(12) UK Patent (19) GB (11) 2564712 (13) B

(45) Date of B Publication 29.01.2020

(54) Title of the Invention: Power Tool

(51) INT CL: ***B25D 9/06*** (2006.01) ***B25D 9/14*** (2006.01) ***B25D 11/06*** (2006.01) ***E02F 3/96*** (2006.01) ***E02F 5/30*** (2006.01)

(21) Application No: **1711765.6**

(22) Date of Filing: **21.07.2017**

(43) Date of A Publication **23.01.2019**

(56) Documents Cited:
CA 002303648 A1
KR 101575059 B1
US 20160201353 A1
US 20130048326 A1
US 20100252289 A1

(58) Field of Search:
As for published application 2564712 A viz:
INT CL **B25D, E02D, E02F, E21C**
Other: **EPODOC & WPI**
updated as appropriate

Additional Fields
Other: **None**

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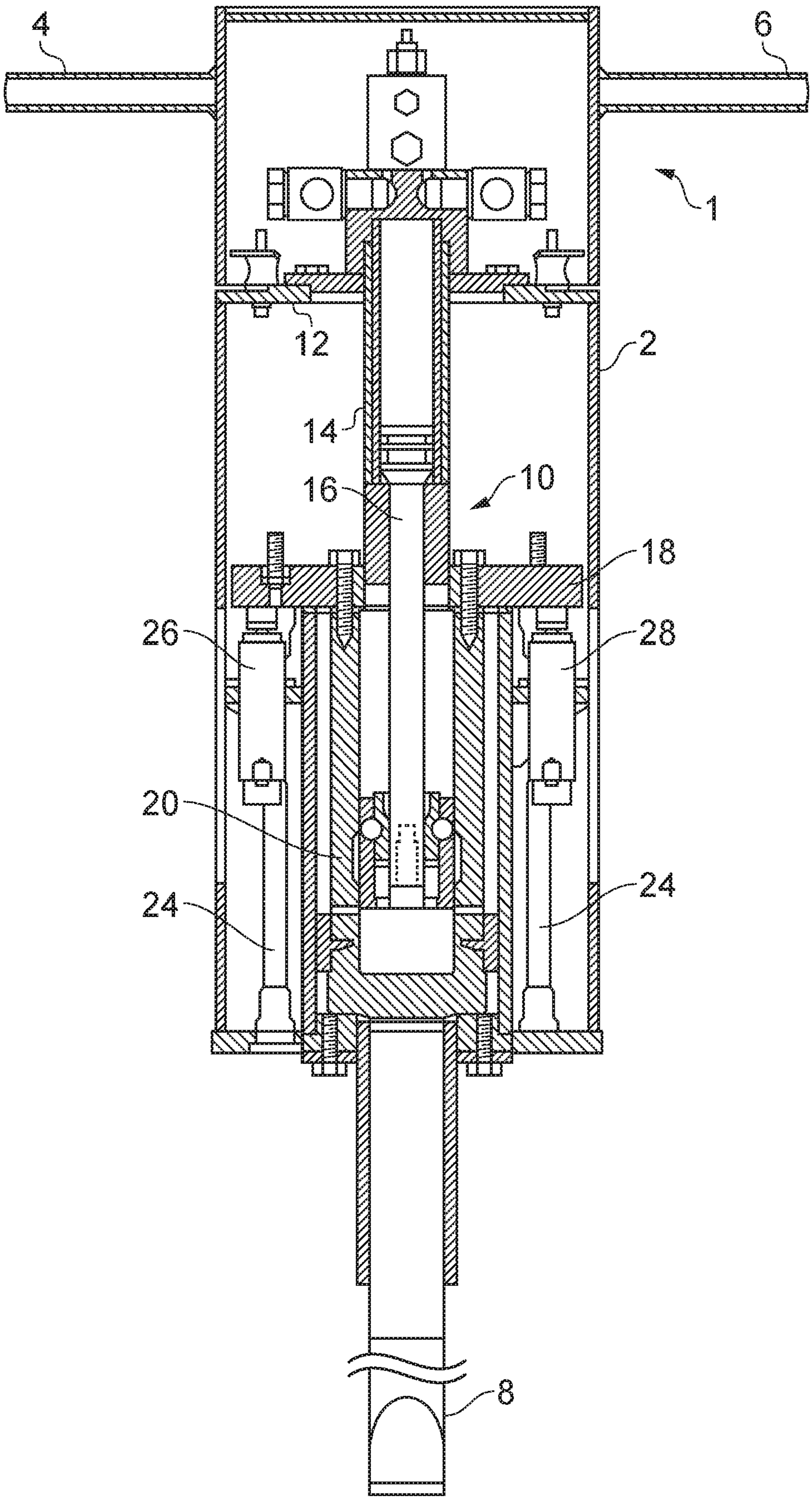

FIG. 1

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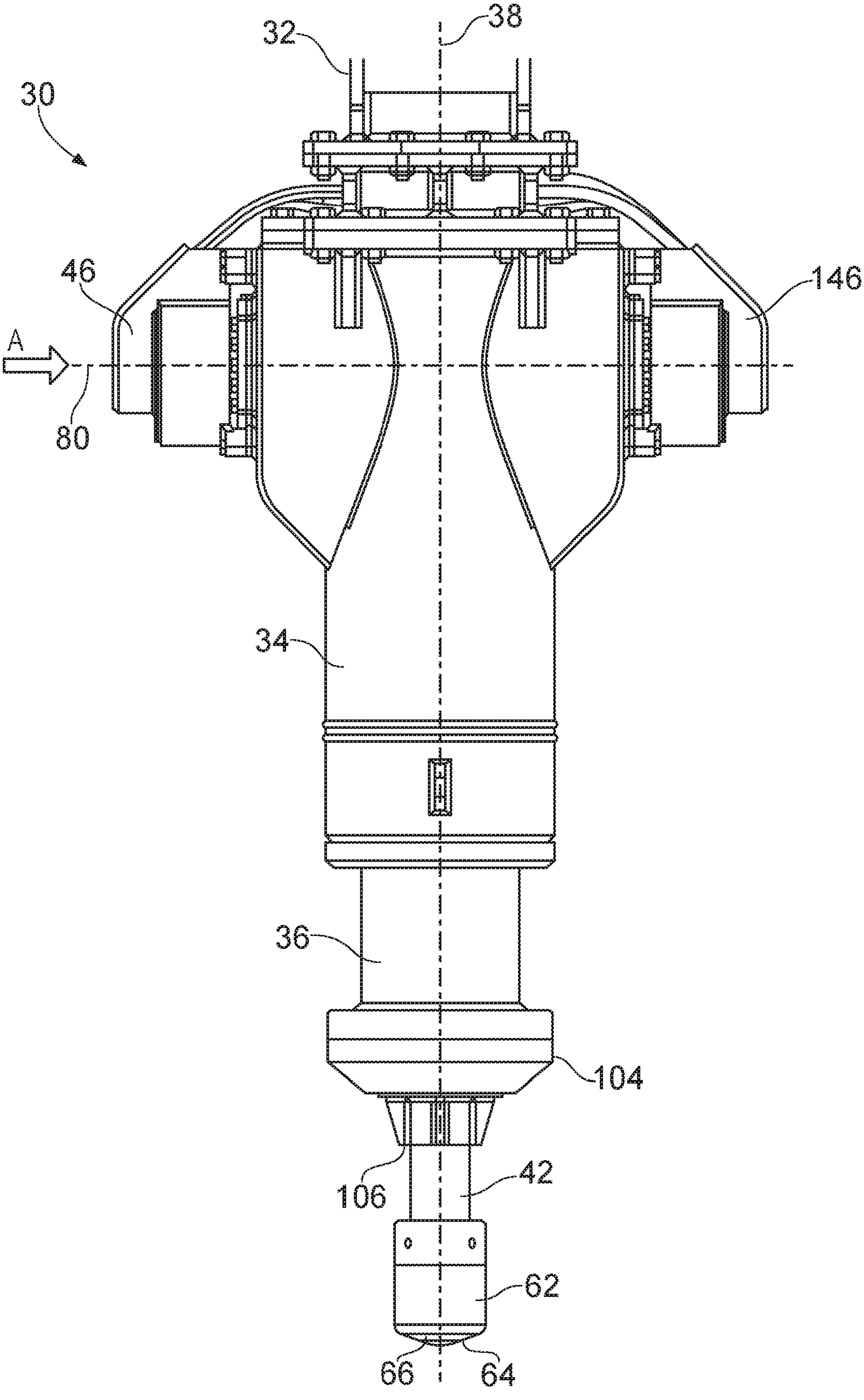

FIG. 2

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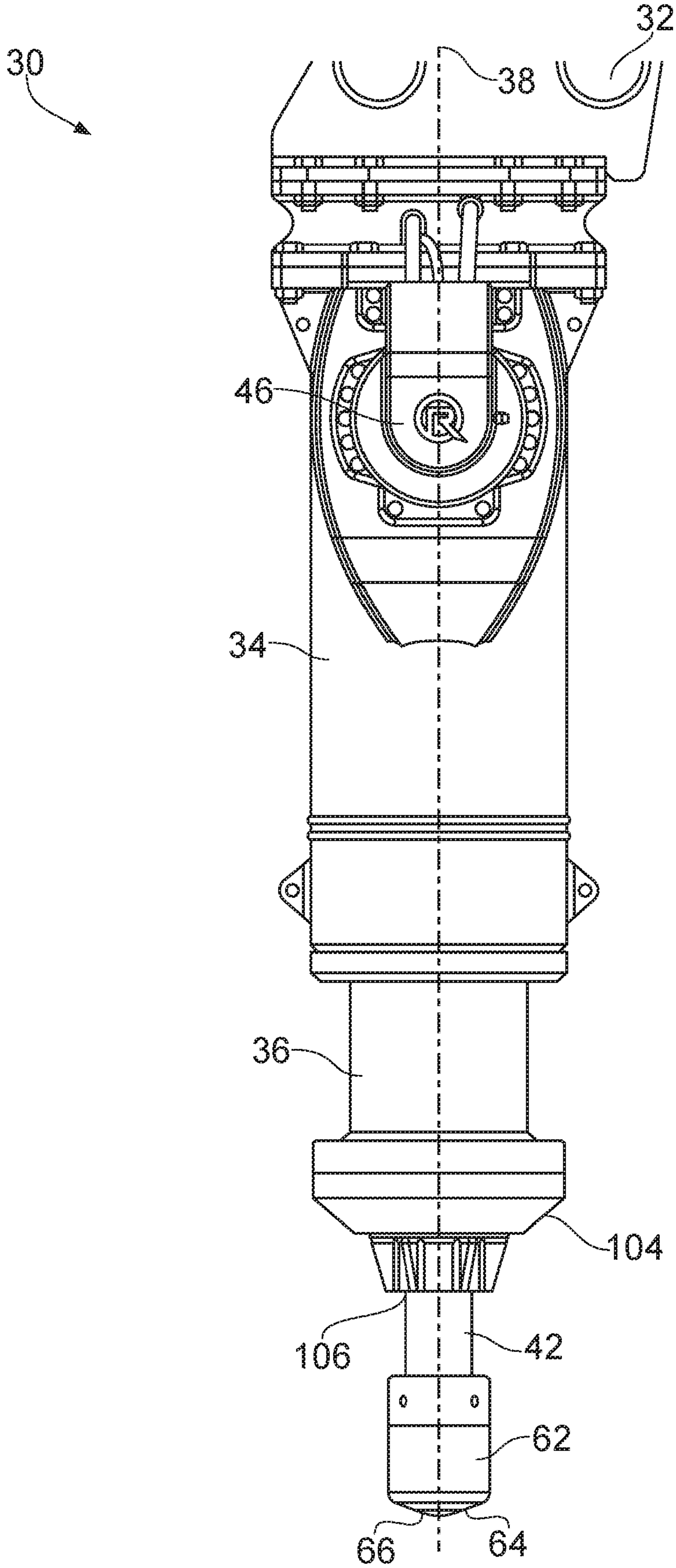

FIG. 3

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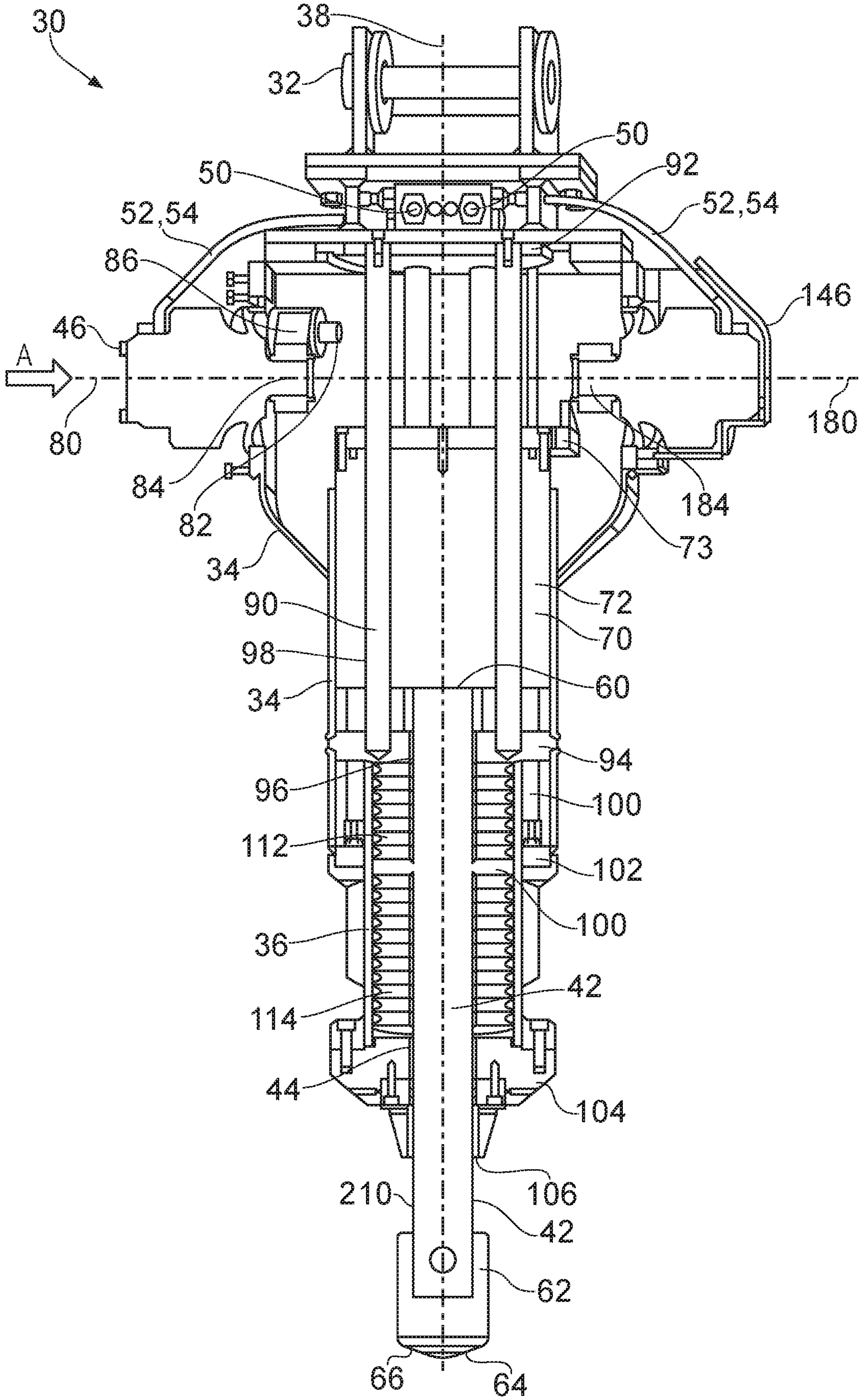
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FIG. 4

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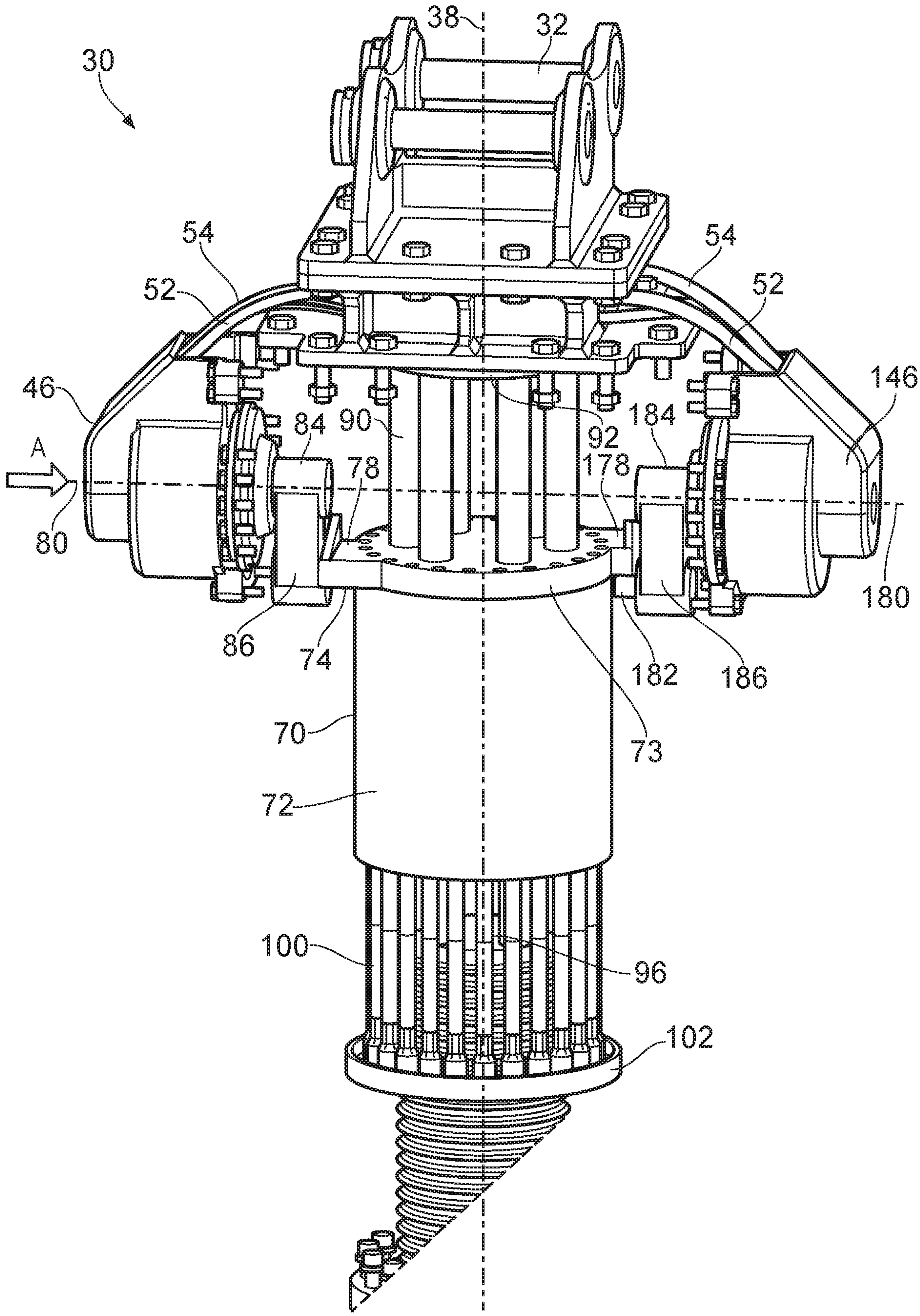
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FIG. 5

