" that is 1/2a, **characterized in that** the multiple radial holes (46, 48) are provided in the receptacle end (44) of the driving axle (12) to be angularly spaced from each other by 60 degrees, and the hollow clutch sleeve (16, 16a) comprises at least one annular groove (72a, 72b) for receiving the clutch bearings (50, 50a, 50b) retained in the radial holes (46, 48) when the screw driving device (10a) is at the clutching position, a locking projection (17) arranged at one side of the driving axle (12, 12a) above the receptacle end (44, 44a) being operable to fix the screw driving device (10, 10a) at the driving position in a reversed direction in order to remove a driven screw from a workpiece, at least one locking gap (43) formed in the top end of the hollow clutch sleeve (16, 16a) to allow the locking projection (17) to pass therethrough for fixing the screw driving device (10, 10a) at the driving position at the reverse direction, wherein when the locking projection (17) passes through the locking gap (43) and the hollow clutch sleeve (16, 16a) is rotated far enough to have the locking projection (17) caught in the hollow clutch sleeve (16, 16a), an axial slit (24) that is formed in the top end of the depth control collar (18) and is split allows the depth control collar (18) to be removed and replaced by another control collar having a different depth in order to change a depth of a screw being driven into a workpiece, the depth control collar (18) having a bottom part that is smaller than a top part of the depth control collar (18).

2. The screw driving device for use with the impact driver according to claim 1, wherein the bottom part of the depth control collar includes an insertion receptacle (62), the insertion receptacle (62) surrounding the channel through which the screwdriver bit (22, 22a) extends, the insertion receptacle (62) receiving and retaining therein an annular magnet (60), so as to hold the bottom end of the screwdriver bit (22, 22a) when the driving axle (12, 12a) is at the driving position, an annular groove (80) formed in a bottom part of the receptacle end (44, 44a) of the driving axle (12, 12a), the annular groove (80) receiving a retention ring (78) in engagement with the screwdriver bit (22, 22a) to hold, in a releasable manner, the screwdriver bit (22, 22a) in the receptacle end (44, 44a) of the driving axle (12, 12a).

