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(54) Title: RECIPROCATING SAW

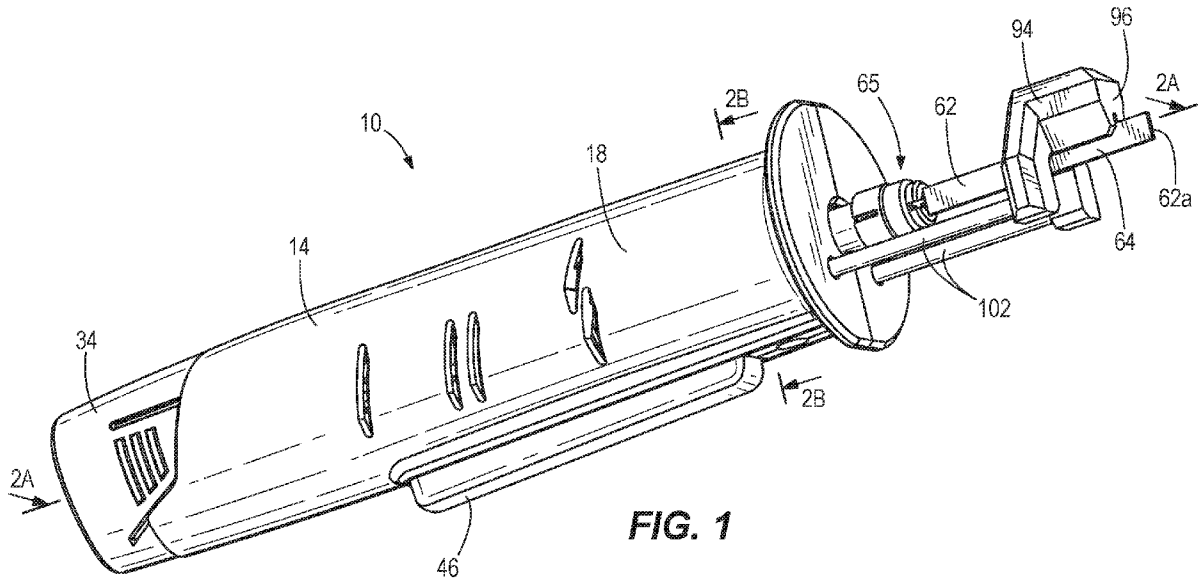


FIG. 1

(57) **Abstract:** A reciprocating saw (10) includes a housing (14) defining a motor housing portion (18), and a motor (22) positioned in the motor housing portion (18), the motor (22) having a motor output shaft (26) defining a rotational axis (30, 89), and a motor activation switch (50) within the motor housing portion (18) and adjacent the motor (22). The reciprocating saw (10) also includes a transmission (54) is positioned downstream of the motor (22) and has a sawbar (58) connectable to a saw blade (62). The transmission (54) converts a rotational input provided by the motor (22) shaft to a reciprocating output of the sawbar (58) along a reciprocating axis (86) that is either coaxial or parallel with the rotational axis (30, 89).

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[Continued on next page]

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Published:

— *with international search report (Art. 21(3))*

RECIPROCATING SAW

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to co-pending U.S. Provisional Patent Application No. 62/624,209 filed on January 31, 2018, the entire contents of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to power tools, and more particularly to reciprocating saws.

BACKGROUND OF THE INVENTION

[0003] Reciprocating saws typically include an electric motor, a blade coupled to a scotch yoke mechanism, and a transmission for transferring torque from the motor to the scotch yoke mechanism, which converts the rotational input from the transmission to a reciprocating output of the blade. Such reciprocating saws are not typically utilized to provide precise cutting operations to a workpiece. However, this becomes challenging as the size and the weight of the saw increases.

SUMMARY OF THE INVENTION

[0004] The present invention provides, in one aspect, a reciprocating saw including a housing defining a motor housing portion, a motor positioned in the motor housing portion, the motor having a motor output shaft defining a rotational axis, and a motor activation switch within the motor housing portion and adjacent the motor. The reciprocating saw also includes a transmission positioned downstream of the motor and having a sawbar connectable to a saw blade. The transmission converts a rotational input provided by the motor shaft to a reciprocating output of the sawbar along a reciprocating axis that is either coaxial or parallel with the rotational axis.

[0005] The present invention provides, in another aspect, a reciprocating saw including a housing defining a motor housing portion, a motor positioned in the motor housing portion, the motor having a motor output shaft defining a rotational axis, and a transmission

positioned downstream of the motor. The transmission includes a pinion driven by the motor output shaft, a ring gear meshed with the pinion and having a pin eccentrically coupled thereto, and a sawbar movable along a reciprocating axis that is either coaxial or parallel with the rotational axis. The sawbar has a slot in which the pin is received. The slot extends in a direction that is transverse to both the rotational axis of the motor output shaft and the reciprocating axis of the sawbar.

[0006] The present invention provides, in another aspect, a reciprocating saw including a housing defining a motor housing portion and a battery receptacle, a motor positioned in the motor housing portion, the motor having a motor output shaft defining a rotational axis, a transmission positioned downstream of the motor and having a sawbar connectable to a saw blade, the transmission converting a rotational input provided by the motor shaft to a reciprocating output of the sawbar along a reciprocating axis that is either coaxial or parallel with the rotational axis, a battery pack at least partially received within the battery receptacle, and a clamp assembly on the sawbar to which the saw blade is attachable. The reciprocating saw defines an overall length of about 12 inches or less between an end of the battery pack protruding from the battery receptacle and a distal end of the clamp assembly. The motor housing portion defines a maximum width of about 2.5 inches or less.

[0007] Other features and aspects of the invention will become apparent by consideration of the following detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a perspective view of a reciprocating saw in accordance with an embodiment of the invention.

