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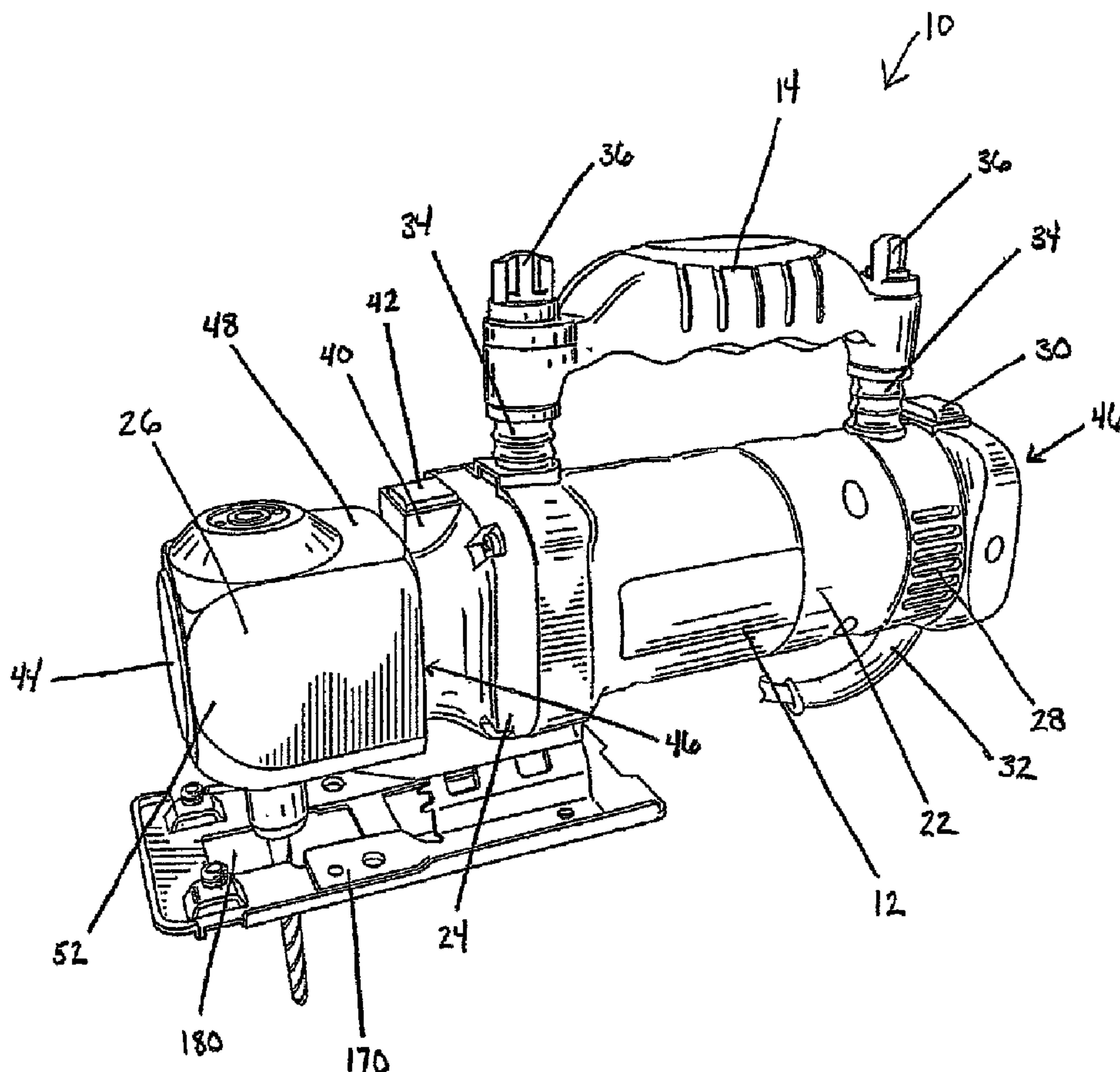
(71) Demandeurs/Applicants:
JINDING GROUP CO. LTD., CH;
BOHLER, DANIEL, DE

(72) Inventeurs/Inventors:
BOHLER, DANIEL, DE;
BAKKER, RIENTS MATHIJS, CN

(74) Agent: SIM & MCBURNEY

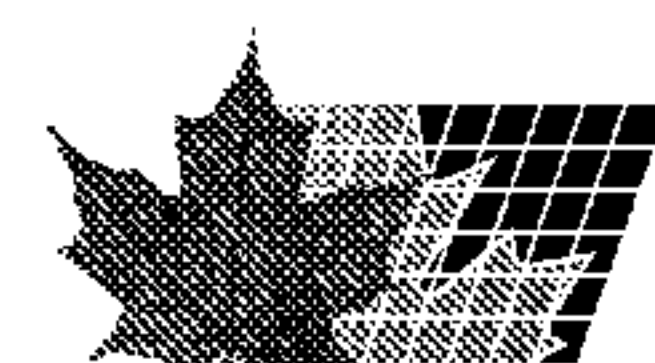
(54) Titre : MACHINE OUTIL ROTATIVE

(54) Title: ROTARY POWER TOOL



(57) Abrégé/Abstract:

A rotary power tool configured to support and drive a tool bit through a work piece. The power tool may include a motor and a tool shaft unit that are generally perpendicular to each other. The motor is configured to rotatably drive the tool shaft unit and tool shaft



(57) **Abrégé(suite)/Abstract(continued):**

unit is configured to support and rotatably drive the tool bit. The tool bit may be configured to cut both axially and laterally through the work piece. The power tool may further include a tool release mechanism and a shoe. The tool release mechanism is for engaging or releasing the tool bit from the tool shaft unit independently from the use of additional hand tools. And the shoe is for controlling the orientation of the tool bit to the work piece.

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(71) Applicant (for all designated States except US): **JINDING GROUP CO. LTD.** [CN/CN]; No. 689 Beijing East Road Eastern Tower, 9th Floor, Shanghai, 200001 (CN).

(71) Applicant and

(72) Inventor: **BOHLER, Daniel** [DE/DE]; Carl-benz-strasse 6, Denzlingen, D-79211 (DE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): **BAKKER, Rients Mathijs** [CN/CN]; No. 689 Beijing East Road Eastern Tower, 9th Floor, Shanghai, 200001 (CN).

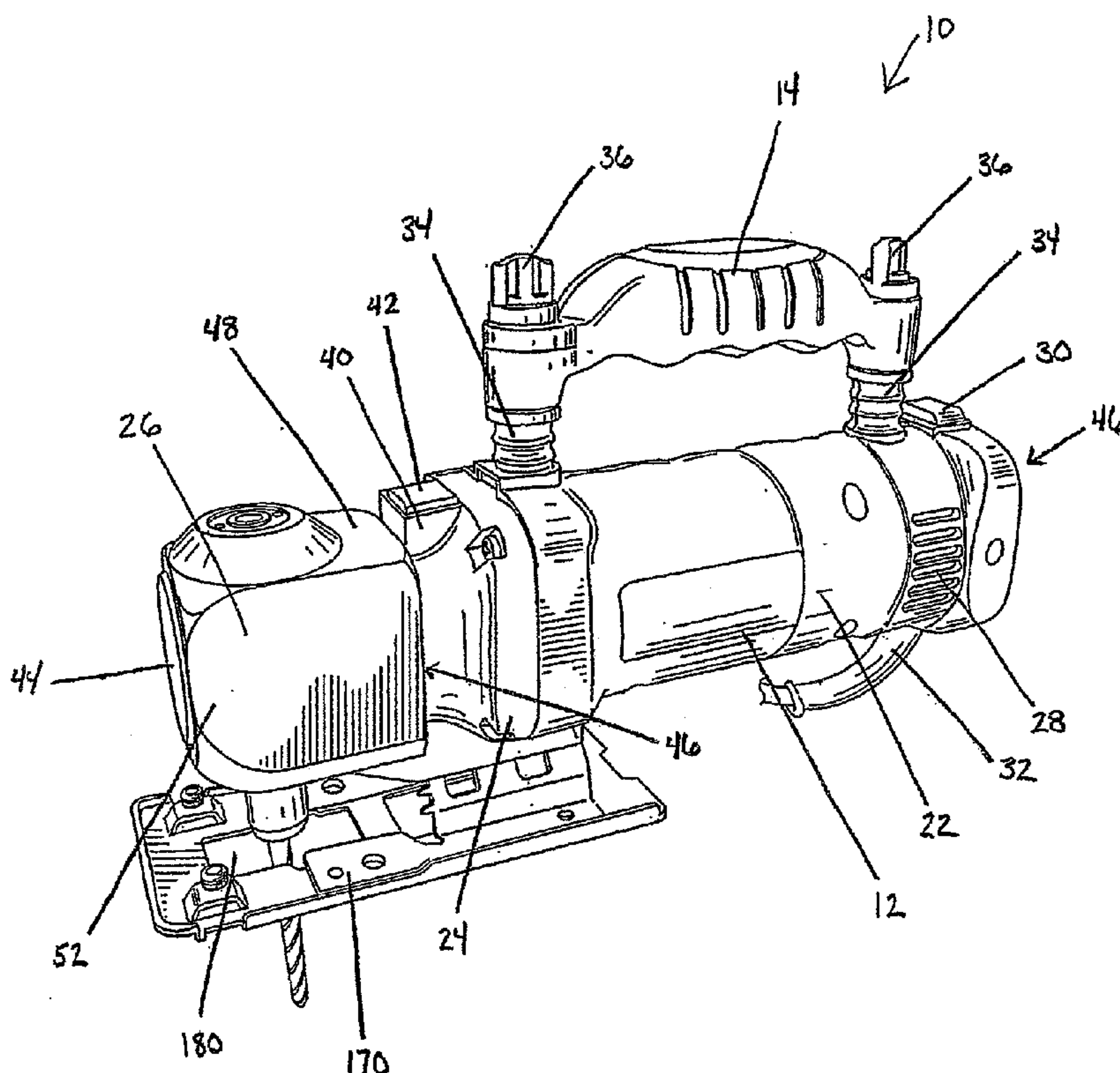
(74) Agents: **GREY, Ian** et al.; Venner Shipley LLP, 20 Little Britain, London EC1A 7DH (GB).