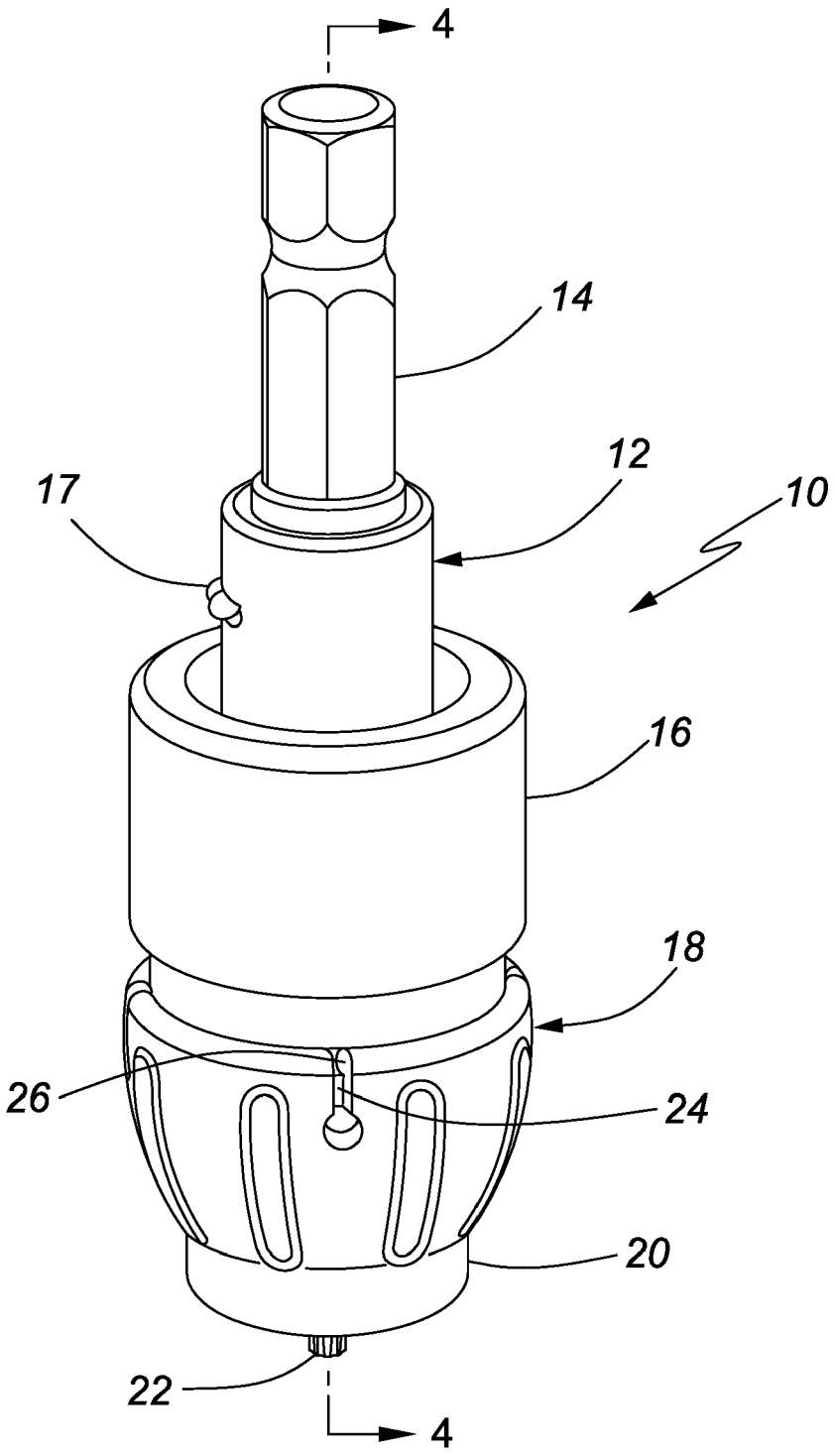

FIG. 1

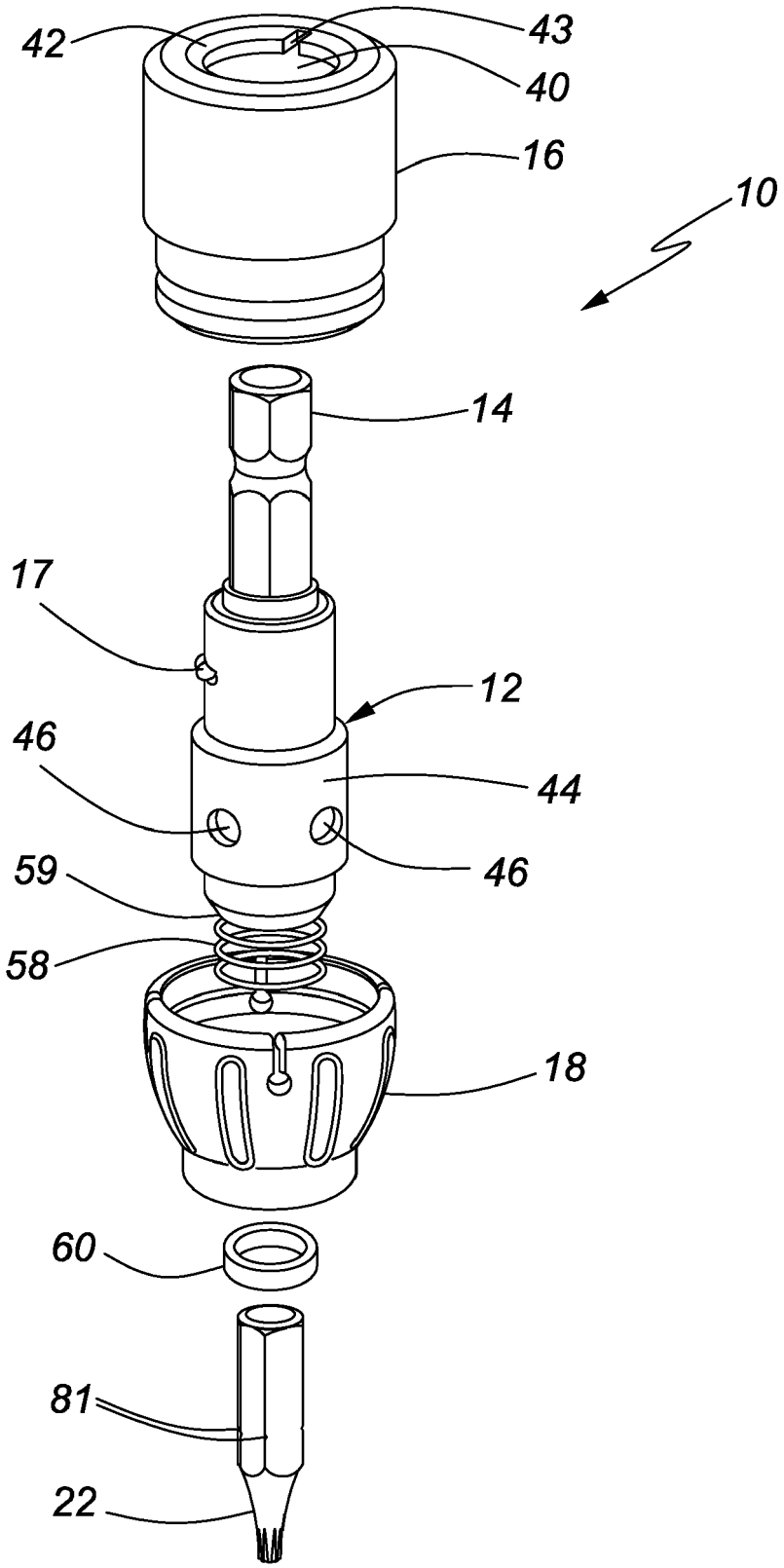