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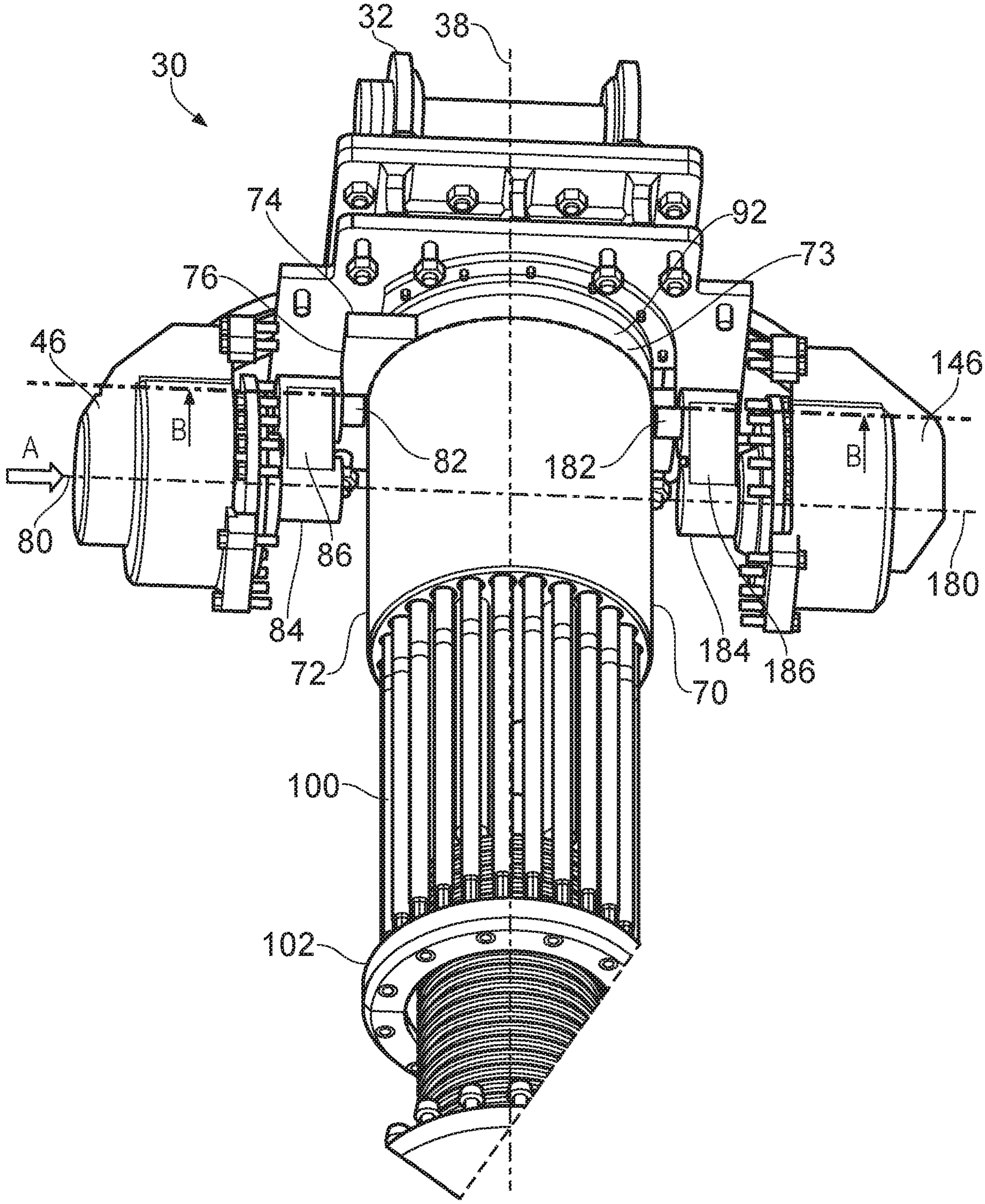
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FIG. 6

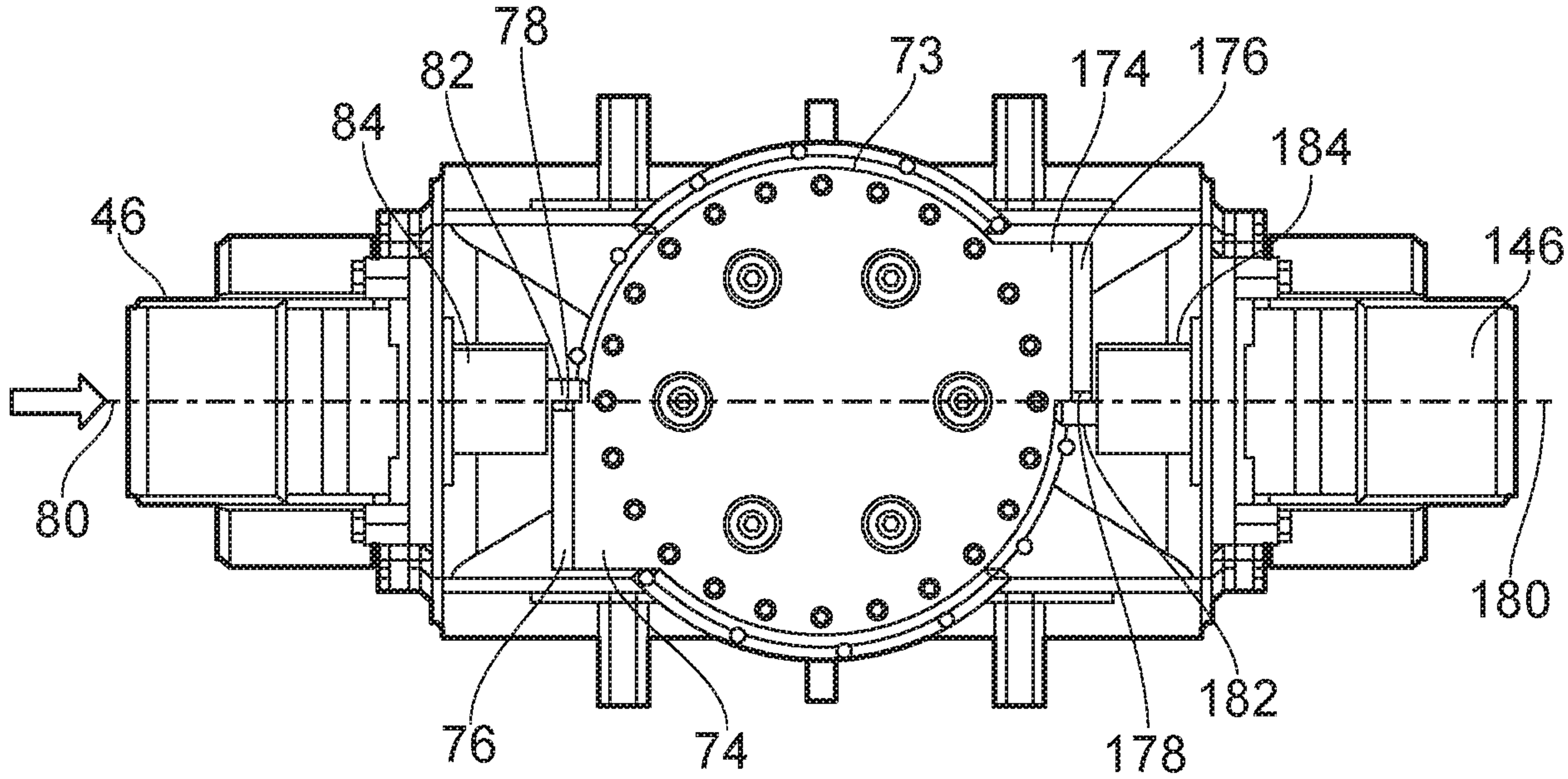

FIG. 7

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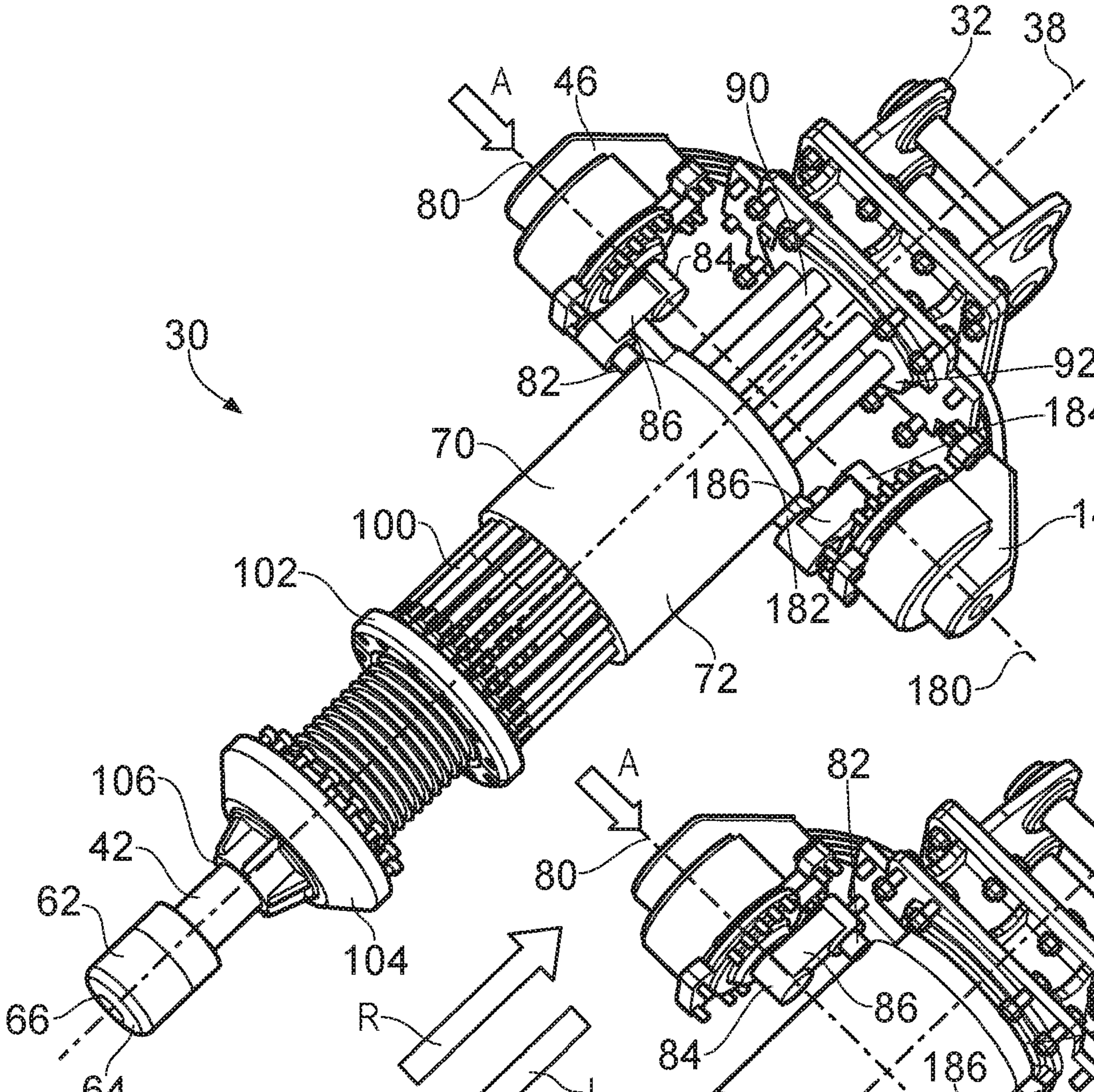
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FIG. 8

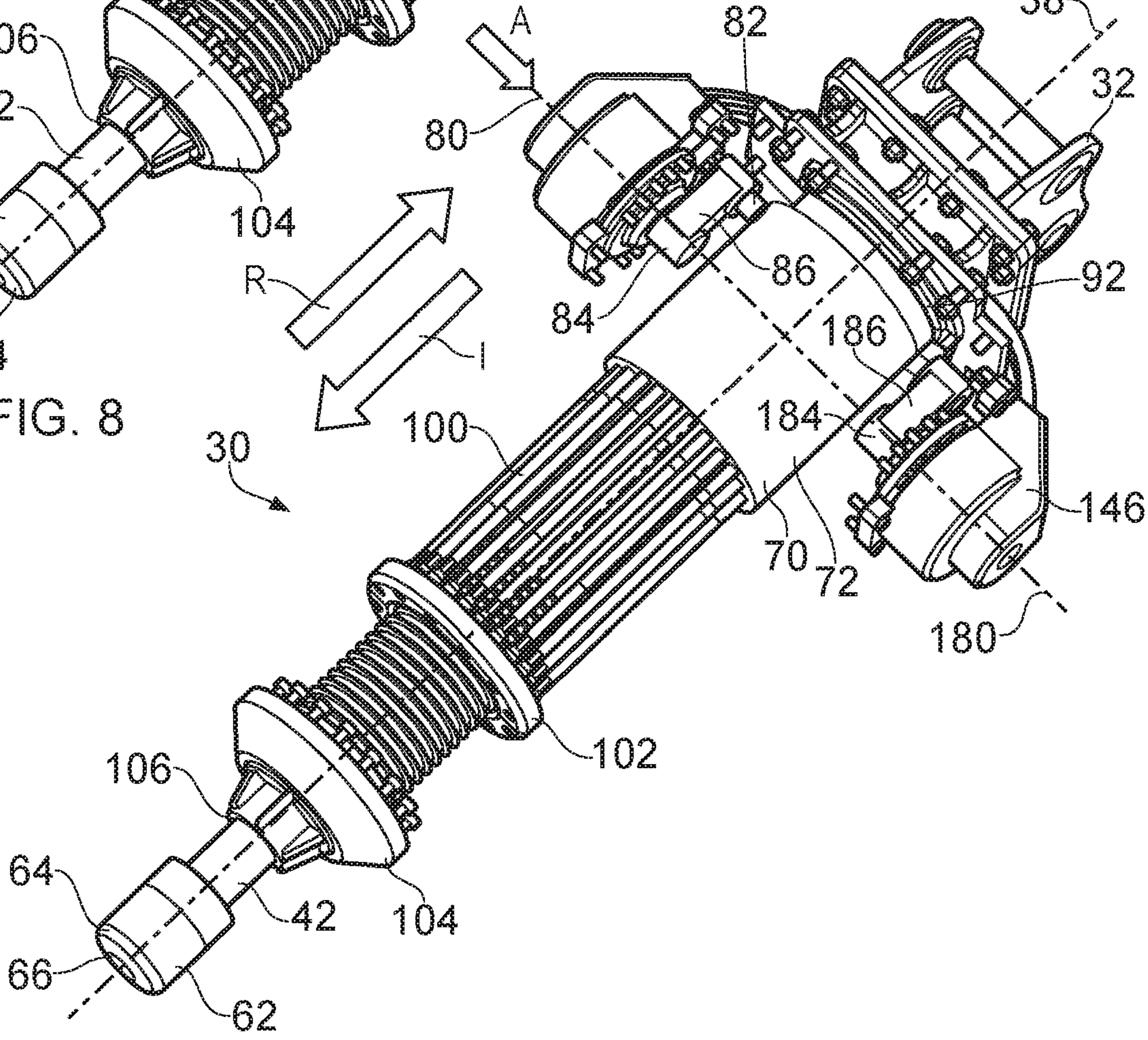
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FIG. 9

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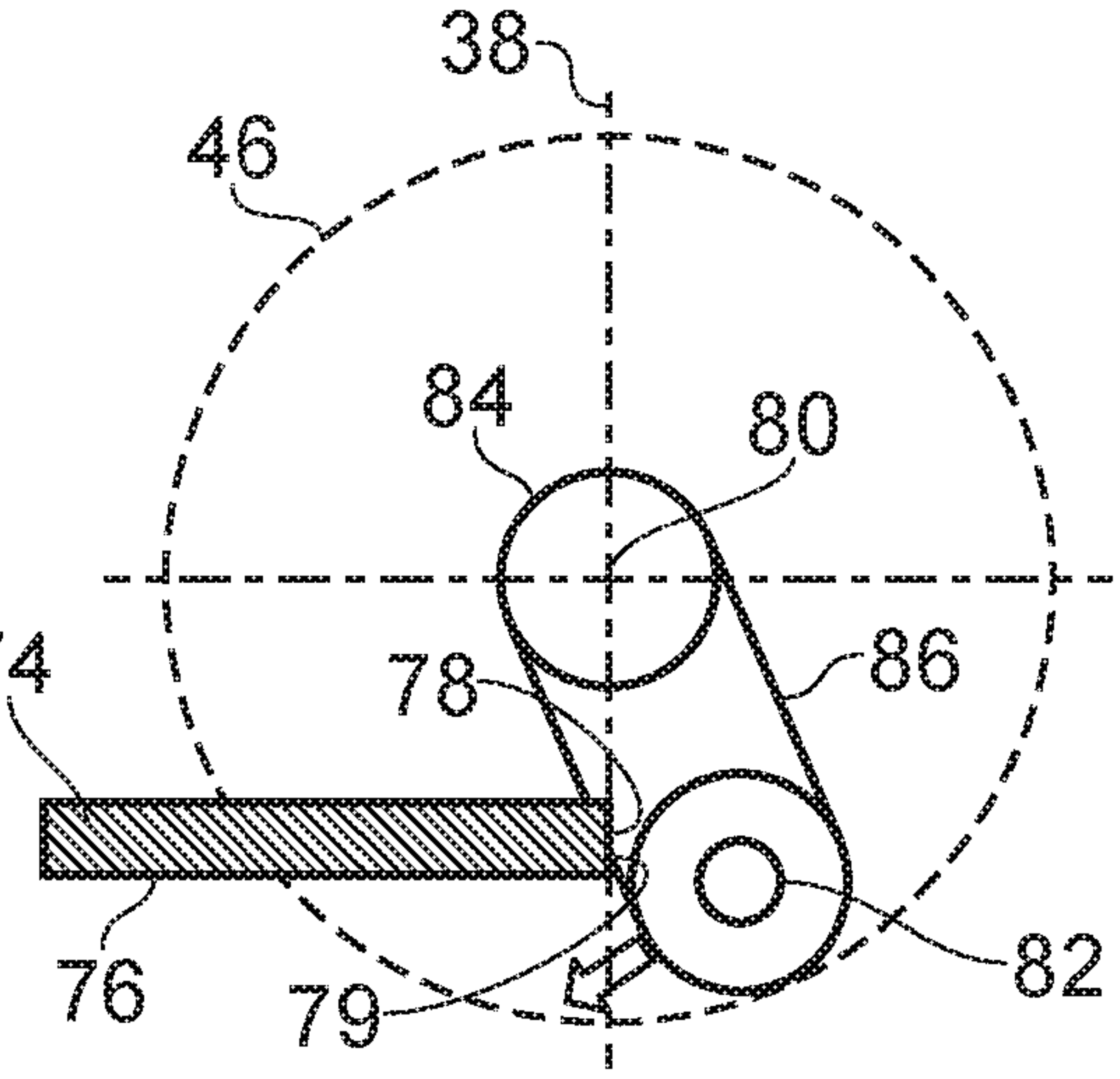