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(54) Title: ROTARY POWER TOOL



(57) Abstract: A rotary power tool configured to support and drive a tool bit through a work piece. The power tool may include a motor and a tool shaft unit that are generally perpendicular to each other. The motor is configured to rotatably drive the tool shaft unit and tool shaft unit is configured to support and rotatably drive the tool bit. The tool bit may be configured to cut both axially and laterally through the work piece. The power tool may further include a tool release mechanism and a shoe. The tool release mechanism is for engaging or releasing the tool bit from the tool shaft unit independently from the use of additional hand tools. And the shoe is for controlling the orientation of the tool bit to the work piece.

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ROTARY POWER TOOL

BACKGROUND OF THE INVENTION

1) Field of Invention

The present invention relates to power tools.

5 2) Description of Related Art

Jigsaws, saber saws, and spiral saws are often used to cut lines through work pieces or surfaces. It is often desirable to make the cut lines as precisely as possible both for functional and aesthetic purposes.

10 Jigsaws and saber saws are commonly referred to as reciprocating tools because they are configured to cut through a work piece by driving a blade back and forth in a reciprocating manner. A reciprocating tool is usually capable of cutting substantially straight lines through the work piece. However, a reciprocating tool is often ill-suited to cut curved lines. Also, a typical reciprocating blade is configured to cut in the upward direction only, which
15 generally causes the surface of the work piece to become damage beyond the cut line. Vibrations created by the back and forth motion of the blade often negatively effect the precision of the tool. Also, the operator of one of these tools must push the tool along and down on the work piece in order to get the cutting blade to engage the material of the work piece properly, which may lead to inaccuracies.

20 Spiral saws, such as the ones offered under the brand name of ROTOZIP® by the Robert Bosch GmbH of Germany, are often used in wood and drywall applications. Unlike reciprocating tools, spiral saws cut through material by rotating a tool bit at high speeds. However, due to the length and size of a typical spiral saw compared to the work area, it is difficult to perform detail or precision
25 work with a spiral saw. Also, the rotation of the tool bit in the same direction as

the motor along the length of the saw creates a tendency for the tool to move in the direction of the rotation rather than in a straight line. More recently, some spiral saws include a relative small surface guide or a jigsaw type handle. Although the guide and the handle are intended to enhance the precision of these tools, both are
5 still limited to either controlling the depth of cut through the work piece or supporting the tool in a fixed orientation with the surface of the work piece.

In light of the foregoing, there remains a need for providing an improved power tool that is easy to handle and capable of cutting through a work piece with precision.

10

BRIEF SUMMARY OF THE INVENTION

The present invention aims to address one or more of the above problems. The present invention provides a rotary power tool configured to support and rotatably drive a tool bit through a work piece. According to one feature of the
15 present invention, the tool bit and the motor that drives the tool bit are generally perpendicular to one another. This generally perpendicular relationship, among other things, reduces the overall length and size of the tool compared to the work piece, which enhances the precision of the tool. Also, the perpendicular relationship reduces the tendency found in conventional spiral saws for the tool to
20 follow the rotation of the tool bit rather than move in a straight line or other desired translation of the tool. Furthermore, various embodiments of the present invention may include one or more of the following features: a tool bit configured to cut at least one of laterally or axially through the work piece, a pivotally supported shoe for controlling the angle of the cut made by the tool bit, a depth adjustor for
25 controlling the depth of the cut made by the tool bit, and a tool shaft unit with a tool release mechanism for loading, supporting, and unloading the tool bit without the use of additional hand tools.

According to one embodiment of the present invention, the power tool includes a body, a motor, and a tool shaft unit. The body defines an interior. The
30 motor is supported within the interior of the body and includes a drive shaft, where the motor is configured to rotatably drive the drive shaft about a drive shaft axis. The tool shaft unit is rotatably driven about a tool shaft axis by the drive shaft and

is configured to support the tool bit. And the tool shaft axis may be generally perpendicular to the drive shaft axis.

The tool shaft unit may include a sleeve and a bush. The sleeve is configured to receive at least a portion of the bush and is rotatably driven by the drive shaft about the tool shaft axis. The bush is rotatably linked to the sleeve and is moveable relative to the sleeve along the tool shaft axis between an open position and a close position. The bush defines a first inner diameter in the open position for receiving or removing the tool bit. While in the close position, the bush defines a second inner diameter that creates a press fit between the bush and the tool bit for retaining the tool bit.

The power tool may further include a tool release mechanism that may be supported substantially within or outside the body and is configured to move the tool shaft unit between the open position and the close position. For example, the tool shaft may extend from a first end to a second end and includes the bush at the second end. The tool release mechanism may engage the first end of the tool shaft unit to move the bush along the tool shaft axis from the close position to the open position. The tool release mechanism may be configured to be activated through an opening defined on a top surface of the body. The tool shaft unit may include at least one biasing mechanism to encourage the bush back to the close position when the tool release mechanism is released.

According to another embodiment the tool release mechanism includes a lever attached to a pinion, where the pinion is configured to engage a rack on an outer surface of the tool shaft unit. The tool shaft unit may be moved from the close position to the open position by activating the lever and causing the pinion to engage the rack and move the tool shaft unit.

In yet another embodiment of the present invention, the power tool may also include a shoe mounted to the body for supporting the tool against the work piece. The body may be pivotal relative to the shoe for adjusting and controlling an angle of cut made by the tool bit through the work piece. The tool may also include a depth adjustor for controlling the depth of the cut made by the tool bit through the work piece. The tool bit may be configured to cut laterally, axially, or both through the work piece.

The power tool may also have a handle for grasping and operating the power tool. For example, the handle may be generally spaced from and parallel to the body and generally perpendicular to the tool shaft axis.

5 BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

Figure 1 is a perspective view of the power tool according to an
10 embodiment of the present invention;

Figure 1a is a perspective view of the power tool according to another embodiment of the present invention;

Figure 2 is a cross-sectional view of the power tool in Figure 1;

Figure 3a is a cross-sectional view of the tool shaft unit and the tool release
15 mechanism in the power tool in Figure 2 with the tool shaft unit in a close position;

Figure 3b is a cross-sectional view of the tool shaft unit and the tool release mechanism in Figure 3a with the tool shaft unit in an open position;

Figure 3c is a cross-sectional view of the tool shaft unit and the tool release mechanism of Figure 3a with a depth adjustor according to an embodiment of the
20 present invention;

Figure 4 is a cross-sectional view of a tool shaft unit and a tool release mechanism according to another embodiment of the present invention;

Figure 5 is a cross-sectional view of a tool shaft unit and a tool release mechanism according to yet another embodiment of the present invention with the
25 tool shaft unit in an open position;

Figure 6 is a cross-sectional view of the tool shaft unit and the tool release mechanism in Figure 5 with the tool shaft unit in a close position; and

Figure 7 is a frontal view of the power tool in Figure 1 illustrating the pivotally supported shoe according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present inventions now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the inventions are shown. Indeed, these inventions may be embodied in many
5 different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

The present invention provides a power tool configured to support and drive a tool bit through a work piece. As explained in more detail below, the
10 power tool includes a motor and a tool shaft unit that are generally perpendicular to each other. The motor is configured to rotatably drive the tool shaft unit. And the tool shaft unit is configured to support and rotatably drive the tool bit. The tool bit may be configured to cut at least one of laterally or axially through the work piece. The power tool may further include one or more of the following: a tool release
15 mechanism, a shoe, and a depth adjustor. The tool release mechanism is for engaging or releasing the tool bit from the tool shaft unit independently from the use of additional hand tools. The shoe is for supporting the power tool and controlling the orientation of the tool bit to the work piece. And the depth adjustor is for controlling the depth of cut made by the tool bit through the work piece.

20 According to the illustrated embodiments, the power tool comprises a body, a handle, a motor, and a tool shaft unit. As shown in Figures 1 and 2, the body 12 may further include a motor housing 22, an intermediate coupling sleeve 24, and a tool shaft housing 26. The motor housing 22 defines an interior for supporting the motor 18. And the tool shaft housing 26 defines an interior for supporting the tool
25 shaft unit 20. The intermediate coupling sleeve 24 connects the two housings 22, 26 together and provides an interior path for connecting the motor 18 to the tool shaft unit 26.

The motor housing 22 may be made from an electrically insulating material, such as plastic or other suitable material known in the art. As shown in
30 Figure 1, the motor housing 22 may define a number of vents 28 for providing circulation to the motor 18 and other components of the tool 10. Also, defined by the motor housing 22 may be an opening for a power switch 30 and an opening for

receiving a power cord 32. The motor housing 22 may further define a number of fastener openings. For example, the motor housing 22 may include fastener openings and fasteners for holding the motor housing together, supporting the motor, or attaching the motor housing 22 to the intermediate coupling sleeve 24.

5 The motor housing 22 may include two mounts 34 for receiving the handle 14. More specifically, the mounts 34 may define threaded holes that engage screws 36 for attaching the handle 14 to the motor housing 22 such that the handle 14 extends generally spaced from and parallel to the top of the motor housing 22. However, one in the art would appreciate that the shape, the size, and the manner
10 in which the handle is attached to the housing may vary. For example, the handle may be integrally formed with the motor housing or other portions of the body of the tool. Also, the outer surface of the motor housing may include raised or extended areas to facilitate the gripping, grasping, or controlling of the tool by the operator either in conjunction with or instead of the handle or handles. Moreover
15 although the illustrated embodiments depict a body having more than one identifiable component 22, 24, 26, one in the art would appreciate that the general shape, size, location, material, construction, and number of components of the body may vary. For example only, the body may have a more monolithic construction than the illustrated embodiments.

20 As shown in Figure 2, the motor 18 includes a drive shaft 38. The drive shaft 38 extends along and is rotatable about an axis, referred to herein as the motor or drive shaft axis. The drive shaft 38 may also include a bevel gear 39 near a distal end from the motor 18. The motor 18 is supported within the interior in a generally horizontal position such that the motor 18 extends along the length of
25 motor housing 22 and the drive shaft 38 extends toward and into the intermediate coupling sleeve 24 and the tool shaft housing 26. The motor 18 is electrically connected to a power source. For example and as illustrated in Figure 1, the motor 22 may be connected to a power cord 32 that is connected to an external power source (not shown). Or the tool may include an internal or a local power source,
30 such as a battery (not shown). The battery may be supported within the motor housing or be part of a separate battery pack that is configured to attach to the tool. The tool may also include a fan (not shown) for ventilating the interior of the tool.