FIG. 2

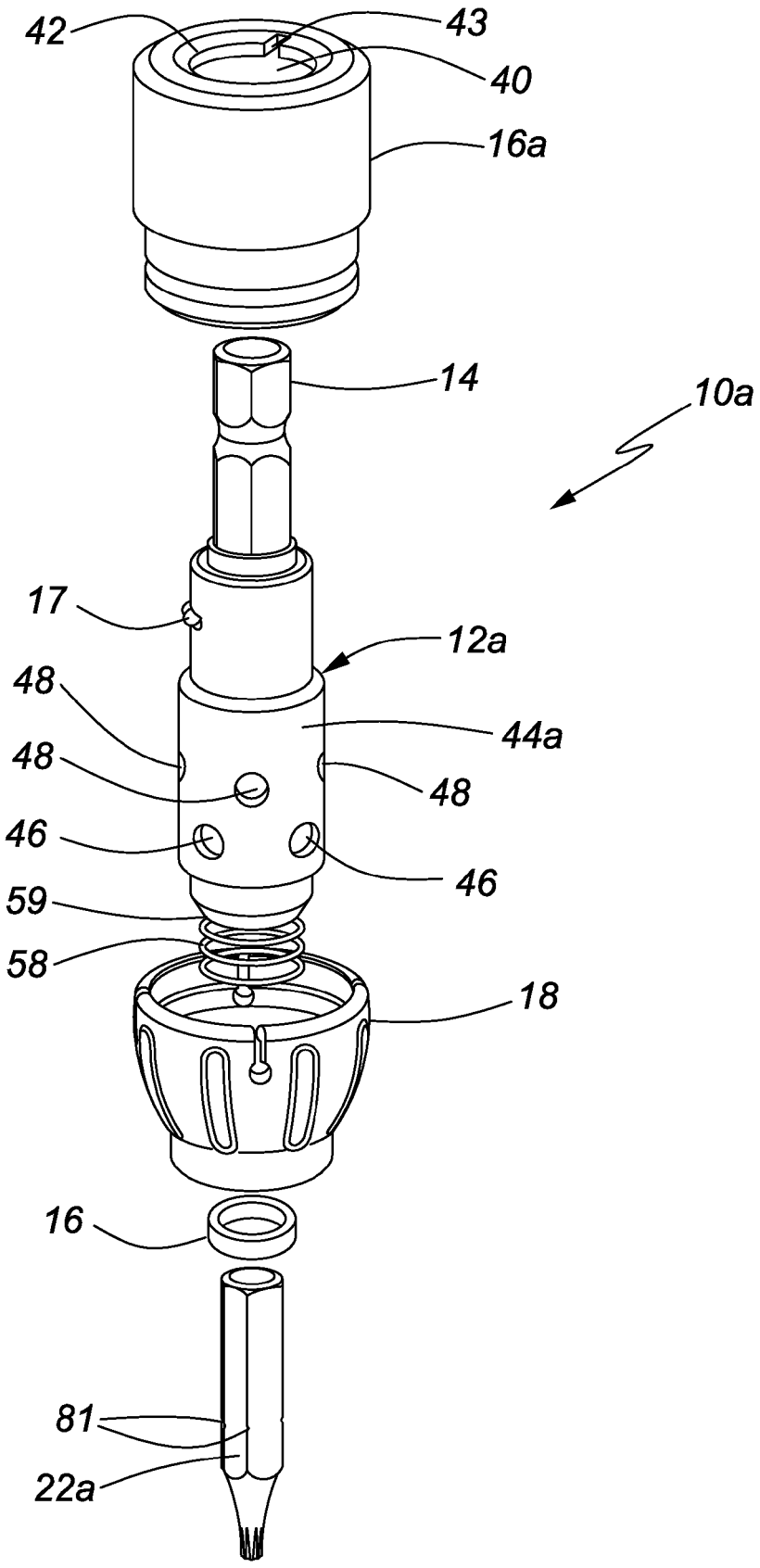

FIG. 3

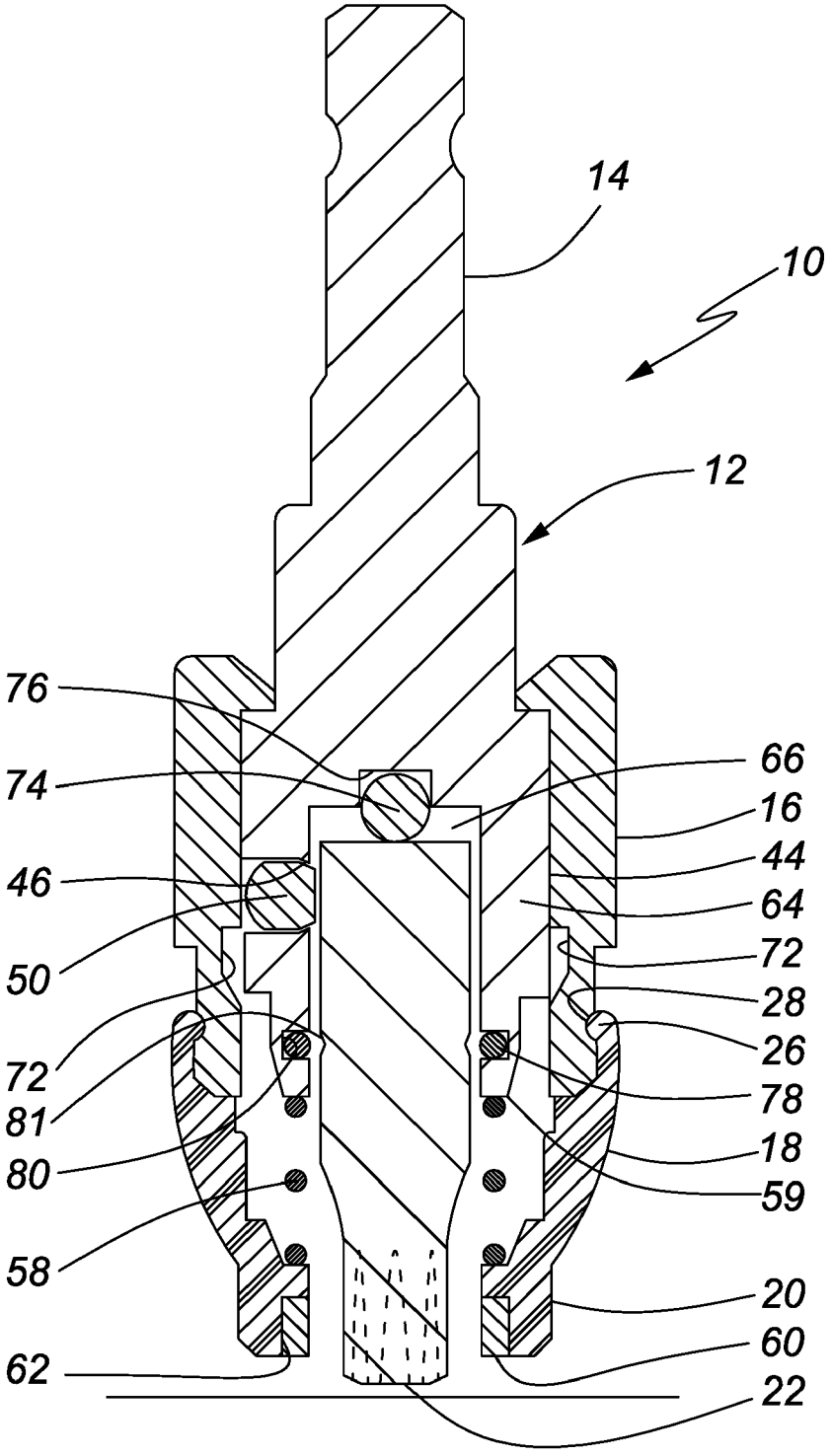
14
10
12
76
74
46
50
72
81
80
58
62
66
16
44
64
72
28
26
78
18
59
20
60
22

