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Description

FIELD OF THE INVENTION

[0001] The invention relates to an impact tool according to the preamble of claim 1, which performs a predetermined operation on a workpiece by at least linear movement of a tool bit in an axial direction of the tool bit. Such an impact tool is known from US 2011/0000693 A1.

BACKGROUND OF THE INVENTION

[0002] US patent No. 4751970 discloses an angular attachment that is attached to a front end of a hammer drill and can transmit rotation and linear movement of a hammer drill body to a tool bit which is oriented at a different angle at an output of the attachment. The angular attachment is designed such that an output part of the tool bit intersects at 90 degrees with an output part of the hammer drill body. Therefore, in performing a drilling operation, for example, on an inner wall surface of a U-shaped drainage ditch (made of concrete), although a conventional hammer drill cannot be inserted into the U-shaped ditch since its body is much longer in its entire length in the axial direction of a tool bit than the inner width of the U-shaped ditch, the above-described known hammer drill can be inserted into the U-shaped ditch by using the angular attachment.

[0003] In the above-described known technique, although the length of the tool bit in the axial direction is shortened by attaching the angular attachment to the output part of the hammer drill, efficient transmission of rotation and linear movement to the tool bit is not realized and the length of the tool body in the axial direction of the tool bit is not shortened.

[0004] EP 2 444 206 A1 (corresponds to JP 2011-000684 (A)) and US 2009/0020302 A1 and DE 10 2006 061 625 A1 (corresponds to US 2011-0000693 A1) each disclose an impact tool according to the preamble of claim 1.

[0005] US 964,875, US 1,959,458, DE 10 2007 059 896 A1, FR 2 938 461 and DE-US 1 938 738 disclose other impact mechanisms.

[0006] It is, accordingly, an object of the invention to provide an impact tool having a tool body of which length in an axial direction of a tool bit is downsized.

MEANS FOR SOLVING THE PROBLEMS

[0007] The object is solved by an impact tool according to claim 1. Further developments are given in the dependent claims.

[0008] According to the invention as disclosed in claim 1, the length of the tool body in the axial direction of the tool bit is defined by the tool holder and the impact cylinder. By provision of this construction, compared with the known impact tool in which the length of the tool body in the axial direction of the tool bit is defined not only by

the tool holder and the impact cylinder but by a mechanism for fluctuating pressure of the air chamber, the length of the tool body in the axial direction of the tool bit can be shortened, so that it can be suitably used for an operation in a limited space. Further, unlike the known angular attachment, the impact force of the striking element can be directly transmitted to the tool bit, so that power transmission can be made without loss.

[0009] According to a preferred embodiment of the impact tool, the impact tool further has a compressed-air feeding cylinder for supplying compressed air to the air chamber of the cylinder. The compressed-air feeding cylinder extends in a different direction from an extending direction of the impact cylinder. Further, the manner of "extending in a different direction" here represents the manner in which the compressed-air feeding cylinder extends in a direction perpendicular or angled to the extending direction of the impact cylinder.

[0010] Generally, in an impact tool, a tool holder that holds a tool bit, an impact cylinder that houses a striking element for applying an impact force to the tool bit and has an air chamber for applying compressed air to the striking element, and a piston that generates compressed air in the air chamber and a driving mechanism for the piston are arranged in series in the axial direction of the tool bit. According to this embodiment, with the construction in which the compressed-air feeding cylinder for applying compressed air to the air chamber of the impact cylinder extends in a different direction from the extending direction of the impact cylinder, the length of the impact tool in the axial direction of the tool bit can be shortened.

[0011] According to the invention, the impact tool has a handgrip which is connected to the tool body and designed to be held by a user in order to operate the impact tool, and a width direction of the handgrip preferably coincides with the extending direction of the impact cylinder. Further, the "width direction of the handgrip" here represents a direction transverse to the extending direction of a grip part of the handgrip to be held by the user's hand, for example, in the case of the handgrip which has the grip part having a linearly extending region. According to this preferred embodiment, by provision of the construction in which the width direction of the handgrip coincides with the extending direction of the impact cylinder, when holding the handgrip with the user's hand, the user's arm (forearm) extends in the extending direction of the impact cylinder or in a direction transverse to the axial direction of the tool bit. Specifically, the extending direction of the arm intersects with the axial direction of the tool bit. Therefore, when performing an operation, for example, on an inner wall surface of a U-shaped drainage ditch (made of concrete), the arm of the user holding the handgrip does not get in the way of the operation.

[0012] According to a further preferred embodiment of the impact tool, the axial direction of the tool bit, the extending direction of the compressed-air feeding cylinder and the extending direction of the handgrip intersect one

another.

[0013] According to this embodiment, with the above-described construction, the impact tool can be compact as a whole.

[0014] According to the invention, the impact tool further has a motion converting mechanism that converts rotation into linear motion and thereby generates compressed air in the air chamber of the impact cylinder. Further, a rotating shaft of the motion converting mechanism is preferably disposed in parallel to the impact cylinder in a predetermined region along the extending direction of the impact cylinder. In this case, the rotating shaft of the motion converting mechanism preferably intersects with the extending direction of the impact cylinder.

[0015] According to this preferred embodiment, the motion converting mechanism for generating compressed air in the air chamber is disposed in parallel to the impact cylinder. Therefore, the length of the impact tool in the axial direction of the tool bit can be shortened, compared with the known impact tool in which the motion converting mechanism is disposed outside a region of the impact cylinder in its longitudinal direction.