For example, the fan may be mounted in the interior of the motor housing between the motor and the rear end of the motor housing. As shown, the power switch 30 near the rear end of the tool 10 may be used to turn the motor 18 on and off. The location of the power switch may vary. For example, it may be incorporated into the handle. Also, the tool may include a separate “safety” switch for inhibiting accidental activation of the tool. One of ordinary skill in the art will appreciate various additional features of conventional power tools which may be employed in an embodiment of the present invention.

The size, type, and power of the motor for the tool may vary depending on several factors, such as external or internal power restrictions, end-use applications, and space restrictions. An example of a motor according to one embodiment of the present invention is a conventional 600 W, 230V - 50 HZ AC electric motor with a no-load rotation speed of 30,000 rpm.

As shown in Figure 1, the intermediate coupling sleeve 24 may be configured for connecting the motor housing 22 and the tool shaft housing 26. For example and according to the illustrated embodiment, the intermediate coupling sleeve 24 may be shaped to connect a generally cylindrical motor housing 22 to a generally rectangular tool shaft housing 26. One end of the coupling sleeve 24 is connected to the front end of the motor housing 22 by a number of fasteners. The opposite end of the coupling sleeve 24 is configured to extend into the tool shaft housing 26 proximate an inner surface of the tool shaft housing 20. The opposite end of the coupling sleeve 24 is connected to the tool shaft housing 26 by a number of fasteners. The intermediate coupling sleeve 24 may further include a post 40 extending upwardly from a top surface of the coupling sleeve 24 to a distal end. The distal end defines an opening that leads to the interior of the tool 10. As described further below, this top opening is configured to receive a plunger 42 for activating the tool release mechanism within the tool shaft housing and the coupling sleeve.

According to the illustrated embodiments, the tool shaft housing 26 is generally rectangular in shape and includes a front end 44, a rear end 46, a top surface 48, a bottom surface 50, and two side walls 52, 53. The rear end 46 is opened and configured to engage the intermediate coupling sleeve 24. The tool

shaft housing **26** is configured to support and surround most or all of the tool shaft unit **20**. For example and as shown in Figure 2, the tool shaft unit **20** may be supported substantially within the tool shaft housing **26** such that the tool shaft unit **26** extends from near the top surface **48** to or through a bottom opening defined by the bottom surface **50** and may be generally perpendicular to the drive shaft **38** of the motor **18**.

In general, the tool shaft unit of the present invention is configured to support and drive a tool bit about an axis, referred to as the tool shaft axis **21**. Figures 3a and 3b illustrate a tool shaft unit **20** according to one embodiment of the present invention. For example, the tool shaft unit may include a bush **54**, an inner shaft **56**, and a surrounding sleeve **58**. The bush **54**, the inner shaft **56**, and the surrounding sleeve **58** are interconnected such that the rotation of one drives the rotation of the others about the tool shaft axis **21**. As explained in more detail below, the bush **54** is configured to support and hold a tool bit and the surrounding sleeve **58** is rotatably drivable about the tool shaft axis **21** by the drive shaft **38** of the motor **18**. Therefore, the tool bit is rotatably drivable about the tool shaft axis **21** by the motor **18** through the drive shaft **38** and the tool shaft unit **20**.

The bush **54** may extend from a first end **60** to a second end **61**. The first end **60**, also referred to as the inner shaft end, is configured to engage the inner shaft **56**. The first end **60** may include a top edge **62**, an inner diameter, an outer diameter, and a threaded region **64** extending from the top edge **62** toward the second end **61**. The threaded region **64** and the outer diameter are configured to engage a threaded region **65** in the inner shaft and link the inner shaft **56** and the bush **54** together. The first end **60** may also define a groove or slot **66** for receiving a locking pin, as further described below. The second end **61**, also referred to as the tool bit end, is configured to engage the tool bit. The second end **61** includes a bottom edge **70**, an inner diameter, and an outer diameter. More specifically, the inner diameter defines a tool shaft **68** for engaging the tool bit. The second end **61** also includes a tapered region **69** wherein the thickness of the bush **54** increases as shown in the figures, such that the outer diameter of the second end **61** increases as it approaches the bottom edge **70**. The second end **61**

defines one or more slits **72** that extend generally parallel to the tool shaft axis **21** from the bottom edge **70** toward the top edge **62** of the bush **54**.

The bush **54** may be moveable along the tool shaft axis **21** between at least two positions, an open position and a close position. In the open position and as shown in Figure 3b, the bush **54** defines a first inner diameter of the tool end **61** that is large enough to allow the tool bit to move in and out of the tool shaft **68**. In the close position and as shown in Figure 3a, the bush defines a second inner diameter that is less than the first inner diameter which creates a press or interference fit between the tool bit and the bush **54**. Therefore, a tool bit may be placed into the tool shaft in the open position, and then by moving the bush into the close position, the tool bit is captured or retained in the tool shaft. And to remove the tool bit, the bush may be moved back into the open position. The slit or slits **72** within the tool end **61** facilitate the changes in the inner diameter of the bush between the close and open positions.

The surrounding sleeve **58** is generally cylindrical in shape and extends from a first end **74**, also referred to herein as a top end, and a second end **76**, also referred to herein as the bottom end, along the tool shaft axis. The surrounding sleeve **58** includes an outer diameter and an inner diameter. The inner diameter defines a sleeve shaft **78**, which is configured to engage and surround at least a portion of the inner shaft **56** and the bush **54**. The inner diameter of the surrounding sleeve **58** may vary along the tool shaft axis. More specifically, the sleeve shaft **78** of the surrounding sleeve **58** may extend from the top end **74** toward the bottom end **76** at a first inner diameter **80** for a first longitudinal distance, then extend for a second longitudinal distance at a second inner diameter **81**, and finally extend for a third longitudinal distance to the bottom edge **70**, wherein the inner diameter increases along the third longitudinal distance. The first inner diameter **80** and the first longitudinal distance are configured for receiving at least a portion of the inner shaft **56**. The second longitudinal distance and second inner diameter **82** are configured for receiving at least portion of the bush **54** from the first end **60** of the bush **54** to the tapered region **69** of the second end **61** of the bush **54**. Also, the second inner diameter **82** may be less than the first inner diameter **80** which prevents the inner shaft **56** from extending beyond

the first longitudinal distance in the surrounding sleeve **58**. The increasing diameter along the third longitudinal distance creates a flared inner surface **84** that is adapted to receive at least a portion of the tapered region **69** of the bush **54**.

5 The surrounding sleeve **58** may also include a bevel gear **79**. The bevel gear **79** of the surrounding sleeve **58** is configured to engage the bevel gear **39** of the drive shaft **38**, such that the rotation of the drive shaft **38** about the drive shaft axis creates a rotation of the surrounding sleeve **58** about the tool shaft axis **21**. The use of a pair of bevel gears directly on the drive shaft and the surrounding sleeve is one example of the many gear trains that may be employed with the present invention. Numerous gear combinations may be used to transmit the rotational force or change rotational speed from the drive shaft to the tool shaft unit for an embodiment of the present invention.

15 The surrounding sleeve **58** may be supported within the tool shaft housing by a number of fixed bearings **81** that allow for the rotation of the surrounding sleeve **58** about the tool shaft axis but fixes the position of the surrounding sleeve in any other direction.

20 The surrounding sleeve **58** may also include a locking pin **85** that extends from the inner surface of the surrounding sleeve **58** into the sleeve shaft **78**. The locking pin **85** is aligned with the pin slot **66** defined in the bush **54**. Specifically, the locking pin **85** and the pin slot **66** are adapted such that pin **85** and slot **66** rotatably link the bush **54** to the surrounding sleeve **58**, i.e. the rotation of surrounding sleeve **58** causes the rotation of the bush **54**. However, the slot **66** is larger than the pin **85** in the direction of the tool shaft axis **21** and thus allows the bush **54** to move relative to the surrounding sleeve **58** along or in the direction of the tool shaft axis **21**.

25 As stated above, the bush may be movable between open and close positions. Specifically, from the open position, the bush is moved upward along the tool shaft axis **21** direction. As the bush is moved upward, the tapered region of the bush engages the flared inner surface of the bottom end of the surrounding sleeve which creates an inward force that reduces the inner diameter of the tool end to the close position.

Because the inner shaft and the bush are linked, one way to move the bush along the tool shaft axis 21 is by moving the inner shaft 56. As shown in Figures 3a and 3b, the inner shaft 56 extends from a top end 86 to a bottom end 88 and includes an outer diameter and an inner diameter. The outer diameter is configured such that at least a portion of the inner shaft 56 is within the surrounding sleeve 58. The inner diameter is configured to receive at least a portion of the first end 60 of the bush 54. And the inner surface of the inner shaft 56 may include the threaded region 65 near the bottom end 88 for engaging the threaded region 65 of the bush 54 and linking the inner shaft 56 and bush 54 to each other. The threaded regions 64, 65 may be provided by forming a helical thread directly onto the surfaces of the inner shaft and the bush or indirectly with the use of threaded inserts. The inner shaft 56 may further include an outwardly extending flange 90 proximate the top end 86 and a first spring 92 that is wrapped around the inner shaft between the flange 90 and the top end 74 of the surrounding sleeve 58. The first spring 92 functions as a biasing force that encourages a minimum distance between the top end 86 of the inner shaft 56 and the top end 74 of the surrounding sleeve 58.

The tool may further include a tool release mechanism. The tool release mechanism is configured to move the bush between the open and close positions and thus allow for the loading and unloading of the tool bit into the bush. For example and according to the embodiment illustrated in Figures 3a and 3b, the tool release mechanism 100 includes a lever 102, a plunger 42, a fixed pin 106, and a biasing mechanism, such as a guide spring 108. The lever 102 extends from a first end 110 to a second end 112. The first end 110 is pivotally fixed to the tool shaft housing. The lever 102 may include two openings 114, 116. The first opening 114 may be aligned with the opening defined by the inner diameter of the inner shaft 56. Also, the first opening 114 may be reinforced by a calotte 115 which is held within the first opening 114 by a press fit. The second opening 116 is proximate the second end 112 of the lever 102. The fixed pin 106 is fixed to the tool shaft housing at a first end and extends from the first end 118 through the second opening 116 of the lever 102 to a second and distal end 119. The guide spring 108 is wrapped around the pin 106 between the first end 118 of the pin 106 and the lever 102. The guide spring 108 creates a biasing force that encourages the lever

102 into a first position, referred to herein as the disengagement position, where the first end 110 disengages the inner shaft 56 and thus the bush 54. The plunger 42 extends from the second end 112 of the lever 102 to and through the opening defined by the post 40 in the intermediate coupling sleeve 24, as seen in Figure 2.