FIG. 4

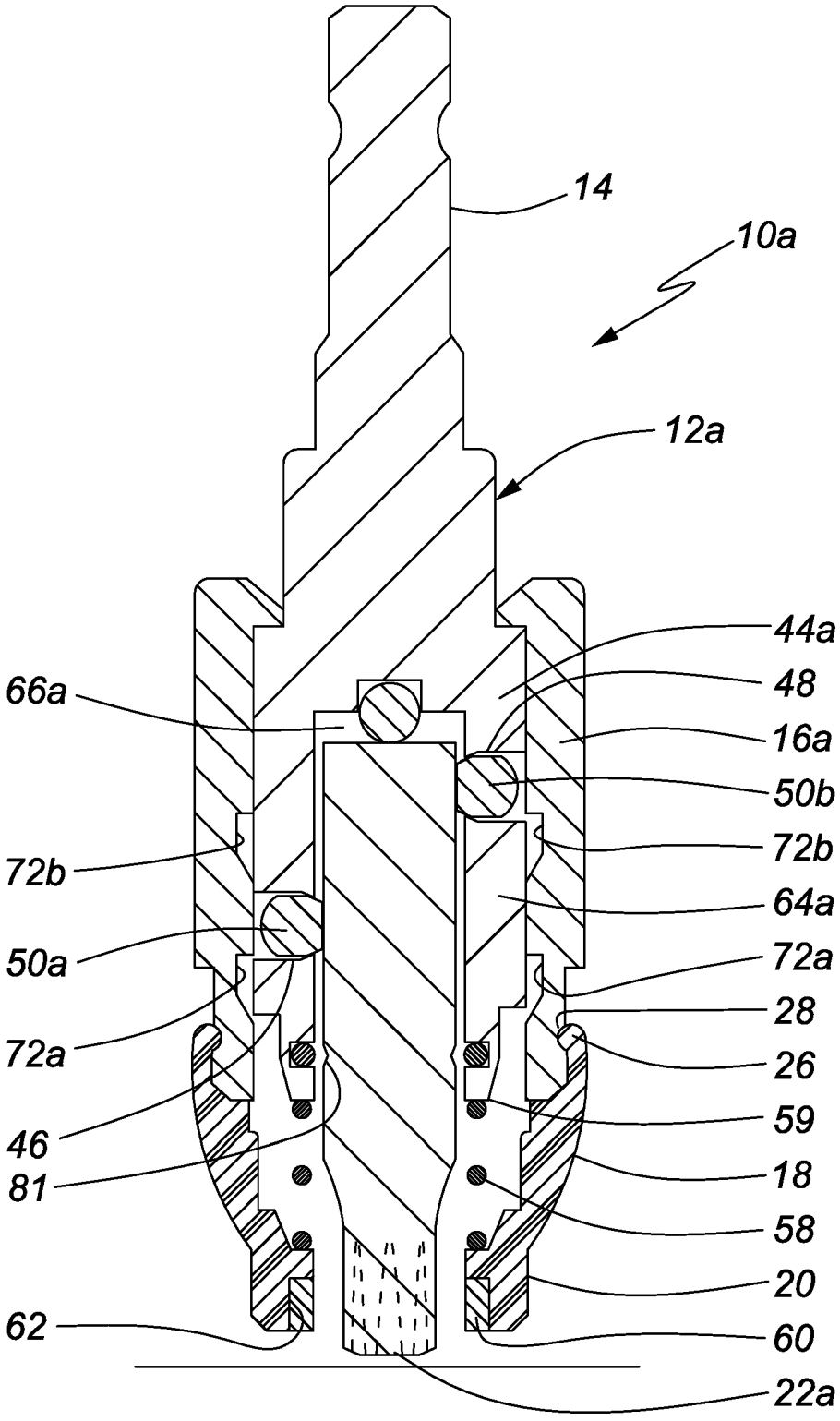
14
10a
12a
44a
48
16a
50b
72b
64a
72a
28
26
59
18
58
20
60
22a
66a
72b
50a
72a
46
81
62