[0009] FIG. 2A is a longitudinal cross-sectional view of the reciprocating saw of FIG. 1.

[0010] FIG. 2B is a lateral cross-sectional view of the reciprocating saw of FIG. 1.

[0011] FIG. 3 is a perspective view of a transmission of the reciprocating saw of FIG. 1.

[0012] FIG. 4 is a perspective view of a scotch yoke mechanism of the reciprocating saw of FIG. 1.

[0013] FIG. 5 is a perspective view of a portion of the reciprocating saw of FIG. 1.

[0014] FIG. 6 is an additional perspective view of a transmission of the reciprocating saw of FIG. 1.

[0015] Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

DETAILED DESCRIPTION

[0016] FIGS. 1 and 2A illustrate a power tool, configured as a compact reciprocating saw 10, embodying the invention. The reciprocating saw 10 includes a housing 14, defining a motor housing portion 18, and an electric motor 22 (FIG. 2A) positioned in the motor housing portion 18. The motor 22 includes a motor output shaft 26 defining a rotational axis 30. The saw 10 also includes a battery pack 34 at least partially received in a battery receptacle 38 in the housing 14 along an insertion axis 42 that is parallel with the rotational axis 30. Alternatively, the insertion axis 42 may be parallel with the rotational axis 30. The saw 10 further includes a motor activation trigger 46 pivotably coupled to the housing 14 and graspable by a user of the reciprocating saw 10 between a first position, in which the motor 22 is deactivated, and a second position, in which is motor 22 is activated. The saw 10 also includes an electrical motor activation switch 50 within the motor housing portion 18 and adjacent the motor 22 that is actuated by the motor activation trigger 46 between a first state coinciding with the first position of the trigger 46, and a second state coinciding with the second position of the trigger. In some embodiments, the motor activation switch 50 is a variable speed trigger switch, such that depressing the trigger 46 to a predetermined position activates the motor 22 at a corresponding rotational speed.

[0017] With reference to FIGS. 2A and 3, the saw 10 also includes a transmission 54 positioned downstream of the motor 22 in the motor housing portion 18. The transmission 54 includes a yoke or spindle, which hereinafter will be referred to as a sawbar 58, connectable to a saw blade 62 (FIG. 2) having a serrated edge 64 in contact with a workpiece. In the illustrated embodiment, the saw 10 includes a clamp assembly (e.g., collet assembly 65) on

the sawbar 58 to quickly attach and release the saw blade 62 to the sawbar 58. As shown in FIG. 3, the transmission 54 also includes a pinion 66 driven by the motor output shaft 26, a ring gear 70 meshed with the pinion 66, and a scotch yoke mechanism 74 driven by the ring gear 70. The scotch yoke mechanism 74 includes a bushing 76 and a pin 78 eccentrically coupled to the ring gear 70 for co-rotation therewith, and the sawbar 58, which includes a laterally extending slot 82 in which the bushing 76 and pin 78 are received. The transmission 54 converts a rotational input provided by the motor output shaft 26 to a reciprocating output of the sawbar 58 along a reciprocating axis 86 (FIG. 2A) that is parallel with the rotational axis 30 of the motor output shaft 26. As shown in FIG. 3, the slot 82 extends in a direction (along axis 87) that is transverse to both the rotational axis 30 of the motor output shaft 26 and the reciprocating axis 86 of the sawbar 58. In some embodiments of the saw 10, the stroke of the reciprocating sawbar 58 is less than 0.5 inches. In the illustrated embodiment of the saw 10, the stroke of the reciprocating sawbar 58 is approximately 0.25 inches. In alternative embodiments, the transmission 54 may include alternative reciprocating mechanisms in place of the scotch yoke mechanism 74, such as a wobble plate mechanism or a barrel cam mechanism.

[0018] With reference to FIG. 2A, the transmission 54 further includes a transmission housing 88 in which the ring gear 70 is supported for rotation and the sawbar 58 is supported for reciprocation. In the illustrated embodiment, the transmission housing 88 includes a base plate 88a on which the ring gear 70 is rotatably supported and a cover 88b secured to the base plate 88a. The base plate 88a includes a first bearing receptacle 60a in which a corresponding bearing 60 is received to rotatably support the ring gear 70 about a rotational axis 89 that is transverse to the rotational axis 30 of the motor output shaft 26. The base plate 88a also includes a second bearing receptacle 68a in which a corresponding bearing 68 is received to rotatably support the pinion 66 about the rotational axis 30.

[0019] With reference to FIG. 4, the transmission 54 further includes a bearing plate 110 located between the cover 88b and the base plate 88a that supports the saw bar 58 both in a lateral direction and a vertical direction, thus restricting movement of the saw bar 58 to translational movement. As shown in FIGS. 2A and 3, in addition to sliding along the bearing plate 110, the sawbar 58 also slides along a bearing insert 118 attached to the face of the ring gear 70 during reciprocation of the sawbar 58. Therefore, a combination of the

bearing plate 110 and the bearing insert 118 provide lateral stability to the sawbar 58 as it reciprocates.

[0020] With reference to FIG. 6, the ring gear 70 includes a circumferential counterweight 90 on one half thereof that moves out of phase with the sawbar 58 during operation of the saw 10 to attenuate vibration caused by the reciprocating sawbar 58 and the other reciprocating components attached to the sawbar 58. The counterweight 90 is annular, and the ring gear bearing 60 is partly recessed within the counterweight 90, thus reducing the height of the ring gear 70, and therefore the maximum width W (FIG. 2B) of the saw 10, where the maximum width W is measured along a dimension that is transverse to the axes 30, 86.