[0016] According to the invention, the impact tool has a handgrip designed to be held by a user in order to operate the impact tool, and the extending directions of the impact cylinder and the handgrip are preferably a parallel to each other.

[0017] According to this preferred embodiment, with the construction in which the extending direction of the handgrip coincides with the extending direction of the impact cylinder, when holding the handgrip with the user's hand, the user's arm (forearm) extends in the extending direction of the impact cylinder or in a direction transverse to the axial direction of the tool bit. Specifically, the extending direction of the arm intersects with the axial direction of the tool bit. Therefore, when performing an operation, for example, on an inner wall surface of a U-shaped ditch, the arm of the user holding the handgrip does not get in the way of the operation.

EFFECT OF THE INVENTION

[0018] According to the invention as defined in claim 1, an impact tool is provided with a tool body of which length in the axial direction of a tool bit is downsized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a sectional plan view showing an entire hammer drill according to a first embodiment.

FIG. 2 is a sectional view taken along line A-A in FIG. 1.

FIG. 3 is a sectional view taken along line B-B in FIG. 2.

FIG. 4 is a sectional view showing a modification to

gear arrangement.

FIG. 5 is a sectional view showing a modification to feeding of compressed air.

FIG. 6 is a sectional view taken along line C-C in FIG. 5.

FIG. 7 is a sectional view showing a further modification to feeding of compressed air.

FIG. 8 is a sectional view taken along line D-D in FIG. 7.

FIG. 9 is a sectional view showing a further modification to feeding of compressed air.

FIG. 10 is a sectional view showing an entire hammer drill according to a second embodiment.

FIG. 11 is an enlarged sectional view showing a motion converting mechanism, in a state in which a piston is moved rearward.

FIG. 12 is a side view showing the motion converting mechanism.

FIG. 13 is a sectional view for showing a sectional shape of an impact cylinder taken along line F-F in FIG. 12.

FIG. 14 is a sectional view showing a modification to the second embodiment.

FIG. 15 is an enlarged sectional view showing the motion converting mechanism according to the modification of FIG. 14, in a state in which the piston is moved rearward.

REPRESENTATIVE EMBODIMENT

(First Embodiment)

[0020] A first embodiment is now described with reference to FIGS. 1 to 3. In this embodiment, an electric hammer drill is described as a representative example of a power tool. As shown in FIGS. 1 and 2, a hammer drill 101 of this embodiment mainly includes a body 103 that forms an outer shell of the hammer drill 101, a hammer bit 119 detachably coupled to one end (front end region) of the body 103 in its longitudinal direction via a tool holder 137, and a handgrip 109 that is provided as a main handle on the opposite side of the body 103 from the hammer bit 119.

[0021] The hammer bit 119 is provided such that its axis extends in a direction transverse to the longitudinal direction of the body 103, and the hammer bit 119 is held by a tool holding member in the form of the hollow tool holder 137 such that it is allowed to linearly move in a longitudinal direction of the tool holder 137 with respect to the tool holder. Thus, the tool holder 137 extends in a direction transverse to the longitudinal direction of the body 103 or in a width direction of the body 103. The body 103 and the hammer bit 119 are features that correspond to the "tool body" and the "tool bit", respectively.

[0022] The body 103 mainly includes an outer housing 105 and an inner housing in the form of a gear housing 107 which is largely covered by the outer housing 105. The outer housing 105 includes a motor housing that

houses a driving motor 111, and the gear housing 107 houses a motion converting mechanism 113, a compression device 114, a striking mechanism 115 and a power transmitting mechanism 117.

[0023] The handgrip 109 is configured as a D-shaped handle having a grip 109a which is designed to be held by a user. The grip 109a extends in a vertical direction transverse to the longitudinal direction of the body 103 and has upper and lower ends connected to the outer housing 105. An axis of the hammer bit 119 extends in a horizontal direction transverse to the longitudinal direction of the body 103 and to the extending direction of the handgrip 109.

[0024] Further, as shown in FIG. 1, the hammer drill 101 has an auxiliary handle in the form of a side grip 110 separately from the above-described handgrip 109. The side grip 110 is a rod-like member extending in a direction transverse to the axial direction of the hammer bit 119. One axial end of the side grip 110 is removably mounted on a generally cylindrical barrel 107a which houses the tool holder 137, and a fixed position of the side grip 110 to the barrel 107a can be adjusted in a circumferential direction around the axis of the hammer bit 119. The barrel 107a is provided as a region of the gear housing 107 which is exposed to the outside through the side surface of the outer housing 105.

[0025] As shown in FIG. 2, the driving motor 111 is disposed such that its axis of rotation runs vertically in a direction (a vertical direction in FIG. 2) generally perpendicular to the longitudinal direction of the body 103. Rotating power of the driving motor 111 is converted into linear motion via the motion converting mechanism 113 and then drives the compression device 114. Compressed air generated by the compression device 114 is led to an impact cylinder 141 and drives the striking mechanism 115. Thus, an impact force is generated in the axial direction (the vertical direction in FIG. 1) of the hammer bit 119 via the striking mechanism 115.

[0026] The power transmitting mechanism 117 reduces the speed of the rotating output of the driving motor 111 and then transmits it to the hammer bit 119 via the tool holder 137, so that the hammer bit 119 is caused to rotate in the circumferential direction. Further, the driving motor 111 is driven by depressing an operating member in the form of a trigger 147 which is disposed on the handgrip 109, and the direction of rotation of the driving motor 111 can be changed by sliding a normal/reverse selector switch 149 disposed adjacent to the trigger 147. A direction in which the normal/reverse selector switch 149 is slid can be arbitrarily set.