FIG. 10a

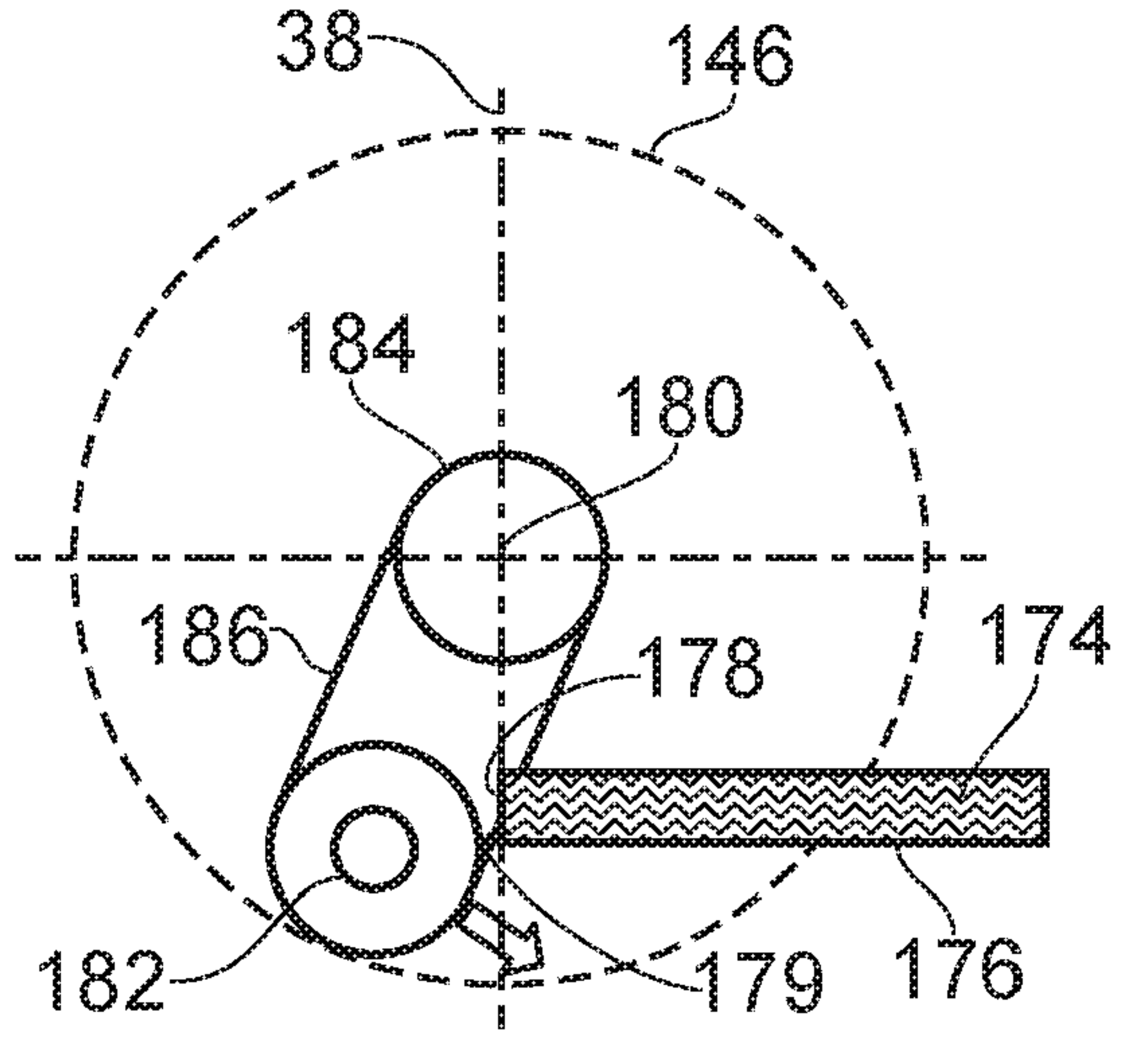

FIG. 10b

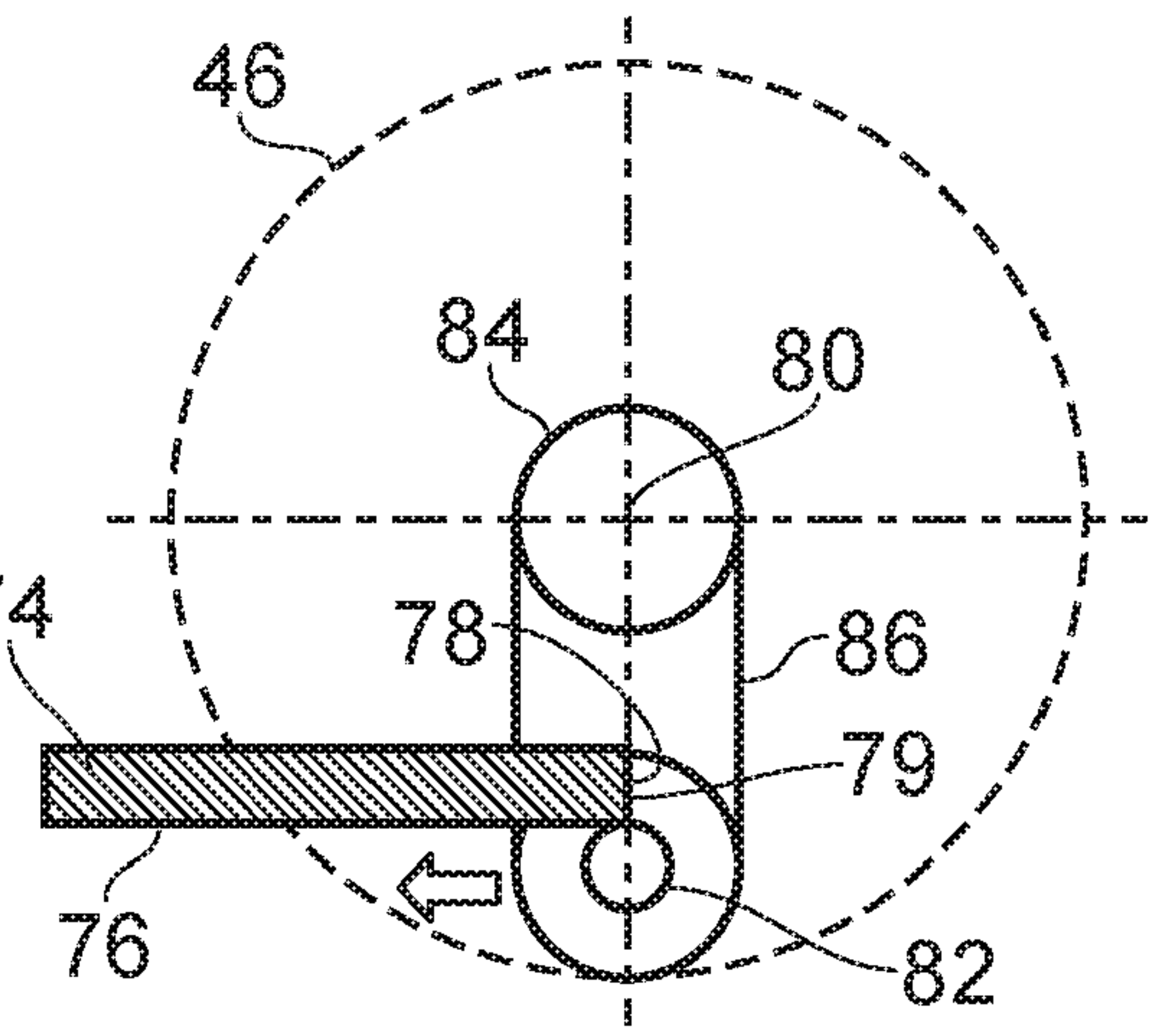

FIG. 11a

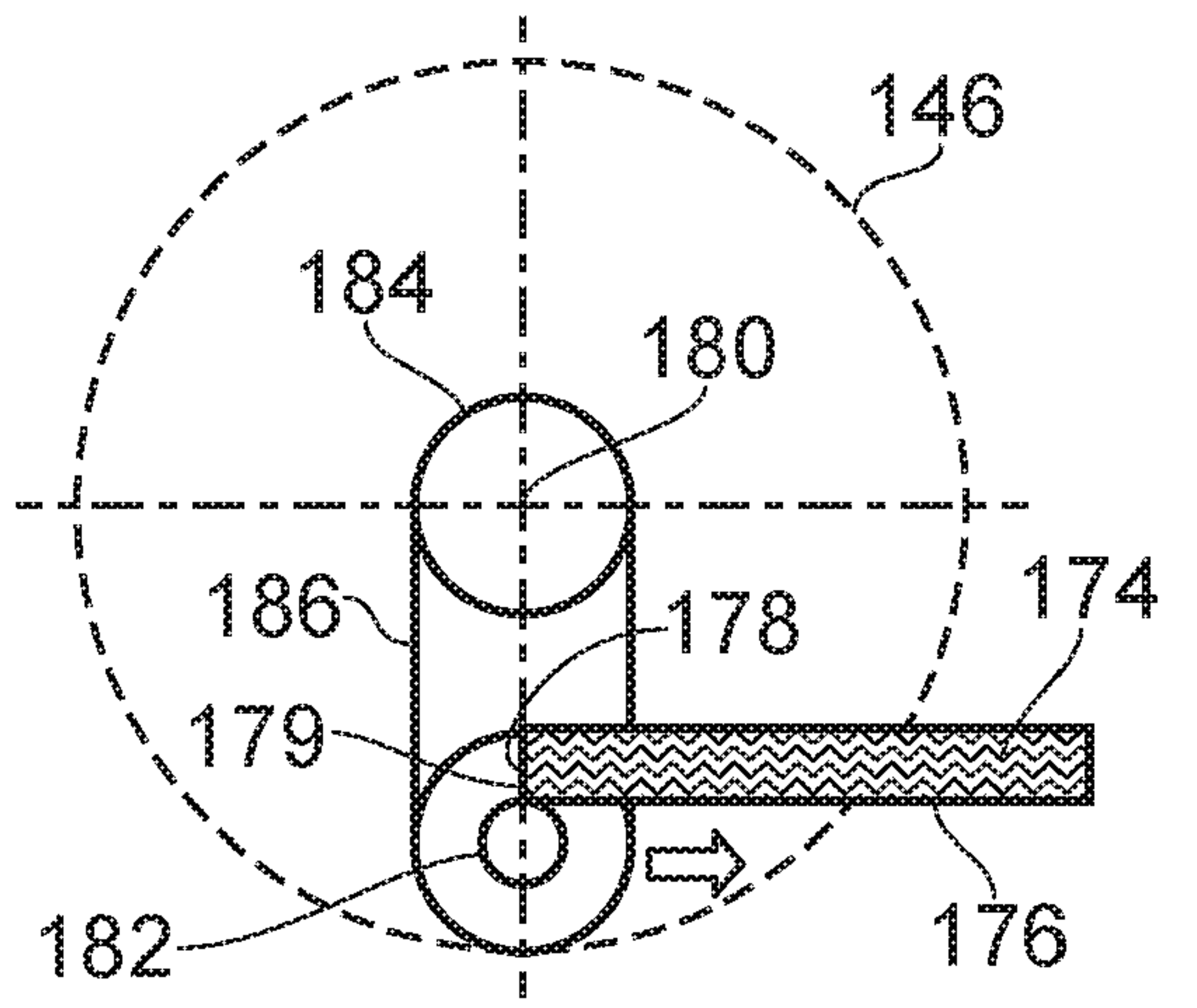

FIG. 11b

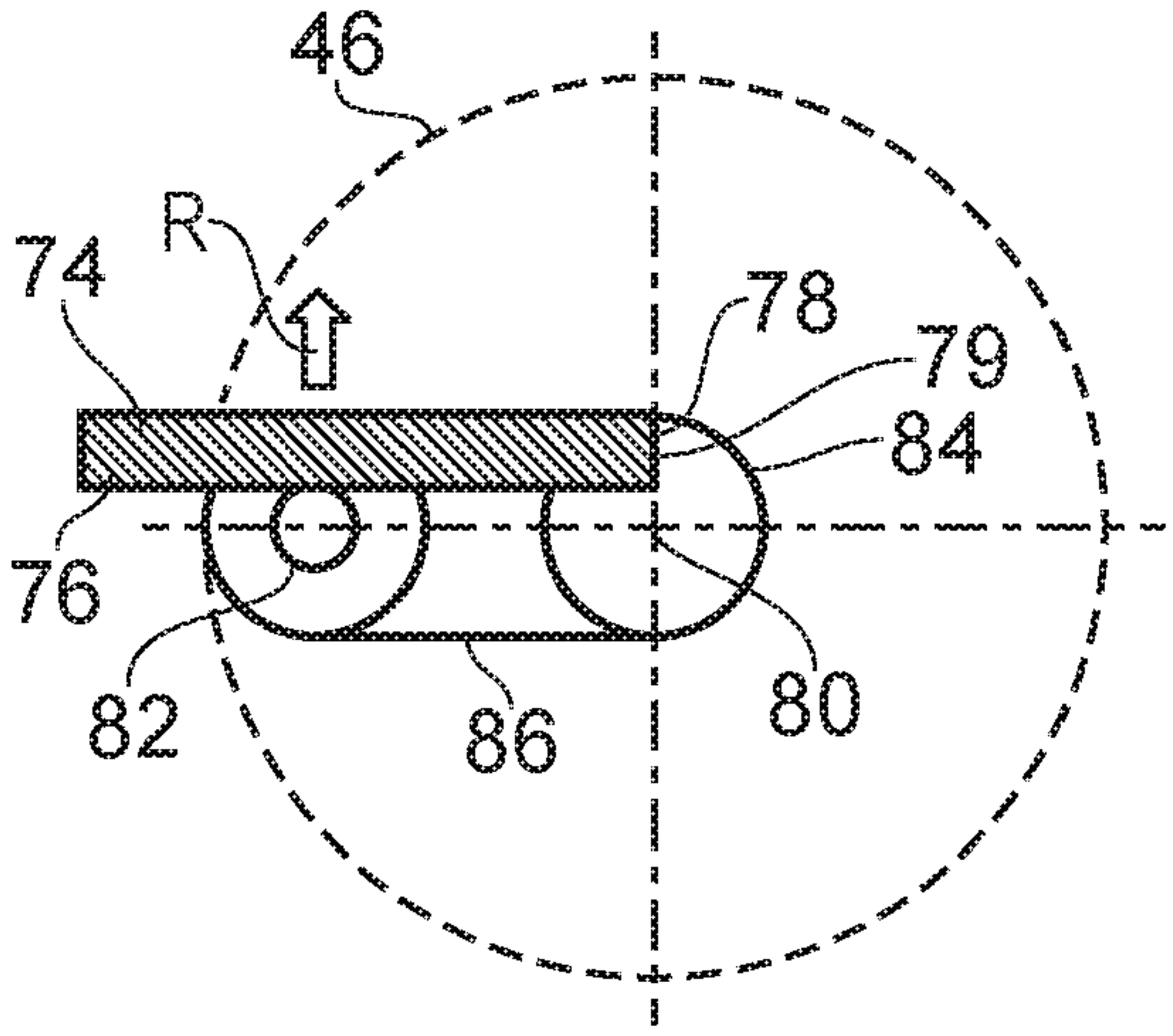

FIG. 12a

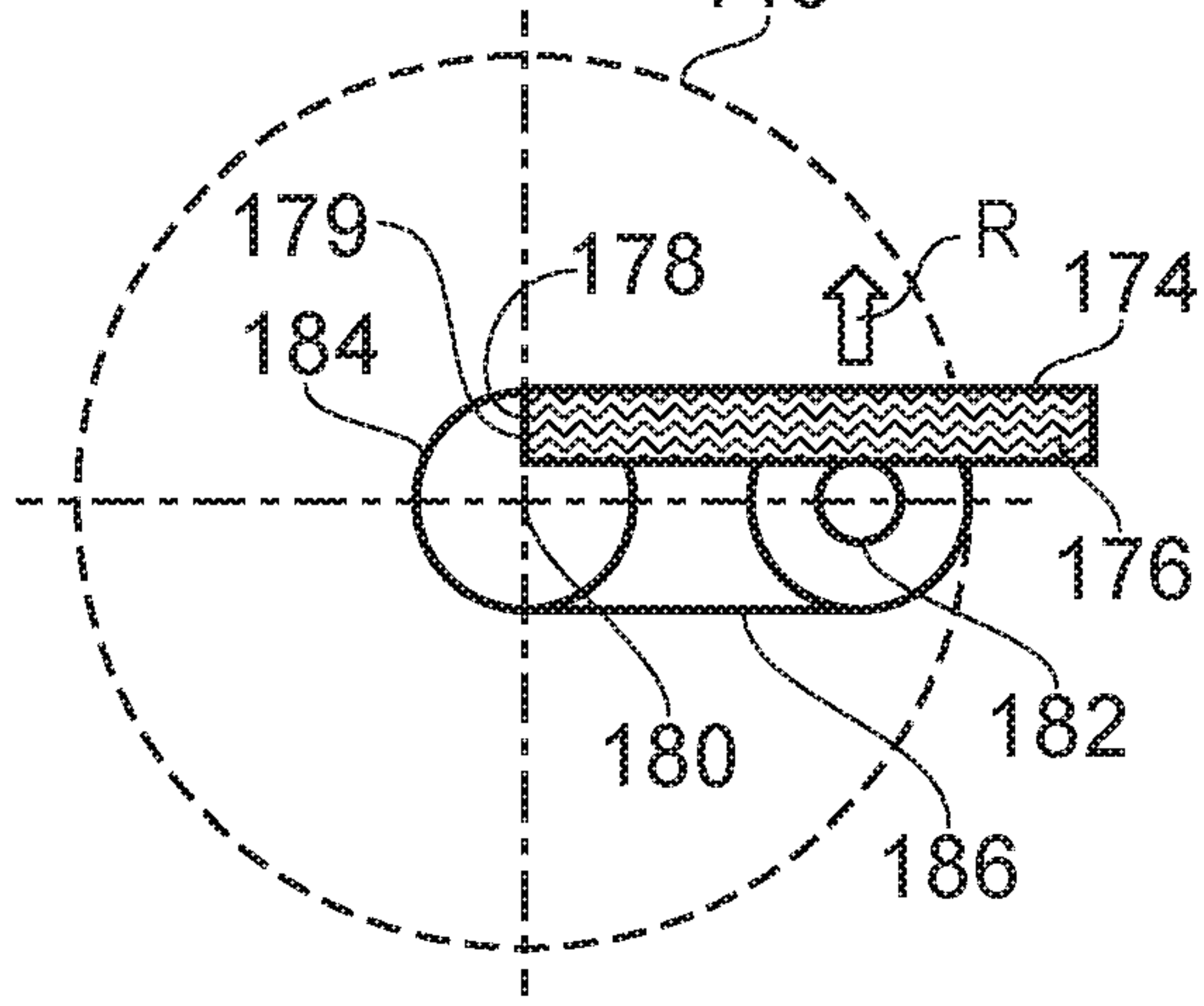

FIG. 12b

19 07 18