[0021] With reference to FIGS. 2A and 5, the saw 10 also includes a shoe 94 extending from the housing 14 against which the saw blade 62 is supportable. The shoe 94 is adjustable relative to the housing 14 to vary the distance D (FIG. 2A) that a distal end 62a of the saw blade 62 protrudes from a distal end 96 of the shoe 94, to thereby vary the cutting depth of the saw blade 62. The optimal cutting depth D of the saw blade is about 0.375 inches to about 1.5 inches. However, in other embodiments of the saw 10, the cutting depth D may be greater than 1.5 inches. The distal end 96 of the shoe 94 also provides a guide surface along which the workpiece being cut by the saw 10 is slidable during a cutting operation.

[0022] To adjust the shoe 94, a fastener 98 (see also FIG. 5) is loosened to release a clamping force exerted on parallel posts 102 connecting the shoe 94 to the housing 14, thereby permitting the posts 102 to slide relative to the housing 14 and adjust the shoe 94 accordingly. To lock the shoe 94 in a new position, the fastener 98 is tightened, thereby reapplying the clamping force to the posts 102. Specifically, the fastener 98 secures a locking plate 100 to the cover 88b, which includes longitudinal grooves 104 (FIG. 5) in which the respective posts 102 are slidable. By tightening the fastener 98, a clamping force is applied to the locking plate 100, which in turn clamps the posts 102 against the cover 88b. In some embodiments (not shown), the fastener 98 may be tightened without the use of tools, for example, through the use of a lever clamp and over-center cam. As shown in FIG. 2A, both the trigger 46 and the housing 14 include respective apertures l06a, l06b that are coaxial with the fastener 98, permitting a hand tool (e.g., a hexagonal wrench) to be inserted through the aligned apertures l06a, l06b and engaged with the fastener 98 for tightening and loosening the fastener 98 as described above.

[0023] Once the cutting depth distance **D** is set by the user of the saw 10 as described above, the saw 10 is ready for use. The user grips the motor housing portion 18 with the palm of their hand and wraps one or more fingers over the trigger 46. With the blade 62 positioned adjacent an edge of a workpiece, the user rests the distal end 96 of the shoe 94 against the workpiece and depresses the trigger 46, thereby activating the motor 22 to reciprocate the blade 62. Alternatively, the user may first activate the motor 22 by depressing the trigger 46, and then plunge the blade 62 into the workpiece without a pilot hole. As the saw 10 is pushed along a cut direction, a reaction force is applied to the blade 62 in an opposite direction. However, the shoe 94 supports the saw blade 62 and prevents it from deflecting, thereby maintaining a straight cutting edge, and permitting the blade 62 to be plunged into a workpiece without first creating a pilot hole. Alternatively, the saw blade 62 may be supported by a separate bracket other than the shoe 94.

[0024] As shown in FIG. 2A, the reciprocating saw 10 defines an overall length L between an end of the battery pack 34 and a distal end of the collet assembly 65 of about 12 inches or less. In some embodiments, the overall length L is between about 10.5 inches and about 10.75 inches. As shown in FIG. 2B, the reciprocating saw 10 also defines a maximum width W of about 2.5 inches or less. In some embodiments, the maximum width of the reciprocating saw 10 is about 2.25 inches. The sawbar 58 defines a length Ls of about 1.94 inches (FIG. 2A), a minimum length Lmin of about 1.40 inches of which is supported on either side of the sawbar 58 by the cover 88b and the base plate 88a (and in particular the bearing plate 110 and the bearing insert 118) when the sawbar 58 is reciprocated to its forwardmost position shown in FIG. 2A. Therefore, a minimum of 72.2% of the length Ls of the sawbar 58 is supported during operation, which amounts to between about 13.0% and about 13.3% of the overall length L. Furthermore, the ratio of the length Ls of the sawbar 58 to the overall length L is about 0.16: 1 or higher, and in the illustrated embodiment, between about 0.18:1 and about 0.2:1.

[0025] The compact size of the reciprocating saw 10 allows for a more accurate and higher controlled cut. Furthermore, the compact size allows for an increased level of cut precision, residual debris management, and portability.

[0026] Various feature of the invention are set forth in the following claims.

CLAIMS

What is claimed is:

1. A reciprocating saw comprising:

a housing defining a motor housing portion;

a motor positioned in the motor housing portion, the motor having a motor output shaft defining a rotational axis;

a motor activation switch within the motor housing portion and adjacent the motor; and

a transmission positioned downstream of the motor and having a sawbar connectable to a saw blade, the transmission converting a rotational input provided by the motor shaft to a reciprocating output of the sawbar along a reciprocating axis that is either coaxial or parallel with the rotational axis.

2. The reciprocating saw of claim 1, wherein the reciprocating axis is parallel with the rotational axis of the motor output shaft.

3. The reciprocating saw of claim 1, further comprising:

a battery pack at least partially received within a battery receptacle in the housing; and

a clamp assembly on the sawbar to which the saw blade is attachable, wherein the reciprocating saw defines an overall length between an end of the battery pack protruding from the battery receptacle and a distal end of the clamp assembly, and wherein the overall length is about 12 inches or less.

4. The reciprocating saw of claim 3, wherein the battery pack is either coaxial or parallel with the rotational axis of the motor.

5. The reciprocating saw of claim 3, wherein the overall length is between about 10.5 inches and about 10.75 inches.

6. The reciprocating saw of claim 5, wherein a ratio of a length of the sawbar to the overall length between the end of the battery pack protruding from the battery receptacle and the distal end of the clamp assembly is between about 0.18:1 and about 0.2:1.

7. The reciprocating saw of claim 3, wherein the motor housing portion defines a maximum width of about 2.5 inches or less.

8. The reciprocating saw of claim 7, wherein the maximum width of the motor housing portion is about 2.25 inches.

9. The reciprocating saw of claim 1, further comprising a shoe extending from the housing against which the saw blade is supportable.