[0027] As shown in FIG. 2, the motion converting mechanism 113 mainly includes a driving gear 121 that is formed on a motor shaft 111a of the driving motor 111 and rotationally driven in a horizontal plane, a driven gear 123 that is engaged with the driving gear 121, a crank shaft 125 that rotates together with the driven gear 123, a crank pin 126 that is eccentrically disposed on the crank shaft 125, a crank arm 127 that is loosely connected to

the crank pin 126 and a driving element in the form of a piston 129 that is mounted to the crank arm 127 via a connecting shaft 128. The motor shaft 111a and the crank shaft 125 are disposed side by side in parallel to each other. The crank shaft 125, the crank pin 126, the crank arm 127 and the piston 129 which are described above, form the crank mechanism.

[0028] The piston 129 is slidably disposed within a bore of an air compression cylinder 131 and the piston 129 and the air compression cylinder 131 form the compression device 114. The air compression cylinder 131 is a feature that corresponds to the "compressed-air feeding cylinder". The air compression cylinder 131 has a compression chamber 131a partitioned by the gear housing 107 and the piston 129. The piston 129 generates compressed air by reducing (decreasing) a volume of the compression chamber 131a and supplies the compressed air to an air chamber 141a of the impact cylinder 141 through an air passage 133 formed in the gear housing 107. The air compression cylinder 131 extends in a same direction as the longitudinal direction of the body 103 and in a direction transverse to both the axial direction of the hammer bit 119 and the extending direction of the handgrip 109. Specifically, the axial direction of the hammer bit 119, the extending direction of the air compression cylinder 131 and the extending direction of the handgrip 109 intersect one another.

[0029] The striking mechanism 115 mainly includes a striking element in the form of a striker 143 that is slidably disposed within a bore of the impact cylinder 141, and an intermediate element in the form of an impact bolt 145 that is slidably disposed within the tool holder 137 and serves to transmit kinetic energy of the striker 143 to the hammer bit 119. The impact cylinder 141 has the air chamber 141a extending in the axial direction of the hammer bit 119 and partitioned by the striker 143 and an inner wall surface 107b of the gear housing 107 which faces the striker 143. When compressed air is generated by movement of the piston 129 in a direction (to the left as viewed in FIGS. 1 and 2) that reduces the volume of the compression chamber 131a and supplied to the air chamber 141a of the impact cylinder 141, the striker 143 is moved forward by this compressed air and then collides with (strikes) the impact bolt 145 and transmits an impact force to the hammer bit 119 via the impact bolt 145.

[0030] When the piston 129 is moved in a direction that increases the volume of the compression chamber 131a, a negative pressure is formed in the air chamber 141a of the impact cylinder 141. Therefore, the striker 143 is sucked by this negative pressure, moved toward the inner wall surface 107b and returned to its retracted position. In order to avoid the striker 143 from colliding with the inner wall surface 107b facing the striker 143 during this return and to secure a predetermined space between the striker 143 and the inner wall surface 107b, a cushioning spring 144 is mounted on the inner wall surface 107b.

[0031] In this embodiment, one end of the air passage

133 is open at the bottom of the compression chamber 131a of the air compression cylinder 131 and the other end is open at a head (a part facing the striker 143) of the air chamber 141a of the impact cylinder 141. With such a construction, compressed air is fed in the longitudinal direction of the impact cylinder 141 through the air passage 133. Further, in this embodiment, the impact cylinder 141 is integrally formed by an extension of the tool holder 137 extending in its longitudinal direction. It may however be constructed such that the tool holder 137 and the impact cylinder 141 are separately formed and connected to each other.

[0032] The impact cylinder 141 and thus the tool holder 137 are caused to rotate via the power transmitting mechanism 117 by the driving motor 111. As shown in FIG. 2, the power transmitting mechanism 117 mainly includes a first intermediate gear 151 that engages with the driving gear 121 driven by the driving motor 111, a second intermediate gear 153 that engages with the first intermediate gear 151, a small bevel gear 155 that rotates together with the second intermediate gear 153 and a large bevel gear 157 that engages with the small bevel gear 155. A first intermediate shaft 152 having the first intermediate gear 151 fitted thereon and a second intermediate shaft 154 having the second intermediate gear 153 and the small bevel gear 155 fitted thereon are disposed in parallel to the motor shaft 111a of the driving motor 111 and rotatably supported on the gear housing 107. The large bevel gear 157 having a rotation axis perpendicular to that of the small bevel gear 155 is rotatably fitted on the impact cylinder 141 and connected to the impact cylinder 141 via a torque limiter 159 (see FIG. 1).

[0033] The torque limiter 159 has clutch teeth 159a which engage with clutch teeth 157a of the large bevel gear 157, and is normally biased in a direction of engagement between the clutch teeth 157a, 159a by a biasing spring (compression coil spring) 161. When resistance torque on the hammer bit 119 reaches a set value, the torque limiter 159 moves in a direction away from the large bevel gear 157 against the biasing force of the biasing spring 161. Thus, the clutch teeth 157a, 159a are disengaged from each other, which results in interrupting transmission of rotation from the large bevel gear 157 to the impact cylinder 141. Further, as shown in FIG. 3, the motor shaft 111a, the crank shaft 125 and the first and second intermediate shafts 152, 154 are disposed on the same straight line P extending in the longitudinal direction of the body 103.