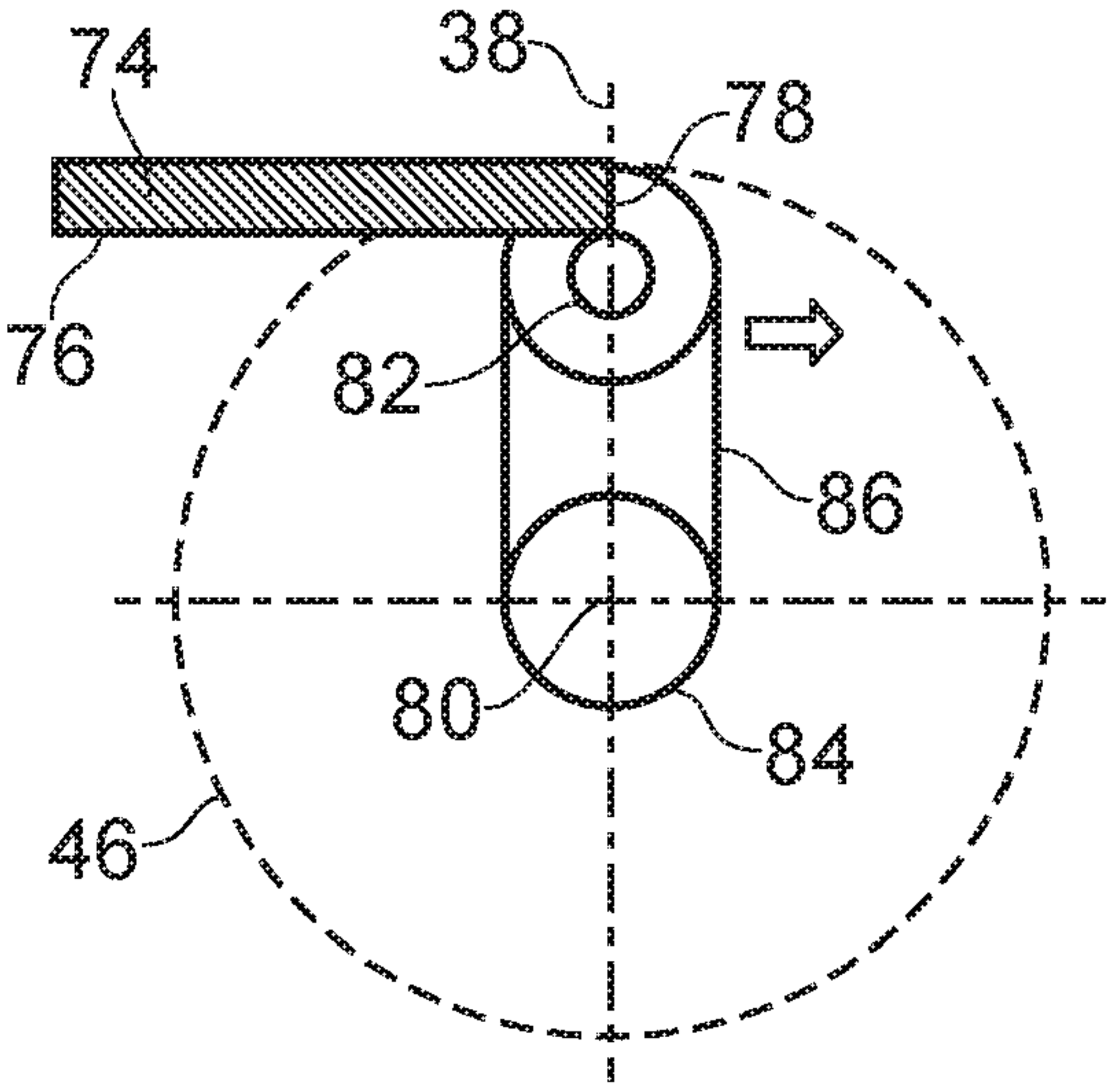

FIG. 13a

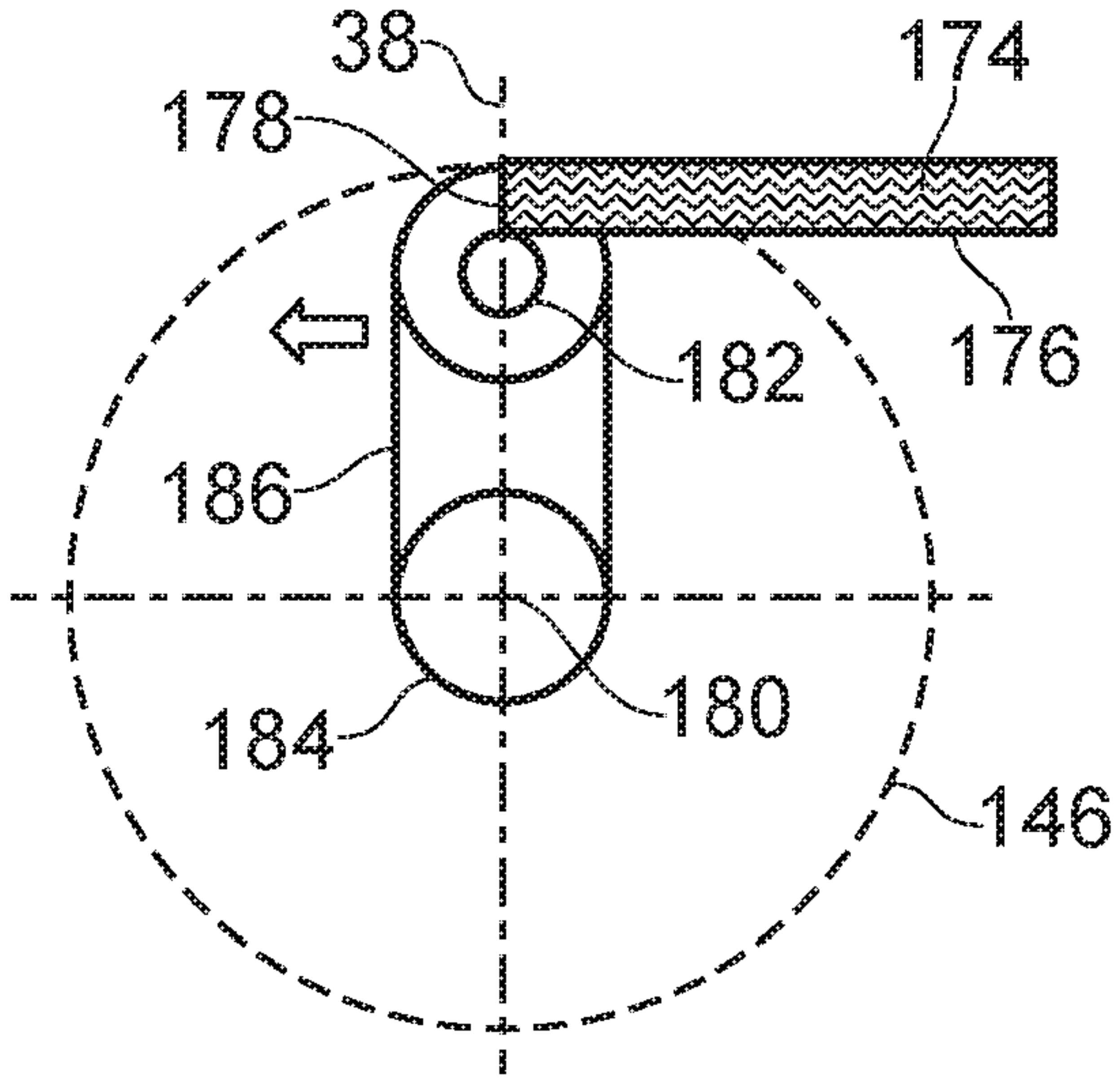

FIG. 13b

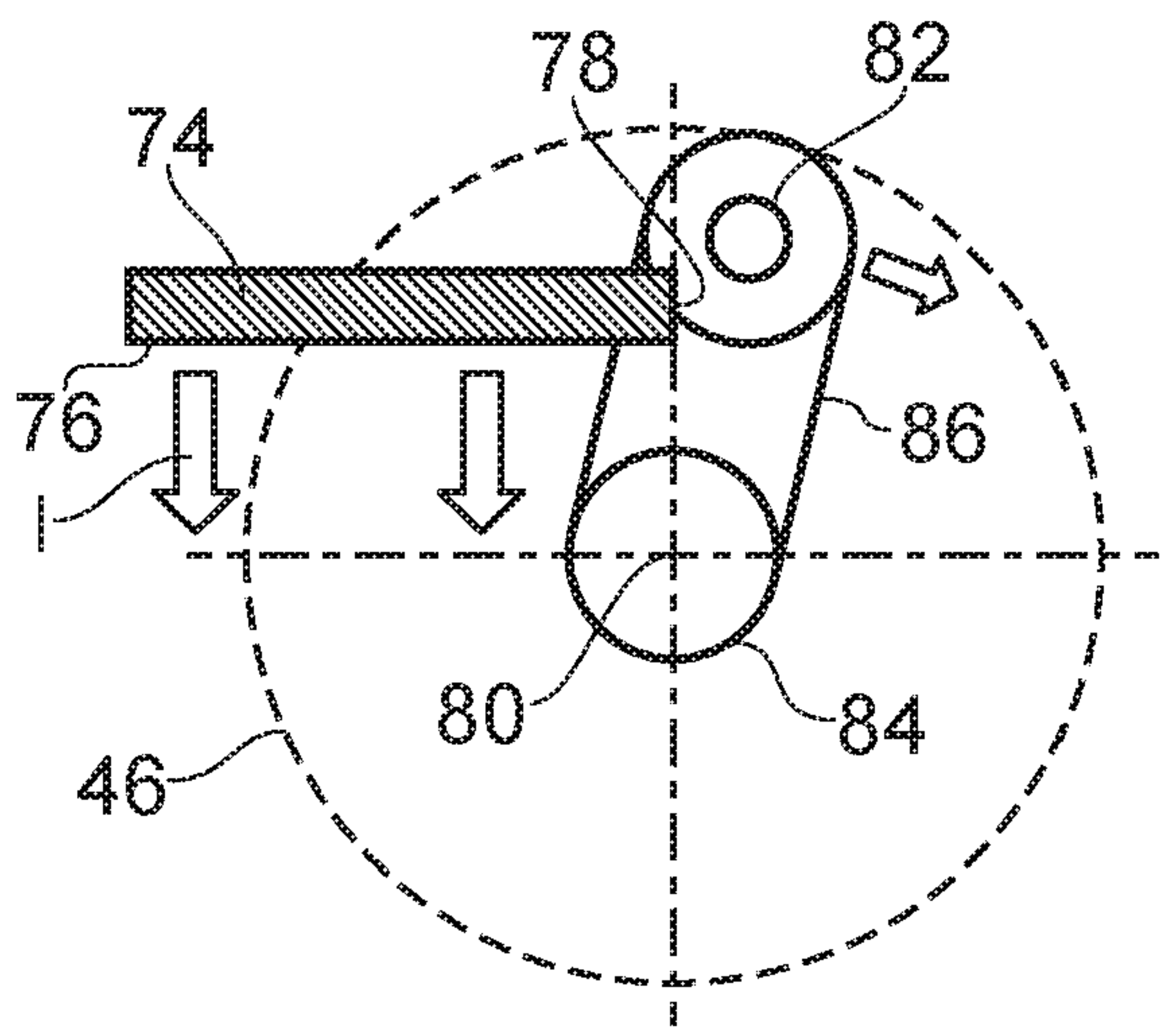

FIG. 14a

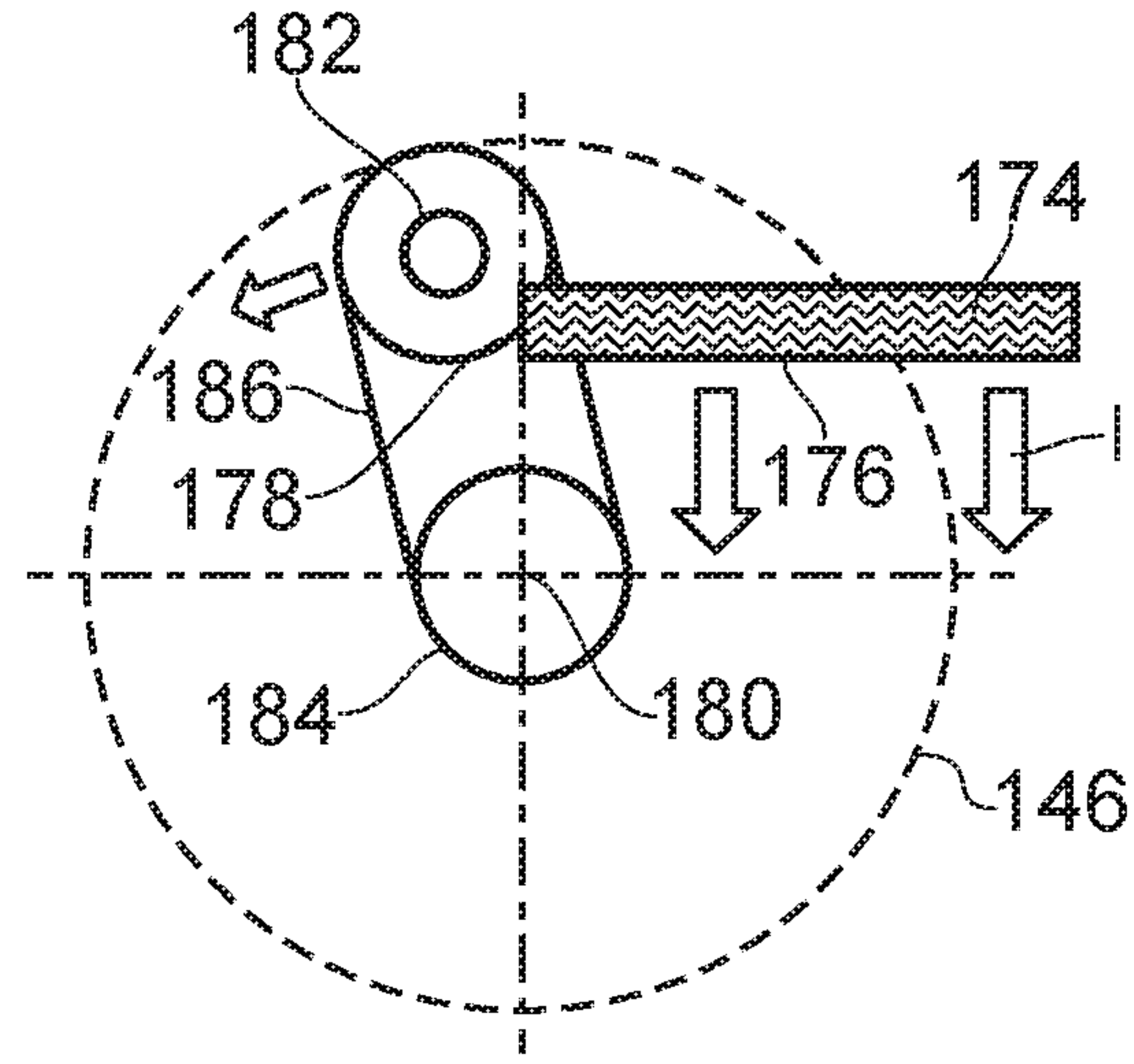

FIG. 14b

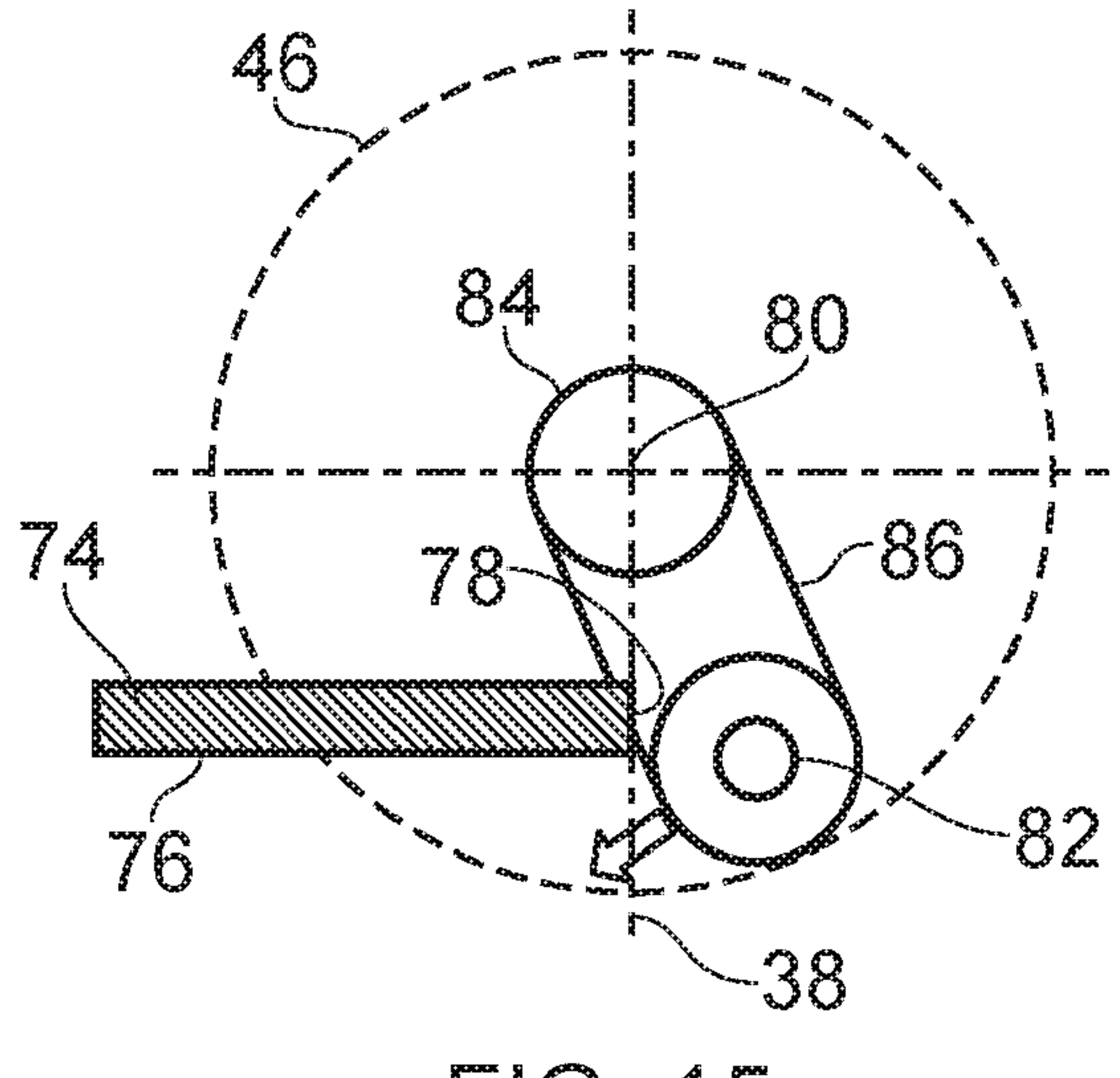

FIG. 15a

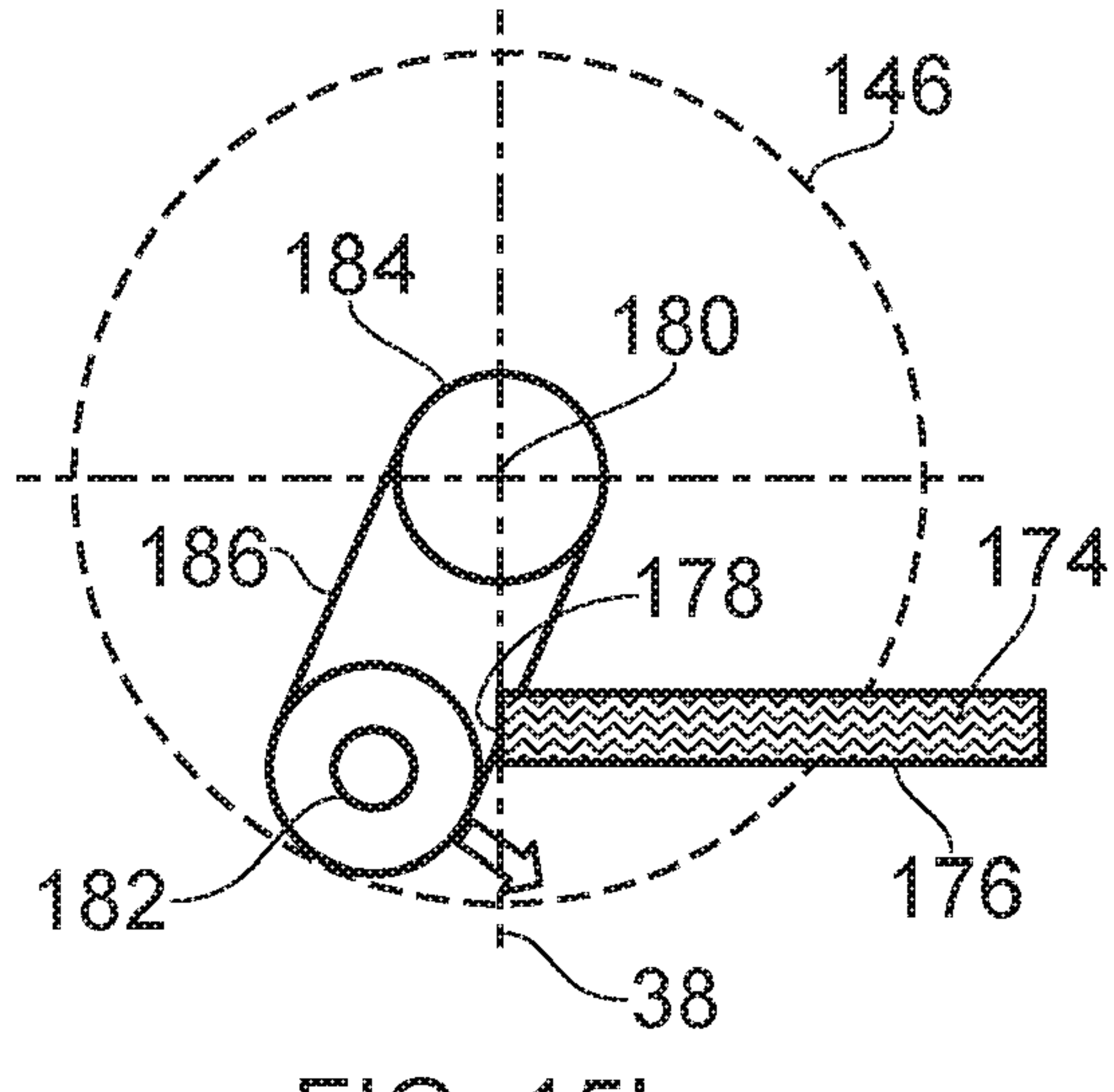