10. The reciprocating saw of claim 9, wherein the position of the shoe relative to the housing is adjustable.

11. The reciprocating saw of claim 10, wherein a cutting depth measured between a distal end of the saw blade and a distal end of the shoe is about 0.375 inches to about 1.5 inches.

12. The reciprocating saw of claim 1, further comprising a motor activation trigger protruding from the motor housing portion, wherein the motor housing portion is graspable by a user of the reciprocating saw to actuate the motor activation trigger between a first position, in which the motor is deactivated, and a second position, in which the motor is activated.

13. The reciprocating saw of claim 1, wherein the transmission includes a scotch yoke mechanism, of which the sawbar is a component, for providing the reciprocating output to the sawbar, and wherein a stroke of the sawbar is less than 0.5 inches.

14. The reciprocating saw of claim 13, wherein the stroke of the sawbar is about 0.25 inches.

15. The reciprocating saw of claim 1, wherein the maximum operating speed of the reciprocating saw is greater than 3000 strokes per minute.

16. The reciprocating saw of claim 15, wherein the maximum operating speed of the reciprocating saw is about 3000 strokes per minute to about 6500 strokes per minute.

17. A reciprocating saw comprising:

a housing defining a motor housing portion;

a motor positioned in the motor housing portion, the motor having a motor output shaft defining a rotational axis; and

a transmission positioned downstream of the motor, the transmission including

a pinion driven by the motor output shaft,

a ring gear meshed with the pinion and having a pin eccentrically coupled thereto, and

a sawbar movable along a reciprocating axis that is either coaxial or parallel with the rotational axis, the sawbar having a slot in which the pin is received, the slot extending in a direction that is transverse to both the rotational axis of the motor output shaft and the reciprocating axis of the sawbar.

18. The reciprocating saw of claim 17, wherein the transmission converts a rotational input provided by the motor output shaft to a reciprocating output of the sawbar along the reciprocating axis.

19. The reciprocating saw of claim 17, further comprising a battery pack at least partially received within a battery receptacle in the housing, wherein the battery pack is either coaxial or parallel with the rotational axis of the motor.

20. The reciprocating saw of claim 17, wherein the ring gear includes a counterweight, and wherein the counterweight is configured to move out of phase with reciprocation of the sawbar during operation to attenuate vibration.

21. The reciprocating saw of claim 20, further comprising a bearing rotatably supporting the ring gear, wherein the bearing is at least partially recessed within the counterweight.

22. The reciprocating saw of claim 17, further comprising a motor activation trigger protruding from the motor housing portion, wherein the motor housing portion is graspable by a user of the reciprocating saw to actuate the motor activation trigger between a first position, in which the motor is deactivated, and a second position, in which the motor is activated.

23. A reciprocating saw comprising:

a housing defining a motor housing portion and a battery receptacle;

a motor positioned in the motor housing portion, the motor having a motor output shaft defining a rotational axis;

a transmission positioned downstream of the motor and having a sawbar connectable to a saw blade, the transmission converting a rotational input provided by the motor shaft to a reciprocating output of the sawbar along a reciprocating axis that is either coaxial or parallel with the rotational axis;

a battery pack at least partially received within the battery receptacle; and

a clamp assembly on the sawbar to which the saw blade is attachable,

wherein the reciprocating saw defines an overall length between an end of the battery pack protruding from the battery receptacle and a distal end of the clamp assembly, wherein the overall length is about 12 inches or less, and wherein the motor housing portion defines a maximum width of about 2.5 inches or less.