[0034] The hammer drill according to this embodiment is constructed as described above. Therefore, when the driving motor 111 is driven by depressing the trigger 147, the motion converting mechanism 113 is driven. Then, the piston 129 is rectilinearly slid within the air compression cylinder 131 and thus compresses the air in the compression chamber 131a and supplies the compressed air to the air chamber 141a of the impact cylinder 141 via the air passage 133. As a result, the striker 143 moves forward within the impact cylinder 141 and collides with

the impact bolt 145, so that the kinetic energy of the striker 143 which is caused by the collision is transmitted to the hammer bit 119.

[0035] Further, the rotating output of the driving motor 111 is transmitted to the impact cylinder 141 via the power transmitting mechanism 117. Therefore, the impact cylinder 141, the tool holder 137 and the hammer bit 119 held by the tool holder 137 are caused to rotate together. In this manner, the hammer bit 119 performs a drilling operation on a workpiece by linear motion in the axial direction and rotation in the circumferential direction.

[0036] In this embodiment, in the hammer drill 101 constructed such that the striker 143 is driven by the compressed air in the air chamber 141a of the impact cylinder 141, the air compression cylinder 131 is provided separately from the impact cylinder 141 and the striker 143 is driven by supplying the compressed air generated in the compression chamber 131a of the air compression cylinder 131 to the air chamber 141a of the impact cylinder 141. Further, the air compression cylinder 131 is disposed such that it extends in a direction transverse to the extending direction of the impact cylinder 141. By provision of this construction, the length of the body 103 in the striking direction or the axial direction of the hammer bit 119 is defined by the extending lengths of the tool holder 137 for holding the hammer bit 119 and the impact cylinder 141. The impact cylinder 141 houses the striker 143 for applying the impact force to the hammer bit 119 and has the air chamber 141a for applying the compressed air to the striker 143.

[0037] According to this embodiment, compared with a known hammer drill having the construction in which the striker 143 is driven via pressure fluctuations of the air chamber 131a caused by linear movement of the piston 129 in the impact cylinder 141, the length of the body 103 in the striking direction of the hammer bit 119 can be shortened. Therefore, in performing a drilling operation, for example, on an inner wall surface of a U-shaped drainage ditch (made of concrete), the tool body 103 can be inserted into the U-shaped ditch with the axis of the hammer bit 119 extending in the width direction of the ditch.

[0038] In the hammer drill 101 according to this embodiment, the impact force of the striker 143 is linearly transmitted to the hammer bit 119. With this construction, compared with a construction in which the impact force of the striker is transmitted to the hammer bit via an angular attachment attached to the front end of the hammer drill, the impact force of the striker 143 can be transmitted to the hammer bit 119 without loss.

[0039] During drilling operation, the user operates the hammer drill 101 while holding the main handle in the form of the handgrip 109 and the auxiliary handle in the form of the side grip 110. In this embodiment, the impact cylinder 141 is designed to extend in the width direction of the handgrip 109 or in a direction transverse to the extending direction of the grip 109a. With this construction, when holding the grip 109a of the handgrip 109 with

the user's hand, the user's arm (forearm) extends in a direction transverse to the extending direction of the impact cylinder 141. Therefore, when performing an operation, for example, on an inner wall surface of a U-shaped ditch, the arm of the user holding the handgrip 109 does not get in the way of the operation.

[0040] In this embodiment, a rear end region of the outer housing 105 in the striking direction is designed as an auxiliary grip 163 (see FIG. 1) which can be pressed with a user's whole palm in case that the side grip 110 is found to be hard to use, or that the side grip 110 is not provided. By provision of this construction, when performing a drilling operation, the user can hold the handgrip 109 with one hand and press the auxiliary handle 163 in the striking direction with the other hand.

[0041] The size (outer diameter) of the driving motor 111 determines the external dimensions of the motor housing 105a of the outer housing 105 which covers the driving motor 111. In this embodiment, as shown in FIG. 3, the driving gear 121, the driven gear 123 of the motion converting mechanism 113 and the first intermediate gear 151 of the power transmitting mechanism 117 are disposed in series on a straight line P which extends in a radial direction through a center of the second intermediate gear 153 (the small bevel gear 155) and in parallel to a rear surface 105b of the outer housing 105 in the striking direction (to the longitudinal direction of the piston 129). By provision of such gear arrangement, if the size (outer diameter) of the driving motor 111 is relatively small, the motor housing 105a of the outer housing 105 can be prevented from bulging rearward of the rear surface 105b of the outer housing 105 in the striking direction. As a result, such gear arrangement doesn't interfere with shortening the length of the body 103 in the striking direction.

[0042] On the other hand, if the size (outer diameter) of the driving motor 111 is relatively large, the motor housing 105a of the outer housing 105 may bulge rearward of the rear surface 105b of the outer housing 105 in the striking direction, so that such gear arrangement interferes with shortening the length of the body 103 in the striking direction. Therefore, a modification as shown in FIG. 4 is provided in order to avoid bulging of the motor housing 105a when the size (outer diameter) of the driving motor 111 is relatively large.

[0043] In this modification, the driving gear 121, the driven gear 123 of the motion converting mechanism 113 and the first intermediate gear 151 of the power transmitting mechanism 117 are disposed on a straight line P1 which is displaced a predetermined distance E in the striking direction from the straight line P extending in a radial direction through the center of the second intermediate gear 153 (the small bevel gear 155) and in parallel to the rear surface 105b of the outer housing 105 in the striking direction. With this construction, the motor housing 105a can be prevented from bulging rearward of the rear surface 105b of the outer housing 105 in the striking direction.