5 The plunger 42 and the lever 102 may be integrally formed as one component, as illustrated in the figures.

In a tool loading operation, an operator may activate the tool release mechanism by pushing down on the plunger 42 which causes the lever 102 to push down on or engage the bush 54 through the inner shaft 56. This downward force

10 moves the inner shaft 56 and bush 54 downward along the tool shaft axis 21. Because the surrounding sleeve 58 is fixed in the direction of the tool shaft axis 21, the bush 54 moves relative to the surrounding sleeve 58 to the open position. In the open position, the tool bit is inserted into the tool shaft 68, and then the operator releases the plunger 42. Because of the guide spring 108, the lever 102

15 moves back upward to the disengagement position. Because of the first spring 92 between the inner shaft 56 and the surrounding sleeve 58, the inner shaft 56 and the bush 54 move back upwards along the tool shaft axis 21 to the close position, wherein the tool bit is retained within the tool shaft 68.

Similarly, in a tool unloading operation, an operator pushes down on the

20 plunger 42 which causes the bush 54 to move downward relative to the surrounding sleeve 58 to the open position, wherein the tool bit is removable from the tool shaft 68.

The lever 102 may be supported substantially within the housing of the tool. More specifically, the lever 102 may be positioned and supported generally

25 between the top surface 48 of the tool shaft housing 26 and the top end 86 of the inner shaft and be activated by the plunger 42 that extends through the post 40 in the intermediate coupling sleeve as described above. However the location of the lever may vary. For example, the lever 3102 may be supported above the top surface 3048 of the tool shaft housing 3026 as illustrated in Figure 1a. According

30 to this embodiment, the first end 3110 of the lever may be supported by two posts 3208 extending from the top surface 3048. And the fixed pin 3106 may be fixed to the top surface 3048 as well. Also, as shown the lever 3102 may not include a

plunger and to activate the lever **3102** an operator may engage the second end **3112** of the lever **3102** directly.

According to one feature of the present invention, the tool may further include a depth adjustor. The depth adjustor is configured to adjust and control the distance that tool bit extends out of the bush, which in turn controls the depth of the cut made by the tool bit through the work piece. For example and as illustrated in Figure 3c, the depth adjustor may be a rod **200**. The rod **200** extends from a handle **202** to a distal threaded end **204**. The rod **200** is configured to fit through the first opening **114** of the lever **102** and within the inner diameter of the inner shaft **56**. Moreover, the distal threaded end **204** is configured to engage a second threaded region **206** on the inside surface of the bush **54** and extend into the tool shaft **68**. By extending into the tool shaft **68**, the threaded end **204** controls the distance that the tool bit may be inserted into the tool shaft **68** in an upward direction along the tool shaft axis **21**. The length of the tool bit that is inserted into the tool shaft has an inverse relationship with the length of the tool bit that extends away from the bush and can cut through the work piece. For example, by decreasing the length of tool bit inserted into the tool shaft, an operator increases the depth of cut made by the tool bit through the work piece. The surface of the rod may include depth or other guide markings to indicate to the operator the proper positioning of the rod to achieve a particular depth of cut. Also, although the depth adjustor is generally described as a rod with a handle, the shape and configuration of the depth adjustor may vary to include any gage that is adapted to adjust the depth of the tool bit into the tool shaft. For safety purposes, the depth adjustor may be configured to be removable from the tool during cutting operations. In fact, the tool may be configured not to operator while the depth adjustor is engaged for safety reasons.

Figure 4 illustrates another embodiment of the present invention. According to this embodiment, the tool shaft unit **1020** further includes an outer sleeve **1122**. The outer sleeve is generally cylindrical and extends about the tool shaft axis **1021** from a first end **1124**, referred to herein as a top end, to a second end **1126**, referred to herein as the bottom end. The outer sleeve **1122** defines an outer diameter and an inner diameter. The inner diameter is configured to receive

at least a portion of the surrounding sleeve **1058**. The outer sleeve **1122** includes a bevel gear **1079** that is configured to engage the bevel gear **1039** on the drive shaft. The outer sleeve **1122** is rotatably driven by the bevel gears **1039**, **1079** about the tool shaft axis **1021**. A number of fixed bearing **1081** and retaining rings **1128**
5 support the outer sleeve **1122** within the tool shaft housing such that outer sleeve **1122** may rotate about the tool shaft axis **1021** but has a fixed position in every other direction.

The outer sleeve **1122** and the surrounding sleeve **1058** are rotatably linked. For example, the outer sleeve **1122** and the surrounding sleeve **1058** are rotatably
10 linked by a tongue and groove configuration. More specifically, the outer sleeve **1122** may include a tongue **1130** that is configured to extend inwardly into a first groove **1132** defined in the outer surface of the surrounding sleeve **1058**. The tongue **1130** and the first groove **1132** are adapted to link the outer sleeve **1122** and the surrounding sleeve **1058** such that the rotation of one rotates the other.

15 However, the first groove **1132** is longer in the direction of the tool shaft axis **1021** than the tongue **1130** to allow the surrounding sleeve **1058** to move along the tool shaft axis relative to the outer sleeve **1122**.

The tool shaft unit **1020** may also include a locking key **1134**. The key is configured to be moveable between at least an extended position and a retracted
20 position. In the extended position, the key **1134** is configured to extend into a second groove **1136** defined in the outer surface of the surrounding sleeve **1058**. The second groove **1136** and the key **1134** are configured such that the surrounding sleeve **1058** is locked from moving in the direction of the tool shaft axis **1021**. Moreover, by locking the surrounding sleeve **1058** in the direction of the tool shaft
25 axis **1021**, the key **1134** is also locking the bush **1054**, the inner shaft **1056**, and the lever **1102** in the direction of the tool shaft axis **1021** due to the linkages between these components. The key **1134** may include a key handle **1138** and a screw pin **1140** that extends away from the key handle **1138** toward the surrounding sleeve **1058** to a distal end **1142**. The key **1134** also includes a nut plate **1144** with a
30 threaded hole that the screw pin **1140** extends through. In order to move the distal end **1142** in or out of the second groove **1136**, i.e., between the extended and retracted positions, the key handle **1138** may be rotated such that threads on the

screw pin **1140** engage the threaded hole of the nut plate **1144** and extend or retract the key **1134** depending on the direction of the rotation.

Figures 5 and 6 illustrate yet another embodiment of the present invention. According to this embodiment, the tool shaft unit **2020** is supported between one
5 horizontal support **2148** and an outer cylindrical support **2146** within the tool shaft housing. The horizontal support **2148** may be the top surface of the tool shaft housing. The outer cylindrical support **2146** defines an inner diameter centered about the tool shaft axis **2021** and configured to receive at least a portion of the tool shaft unit **2020**. The outer cylindrical support **2146** also defines at least one
10 side through-opening **2150**. The outer sleeve **2122** of the tool shaft unit is linked to the surrounding sleeve **2058** of the tool shaft unit by a number of fixed bearing **2081** and retaining rings **2128**, such that the movement of one in the direction of the tool shaft axis **2021** results in an equal movement of the other. However, the outer sleeve **2122** and the surrounding sleeve **2058** are not rotationally linked.
15 Therefore the surrounding sleeve **2058** may rotate independently from the outer sleeve **2122**. As described above the surrounding sleeve **2058**, the inner shaft **2056**, and the bush **2054** may be rotationally linked to each such that the rotation of one results in the rotation of the others. Also, according to this embodiment, the surrounding sleeve **2058** is rotationally linked to a bevel gear **2079**. More
20 specifically, the surrounding sleeve **2058** may include an inwardly extended tongue **2152** that is adapted to extend into a groove **2154** defined in an inner surface of the bevel gear **2079**. The tongue **2152** and the groove **2154** rotationally link the surrounding sleeve **2058** to the bevel gear **2079**. However, the groove **2154** is longer in the direction of the tool shaft axis **2021** than the tongue **2152** allowing the
25 surrounding sleeve **2058** to move along the tool shaft axis **2021** independently from the bevel gear **2079**.

The tool shaft unit **2020** may include a first spring **2092** and a second spring **2093**. The first spring **2092** is wrapped around the inner shaft **2056** between the outer flange **2090** of the inner shaft and the top end **2074** of the surrounding
30 sleeve. The second spring **2093** is wrapped around the surrounding sleeve **2058** between the end of the bevel gear **2079** and a stop **2156** formed on the outer surface of the surrounding sleeve **2058**. The two springs **2092**, **2093** create a bias

position for the tool shaft unit **2020**, wherein the top end **2086** of the inner shaft is at predetermined distance from the horizontal support **2148**, as shown in Figure 6.

According to this embodiment, the tool release mechanism **2100** includes a pinion **2158** and lever **2160**. The pinion is configured to engage a rack **2162**
5 defined on the outer surface of the outer sleeve **2122** through the side through-opening **2150** in the cylindrical support **2146** as shown in Figures 5 and 6. The rack **2162** may be formed directly onto the outer surface or indirectly by an insert. The lever **2160** is attached to the pinion **2158** and extends to a distal end. The lever may extend through an opening in the front end **2044** of the tool shaft housing
10 for access.

By pushing down on or engaging the lever **2160**, the pinion **2158** raises the outer sleeve **2122** upwards toward the horizontal support **2148**. The upward movement of the outer sleeve **2122** creates an upward movement in the surrounding sleeve **2058**, which in turn creates an upward movement in the inner
15 shaft **2056** and the bush **2054** due to the first spring **2092**. Before reaching a maximum upward position for the outer sleeve **2122** and the surrounding sleeve **2058**, the top end **2086** of the inner shaft contacts the horizontal support **2148** and prevents any further movement upwards of the inner shaft **2056** or the bush **2054**. The continuing upward movement of the outer sleeve **2122** and the surrounding
20 sleeve **2058** causes the surrounding sleeve **2058** to move upward in the direction of the tool shaft axis **2021** relative to the bush **2054**. This relative movement moves the bush **2054** to the open position such that a tool bit may be inserted or removed from the tool shaft, as illustrated in Figure 5. After releasing the lever **2160**, the biasing forces created by the first and second springs **2092**, **2093** encourages the
25 tool shaft unit **2020** back to its biased position, wherein the bush **2054** is in the closed position, as illustrated in Figure 6.