FIG. 15b

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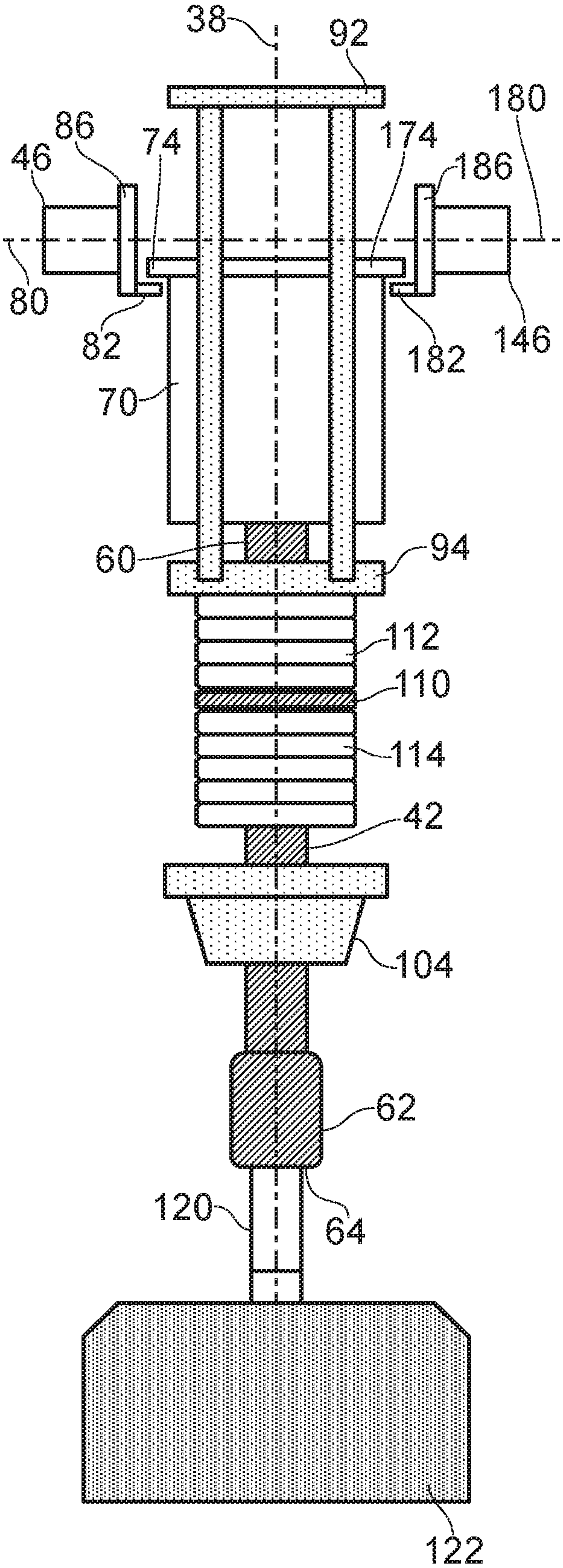

FIG. 16

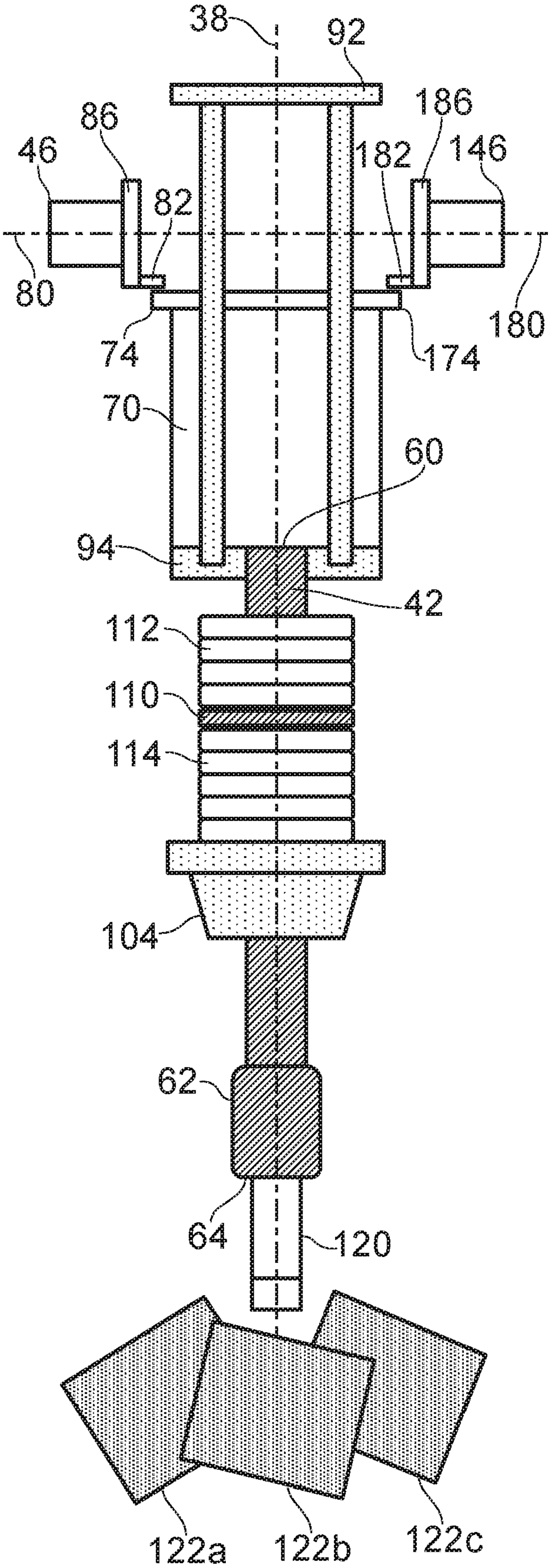

FIG. 17

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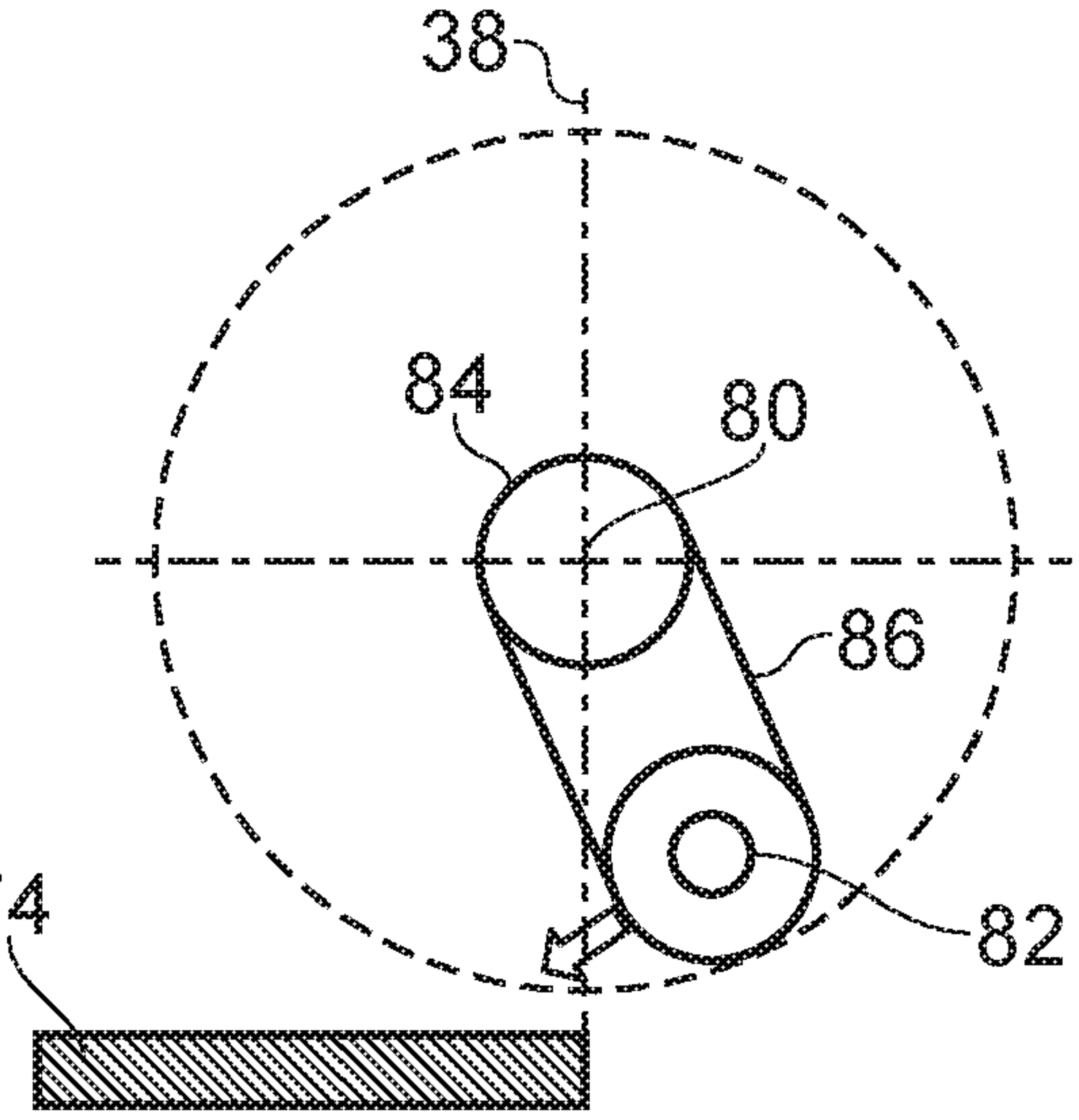