FIG. 5

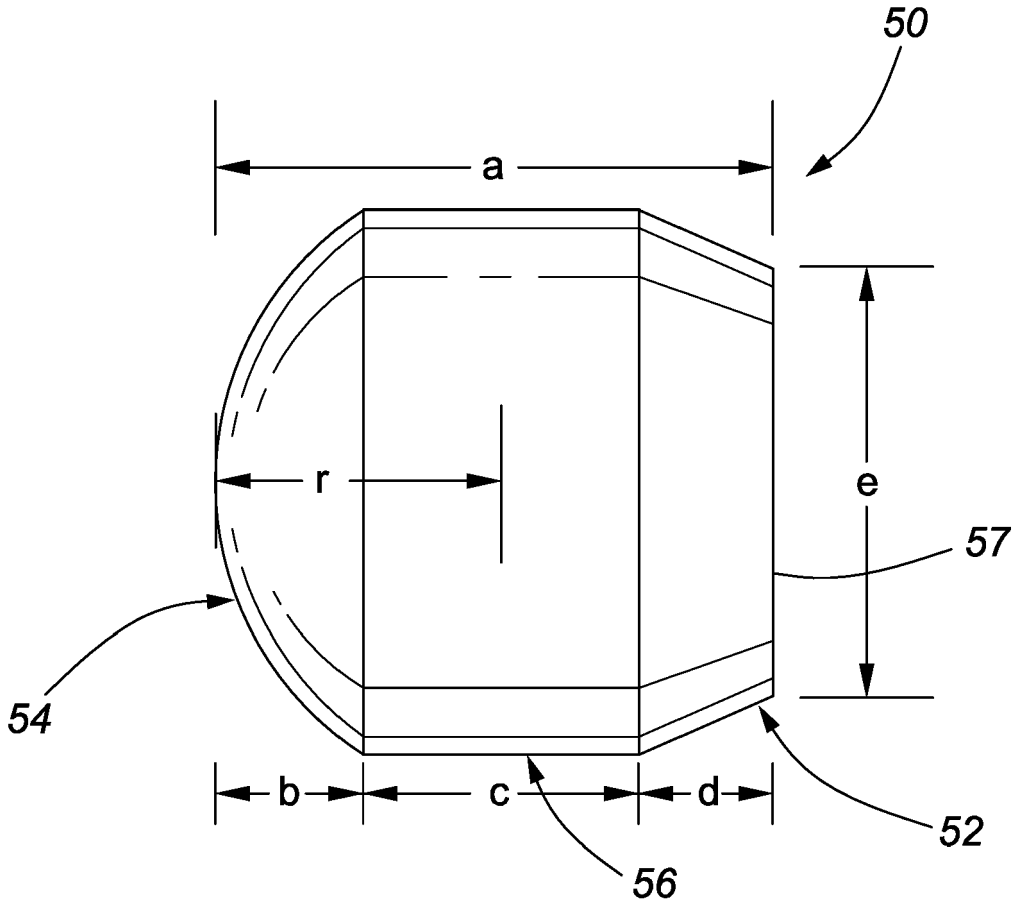

FIG. 6

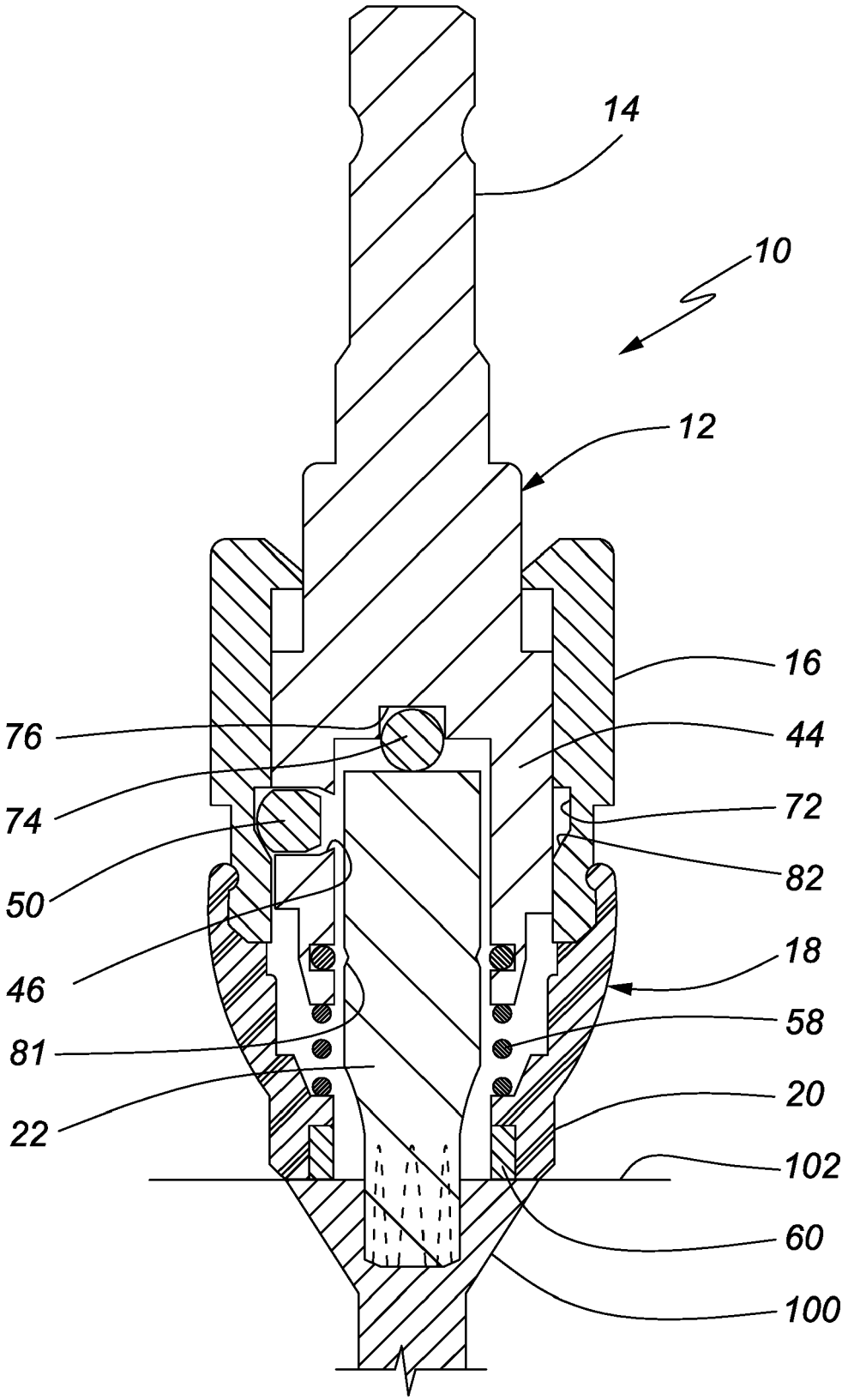

FIG. 7