According to another feature of the present invention, the tool may include a shoe. The shoe plate may provide a means for adjusting and controlling the angle of the cut made by the tool bit through the work piece. For example, as
30 shown in Figure 7, the body **12** of the tool **10** may be placed in a generally parallel relationship with the shoe **170**. In the parallel relationship, the tool bit is positioned to make a perpendicular cut through the work piece. In order to make a

bevel cut, i.e., a cut at an angle other than perpendicular, the body 12 may be pivoted relative to the shoe 170, as illustrated by the dashed lines in Figure 7. For example, the body may be pivoted such that the tool bit is positioned to make a 15°, 30°, 45°, 60°, 70°, or 85° cut through the work piece, or any cut between 10°
5 to 90°.

The shoe 170 may include a base plate 172, a support bracket 174, a clamp 176, and an adjustor wheel 178. The base plate 172 has a substantially flat bottom for applying on a work piece and at least one opening 180 configured to provide access to the work piece for the tool bit. The support bracket 174 extends from a
10 first end 182 to a second end 184 and provides a semi-cylindrically curved surface 186. The surface 186 defines a groove 188 that extends between the first end 182 and the second end 184. The first end 182 and the second end 184 are connected to the base plate 172. The clamp 176 includes a head 190 configured to engage an inner surface of the support bracket 174 and a pin 192 that extends from the head
15 190 to a distal end. The pin 192 is configured to extend through the groove of the support bracket 174 and a threaded hole 194 defined by the adjustor wheel 178.

The adjustor wheel 178 is rotationally mounted to the bottom or the interior of the body.

To adjust or pivot the tool body 12 to the shoe 170, or more specifically the
20 base plate 172, the adjustor wheel 178 may be rotated to engage a threaded portion of the pin 192 such that the head 190 of the clamp 176 moves away from or disengages the inner surface of the support bracket 174, then the tool body 12 may be pivoted along the groove of the support bracket 174. To lock or fix the tool
25 body 12 in place relative to the base plate 172, the adjustor wheel 178 may be rotated in an opposite direction to engage the threaded portion of the pin 192 such that the head 190 of the clamp 176 moves toward and engages the inner surface of the support bracket 174.

One in the art would appreciate the numerous manners in which the body may be pivotally supported and attached to a shoe. For example purposes only, the
30 present invention may include a shoe as disclosed in U.S. Patent Nos. 4,837,935; 5,012,583; 5,778,538; or 6,357,124. Each of which are hereby incorporated by reference in their entirety.

As stated above, one of the features of this inventive power tool is supporting and rotatably driving a tool bit through a work piece. The tool bit is configured to cut at least one of laterally or axially through the work piece. As used herein, "to cut laterally" describes cutting in a direction generally perpendicular to the length of the tool bit. Tool bits configured to cut laterally are known in the art for use with routers. As used herein, "to cut axially" describes cutting in the length direction of the tool bit. Tool bits configured to cut axially are known in the art for use with conventional power drills. The tool bit may also be configured to cut both axially and laterally. As used herein, "to cut axially" describes cutting in the direction of the length of the tool bit. Tool bits configured to cut both axially and laterally are commercially available, including some router tool bits and ROTOZIP® bits by the Robert Bosch Tool Corporation of Germany. Furthermore, such bits are disclosed in U.S. Patent Nos. 5,143,490 and 6,758,639. Both of which are incorporated by reference in their entirety. Also, as used herein to "cut through a work piece" is intend to include through cuts, i.e., cuts that extend through the entire thickness of a work piece, and non-through cuts, i.e., cuts that only extend partially into a work piece for creating channels or other recesses in a work piece.

The present inventions provide several features. For example, the rotating tool bit avoids the vibrations and other problems associated with a reciprocating blade. Moreover, the perpendicular motor to the tool shaft unit reduces the overall length and size of the tool compared to the work piece, which enhances the precision of the tool. Also, the perpendicular relationship reduces the tendency found in conventional spiral saw for the tool to follow the rotation of the tool bit rather than go in a straight line or other desired translation of the tool. The pivotally supported shoe may control the angle of cut, while the depth adjustor may control the depth of cut. The tool shaft unit and the tool release mechanism allow for the loading and unloading of tool bits without the use of additional hand tools.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the

associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, such as horizontal, vertical, top, 5 bottom, front, and rear, they are used in a generic and descriptive sense only and not for purposes of limitation.

THAT WHICH IS CLAIMED:

1. A power tool for rotatably driving a tool bit configured to cut at least one of
5 laterally and axially through a work piece, the power tool comprising:
a body defining an interior;
a motor supported within the interior of the body and includes a drive shaft,
wherein the motor is configured to rotate the drive shaft about a drive shaft axis;
a tool shaft unit supported substantially within the interior of the body,
10 rotatable about a tool shaft axis by the drive shaft, and configured to support and
rotate the tool bit about the tool shaft axis, wherein the tool shaft axis is generally
perpendicular to the drive shaft axis; and
a shoe mounted to the body for supporting the power tool against the work
piece.
15
2. The power tool according to Claim 1, wherein the body is configured to
pivot relative to the shoe for adjusting and controlling an angle of cut made by the
tool bit through the work piece.
- 20 3. The power tool according to Claim 1 further comprising a handle for
operating the tool, the handle being generally perpendicular to the tool shaft axis.
4. The power tool according to Claim 1 further comprising a tool release
mechanism held substantially within the interior of the body and configured to
25 move the tool shaft unit between an open position, wherein the tool bit may be
inserted into and removed from the tool shaft unit independently from the use of an
additional hand tool, and a close position, wherein the tool bit may be retained by
the tool shaft unit.
- 30 5. The power tool according to Claim 4, wherein the tool shaft unit extends
from a first end to a second end and includes a bush at the second end, the bush
defines a first inner diameter in the open position for receiving and removing the

tool bit and defines a second inner diameter in the close position that creates a press fit between the bush and tool bit for retaining the tool bit.

6. The power tool according to Claim 5, wherein the tool shaft unit further
5 includes a sleeve configured to receive at least a portion of the bush, the sleeve and bush being rotationally linked and the bush being movable relative to the sleeve along the tool shaft axis between the open position and the close position.

7. The power tool according to Claim 5, wherein the tool release mechanism
10 is configured to engage the first end of the tool shaft unit in order to move the bush along the tool shaft axis from the close position to the open position.

8. The power tool according to Claim 7, wherein the body defines an opening on a top surface for activating the tool release mechanism.

15 9. The power tool according to Claim 7, wherein the tool shaft unit includes at least one biasing mechanism to encourage the bush towards the close position.

10. The power tool according to Claim 1 further comprising a depth adjustor
20 for adjusting a depth of cut made by the tool bit.

11. A power tool for rotatably driving a tool bit configured to cut at least one of laterally and axially through a work piece, the power tool comprising:

a body defining an interior;

25 a motor supported within the interior of the body and includes a drive shaft, wherein the motor is configured to rotate the drive shaft about a drive shaft axis; and

a tool shaft unit supported substantially within the interior of the body and including a sleeve and a bush, wherein the sleeve is configured to receive at least a
30 portion of the bush and be rotated by the drive shaft about a tool shaft axis, wherein the bush is rotatably linked to the sleeve and is moveable relative to the sleeve along the tool shaft axis between an open position and a close position, and

wherein the bush defines a first inner diameter in the open position for receiving or removing the tool bit and defines a second inner diameter in the close position for retaining the tool bit.

5 12. The power tool according to Claim 11 further comprising a tool release mechanism configured to engage and move the tool shaft unit from the close position to the open position.

10 13. The power tool according to Claim 12, wherein the tool shaft unit extends from a first end defined by the bush and a second end opposite the bush, and wherein the tool release mechanism is configured to engage the second end.

14. The power tool according to Claim 13, wherein the tool release mechanism is substantially contained within the interior of the body.

15

15. The power tool according to Claim 14, wherein the tool release mechanism is configured to be activated through an opening defined in a top surface of the body.

20 16. The power tool according to Claim 13, wherein the tool release mechanism includes a lever supported above a top surface of the body.