FIG. 18a

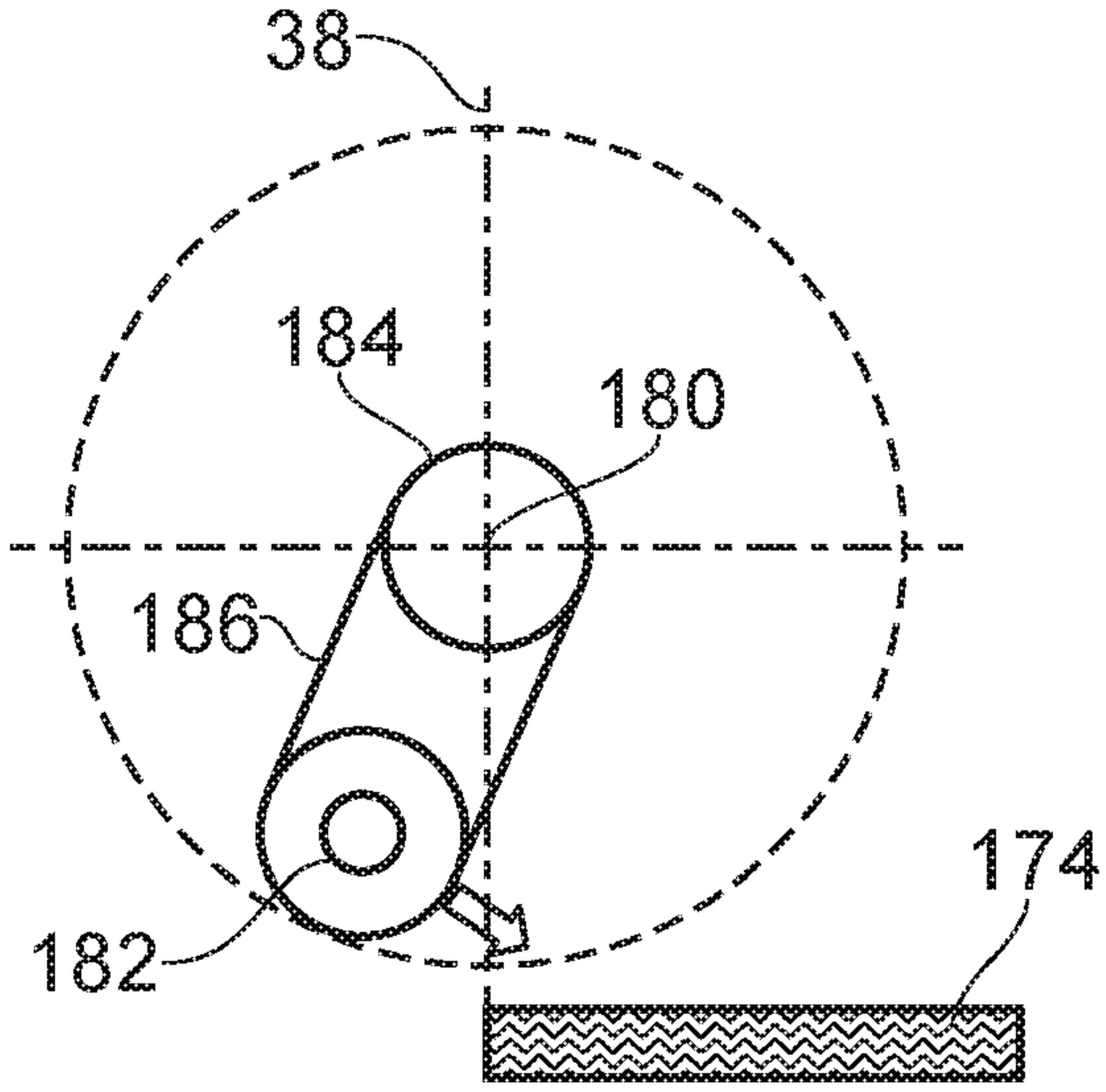

FIG. 18b

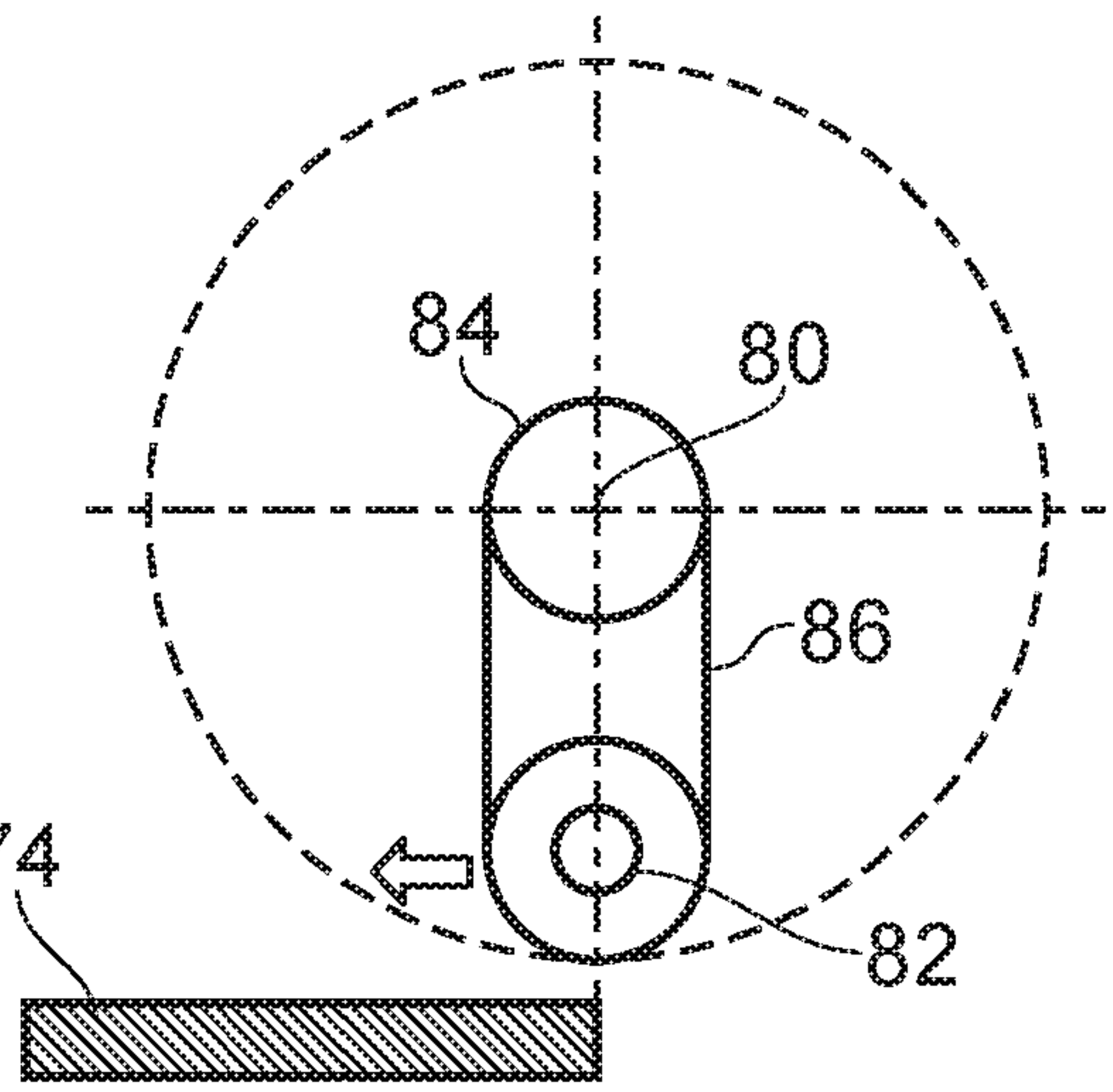

FIG. 19a

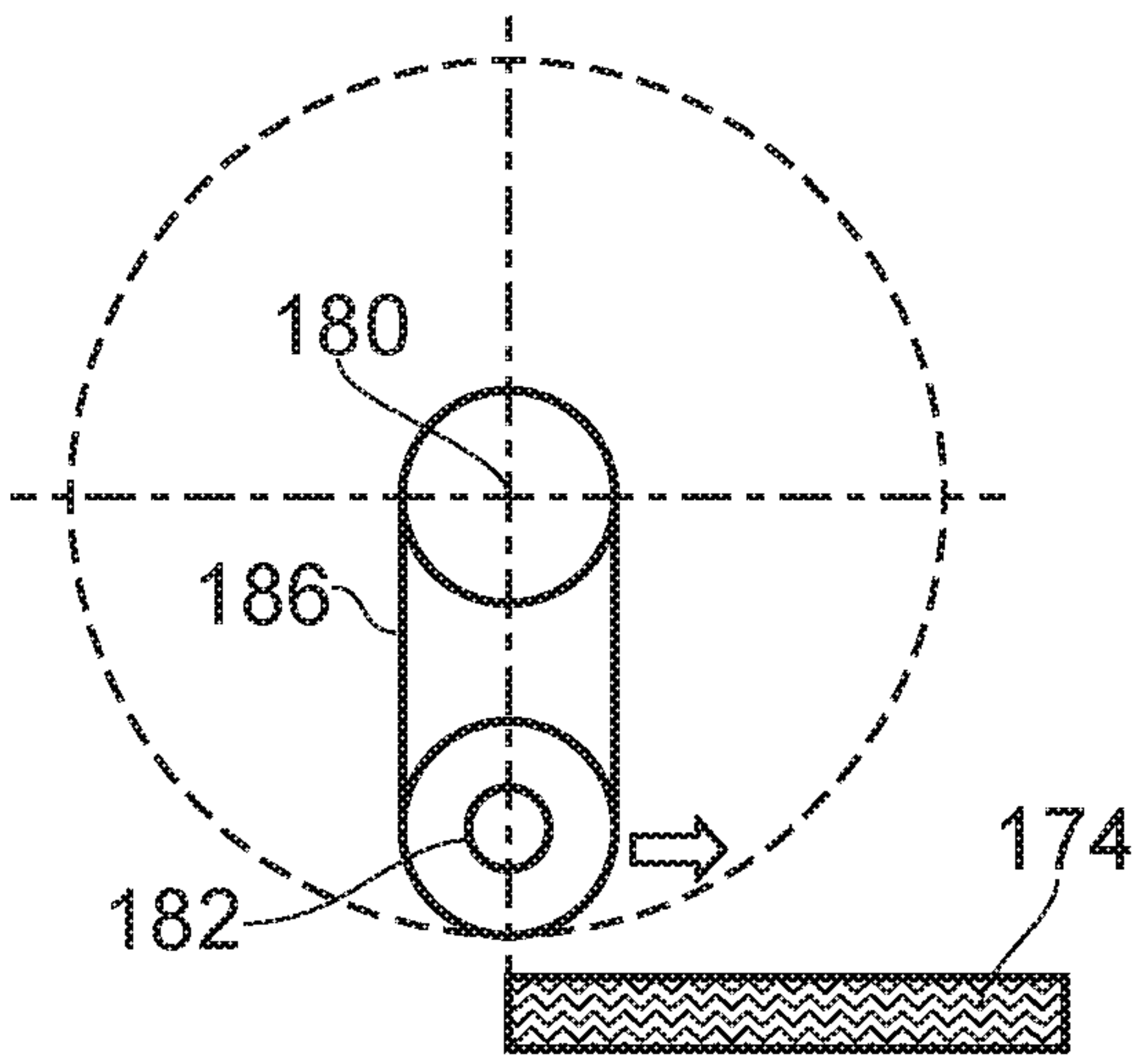

FIG. 19b

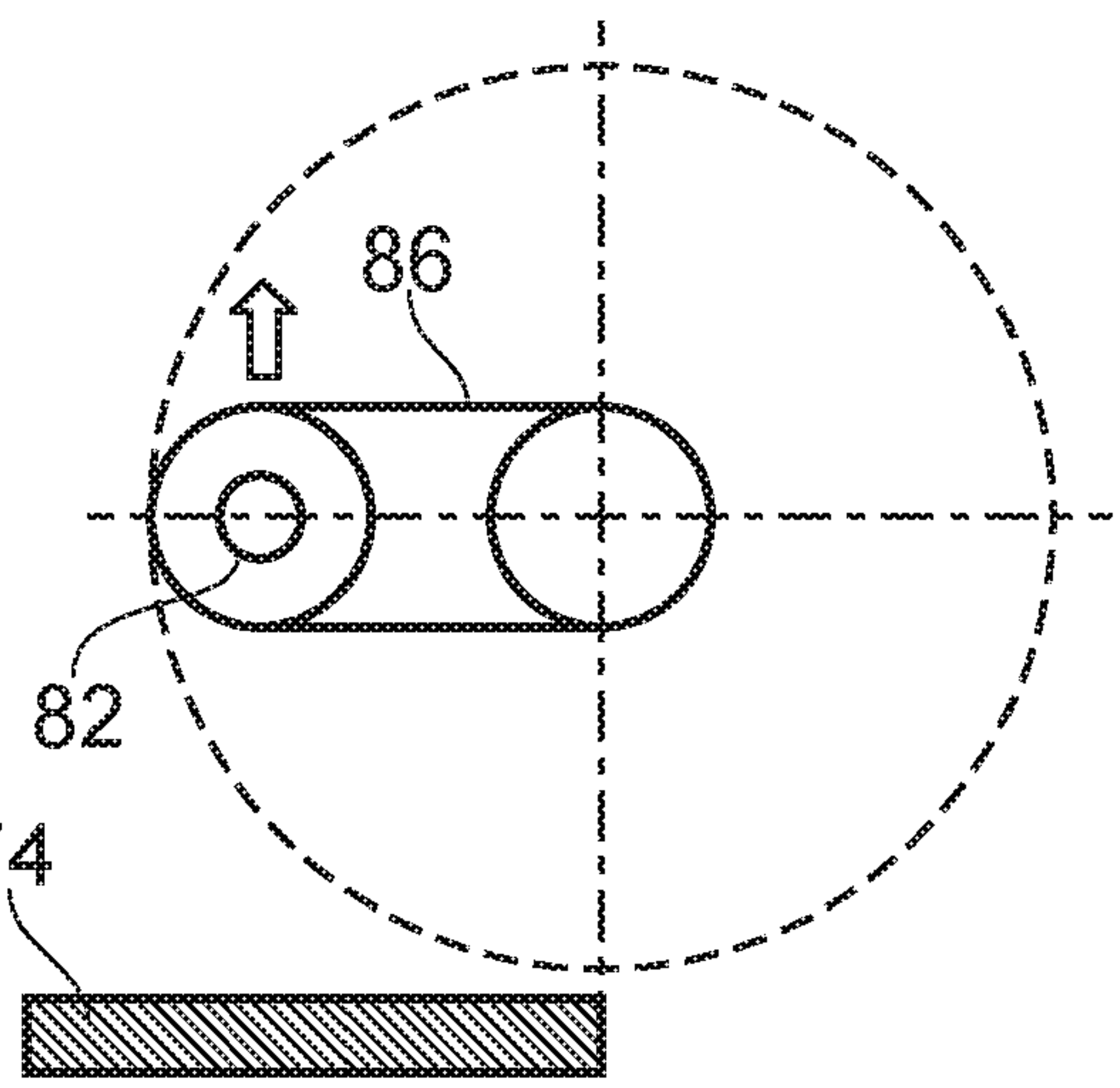

FIG. 20a

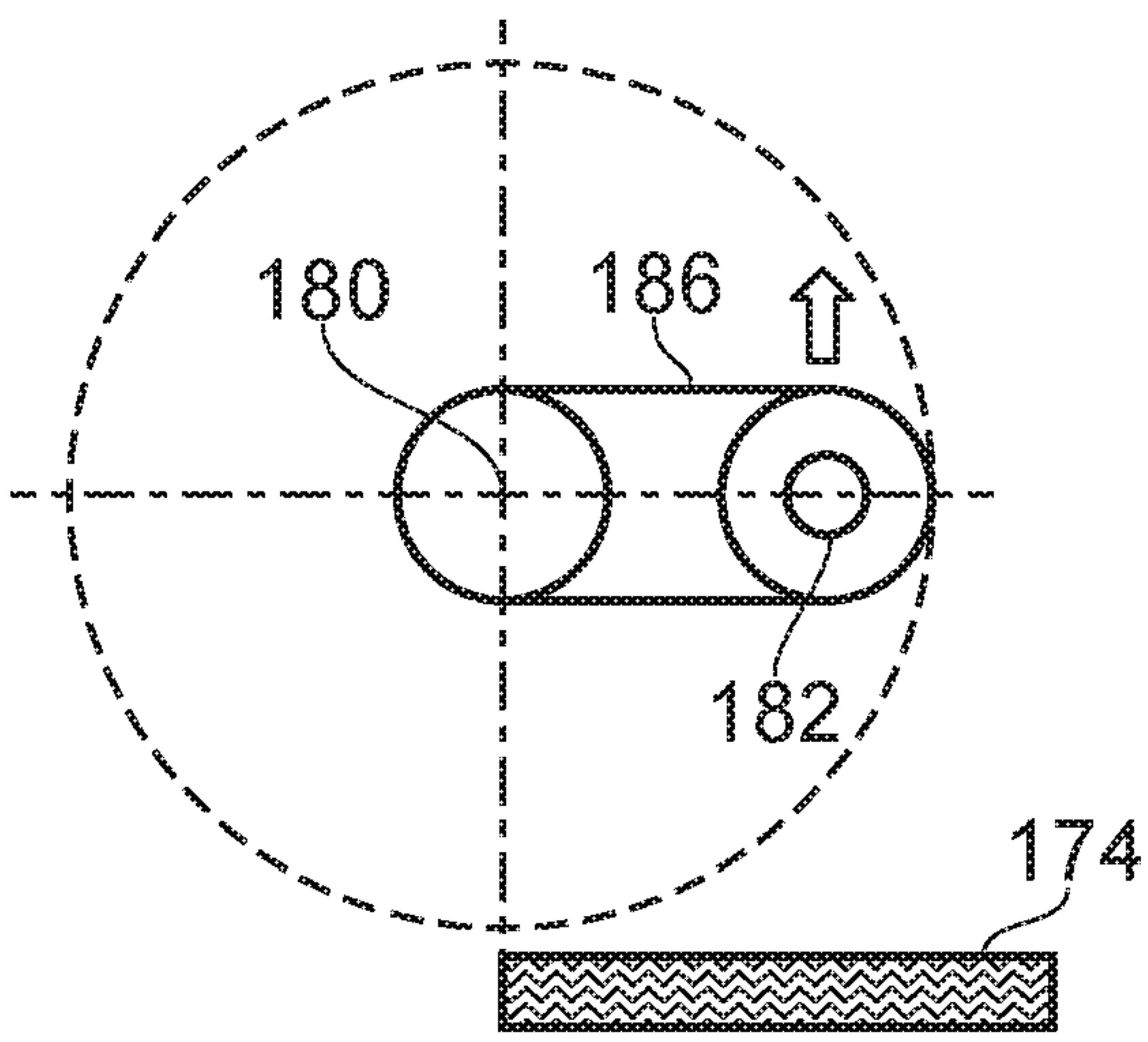

FIG. 20b

POWER TOOL

The present disclosure relates to a power tool.

Background

Hydraulic breakers for cutting masonry are well known. Typically they incorporate a weight which is raised against gravity by using hydraulics. The weight is driven into an accumulator and the combination of hydraulics and the accumulator are used to drive the weight against a drill bit delivering an impact force to a masonry target.

Figure 1 shows an alternative power tool as described in GB2375319B (BACA Limited). The tool 1 comprises a cuboid structural casing 2 to carry upper handles 4,6, and a work piece 8 in the form of a chisel. Inside, and further supported by, the casing there is a hydraulic ram 10 mounted through a platform 12. The ram comprises a cylinder 14 and a piston 16. Mounted onto a moving platform 18 there is a body 20 in the form of a heavy weight. Mounted between the moving platform and the bottom wall of the jackhammer are two elastic ropes 22,24 and shock absorbers 26,28. The jackhammer is shown in a vertical orientation with the chisel lower-most at the foot of the jackhammer.

The ram cylinder comprises a clutch which must capture and release the body 20 with each cycle. The clutch may be prone to wear which may result in mis-capture or pre-mature release if not maintained properly, resulting in a lack of effectiveness of the device.

The moving platform 18 slides on the exterior surface of the ram cylinder 14. This necessitates the need for the external surface of the ram cylinder 14 to be machined to a close tolerance. It also introduces extra loads and wear on the ram cylinder. If the moving platform is not aligned correctly on the ram, its movement along the ram cylinder may create unwanted vibration and resistance.

Additionally since the casing 2 is structural, with the other tool components being mounted off the casing 2, it comprises a casting of robust and heavy design. Hence the casing contributes significantly to the overall weight of the power tool.

Hence, a power tool which provides the advantages of the device of Figure 1, but delivers a higher impact force per unit weight of the power tool, and provides an improved actuator and body interface, is highly desirable.

Summary

According to the present disclosure there is provided an apparatus and method as set forth in the appended claims. Other features of the invention will be apparent from the dependent claims, and the description which follows.

Accordingly there may be provided a power tool (30) comprising : an impact tool (42) having a head end (60); a body (70) comprising : a first flange (74) comprising : a first engagement land (76) and a first engagement edge (78); a first actuator (46) for moving the body (70) along an operational axis (38): from an impact position at which the body (70) is operable to transfer impact energy to the head end (60) of the impact tool (42) to a retracted position spaced apart from the impact position along the operational axis (38). The first actuator (46) may comprise : a first actuator rotational axis (80), and a first engagement member (82) offset from, and rotatable around, the first actuator rotational axis (80), the first engagement member (82) and first flange (74) arranged relative to each such that : at the impact position the first engagement member (82) is operable to engage with the first flange engagement edge (78), and as the first engagement member (82) rotates around the first actuator rotational axis (80), the first engagement member (82) : travels along the first flange (74) engagement land; and simultaneously urges the body (70) in a direction away from the body (70) impact position towards the body (70) retracted position; and at the retracted position the first engagement member (82) is operable to move past the first flange engagement edge (78) to thereby disengage the body (70) from the first engagement member (82), thereby permitting the body (70) to move on an impact stroke to the impact position.

The body (70) may comprise : a second flange (174) comprising : a second engagement land (176), and a second engagement edge (178); a second actuator (146) for moving the body (70) along the operational axis (38).

The power tool may further comprise : a second actuator rotational axis (180), a second engagement member (182) offset from, and rotatable around, the second actuator rotational axis (180). The second engagement member (182) and second flange (174) may be arranged relative to each other such that : at the impact position the second engagement member (182) is operable to engage with the second flange engagement edge (178), and as the second engagement member (182) rotates around the second actuator rotational axis (180), the second engagement member (182) : travels along the second flange engagement land (176); and simultaneously urges the body (70) in a direction away from the body (70) impact position towards the body (70) retracted position. At the retracted position the second engagement member (182) may be operable to move past the second flange engagement edge (178) to

thereby disengage the body (70) from the second engagement member (182), thereby permitting the body (70) to move on an impact stroke to the impact position.

The first engagement member (82) and second engagement member (182) may be operable to rotate about their respective actuator axes; and may be operable such that : the first engagement member (82) engages with the first flange engagement edge (78) at the same instant as the second engagement member (182) engages with the second flange engagement edge (178); and the first engagement member (82) disengages from the first flange engagement edge (78) at the same instant as the second engagement member (182) disengages from the second flange engagement edge (178).

The first actuator rotational axis (80) may be perpendicular to the operational axis (38).

The second actuator rotational axis (180) may be perpendicular to the operational axis (38).

The first actuator rotational axis (80) may be aligned with the second actuator rotational axis (180).

The first flange engagement edge (78) may be aligned with the first actuator rotational axis (80).

The second flange engagement edge (178) may be aligned with the second actuator rotational axis (180).

The first flange engagement edge (78) may be aligned with the second flange engagement edge (178).

The first flange (74) may extend away from the first flange engagement edge (78) in a first direction away from the first actuator rotational axis (80). The second flange (174) may extend away from the second flange engagement edge (178) in a second direction away from the second actuator rotational axis (180). The first direction may be in an opposite direction to the second direction.

The first actuator (46) and second actuator (146) may be operable to be hydraulically actuated. Each of the first actuator (46) and second actuator (146) may comprise a fluid coupling for fluid communication with a fluid supply to drive the actuators (46, 146). The fluid supply of the first actuator (46) and second actuator (146) may be controllable such that the fluid supply pressure to both actuators (46, 146) is matched.

The fluid supply of the first actuator (46) and second actuator (146) may be in fluid communication with each other.

The power tool (30) may further comprise a plurality of rods (90) held in a fixed relationship to one another by : a first mount (92) towards one end of the rods (90), and a second mount (94) spaced apart from the first mount (92) along the operational axis (38) towards an opposite end of the rods (90).

The second mount (94) may be provided with an aperture (96) through which the impact tool (42) extends.

The body (70) may define passages (98) in slideable engagement with at least some of the rods (90), the passages (98) being configured such that the body (70) may translate between the impact position and the retracted position along at least said rods (90).

One end of an array of elastic ropes (100) may be coupled to the body (70) and another end of the elastic ropes (100) is coupled to a third mount (102).

The array of ropes (100) may be configured such that : the body (70) may translate from the impact position to the retracted position in a retraction direction along its carrying rods (90) under the action of the actuator (46, 146) and against the force developed by the elastic ropes (100). The body (70) may be biased to move in an impact direction along said rods (90) towards its impact position from its retracted position by the elastic ropes (100) whilst uncoupled from the actuator (46, 146).