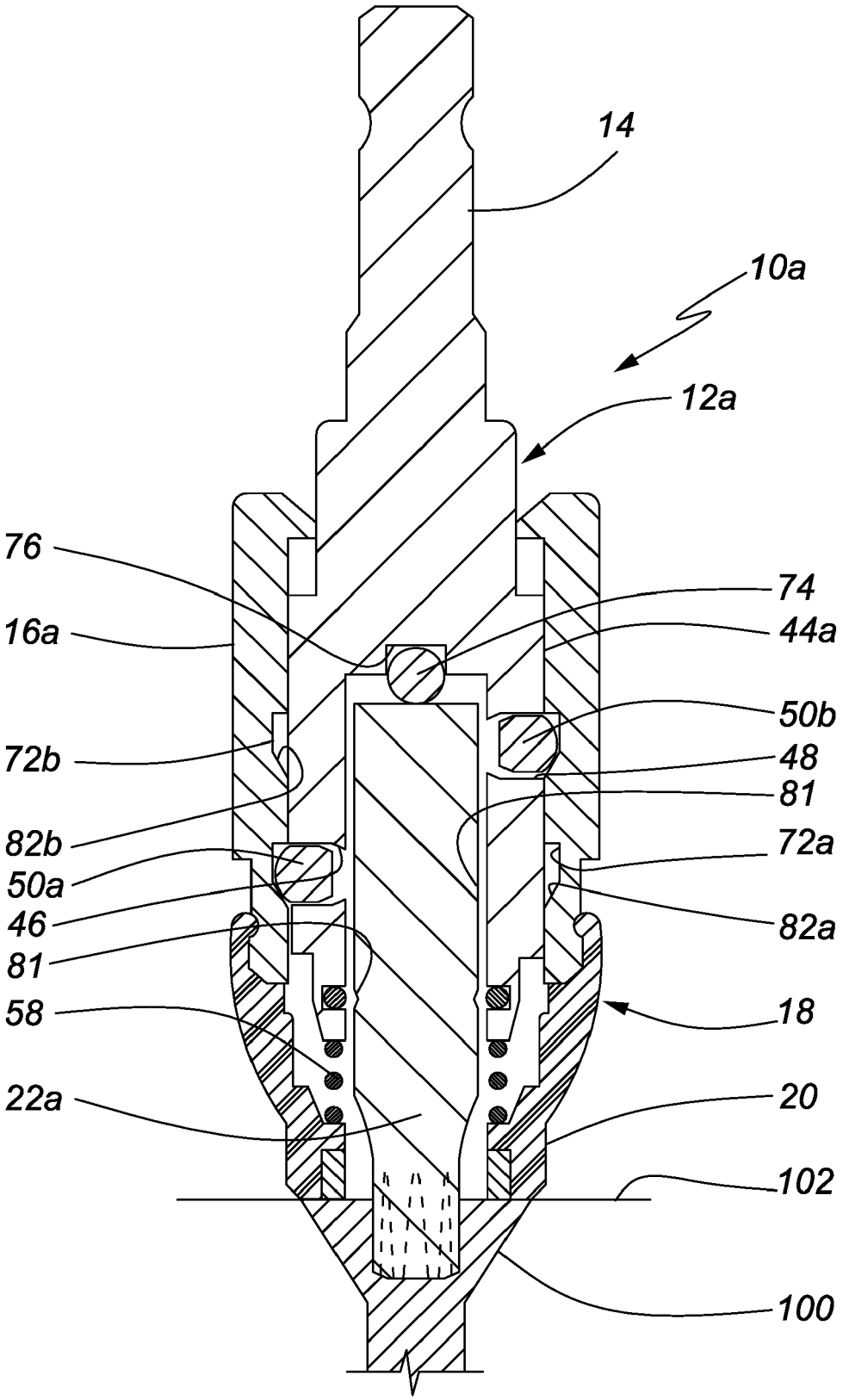
14
10a
12a
76
74
16a
44a
50b
72b
48
81
82b
72a
50a
46
82a
81
58
18
22a
20
102
100