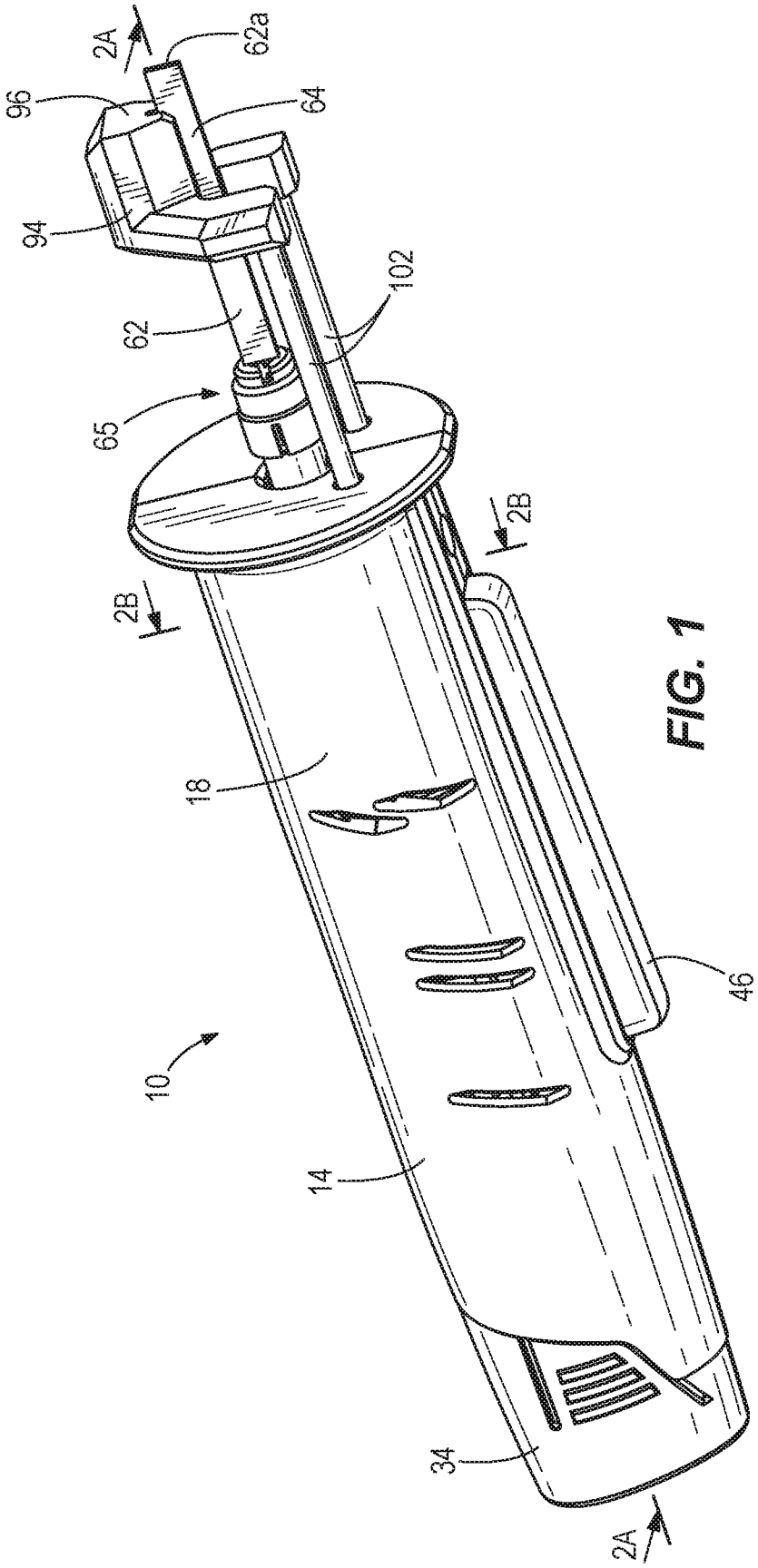


FIG. 1

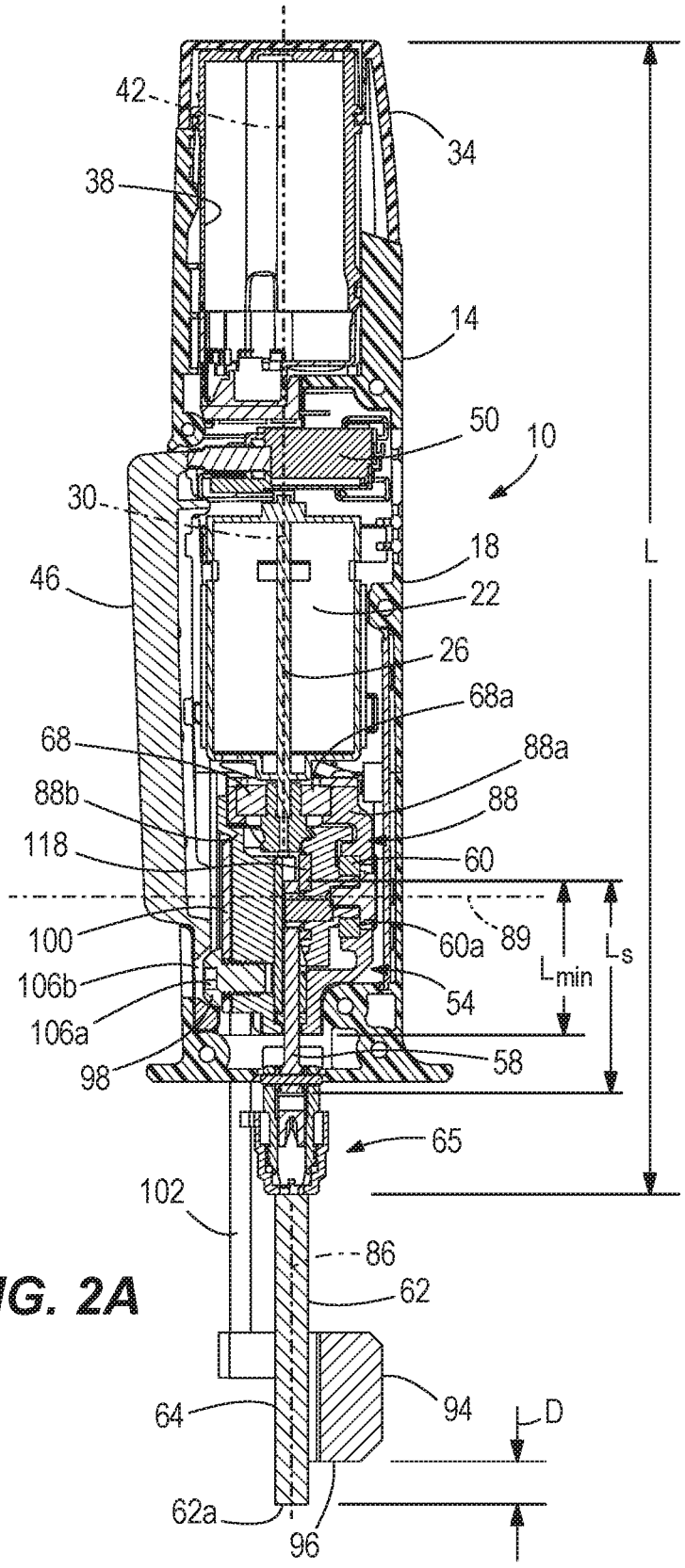

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60a
89
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62a
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FIG. 2A