A first casing (34) may extend between the first mount (92) and the second mount (94). A second casing (36) may extend from the second mount (94) along the operational axis (38). The second casing (36) module may terminate in an end plate (104). The impact tool (42) may extend out of an aperture (106) in the end plate (104).

The impact tool (42) may comprise a tool carrier (42) comprising : a foot end (64) at an opposite end of the impact tool (42) to the head end (60), the foot end (64) being provided with a tool mount (66) configured to transmit the impact energy to a tool.

A support land (110) may extend from the impact tool (42) part of the way between the head end (60) and the foot end (64) a first damping member (112) is provided between the support land (110) and second mount (94). A second damping member (114) may be provided between the support land (110) and the second casing (36) end plate (104).

The body (70) may be operable to travel along the operational axis (38) between : the impact position; and a rest position spaced apart from the impact position; wherein at the rest position the first engagement member (82) is spaced apart from the first flange (74) as the first engagement member (82) rotates about the first rotational axis (80).

At the rest position the second engagement member (182) may be spaced apart from the second flange (74) as the second engagement member (182) rotates about the second rotational axis (180).

There may also be provided a method of applying a percussive force to an object, using a power tool (30) as claimed in any preceding claims.

Hence there is provided a power tool with an improved *"catch and release"* interface between an actuator and a body to deliver an impulsive force to a tool. The interface provides positive engagement and dis-engagement as well as being technically simpler and more reliable than an arrangement of the related art.

Brief Description of the Drawings

Examples of the present disclosure will now be described with reference to the accompanying drawings, in which:

Figure 1 shows an example of the related art, as described earlier;

Figure 2 shows a front view of a power tool according to the present disclosure;

Figure 3 shows a side view of the arrangement of Figure 2 as viewed in the direction of arrow "A" shown in Figure 2.

Figure 4 shows a sectional view of the arrangement shown in Figure 2;

Figure 5 shows internal components of the arrangement presented in Figure 2;

Figure 6 shows the arrangement of Figure 5 from a different angle and with the internal components in a different relative configuration;

Figure 7 shows a view along the section line BB shown in Figure 6;

Figures 8 and 9 show the arrangement of Figures 5, 6 with components of the arrangement in different relative configurations;

Figures 10 to 15 show the operation of a *“catch and release”* interface of an actuator and body according to the present disclosure.

Figure 16 shows internal components of the power tool of the present disclosure in an “impact” configuration;

Figure 17 shows internal components of the power tool of the present disclosure in a “rest” configuration; and

Figures 18 to 20 show the operation of an actuator and body according to the present disclosure when in the “rest” configuration shown in Figure 17.

Detailed Description

Figures 2 and 3 show different views of the power tool when assembled according to the present disclosure. Figure 4 shows a sectional view of the arrangement shown in Figure 2. Figures 5, 6 show different views of the power tool with outer casing elements removed for clarity to show detail of features of the device of the present disclosure.

The power tool 30 comprises a mount 32 so that the power tool 30 can be engaged with a carrier arm of a parent machine (for example a backhoe loader). It further comprises a first casing 34 and a second casing 36 spaced along the length of an operational axis 38. The operational axis 38 extends along the length of the power tool.

Although the body 70 and casings 34, 36 in the present example are shown as cylindrical, they could have a different cross-sectional shape, for example polygonal or square.

The power tool also comprises an impact tool 42 which is aligned with (i.e. centred on) the operational axis 38 and extends from an aperture 44 at an end of the second casing 36. Hence the operational axis 38 may substantially extend from the mount 32 to the end of the impact tool 42.

As shown in Figure 4, the impact tool 42 comprises a head end 60. The impact tool 42 may be provided as a tool carrier 62 which comprises a foot end 64 at an opposite end of the impact tool 42 to the head end 60. The foot end 64 may be provided with a tool mount 66 configured to transmit an impact energy created by the power tool to a tool 120 connected thereto (not shown in Figure 4, illustrated in Figures 16, 17). Hence the impact tool 42 may comprise a tool carrier 66 for mounting an impact tool 120 along the operational axis 38. Alternatively the impact tool 42 may comprise an integral cutting tool.

The power tool further comprises a first actuator 46. The first actuator 46 may be mounted to the first casing 34. In the example shown there is also provided a second actuator 146 mounted diametrically opposite the first actuator 46. The second actuator 146 may be mounted to the first casing 34. In other examples the power tool of the present disclosure may be provided with a single actuator, or three or more actuators.

The first actuator 46 may be operable to be hydraulically actuated. Each of the actuators 46, 146 may be operable to be hydraulically actuated.

In the example shown the first actuator 46 and second actuator 146 are operable to be hydraulically actuated. Each of the first actuator 46 and second actuator 146 comprise a fluid coupling 50 for fluid communication with a fluid supply to drive the actuators 46, 146. The fluid supply may be provided as a source of hydraulic fluid provided under pressure by a parent vehicle which is coupled to the power tool 30.

The fluid coupling 50 is in fluid communication with the actuator 46, 146 via pairs of pipes 52, 54 which provide an inlet and outlet for the hydraulic fluid to thereby provide a flow of hydraulic fluid through the respective actuators 46, 146. The fluid supply of the first actuator 46 and second actuator 146 are controllable such that the fluid supply pressure to both actuators 46, 146 is matched. That is to say the system is configured such that the fluid pressure supplied to both actuators 46, 146 is the same by virtue of the fluid supply of the first actuator 46 and second actuator 146 being in fluid communication with each other. Hence an increase in load on one actuator results in an increase in force applied by the other actuator.

Further details of the power tool of the present disclosure are shown in Figures 4, 5, 6. As shown in previous examples, the power tool 30 defines the operational axis 38. The power tool 30 further comprises a body 70 centred on the operational axis 38. The first actuator 46 is provided for moving the body 70 along the operational axis 38. It is operable to move the body 70 from an impact position at which the body 70 is operable to transfer impact energy to the head end 60 of the impact tool 42 (as shown in Figures 4, 5, 8) to a retracted position spaced apart from the impact position along the operational axis towards the mount 32 end of the power tool (as shown in Figures 6, 9).

As shown in Figure 5, the body 70 comprises a main body portion 72 and a first flange 74 which extends away from the main body portion 72 in a direction away from the operational axis 38. The first flange 74 may be provided as part of a top plate 73 attached to the “top” of the body 70. As shown in Figure 6 the first flange 74 comprises a first engagement land 76 which faces towards the impact position (i.e. towards the impact tool 42, away from the mount end 32). The first flange 76 has a first engagement edge 78 shown in Figure 5, but hidden from view in Figure 6.

As shown in Figure 4, the first actuator 46 comprises a first actuator rotational axis 80. The first actuator rotational axis 80 may intersect the operational axis 38. The first actuator rotational axis 80 is provided at an angle to the operational axis 38. As shown in the figures, the first actuator rotational axis 80 may be provided perpendicular to the operational axis 38.

The first actuator 46 also comprises a first engagement member 82 offset from, and rotatable around, the first actuator rotational axis 80. The first actuator 46 further comprises a shaft 84 centred on and rotatable about the first actuator rotational axis 80. The first engagement member 82 is coupled to the first shaft 84 via an arm 86. Hence rotation of the shaft 84 about the rotational axis 80 rotates the first engagement member 82 around the first rotational axis 80. Put another way, the first engagement member 82 is coupled to the first shaft 84 and offset, by a fixed distance, from the first actuator rotational axis 80 so that the first engagement member 82 is rotatable around the first actuator rotational axis 80 to describe a (circular) path around the first actuator rotational axis 80.

The first engagement member 82 and first flange 74 are arranged relative to each other such that at the impact position the first engagement member 82 is operable to engage with the first flange engagement edge 78. The first engagement member 82 and first flange 74 are also arranged relative to each other such that as the first engagement member 82 rotates around the first actuator axis 80, the first engagement member 82 travels from the first flange engagement edge 78 along the first flange engagement land 76 and simultaneously urges the body 70 (by virtue of its connection to the first flange 74) in a direction away from the body impact position towards the body retracted position. The first engagement member 82 and first flange 74 are also arranged relative to each other such that at the retracted position the first engagement member 82 is operable to move past the first flange engagement edge 78 to thereby disengage the body 70 from the first engagement member 82, thereby permitting the body 70 to move on an impact stroke to the impact position.

The body 70 further comprises a second flange 174 which extends away from a main body portion of the body 70 in a direction away from the operational axis 38. The second flange 174 may be provided as part of a top plate 73 attached to the “top” of the body 70. The second flange 174 comprises a second engagement land 176 which faces towards the impact position. The second flange 174 has a second engagement edge 178.

The second actuator 146 comprises a second actuator rotational axis 180. The second actuator rotational axis 180 may intersect the operational axis 38. The second actuator rotational axis 180 is provided at an angle to the operational axis 38. As shown in the figures, the second actuator rotational axis 180 may be provided perpendicular to the operational axis 38.

The second actuator 146 also comprises a second engagement member 182 offset from, and rotatable around, the second actuator rotational axis 180. The second actuator 146 also comprises a second shaft 184 rotatable around the second rotational axis 180. In the example shown, the second actuator rotational axis 180 is aligned with the first actuator rotational axis 80. The second actuator rotational axis 180 may be co-axial with the first actuator rotational axis 80.

The second engagement member 182 is coupled to the second shaft via an arm 186 and offset by a fixed distance from the second actuator rotational axis 180 so that the second engagement member 182 is rotatable to describe a (circular) path around the second actuator rotational axis 180.

In the example shown the first engagement member 82 is provided on a first member 86, provided as an arm 86, which extends from the first shaft 84, and the second engagement member 182 is provided on a second member 186, provided as an arm 186, which extends from the second shaft 184. In alternative examples the first member 86 and second member 186 may be provided as a plate or disc or other member which supports the first engagement member 82 and/or second engagement member 182 offset from the rotational axis of their respective actuators 46, 146.

The second engagement member 182 and second flange 174 are arranged relative to each other such that at the impact position the second engagement member 182 is operable to engage with the second flange engagement edge 178. The second engagement member and second flange are also arranged relative to each other such that as the second engagement member 182 rotates around the second actuator rotational axis 180, the second engagement member 182 travels from the second flange engagement edge 178 along the second flange engagement land 176 and simultaneously urges the body 70 in a direction away from the body impact position towards the body retracted position. The second engagement member 182 and second flange 174 are also arranged relative to each other such that at the retracted position the second engagement member 182 is operable to move past the second flange engagement edge 178 to thereby disengage the body 70 from the second engagement member 182, thereby permitting the body 70 to move on an impact stroke to the impact position.

The first engagement member 82 and second engagement member 182 may be operable to rotate in opposite directions relative to one another about their respective actuator axes 80, 180 when viewed along an axis aligned with the first rotational axis 80 and/or second rotational axis 180 (e.g. the direction indicated by arrow A in Figures 2, 4 to 8).

The first engagement member 82 and second engagement member 182, by virtue of their coupling to the actuators 46, 146 respectively, are controllable (i.e. operable) such that the first engagement member 82 engages with the first flange engagement edge 78 at the same instant as the second engagement member 182 engages with the second flange engagement edge 178, so both the first engagement member 82 and the second engagement member 182 engage with their respective flanges 74, 174 at the same time. The actuators 46, 146 are also controllable (i.e. operable) such that the first engagement member 82 passes the first flange engagement edge 78 at the same instant as the second engagement member 182 passes the second flange engagement edge 178 so both the first engagement member 82 and second engagement member 182 disengage from their respective flanges 74, 174 at the same time.

The first engagement land 76 may be the same length as the second engagement land 176. The actuator 46 and actuator 146 may be operable to rotate their respective first shaft 84 and second shaft 184 about their respective actuator axes 80, 180 at the same angular speed at a given instant in time. That is to say, the actuator 46 and actuator 146 may be operable to rotate their respective first shaft 84 and second shaft 184 about their respective actuator axes 80, 180 with the same velocity profile, where the velocity may be dependent on angular position.

The first engagement member 82 and second engagement member 182 may each comprise a freely rotatable roller. That is to say, the first engagement member 82 and/or second engagement member 182 may comprise a rotatable member carried on a bearing such that as it moves along the engagement land it rotates, thereby reducing wear on the engagement land and its own bearing/outer surface.

As shown in Figure 7, the first engagement edge 78 may be aligned with the first actuator rotational axis 80. That is to say the first engagement edge 78 may be aligned with a plane that extends through the operational axis 38 and first actuator rotational axis 80.

The second engagement edge 178 may be aligned with the second actuator rotational axis 180. That is to say the second engagement edge 178 may be aligned with a plane that extends through the operational axis 38 and second actuator rotational axis 180.

The first flange engagement edge 78 may be aligned with the second flange engagement edge 178. The first actuator rotational axis 80 may be aligned with the second actuator rotational axis 180. That is to say both the first flange engagement edge 78 and the second flange engagement edge 178 may sit along a common axis which is defined by the first actuator rotational axis 80 and the second actuator rotational axis 180.

The first flange 74 extends away from the first flange engagement edge 78 along a side of the body 70 in a first direction away from the first actuator rotational axis 80. The second flange 174 extends away from the second flange engagement edge 178 along a side of the body 70 in a second direction away from the second actuator rotational axis 182, the first direction being in an opposite direction to the second direction.

As shown in Figures 4, 5 the power tool further comprises a plurality of rods 90 held in a fixed relationship to one another by a first mount 92 towards one end of the rods 90 towards the mounting end 32, and a second mount 94 spaced apart from the first mount 92 along the operational axis 38 towards an opposite end of the rods 90 towards the tool carrier 42 end of the power tool 30. The second mount 94 is provided with an aperture 96 through which the impact tool 42 extends. The rods 90 may be parallel to the operational axis 38. That is to say, the rods 90 may be aligned with, but spaced apart from, the operational axis 38. The rods 90 may be parallel to each other.

The body 70 defines passages 98 in slidable engagement with at least some of the rods 90, the passages 98 configured such that the body 70 may translate between the impact position and the retracted position along at least some of the rods 90.

As shown in Figures 5, 6, 8, 9 one end of an array of elastic ropes 100 is coupled to the body 70, and another end of the elastic ropes is coupled to a third mount 102. The third mount 102 is spaced apart from the second mount 94 in a direction away from the first mount 92. Hence the third mount 102 may be provided spaced apart from the second mount 94 in a direction along the operational axis 38 such that the third mount 102 faces one side of the second mount 94, and the first mount faces an opposing side of the second mount 94.

The ropes 100 pass through apertures, or spaces, provided in the second mount 94 and are mounted to the third mount 102, rather than the second mount 94, in order to provide contraction spaces for the ropes 100.

The array of ropes 100 may comprise any number of elastic ropes, depending on their length, diameter and the material from which they are made, although the amount of energy that can be stored and released increases with the number of elastic ropes. The power tool 30 of the present example is provided with 24 elastic ropes.

The array of ropes 100 is coupled to the body 70 and are configured such that the body 70 may translate from the impact position to the retracted position (as shown in Figures 6, 9) in a retraction direction along its carrying rods 90 under the action of the actuators 46, 146 against the force developed by the elastic ropes 100. The retraction direction is shown by arrow “R” in Figure 9. The array of elastic ropes are also configured such that the body 70 is biased to move in an impact direction along at least some of the rods 90 towards its impact position (as shown in Figures 4, 5, 8) from its retracted position by the elastic ropes while uncoupled from the actuators 46, 146. The impact direction is shown by arrow “I” in Figure 9.

The first casing 34 may extend between the first mount 92 and the second mount 94 and/or the third mount 102. The second casing 36 may extend from the second and/or third mount 102 along the operational axis 38, the second casing 36 terminating in an end plate or hub 104, wherein the impact tool 42 extends out of an aperture 106 in the end hub 104, and the end plate/hub 104 closes the aperture 44 of the second casing 36.

A support land 110 extends from the impact tool 42 part of the way between the head end 60 and the foot end 64. A first damping member 112 may be provided between the support land 110 and second mount 94, and a second damping member 114 may be provided between the support land 110 and the second casing end plate/hub 104.

The elastic ropes 100 are located on a common pitch circle diameter and are provided outwards (for example radially outwards) of the rods 90.

The body 70 may be provided with a greater mass than the mass of the tool carrier 42 or a greater mass than the combined mass of the tool carrier 42 and resultant tool assembly (i.e. the tool carrier 42 holding a tool). The ropes may be coupled via a direct load transmission path to the third mount 102 and body 70.

In one example the combined mass of the body 70 (including flanges) may be about 725 kg.

The first damper 112 may comprise at least two damping members in series along the operational axis 38. The at least two damping members may have different stiffness to one another. The second damper 114 may also comprise a number of damping member and series, with different stiffness.

In use, shock loads will be high due to the energy being produced by the action of the actuators, body and ropes. The shock loads may be because of “blank fire”, produced when the impact tool being used easily penetrates a material and the body 70 moves beyond its normal stopping point with the impact tool 42. In this scenario the body 70 will press the support land 110 into contact with the second damper 114, which absorbs the shock energy.

Alternatively the shock loads may be because of “recoil” which is produced when the impact tool 42 strikes hard material and a shock wave travels back up the impact tool 42 and rest of the body of the power tool 30. In this scenario the support land 110 is forced into contact with the first damper 112 which absorbs the shock load.

In both cases the configuration of the device of the present invention is beneficial as the arrangement of the first damper 112, second damper 114 and support land 110 is such as to reduce shock loads travelling into the structure of the power tool 30, and hence prevent shock loads being passed back through to a parent vehicle upon which the power tool 30 is mounted. This extends the life of the vehicle as well as reducing user (i.e. driver) discomfort.

Figures 10 to 15 show operation and interaction between the engagement members 82, 182 and their respective flanges 74, 174 on the body 70. Figures 10a, 11a, 12a, 13a, 14a and 15a relate to the first actuator 46, the first engagement member 82 and first flange 74. Figures 10b, 11b, 12b, 13b, 14b and 15b relate to the second actuator 146, second engagement member 182 and second flange 174.

Only features necessary to illustrate the interaction between the actuators 46, 146 and the flanges 74, 174 of the body 70 are shown, with the flanges 74, 174 being shown in isolation from the body 70 to which they are attached, and hence neither the rods 90 on which the body 70 is carried, nor the ropes 100, are shown. However the movement and interaction of these may be understood with reference to the referenced Figures.

As can be seen in Figures 10 to 15, the shafts 84, 184 of the first and second actuators 46, 146 respectively rotate in different directions, powered to move by a flow of pressurised hydraulic fluid provided from the fluid source.

The power tool 30 of the present disclosure is intended to be powered by conventional auxiliary “hammer” circuits found on a conventional excavator (e.g. a backhoe loader). The required flow rate may be about 250 litres per minute at a pressure of about 145 bar, which is similar to that of a conventional device, and thus the device of the present application will be compatible with existing systems. Such flow and pressure may achieve a blow rate of 60 blows per minute (bpm).

The frequency may be altered by reconfiguring the actuator, for example by altering cam profiles within each actuator.

The representations shown in Figures 10 to 15 are as viewed from the viewpoint indicated by arrow “A” along the common axis defined by the first rotational axis 80 and second rotational axis 180 of the actuators 46, 146.