[0044] A modification to a feeding passage of compressed air in this embodiment is now described with reference to FIGS. 5 and 6. In the above-described embodiment, compressed air is supplied into the air chamber 141a through the head of the impact cylinder 141. In this modification, however, the air passage 133 for supplying compressed air is formed through a sidewall of the impact cylinder 141 such that the compressed air is supplied into the air chamber 141a in the radial direction from the side or from a direction transverse to the longitudinal direction of the impact cylinder 141. With this construction, compared with the construction in which compressed air is supplied through the head of the impact cylinder 141, the length of the air passage 133 required can be shorter, and thus the length of the tool body 103 in the striking direction can be further shortened that much.

[0045] Further, in this modification, the air passage 133 is directly connected to the impact cylinder 141, so that the impact cylinder 141 cannot be rotated. Therefore, the impact cylinder 141 is formed separately from the tool holder 137 and fixed to the gear housing 107. Further, the tool holder 137 has an extension 137a which is fitted on the impact cylinder 141 and can rotate with respect to the impact cylinder 141, and the large bevel gear 157 is fitted on the extension 137a and can rotate together with the extension 137a. By provision of this construction, even though the impact cylinder 141 is fixed to the gear housing 107, the rotating output of the driving motor 111 can be transmitted to the tool holder 137 for holding the hammer bit 119.

[0046] A further modification to the feeding passage of compressed air in this embodiment is now described with reference to FIGS. 7 and 8. In this modification, a ring-like member 165 and a connecting pipe 167 form the air passage 133. The ring-like member 165 is fitted on the impact cylinder 141 such that it can rotate with respect to the impact cylinder 141, and has an annular groove 165a formed in its inner circumferential surface and extending in its circumferential direction. The connecting pipe 167 serves to provide communication between the compression chamber 131a of the air compression chamber 131 and the annular groove 165a of the ring-like member 165. Further, the annular groove 165a communicates with the air chamber 141a via a plurality of vent holes 169 which are formed in the wall of the impact cylinder 141 and arranged in the circumferential direction. Therefore, according to this modification, in the construction in which the impact cylinder 141 rotates together (is integrally formed) with the tool holder 137, the compressed air of the air compression chamber 131 can be supplied to the air chamber 141a from the side or from a direction transverse to the longitudinal direction of the impact cylinder 141. Therefore, like the modification as viewed in FIG. 4, the length of the tool body 103 in the striking direction can be further shortened.

[0047] A further modification to the feeding passage of compressed air in this embodiment is now described with

reference to FIG. 9. In this modification, the air compression cylinder 131 is obliquely disposed such that its longitudinal axis is inclined at a predetermined angle with respect to the longitudinal direction of the body 103. Further, a front end of a tubular part 171 protrudes from the bottom of the compression chamber 131a and is connected to the gear housing 107. Further, the head of the impact cylinder 141 is opposed to the inner wall surface of the gear housing 107 with a predetermined clearance such that the clearance forms an inner passage 173 to the air chamber 141 a. The inner passage 173 communicates with the compression chamber 131a of the air compression cylinder 131 via the tubular part 171 connected to the gear housing 107.

[0048] According to this modification, like the modification as viewed in FIGS. 7 and 8, in the construction in which the impact cylinder 141 rotates together (is integrally formed) with the tool holder 137, the compressed air of the air compression chamber 131 can be supplied to the air chamber 141a from the side or from a direction transverse to the longitudinal direction of the impact cylinder 141. Therefore, the length of the tool body 103 in the striking direction can be further shortened.

(Second Embodiment)

[0049] A second embodiment is now described with reference to FIGS. 10 to 13. Further, the description of the second embodiment is focused on the points of difference in order to avoid overlapping descriptions with the first embodiment, and components in this embodiment which are substantially identical to those in the first embodiment are given like numerals as in the first embodiment. As shown in the drawings, in this embodiment, the piston 129 which is one of components forming the motion converting mechanism 113 and performs linear movement is slidably disposed within the bore of the impact cylinder 141. Therefore, the striker 143 is driven via pressure fluctuations of the air chamber 141a which are caused by sliding movement of the piston 129, collides with (strikes) the impact bolt 145 which is slidably fitted in the tool holder 137 and transmits the impact force to the hammer bit 119 via the impact bolt 145. Thus, the air compression cylinder in the first embodiment is not provided. The impact cylinder 141 is separately formed from the tool holder 137. The impact cylinder 141 is fitted in the tool holder 137 such that it can coaxially rotate with respect to the tool holder 137, and fixed to the gear housing 107.

[0050] The driving motor 111 is disposed such that the motor shaft 101a extends in the same direction as the longitudinal direction of the body 103 or in a direction transverse to the axial direction of the hammer bit 119 (the extending directions of the tool holder 137 and the impact cylinder 141). In this embodiment, the motion converting mechanism 113 for converting the rotating output of the driving motor 111 into linear motion is disposed in parallel to the impact cylinder 141 in a predetermined

region along the longitudinal direction of the impact cylinder 141. In other words, the motion converting mechanism 113 and the impact cylinder 141 are disposed to overlap each other when viewed from a direction (the longitudinal direction of the body 103) transverse to the axial direction of the hammer bit 119. Further, the rotation axis of the crank shaft 125 intersects with the extending direction of the impact cylinder 141. The crank shaft 125 is a feature that corresponds to the "rotation axis".