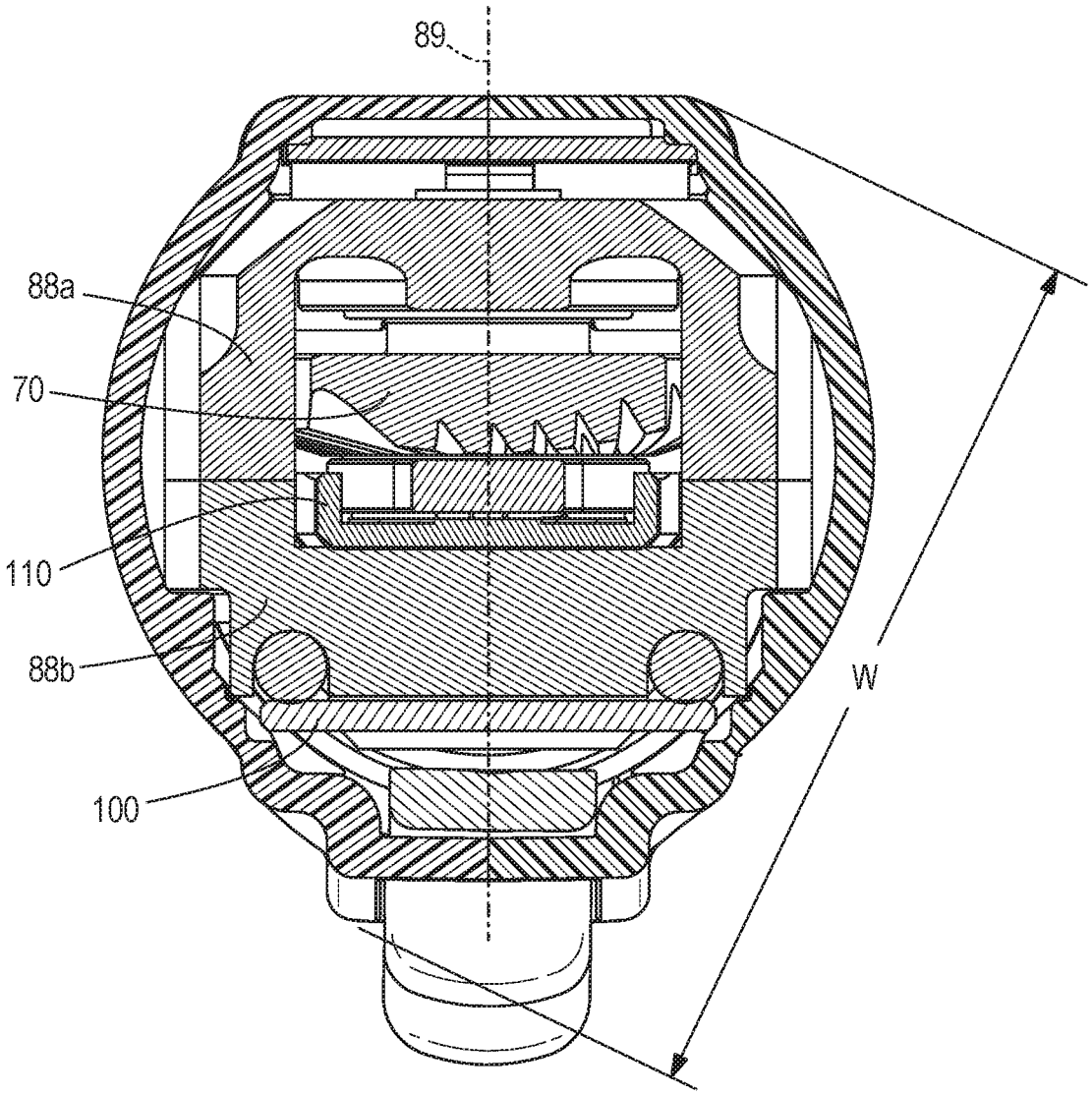


FIG. 2B

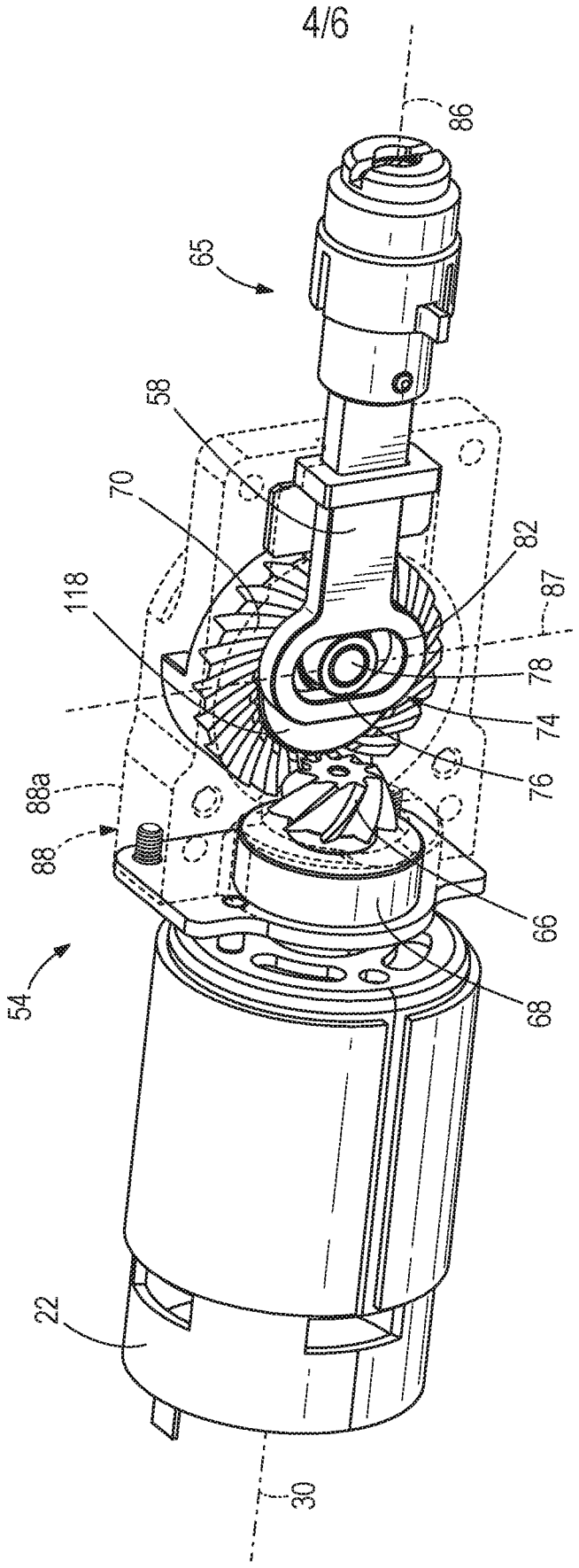


FIG. 3

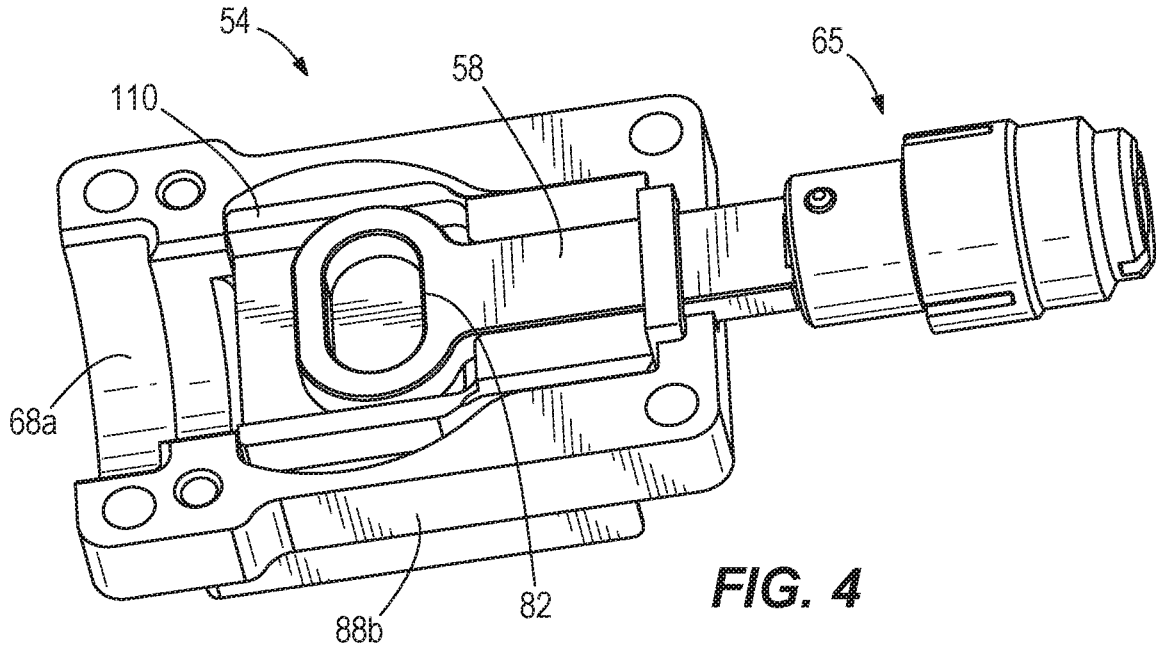


FIG. 4

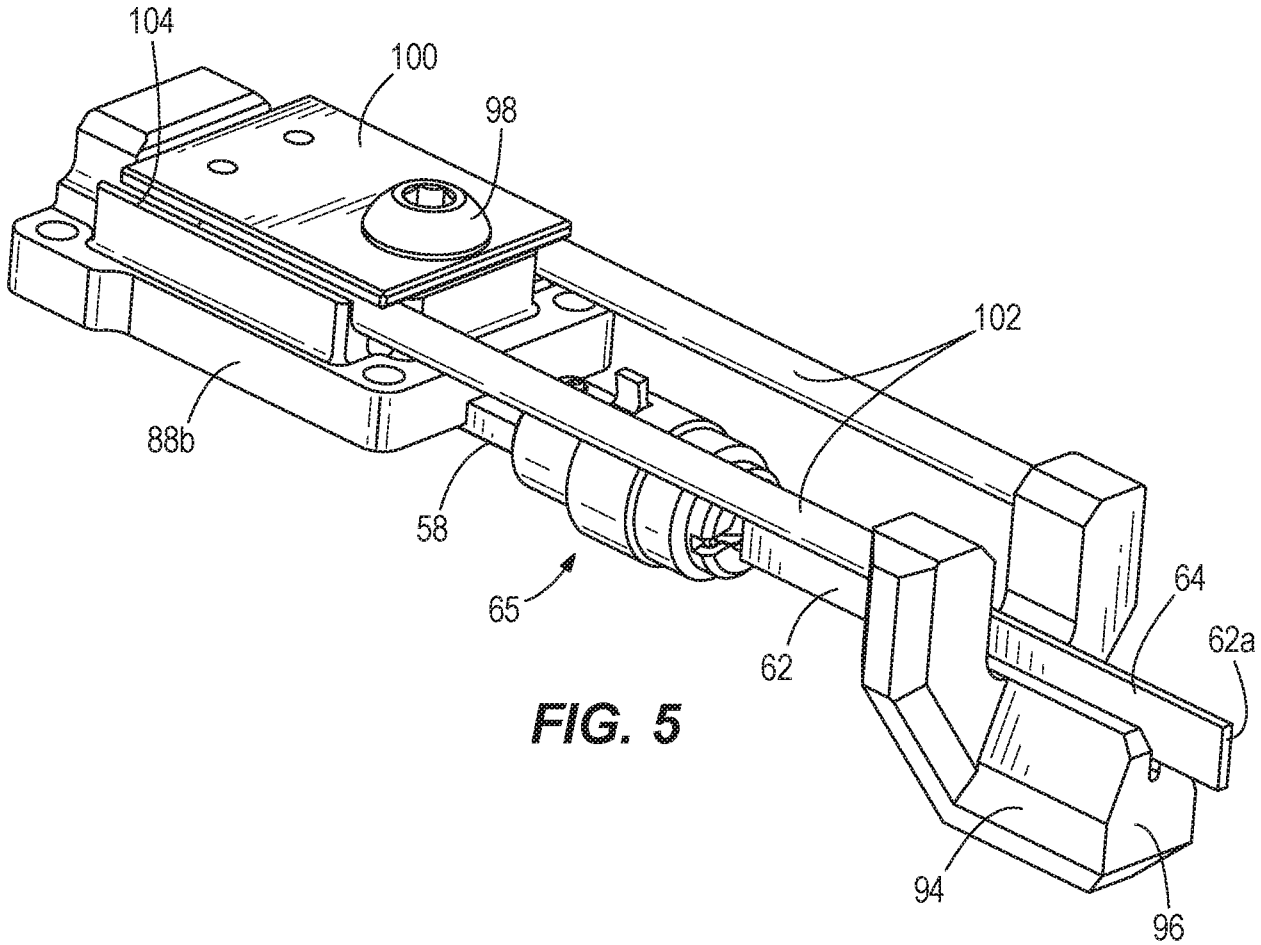


FIG. 5

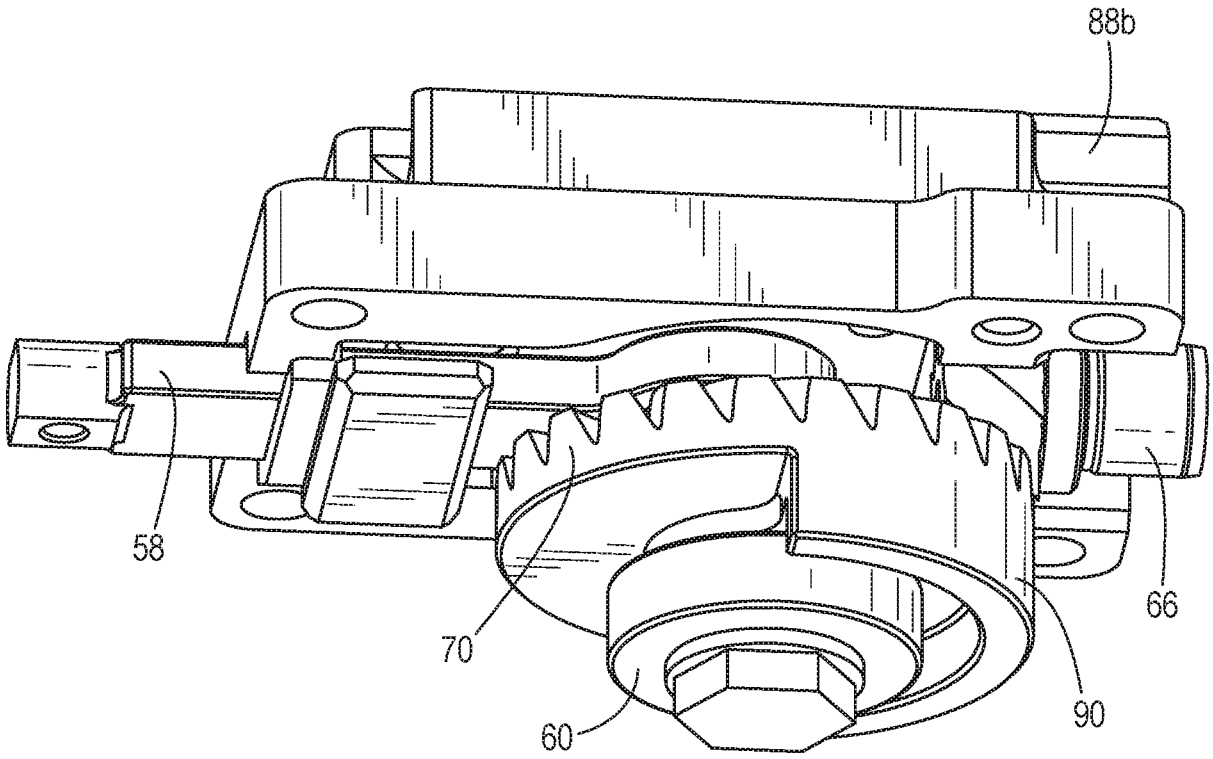


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US20 19/0 15566

A. CLASSIFICATION OF SUBJECT MATTER
INV. B23D5 1/ 16 B23D5 1/0 1
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B23D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/133210 A1 (WEIR J ALAN [US] ET AL) 30 May 2013 (2013-05-30)	1-12, 15-19, 22,23
Y	paragraphs [0001], [0019], [0023], [0035], [0038] figures 1,2,7,11,12	13,14, 20,21

X	GB 2 234 032 A (BLACK & DECKER INC [US]) 23 January 1991 (1991-01-23)	1-3,5-8, 23
A	page 1, lines 4-11 page 3, lines 26-30 page 4, lines 26-38 page 5, line 38 - page 6, line 6 figures	4,9,12, 15,20,22

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 April 2019	29/04/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Chariot, David

1

Form PCT/ISA/210 (second sheet) (April 2005)

International application No
PCT/US2019/015566

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	paragraphs [0002], [0029], [0030],	20,21
A	[0034], [0035]	3,13,15,
	figures 2,3,5,7,8,9,10	22

Y	US 5 099 705 A (DRAVNIEKS KONSTANTINS [US]) 31 March 1992 (1992-03-31)	13,14
A	column 1, lines 5-8	1,4
	column 4, lines 32-39	
	figures 2,3	

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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