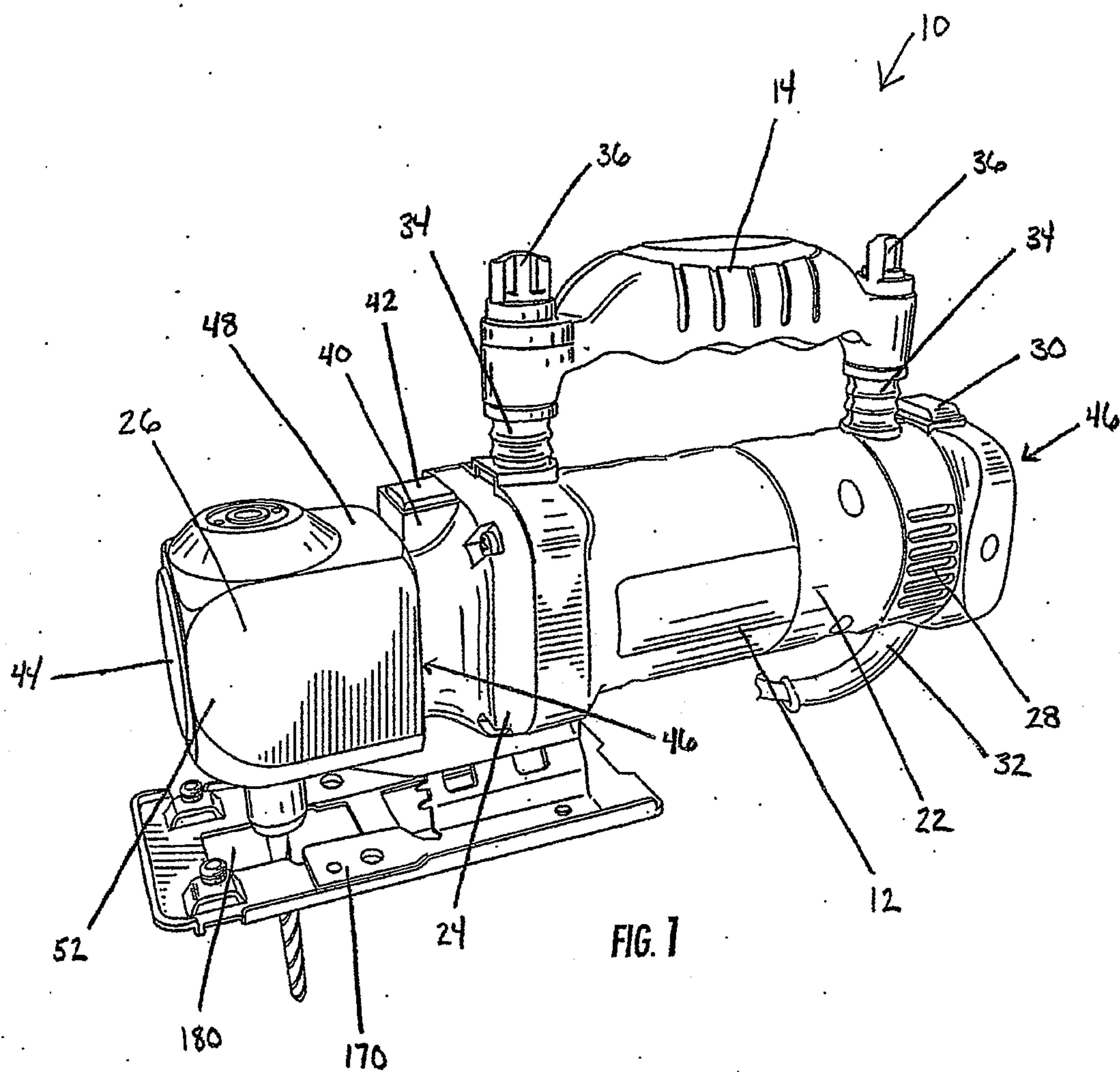
25 17. The power tool according to Claim 12, wherein the tool shaft unit includes a rack on an outer surface of the tool shaft unit and the tool release mechanism includes a lever attached to a pinion, and wherein the pinion is configured to engage the rack, such that the lever moves the pinion against the rack to move the tool shaft unit from the close position to the open position.

30 18. The power tool according to Claim 11, wherein the tool shaft axis is generally perpendicular to the drive shaft axis.

19. The power tool according to Claim 11 further comprising a handle for operating the tool, the handle being generally perpendicular to the tool shaft axis.
20. The power tool according to Claim 11 further including a shoe mounted to the body for supporting the power tool against the work piece.
21. The power tool according to according to Claim 19, wherein the body is configured to pivot relative to the shoe for adjusting and controlling an angle of cut made by the tool bit through the work piece.
22. A power tool for rotatably driving a tool bit through a work piece, the power tool comprising:
- a body including a top surface, a bottom surface and interior, the top surface defines a top opening and the bottom surface defines a bottom opening;
 - a motor supported within the interior of the body and includes a drive shaft, wherein the motor is configured to rotate the drive shaft about a drive shaft axis;
 - a tool shaft unit supported substantially within the interior of the body, rotatable about a tool shaft axis by the drive shaft, and configured to engage the tool bit near the bottom surface, wherein the tool shaft unit has an open position for inserting and releasing the tool bit and a close position for supporting the tool bit during a cutting operation; and
 - a tool release mechanism configured to engage and move the tool shaft unit from the close position to the open position, wherein the tool release mechanism engages the tool shaft unit near the top surface.
23. The power tool according to Claim 22, wherein the tool shaft axis is generally perpendicular to the drive shaft axis.
24. The power tool according to Claim 22 further comprising a shoe mounted to the body for supporting the power tool against the work piece.

25. The power tool according to Claim 24, wherein the body is pivotal to the shoe for adjusting and controlling an angle of cut made by the tool bit through the work piece.
- 5 26. The power tool according to Claim 22 further comprising a depth adjustor for adjusting a depth of cut made by the tool bit.

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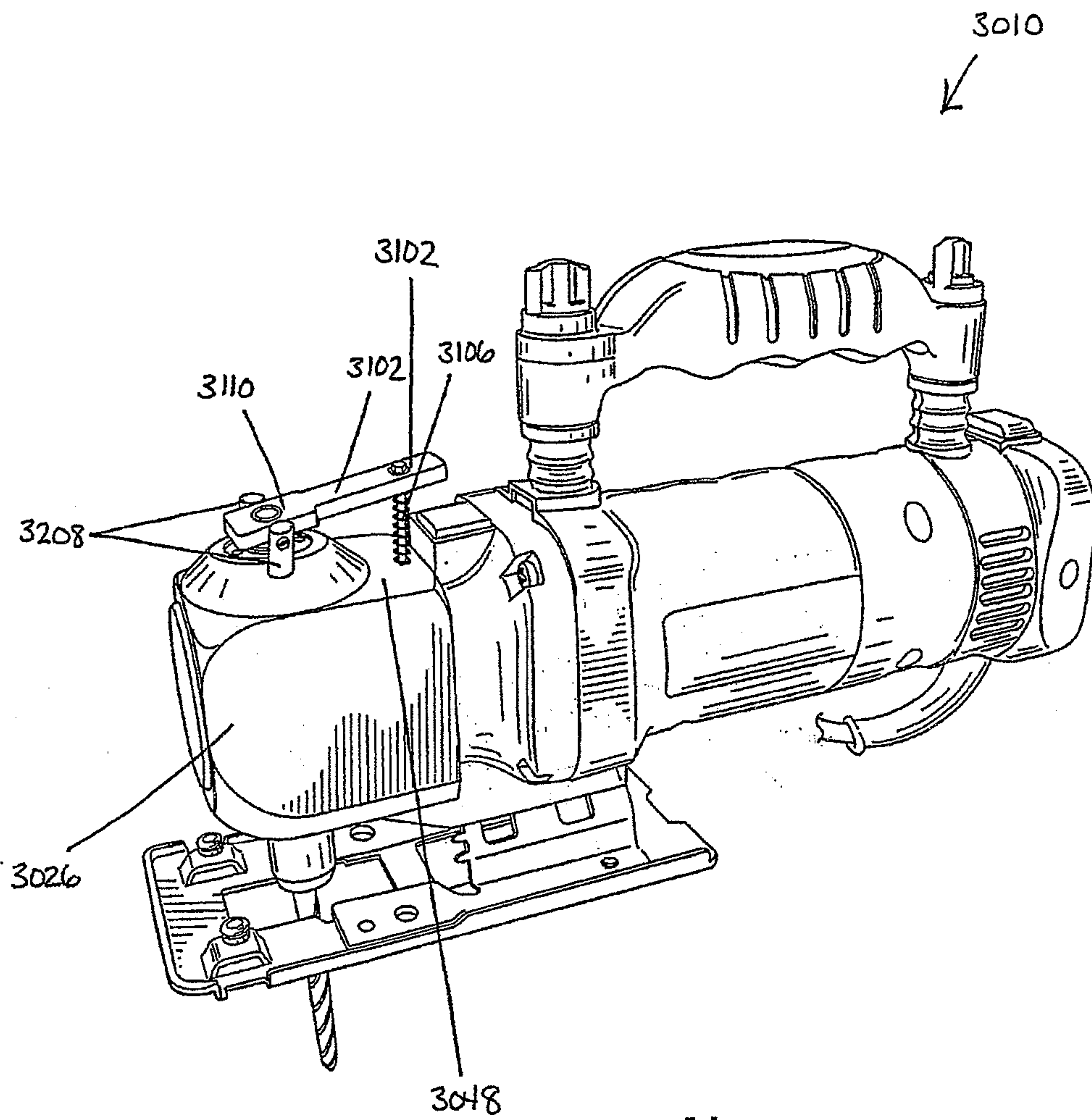
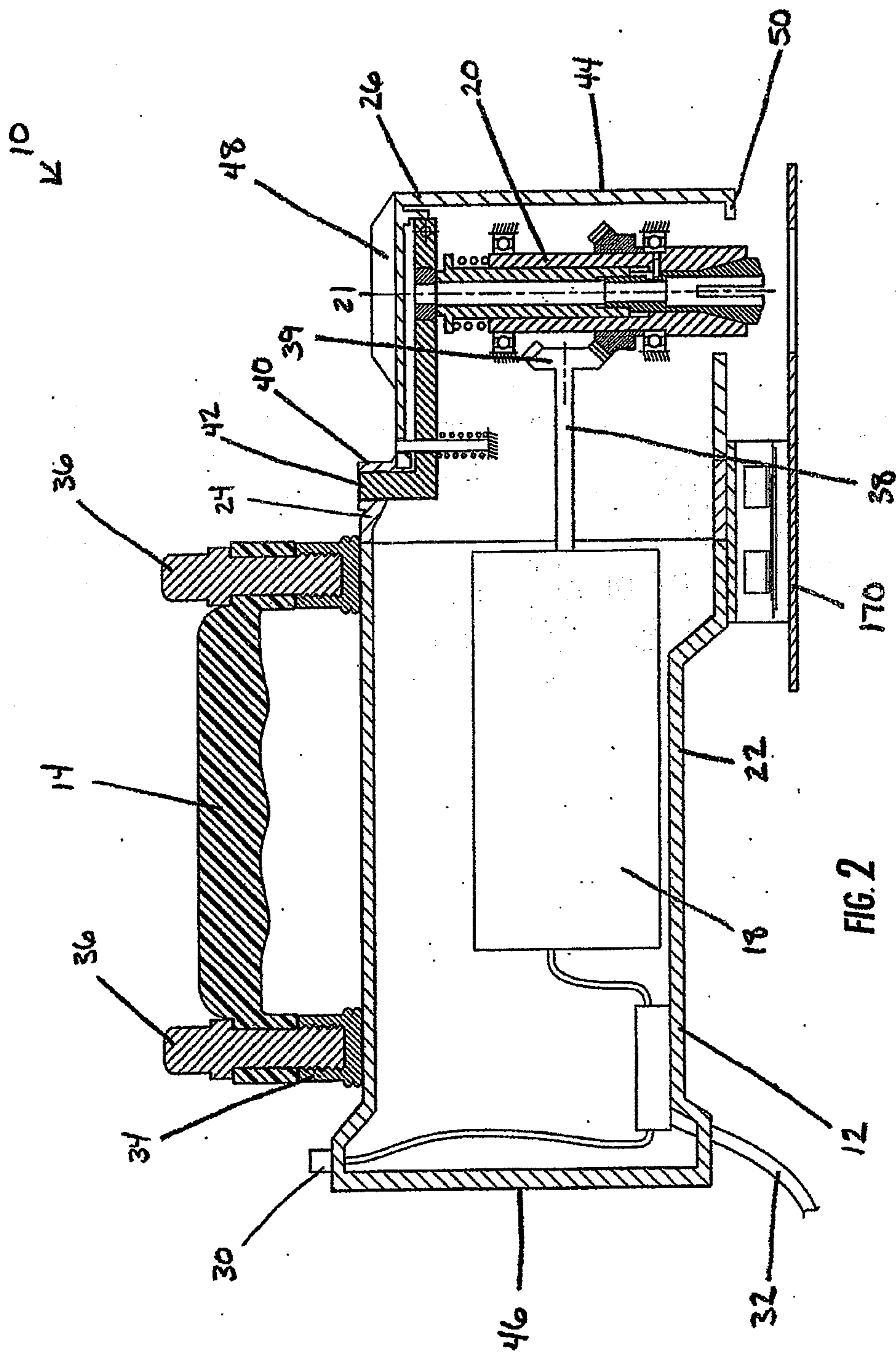
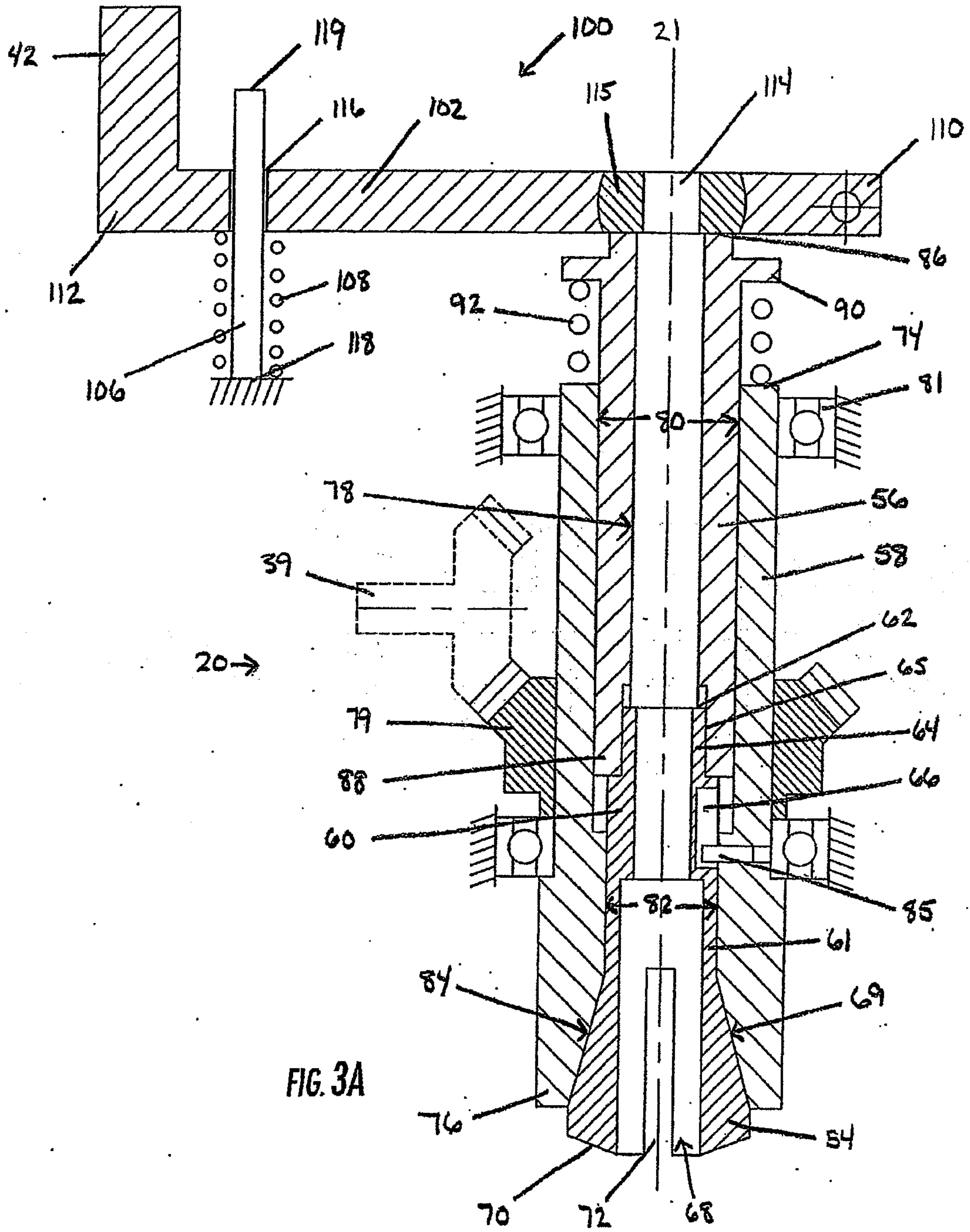