[0051] The motion converting mechanism 113 has a crank arm 181 formed by a generally U-shaped member. An escape groove 183 is formed in a peripheral wall (side wall) of the impact cylinder 141 in order to install the crank arm 181. A bottom region 181a of the U-shaped crank arm 181 (shown by a two-dot chain line in FIG. 12) has a circular section. The crank arm 181 is installed with the bottom region 181a through the escape groove 183, and in this state, one end of the crank arm 181 is connected to a connecting shaft 128 of the piston 129 and the other end is connected to the crank pin 126. The escape groove 183 has such a width and an axial length that the crank arm 181 is allowed to move in the longitudinal direction of the impact cylinder 141 while swinging on the connecting shaft 128.

[0052] As described above, in this embodiment, the crank arm 181 is U-shaped and allowed to move in the escape groove 183 formed in the peripheral wall of the impact cylinder 141. By provision of this construction, the motion converting mechanism 113 can be disposed in parallel to the impact cylinder 141 in a region along the extending direction (the longitudinal direction) of the impact cylinder 141. As a result, the length of the tool body 103 in the striking direction or the axial direction of the hammer bit 119 is defined by the extending lengths of the tool holder 137 for holding the hammer bit 119 and the impact cylinder 141 for housing the piston 129 and the striker 143. Therefore, the length of the tool body 103 in the striking direction can be shortened, compared with a known hammer drill in which the motion converting mechanism 113 is disposed in a rear position outside a region along the longitudinal direction of the impact cylinder 141.

[0053] When performing a drilling operation with the hammer drill 101 constructed as described above, for example, on an inner wall surface of a U-shaped ditch, like the first embodiment, the tool body 103 can be inserted into the U-shaped ditch with the axis of the hammer bit 119 extending in the width direction of the ditch. In this case, the impact force of the striker 143 is linearly transmitted to the hammer bit 119. With this construction, compared with the construction in which the impact force of the striker is transmitted to the hammer bit via an angular attachment attached to the front end of the hammer drill, the impact force of the striker 143 can be transmitted to the hammer bit 119 without loss.

[0054] The handgrip 109 is configured as a D-shaped handle having the grip 109a designed to be held by a user. The grip 109a extends in a direction transverse to

the longitudinal direction of the body 103 and in parallel to the extending direction of the impact cylinder 141, and has upper and lower ends connected to the outer housing 105. With this construction, the handgrip 109 can be configured to extend within the length of the hammer drill 101 in the striking direction.

[0055] The trigger 147 for starting and stopping the driving motor 111 and the normal/reverse selector switch 149 are disposed on the handgrip 109. In this embodiment, the trigger 147 and the normal/reverse selector switch 149 are disposed in a front region (a lower region as viewed in FIG. 10) of the handgrip 109 in the striking direction (along the extending direction of the handgrip 109). Specifically, in this embodiment, the handgrip 109 is designed and configured to be held such that the user's thumb and index finger are set on the front region of the handgrip 109 in the striking direction.

[0056] Further, a rear end region of the outer housing 105 in the striking direction is designed as an auxiliary grip 163 which can be pressed with a user's whole palm. By provision of this construction, when performing a drilling operation, the user can hold the handgrip 109 with one hand and press the auxiliary handle 163 in the striking direction with the other hand.

[0057] In this embodiment, as for the power transmitting mechanism 117 for transmitting the rotating output of the driving motor 111 to the hammer bit 119, rotation of an intermediate gear 185 which engages with the driving gear 121 driven by the driving motor 111 is transmitted to an intermediate shaft 186 via a torque limiter 187, and this rotation of the intermediate shaft 186 is transmitted from a small bevel gear 188 to the tool holder 137 via a large bevel gear 189 which engages with the small bevel gear 188. The small bevel gear 188 is integrally formed with an axial end of the intermediate shaft 186. The large bevel gear 189 is spline-fitted onto the tool holder 137 and rotates together with the tool holder 137. Specifically, the power transmitting mechanism 117 according to this embodiment has a single intermediate shaft, so that it is made simpler in structure compared with the power transmitting mechanism 117 of the first embodiment which has two intermediate shafts.

[0058] A modification to the second embodiment is now described with reference to FIGS. 14 and 15. In this modification, a crank arm 191 is formed by a linear rod-like member or a plate-like member. Further, the connecting shaft 128 of the piston 129 has an extension 128a which extends outward of the impact cylinder 141 through the escape groove 183, and the extension 128a is connected to a crank arm 191. Therefore, according to this modification, like in the second embodiment, the length of the tool body 103 in the striking direction can be shortened compared with the known hammer drill.

[0059] In this modification, the trigger 147 for starting and stopping the driving motor 111 and the normal/reverse selector switch 149 are disposed in a rear region (an upper region as viewed in FIG. 14) of the handgrip 109 in the striking direction (along the extending direction

of the handgrip 109). Specifically, in this embodiment, the handgrip 109 is designed and configured to be held such that the user's thumb and index finger are set on the rear region of the handgrip 109 in the striking direction.

[0060] In the above-described embodiment, the hammer drill 101 is described as a representative example of an impact tool, but the teachings can be applied to a hammer in which the hammer bit 119 is caused to perform only linear movement in the axial direction.