In this example the first actuator 46 rotates in a clockwise direction and the second actuator 146 rotates in an anti-clockwise direction. In other examples the first actuator 46 may rotate in an anti-clockwise direction and the second actuator 146 may rotate in a clockwise direction. In other examples the first actuator 46 and the second actuator 146 may rotate in the same direction.

Figures 10a, 10b show the flanges 74, 174 (attached to the body 70) when the body 70 is in the impact position, that is to say sat on top of the head end 60 of the impact tool 42 (as shown in Figures 4, 5, 8). In this example the impact tool 42 (e.g. with a cutting tool attached to the mount 66) is in contact with a material to be machined (as shown in Figure 16), and hence the impact tool 42 is retracted into the casing of the power tool at most as far as allowed by the first damper 112. Put another way, because the shoulder 110 of the impact tool 42 will press into contact with the first damper 112, the impact tool 42 may retract into the second casing 36 as far as allowed by the thickness of the first damper 112. Consequently, the body 70 is pushed by the head end 60 of the impact tool to a given position on the rods 90. In this position, the flanges 74, 174 are in position where they may be engaged by the engagement members 82, 182.

Figures 10a, 10b show such an example, in which the shafts 84, 184 are shown to be moving to bring the engagement members 82, 182 towards bottom dead centre (BDC) and hence towards the respective engagement edges 78, 178 of the flanges 74, 174.

In Figures 11a, 11b the engagement members 82, 182 are shown having just engaged with their respective flanges 74, 174 at their respective flange engagement edges 78, 178. The actuators 46, 146 are controlled to ensure that the engagement members 82, 182 engage with their respective flange engagement edges 78, 178 at the same instant. However if there is a difference between the positions (i.e. a lag) between the first shaft 84 and second shaft 184 then, because the fluid supply between the actuators 46, 146 is connected, and therefore balanced/matched, the actuator of the lagging engagement member 82, 182 will be subject to an increased force due to the increased load on the other (i.e. the leading) one of the engagement members 82, 182. Hence the arrangement will inherently correct any lag which occurs in the angular positions of the engagement members 82, 182.

Having engaged with the flange engagement edge 78, 178 the respective engagement member 82, 182 travels along the respective flange engagement land 76, 176 as the actuators 46, 146 rotate the shafts 84, 184 and hence move the angular position of the engagement members 82, 182 to lift the flanges 74, 174 and hence urge/move the body 70 in a direction away from the body impact position (as shown in Figures 4,5,8) towards the body retracted position (that is to say to move the body in the retraction direction “R”, as shown in Figures 9, 12a, 12b).

Until halfway between bottom dead centre and top dead centre (TDC) (as indicated in Figures 12a, b) the engagement members 82, 182 move away from the flange engagement edge 78, 178 along the engagement land 76, 176. As the engagement members 82, 182 continue towards top dead centre, the shafts 84, 184 continue to turn and hence continue to lift the flanges 74, 174 (and hence body 70) in the retraction direction “R”. Halfway between bottom dead centre and top dead centre the engagement members 82, 182 reverse course and move back along the engagement land 76, 176 towards the flange engagement edge 78, 178.

At top dead centre (TDC), or shortly thereafter, as shown in Figures 13a, 13b, which corresponds to the retracted position as shown in Figures 6, 9, the engagement member 82, 182 reaches the flange engagement edge 78, 178. Hence to reach this point, the body 70 has been translated from the impact position to the retracted position in the retraction direction “R” along its carrying rods 90 under the action of the actuator 46, 146 and against a force developed by the elastic ropes 100.

The actuators 46, 146 continue to turn the engagement members 82, 182 so that the engagement members 82, 182 then move past the flange engagement edge 78, 178 to thereby disengage the body 70 from the engagement members 82, 182, as shown in Figures 14a, 14b. This permits the body 70 to move in an impact stroke, in the impact direction “I”, to the impact position, as shown in Figures 14a, 14b. Hence released/uncoupled from the actuators, and because the body 70 is biased to move in the impact direction “I” by the ropes 100, the body then moves from the retracted position along the rods 90 upon which it is carried towards its impact position by the elastic ropes 100.

Since the engagement members 82, 182 are unloaded at this point in the cycle, they rotate around to bottom dead centre (BDC) position, as shown in Figures 15a, 15b towards engaging with the flange engagement edge 78, 178, and as shown in Figures 10a, 10b, thereby starting the cycle again.

Hence the actuators are operable to continually rotate the engagement members 82, 182 around their respective rotational axes 80, 180 to engage with the flange 74, 174, and hence move the body 70 to a retracted position, and then release the flange 74, 174 to allow the body 70 to move to an impact position, and to repeat the cycle as required.

Although the angular speed of the actuators 46, 146 and the engagement members 82, 182 may not be constant, they will continually rotate in the same direction.

Figure 16 shows the relative spacing of the actuators 46, 146 and their respective flanges 74, 174 when the impact tool 42 is in the impact position. That is to say, when a tool 120 is mounted in the tool carrier 62 of the impact tool 42 and is in contact with a target object 122, or (not shown) when a cutting part of the impact tool 42 is in contact with the target object 122, then the head end 60 of the impact tool 42 forces/urges the body 70 to the impact position in which the engagement members 82, 182 can engage and disengage with the flanges 74, 174 as described above.

However, should no load be applied to the impact tool 42 (for example the power tool is lifted away from a target material so the impact tool is not in contact with a material, or as shown in Figure 17, because the target object has broken and fallen away from the tool 120 and/or cutting part of the impact tool 42) then the impact tool 42 may extend further from the end of the power tool 30 casing, and hence the body 70 may be drawn closer to the second mount 94, and hence further away from the reach of the engagement members 82, 182. In this position (named the “rest position”) the flanges 74, 174 are too far away from the engagement members 82, 182 to be engaged by them, and the engagement members 82, 182 are rotatable around their axis 80, 180 by the actuators 46, 146 without making contact with (i.e. without engagement with) the flanges 74, 174 of the body 70.

Thus the retracted position, impact position and rest position of the body 70 are spaced along the operational axis 38 in series, with the impact position located between the retracted position and the rest position. The distance between the retracted position and the impact position may be greater than the distance between the impact position and the rest position.

Figures 18 to 20 show operation and interaction between the engagement members 82, 182 and their respective flanges 74, 174 on the body 70 in the mode of operation shown in Figure 17 when the body is in the rest position.

The actuators 46, 146 operate as before to move the engagement members 82, 182 around their respective rotational axes 80, 180. However, with the body 70 in the rest position, spaced apart from the impact position along the operational axis 38 towards the second mount 94, a clearance is maintained between the flanges 74, 174 and the engagement members 82, 182. Hence while the body 70 is in the rest position, it is not engageable by the engagement members 82, 182, and hence will be free of the actuators 46, 146, and hence will not be drawn by the actuators 46, 146 to the retracted position.

This reduces unnecessary vibrations and wear on the power tool, as well as providing a safety feature e.g. if no load is applied to the impact tool 42, then no impact load will be applied to the impact tool 42.

As soon as the cutting part of the impact tool 42 (e.g. cutting tool 120) is placed in contact with a target 122, then the body 70 will be urged back to the impact position (shown in Figure 16) by virtue of its connection with the head end 60 of the impact tool 42. That is to say, the body 70 is operable to travel along the operational axis 38 between the impact position and the rest position, wherein at the rest position the first engagement member 82 is spaced apart from the first flange 74 as the first engagement member 82 rotates about the first rotational axis 80. Additionally, at the rest position the second engagement member 182 is spaced apart from the second flange 74 as the second engagement member 182 rotates about the second rotational axis 180. Put another way, the body 70 is operable to travel along the operational axis 38 between the impact position and the rest position, wherein at the rest position the first engagement member 82 is spaced apart from the first flange 74 in the direction of the operational axis 38 as the first engagement member 82 rotates about the first rotational axis 80. Additionally, at the rest position the second engagement member 182 is spaced apart from the second flange 74 in the direction of the operational axis 38 as the second engagement member 182 rotates about the second rotational axis 180.

Hence the impact tool 42 is operable to travel along the operational axis 38 between the impact position at which the head end 60 of the impact tool 42 is a first distance (X) from the actuator rotational axis 80, 180, and the rest position in which the head end 60 of the impact tool 42 is a second distance (Y) from the actuator rotational axis 80, 180, the second distance (Y) being greater than the first distance (X). The first engagement member 82 and first flange 74 are arranged relative to each such that when the impact tool 42 is in the rest position the first engagement member 82 is spaced apart from the first flange 74 as it rotates about the first actuator rotational axis 80. Additionally when the impact tool 42 is in the rest position the second engagement member 182 is spaced apart from the second flange 174 as it rotates about the second actuator rotational axis 180.

A device of the present disclosure is thus advantageous since it comprises a simpler actuation mechanism than examples of the related art, the present invention employing constantly rotating actuators 46, 146 to catch/engage with and release the body 70 which provides an impact load to the impact tool 42. This provides a more constant load on the hydraulic supply to which it is attached, as well as being inherently easier to control, maintain and manufacture than examples of the related art.

Additionally the cyclic speed of impulse delivery (i.e. the rate at which the body 70 is retracted and released to provide an impact load) may be tuned to a specific requirement, which is considerably harder to achieve with examples of the related art.

A device of the present disclosure also advantageous since it provides a device having a substantially greater energy output per unit weight than either a purely pneumatic drill or the device as shown in Figure 1. Hence masonry cutting operations take less time to perform with a device of the present disclosure. Thus any device powering or manoeuvring the tool (for example a backhoe loader) can move off station sooner, hence use less fuel and reduce noise pollution.

Since the power tool 30 of the present disclosure is inherently more efficient, the carrier vehicle, which provides power to the tool 30, may operate at a lower engine power setting than would be required with a power tool of the related art, thereby extending the life of the carrier vehicle, and reducing fuel consumption.

In examples where the actuator 46, 146 is operated by hydraulic fluid delivered from a carrier vehicle, a power tool according to the present invention will require less work to be done by the fluid, and expose the fluid to less vibration and maintain the fluid at a lower temperature, thus extending the life of the hydraulic fluid. Additionally, during operation of the device of the present disclosure, hydraulic fluid is flowed under pressure to power the actuators 46, 146, but is not subject to extremes of pressure changes as would be experienced in a conventional hydraulic breaker. This also extends the life of the hydraulic fluid being used.

Additionally the multiple (e.g. six) rod 90 support structure, in combination with passages for the rods extending the full length of the body 70, provides an improved bearing surface for the body 70 to slide along, increases stability of body 70 as it moves along the rods 90, and hence decreases vibration during the impact and retraction strokes.

Additionally the body 70 is made as large as possible for the volume available in the casing of the power tool, thereby providing a larger momentum, and hence force, to strike the tool carrier 42. This provides an advantage over examples of the related art which comprise central rams (for example, as shown in figure 1) as to achieve the same mass in a central ram arrangement the body would have to be longer and/or have a greater diameter, thereby increasing the size of the casing and power tool as a whole.

The power tool of the present disclosure achieves high torque using leverage developed by the offset engagement members 82, 182 to retract the body 70 against a high retraction force provided by the ropes 100 to thereby develop a large potential energy, which in turn provides a large impulse force to the impact tool 42 when the body is released.

This provides an advantage over examples of the related art which comprise central rams (for example, as shown in figure 1) as such ram cylinders would need to be of significant diameter in order to be operable to achieve the same retraction force, which thus increases the size of the device as a whole, as well as requiring a source of higher pressure fluid than that required by a device of the present disclosure.

The power tool of the present disclosure also includes an advantageous damping system including the first damper 112 and second damper 114 which are operable to absorb shock loads imparted to the tool carrier 42 during a misfire. This is extremely important as it prevents vibration and loads being transmitted to the casing of the power tool 30 and hence to the vehicle carrying the power tool 30. Since the carrier vehicle is exposed to less vibration and shock loads, the life of its components are increased. Additionally, the operator of the carrier vehicle is more comfortable, and hence can operate the device more effectively.

The modular nature of the power tool 30 makes it easier to assemble, re-configure and maintain.

The tool carrier 42 also allows for easy replacement of tools, for example to achieve a different cutting operation, or to replace a damaged tool.

Although the figures of the present application show a jack hammer type tool, the power tool of the present disclosure may form part of any power tool where it is required to deliver a cyclic percussive force to a target object.

Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

CLAIMS

1 A power tool (30) comprising :

an impact tool (42) having a head end (60);

a body (70) comprising :

a first flange (74) comprising :

a first engagement land (76) and
a first engagement edge (78);

a first actuator (46) for moving the body (70) along an operational axis (38):

from an impact position at which the body (70) is operable to transfer impact energy to the head end (60) of the impact tool (42)

to a retracted position spaced apart from the impact position along the operational axis (38);

the first actuator (46) comprising :

a first actuator rotational axis (80), and

a first engagement member (82) offset from, and rotatable around, the first actuator rotational axis (80),

the first engagement member (82) and first flange (74) arranged relative to each such that :

at the impact position the first engagement member (82) is operable to engage with the first flange engagement edge (78), and as the first engagement member (82) rotates around the first actuator rotational axis (80), the first engagement member (82) :

travels along the first flange (74) engagement land; and simultaneously urges the body (70) in a direction away from the body (70) impact position towards the body (70) retracted position; and

at the retracted position the first engagement member (82) is operable to move past the first flange engagement edge (78) to thereby disengage the body (70) from the first engagement member (82),

thereby permitting the body (70) to move on an impact stroke to the impact position;

wherein the power tool (30) further comprises :

a plurality of rods (90) held in a fixed relationship to one another by :

a first mount (92) towards one end of the rods (90), and

a second mount (94) spaced apart from the first mount (92) along the operational axis (38) towards an opposite end of the rods (90); and

the body (7) defines passages (98), each of the passages (98) accommodating one of the rods (90),

the passages (98) being configured such that the body (70) may translate between the impact position and the retracted position along said rods (90).

2 A power tool (30) as claimed in claim 1 wherein :

the second mount (94) is provided with an aperture (96) through which the impact tool (42) extends.

3 A power tool (30) as claimed in claim 1 or claim 2 wherein :

the body (70) comprises :

a second flange (174) comprising :

a second engagement land (176), and

a second engagement edge (178);

and the power tool further comprises :

a second actuator (146) for moving the body (70) along the operational axis (38), and comprising :

a second actuator rotational axis (180),

a second engagement member (182) offset from, and rotatable around, the second actuator rotational axis (180),

the second engagement member (182) and second flange (174) are arranged relative to each other such that :

at the impact position the second engagement member (182) is operable to engage with the second flange engagement edge (178), and as the second engagement member (182) rotates around the second actuator rotational axis (180), the second engagement member (182) :

travels along the second flange engagement land (176); and

simultaneously urges the body (70) in a direction away from the body (70) impact position towards the body (70) retracted position; and

at the retracted position the second engagement member (182) is operable to move past the second flange engagement edge (178) to thereby disengage the body (70) from the second engagement member (182),

thereby permitting the body (70) to move on an impact stroke to the impact position.

4 A power tool (30) as claimed in claim 3 wherein :

the first engagement member (82) and second engagement member (182) are operable to rotate about their respective actuator axes; and are operable such that :

the first engagement member (82) engages with the first flange engagement edge (78) at the same instant as the second engagement member (182) engages with the second flange engagement edge (178); and

the first engagement member (82) disengages from the first flange engagement edge (78) at the same instant as the second engagement member (182) disengages from the second flange engagement edge (178).

5 A power tool (30) as claimed in any one of claims 1 to 4 wherein :

the first actuator rotational axis (80) is perpendicular to the operational axis (38).

6 A power tool (30) as claimed in any one of claims 3, 4, or claim 5 when dependent on claim 3 :

the second actuator rotational axis (180) is perpendicular to the operational axis (38).

7 A power tool (30) as claimed in any one of claims 3 to 6 wherein :

the first actuator rotational axis (80) is aligned with the second actuator rotational axis (180).

8 A power tool (30) as claimed in any one of claims 1 to 7 wherein :

a plane defined by the operational axis (38) and first actuator rotational axis (80) is coplanar with the surface of the first engagement edge (78).

9 A power tool (30) as claimed in any one of claims 2 to 9 wherein :

a plane defined by the operational axis (38) and second actuator rotational axis (180) is coplanar with the surface of the second engagement edge (178).

10 A power tool (30) as claimed in any one of claims 2 to 9 wherein :

the surface of the first flange engagement edge (78) is coplanar with the surface of the second flange engagement edge (178).

11 A power tool (30) as claimed in any one of claim 7 to 10 wherein :

the first flange (74) extends away from the first flange engagement edge (78) in a first direction away from the first actuator rotational axis (80); and

the second flange (174) extends away from the second flange engagement edge (178) in a second direction away from the second actuator rotational axis (180);

the first direction being in an opposite direction to the second direction.

12 A power tool (30) as claimed in any one of claims 3 to 11 wherein :

the first actuator (46) and second actuator (146) are operable to be hydraulically actuated;

each of the first actuator (46) and second actuator (146) comprise a fluid coupling for fluid communication with a fluid supply to drive the actuators (46, 146); and

the fluid supply of the first actuator (46) and second actuator (146) being controllable such that

the fluid supply pressure to both actuators (46, 146) is matched.

13 A power tool (30) as claimed in claim 12 wherein :

the fluid supply of the first actuator (46) and second actuator (146) are in fluid communication with each other.

14 A power tool (30) as claimed in any one of the preceding claims wherein :

the passages (98) are in slideable engagement with at least some of the rods (90).

15 A power tool (30) as claimed in any one of the preceding claims wherein :

one end of an array of elastic ropes (100) is coupled to the body (70) and another end of the elastic ropes (100) is coupled to a third mount (102); the array of ropes (100) configured such that :

the body (70) may translate from the impact position to the retracted position in a retraction direction along its rods (90) under the action of the or each actuator (46, 146) and against the force developed by the elastic ropes (100); and wherein the body (70) is biased to move in an impact direction along said rods (90) towards its impact position from its retracted position by the elastic ropes (100) whilst uncoupled from the or each actuator (46, 146).

16 A power tool (30) as claimed in any one of the preceding claims wherein :

a first casing (34) extends between the first mount (92) and the second mount (94);

a second casing (36) extends from the second mount (94) along the operational axis (38);

the second casing (36) module terminating in an end plate (104); and

the impact tool (42) extends out of an aperture (106) in the end plate (104).

17 A power tool (30) as claimed in any one of the preceding claims wherein :

the impact tool (42) comprises a tool carrier (42) comprising :

a foot end (64) at an opposite end of the impact tool (42) to the head end (60),

the foot end (64) being provided with a tool mount (66) configured to transmit the impact energy to a tool.

18 A power tool (30) as claimed in claim 17 wherein :

a support land (110) extends from the impact tool (42) part of the way between the head end (60) and the foot end (64)

a first damping member (112) is provided between the support land (110) and second mount (94); and

a second damping member (114) is provided between the support land (110) and the second casing (36) end plate (104).

19 A power tool (30) as claimed in any one of claims 1 to 18 wherein :

the body (70) is operable to travel along the operational axis (38) between :

the impact position; and

a rest position spaced apart from the impact position;

wherein at the rest position the first engagement member (82) is spaced apart from the first flange (74) as the first engagement member (82) rotates about the first rotational axis (80).

20 A power tool (30) as claimed in claim 19 when dependent on claim 3 :

at the rest position the second engagement member (182) is spaced apart from the second flange (74) as the second engagement member (182) rotates about the second rotational axis (180).

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