FIG. 8

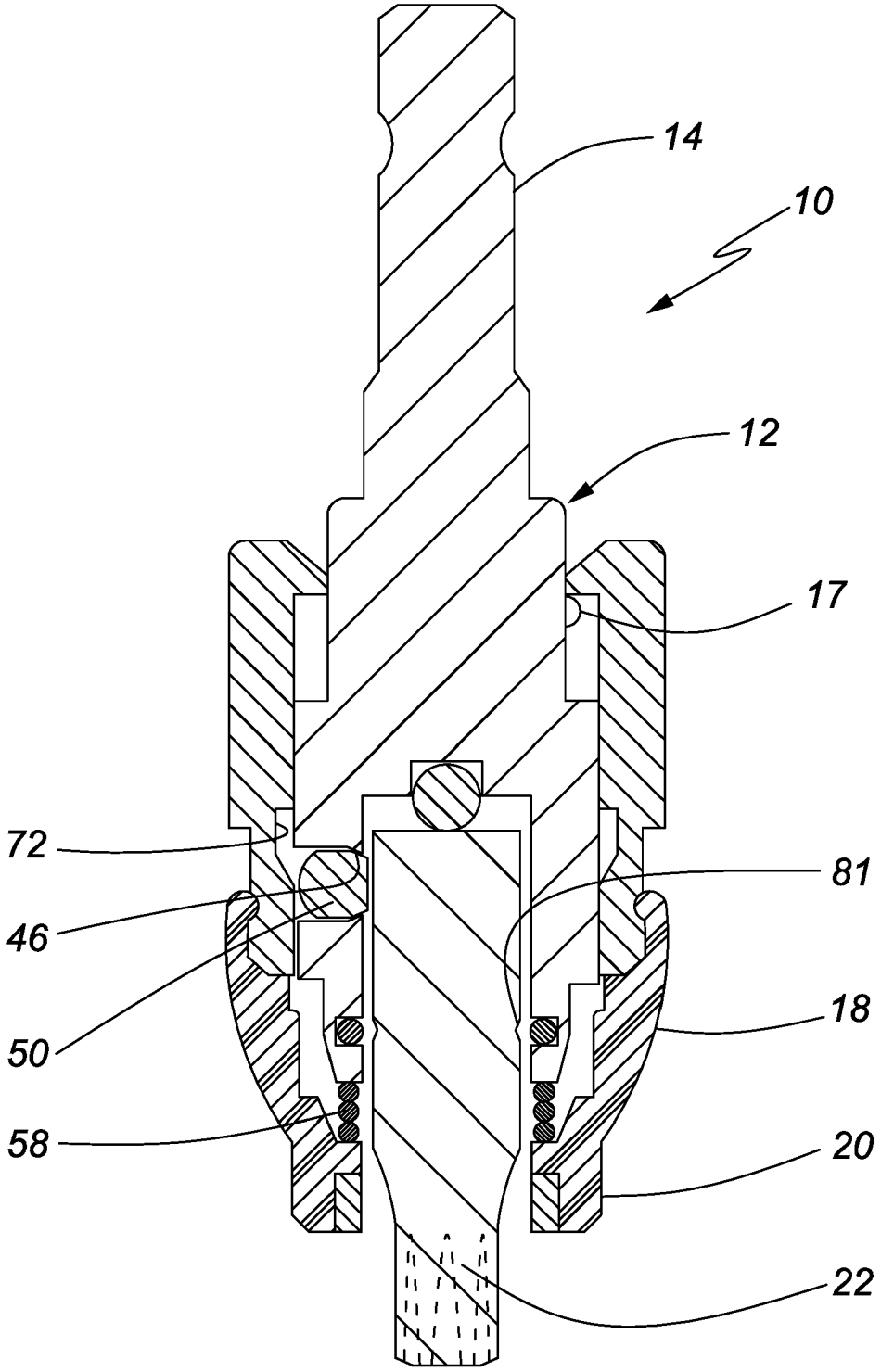

FIG. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 19 19 3691

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	US 2018/126523 A1 (RAJOTTE JACQUES [CA] ET AL) 10 May 2018 (2018-05-10) * the whole document * -----	1,2	INV. B25B23/00 B25B23/12

TECHNICAL FIELDS SEARCHED (IPC)

B25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	12 February 2020	Hartnack, Kai

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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12-02-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2018126523 A1	10-05-2018	NONE	

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