FIG. 1A

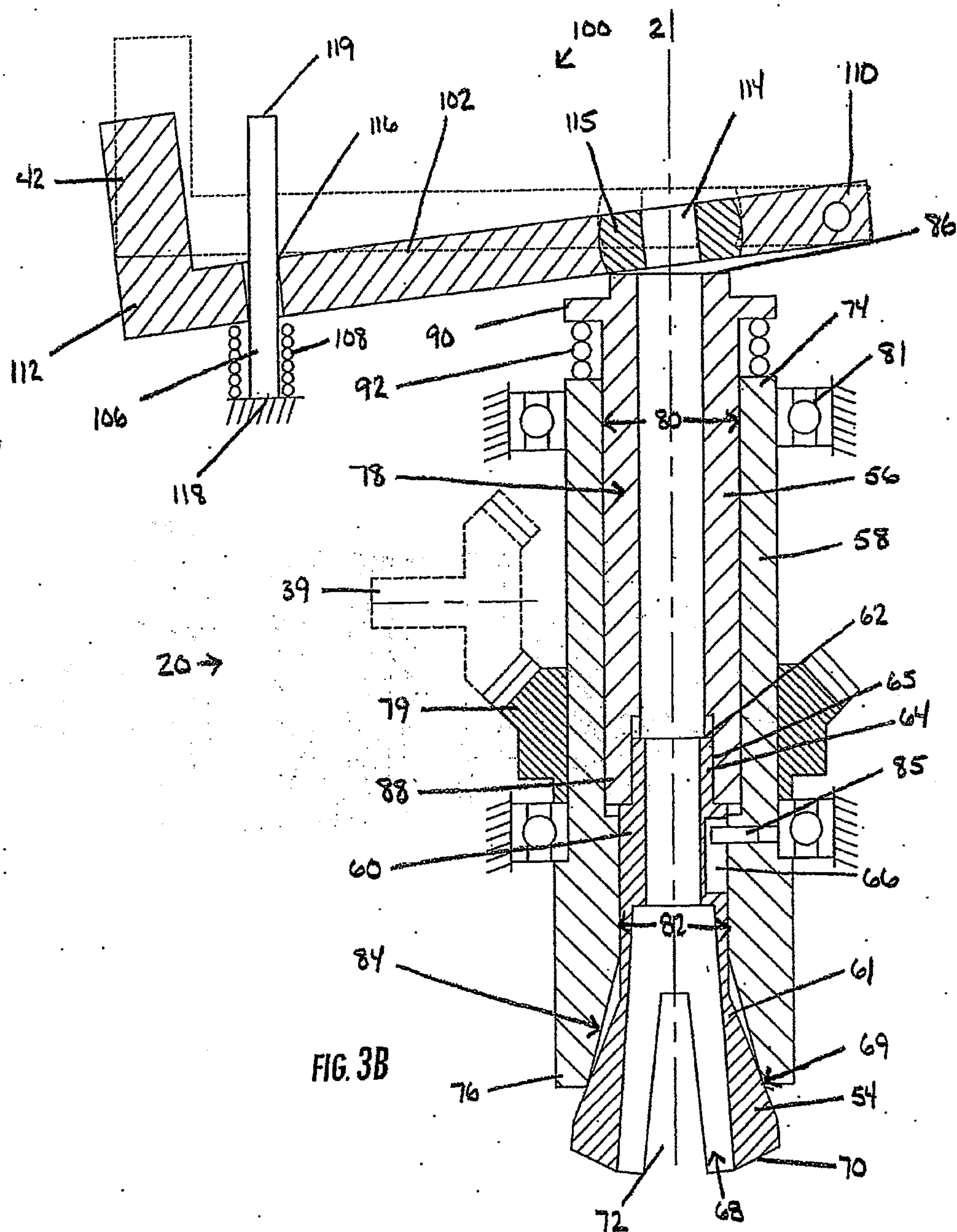
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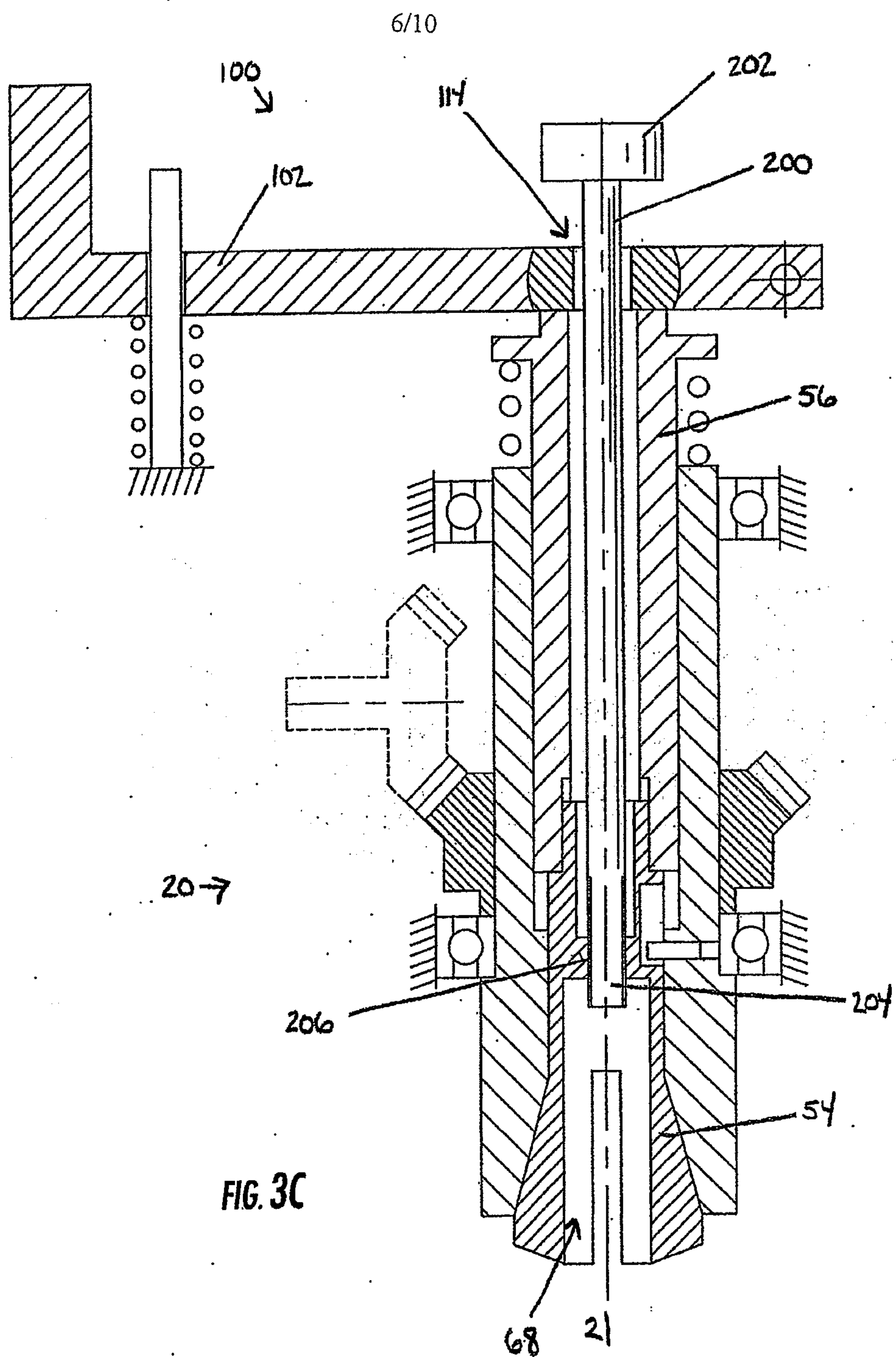