Description of Numerals

[0061]

101 hammer drill (impact tool)
 103 body
 105 outer housing
 105a motor housing
 105b rear surface in the striking direction
 107 gear housing
 107a barrel
 107b inner wall surface
 109 handgrip
 109a grip
 110 side grip
 111 driving motor
 111a motor shaft
 113 motion converting mechanism
 114 compression device
 115 striking mechanism
 117 power transmitting mechanism
 119 hammer bit (tool bit)
 121 driving gear
 123 driven gear
 125 crank shaft
 126 crank pin
 127 crank arm
 128 connecting shaft
 128a extension
 129 piston
 131 air compression cylinder
 131a compression chamber
 133 air passage
 137 tool holder
 137a extension
 141 impact cylinder
 141a air chamber
 143 striker (striking element)
 144 cushioning spring
 145 impact bolt
 147 trigger
 149 normal/reverse selector switch
 151 first intermediate gear
 152 first intermediate shaft
 153 second intermediate gear
 154 second intermediate shaft
 155 small bevel gear

157 large bevel gear
 157a clutch teeth
 159 torque limiter
 159a clutch teeth
 161 biasing spring
 163 auxiliary grip
 165 ring-like member
 165a annular groove
 167 connecting pipe
 169 vent hole
 171 tubular part
 173 inner passage
 181 crank arm
 181a U-shaped bottom region
 183 escape groove
 185 intermediate gear
 186 intermediate shaft
 187 torque limiter
 188 small bevel gear
 189 large bevel gear
 191 crank arm

Claims

1. An impact tool for performing a predetermined operation on a workpiece by at least linear movement of a tool bit, comprising
 a driving motor (111) having a rotation axis,
 a tool holder (137) that is adapted to hold a tool bit (119) so as to allow relative movement of the tool bit in an axial direction of the tool bit,
 a striking element (143) that is adapted to move linearly in the axial direction of the tool bit and to apply an impact force to the tool bit,
 an impact cylinder (141) that is connected to the tool holder (137), the impact cylinder housing the striking element (143) to allow relative movement, the impact cylinder having an air chamber (141a) that is adapted to cause compressed air to act upon the striking element,
 a motion converting mechanism (113) that is adapted to convert rotation output of the driving motor (111) into linear motion and to thereby generate compressed air in the air chamber (141a) of the impact cylinder,
 a handgrip (109, 109a) designed to be held by a user in order to operate the impact tool,
 a tool body (103) that has a front end and a rear end in its longitudinal direction, the tool body (103) having an outer housing (105), wherein the outer housing (105) houses the driving motor (111), wherein the tool holder (137) is provided at the region of the front end of the tool body (103) and the handgrip (109, 109a) is provided at the rear end of the tool body (103),
 wherein both the tool holder (137) and the impact cylinder (141) extend in the axial direction of the tool

bit (119), wherein the axial direction of the tool bit (119) extends in a direction transverse to the longitudinal direction,

characterized in that

- 5 the tool body (103) has a gear housing (107) largely covered by the outer housing (105), wherein the gear housing (107) houses the motion converting mechanism (113) and the impact cylinder (141),
- 10 wherein the length of the tool body (103) in the axial direction of the tool bit (119) is the sum of the length of the tool holder (137), the length of the impact cylinder (141), the width of end walls of the outer housing (105) and the gear housing (107), respectively,
- 15 at the end of the impact cylinder (141) opposite the tool bit (119), and optionally the width of an air passage (133) formed in the end wall of the gear housing (107).
- 20 2. The impact tool as defined in claim 1, further comprising a compressed-air feeding cylinder (131) for supplying compressed air to the air chamber of the impact cylinder, wherein the compressed-air feeding cylinder extends in a direction different from an extending direction of the impact cylinder (141).
- 25 3. The impact tool as defined in claim 2, wherein a width direction of the handgrip coincides with the extending direction of the impact cylinder (141).
- 30 4. The impact tool as defined in claim 3, wherein the extending direction of the compressed-air feeding cylinder intersects the axial direction of the tool bit, and the extending direction of the compressed-air feeding cylinder intersects the extending direction of the handgrip.
- 35 5. The impact tool as defined in claim 1, wherein the motion converting mechanism (113) is disposed in parallel to the impact cylinder (141) in a predetermined region along the extending direction of the impact cylinder,
- 40 6. The impact tool as defined in claim 5, wherein the rotating axis of a rotating shaft (125) of the motion converting mechanism (113) intersects with the extending direction of the impact cylinder (141).
- 45 7. The impact tool as defined in claim 5 or 6, wherein the extending directions of the impact cylinder (141) and the handgrip (109, 109a) are parallel.
- 50
- 55

Patentansprüche

1. Schlagwerkzeug zum Ausführen eines vorbestimmten Arbeitsvorganges an einem Werkstück durch zumindest lineare Bewegung eines Werkzeugbits, mit