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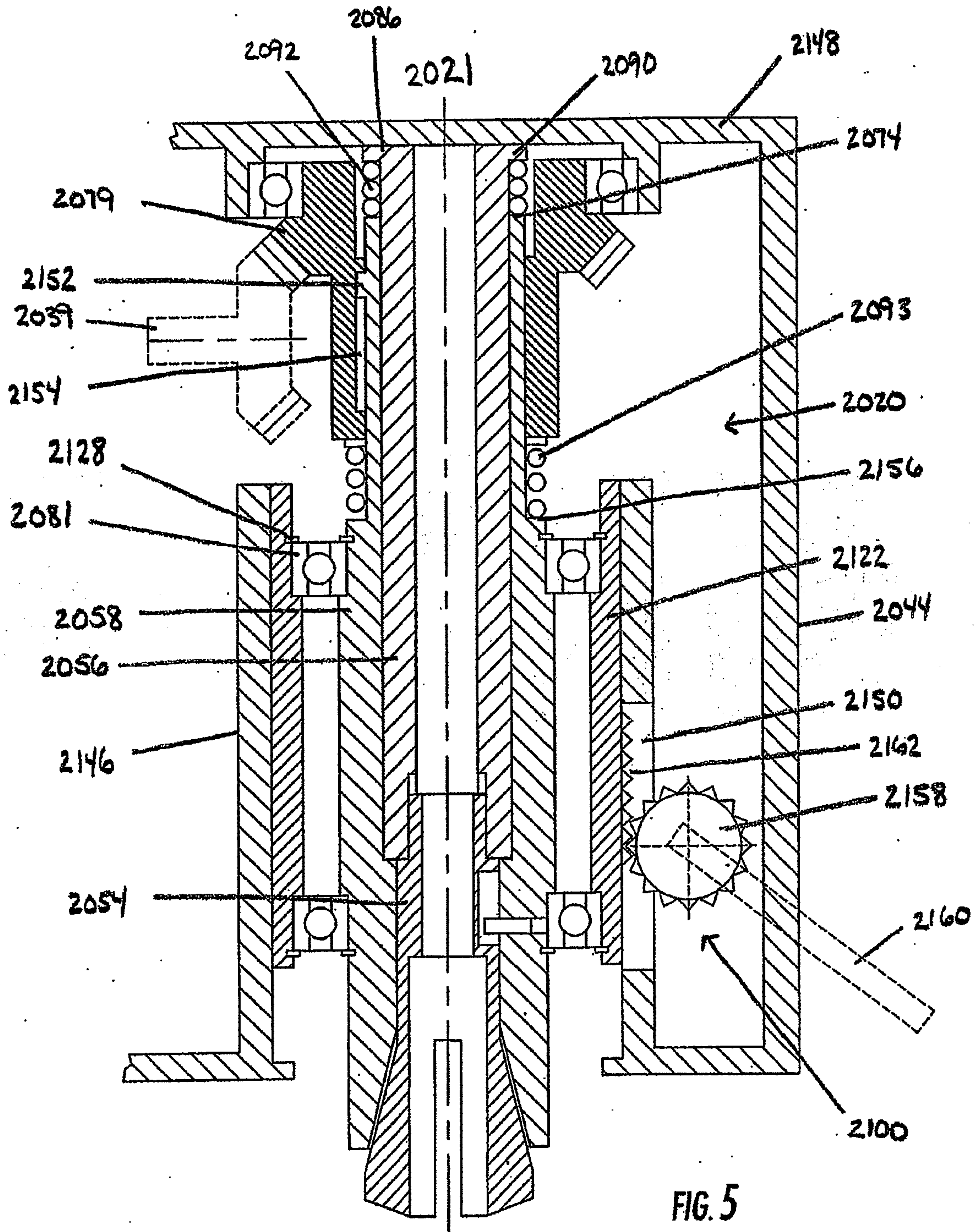


FIG. 5

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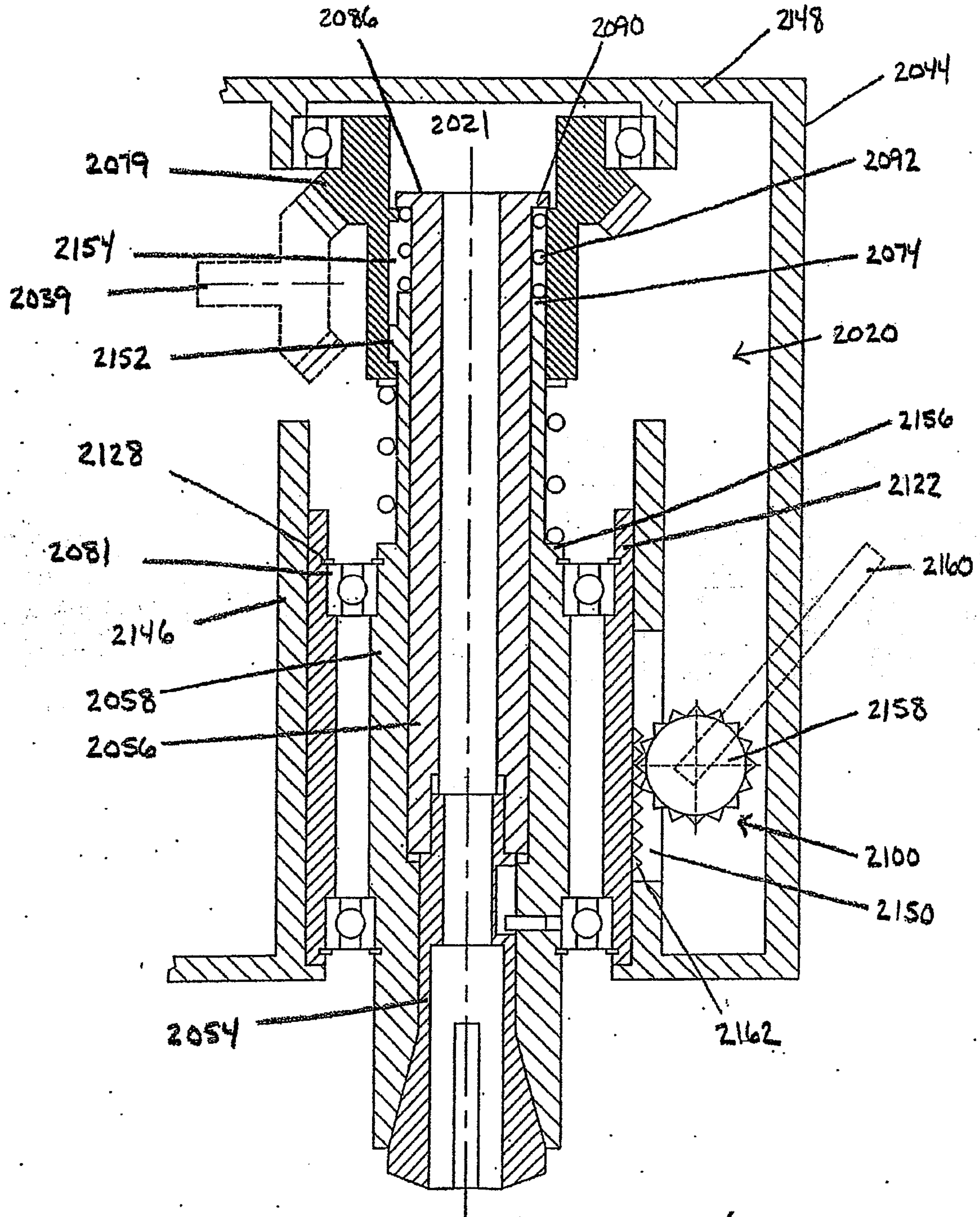


FIG. 6

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