einem Antriebsmotor (111), der eine Drehachse aufweist,
 einem Werkzeughalter (137), der zum Halten eines Werkzeugbits (119) so angepasst ist, dass er eine relative Bewegung des Werkzeugbits in eine axiale Richtung des Werkzeugbits ermöglicht,
 einem Schlagelement (143), das dazu angepasst ist, sich linear in der axialen Richtung des Werkzeugbits zu bewegen und eine Schlagkraft dem Werkzeugbit aufzubringen,
 einem Schlagzylinder (141), der mit dem Werkzeughalter (137) verbunden ist, wobei der Schlagzylinder das Schlagelement (143) so aufnimmt, dass er eine relative Bewegung ermöglicht, und der Schlagzylinder eine Luftkammer (141a) aufweist, die zum Bewirken, dass komprimierte Luft auf das Schlagelement wirkt, angepasst ist,
 einem Bewegungsumwandlungsmechanismus (113), der dazu angepasst ist, eine Drehausgabe des Antriebsmotors (111) in eine lineare Bewegung umzuwandeln, und dabei komprimierte Luft in der Luftkammer (141a) des Schlagzylinders erzeugt,
 einem Handgriff (109, 109a), der so gestaltet ist, dass ihn ein Benutzer zum Betätigen des Schlagwerkzeugs halten kann,
 einem Werkzeughalter (103), der ein vorderes Ende und ein hinteres Ende in seiner Längsrichtung aufweist, und der Werkzeughalter (103) ein äußeres Gehäuse (105) aufweist, wobei das äußere Gehäuse (105) den Antriebsmotor (111) aufnimmt, bei dem der Werkzeughalter (137) in dem Bereich des vorderen Endes des Werkzeughalters (103) vorgesehen ist und der Handgriff (109, 109a) an dem hinteren Ende des Werkzeughalters (103) vorgesehen ist,
 bei dem sich sowohl der Werkzeughalter (137) als auch der Schlagzylinder (141) in der axialen Richtung des Werkzeugbits (119) erstrecken, wobei sich die axiale Richtung des Werkzeugbits (119) in eine Richtung transversal zur der Längsrichtung erstreckt,
dadurch gekennzeichnet, dass
 der Werkzeughalter (103) ein Getriebegehäuse (107) aufweist, das überwiegend durch das äußere Gehäuse (105) abgedeckt ist,
 bei dem das Getriebegehäuse (107) den Bewegungsumwandlungsmechanismus (113) und den Schlagzylinder (141) aufnimmt,
 bei dem die Länge des Werkzeughalters (103) in der axialen Richtung des Werkzeugbits (119) die Summe der Länge des Werkzeughalters (137), der Länge des Schlagzylinders (141), der Breite von Endwänden des äußeren Gehäuses (105) bzw. des Getriebegehäuses (107) an dem Ende des Schlagzylinders (141), das dem Werkzeugbit (119) gegenüberliegt, und optional der Breite einer Luftpassage (133) ist, die in der Endwand des Getriebegehäuses (107) ausgebildet ist.

2. Schlagwerkzeug nach Anspruch 1, das weiter einen Kompressionsluftzuführungszyylinder (131) zum Zuführen von komprimierter Luft zu der Luftkammer des Schlagzylinders aufweist, bei dem sich der Kompressionsluftzuführungszyylinder in einer von einer Erstreckungsrichtung des Schlagzylinders (141) unterschiedlichen Richtung erstreckt.
3. Schlagwerkzeug nach Anspruch 2, bei dem eine Breitenrichtung des Handgriffes mit der Erstreckungsrichtung des Schlagzylinders (141) zusammenfällt.
4. Schlagwerkzeug nach Anspruch 3, bei dem die Erstreckungsrichtung des Kompressionsluftzuführungszyinders die axiale Richtung des Werkzeugbits kreuzt und die Erstreckungsrichtung des Kompressionsluftzuführungszyinders die Erstreckungsrichtung des Handgriffes kreuzt.
5. Schlagwerkzeug nach Anspruch 1, bei dem der Bewegungsumwandlungsmechanismus (113) parallel zu dem Schlagzylinder (141) in einem vorbestimmten Bereich entlang der Erstreckungsrichtung des Schlagzylinders angeordnet ist.
6. Schlagwerkzeug nach Anspruch 5, bei dem die Drehachse einer Drehwelle (125) des Bewegungsumwandlungsmechanismus (113) mit der Erstreckungsrichtung des Schlagzylinders (141) kreuzt.
7. Schlagwerkzeug nach Anspruch 5 oder 6, bei dem die Erstreckungsrichtungen des Schlagzylinders (141) und des Handgriffes (109, 109a) parallel sind.

Revendications

1. Outil à percussion pour réaliser une opération prédéterminée sur une pièce de travail par au moins un mouvement linéaire d'une mèche d'outil, comprenant
 un moteur d'entraînement (111) présentant un axe de rotation,
 un support d'outil (137) qui est adapté pour maintenir une mèche d'outil (119) de sorte à permettre le mouvement relatif de la mèche d'outil dans une direction axiale de la mèche d'outil,
 un élément de frappe (143) qui est adapté pour se déplacer linéairement dans la direction axiale de la mèche d'outil et pour appliquer une force d'impact à la mèche d'outil,
 un cylindre à percussion (141) qui est relié au support d'outil (137), le cylindre à percussion logeant l'élément de frappe (143) pour permettre le mouvement relatif, le cylindre à percussion présentant une chambre d'air (141 a) qui est adaptée pour amener l'air compressé à agir sur l'élément de frappe,

un mécanisme de conversion de mouvement (113) qui est adapté pour convertir la sortie de rotation du moteur d'entraînement (111) en mouvement linéaire et pour générer par là même l'air comprimé dans la chambre d'air (141a) du cylindre à percussion, une poignée (109, 109a) conçue pour être tenue par un utilisateur afin d'actionner l'outil à percussion, un corps d'outil (103) qui présente une extrémité avant et une extrémité arrière dans sa direction longitudinale, le corps d'outil (103) présentant un logement extérieur (105), dans lequel le logement extérieur (105) loge le moteur d'entraînement (111), dans lequel le support d'outil (137) est prévu sur la région de l'extrémité avant du corps d'outil (103) et la poignée (109, 109a) est prévue sur l'extrémité arrière du corps d'outil (103), dans lequel à la fois le support d'outil (137) et le cylindre à percussion (141) s'étendent dans la direction axiale de la mèche d'outil (119), dans lequel la direction axiale de la mèche d'outil (119) s'étend dans une direction transversale à la direction longitudinale,

caractérisé en ce que

le corps d'outil (103) présente un logement d'engrenage (107) couvert largement par le logement extérieur (105),

dans lequel le logement d'engrenage (107) loge le mécanisme de conversion de mouvement (113) et le cylindre à percussion (141),

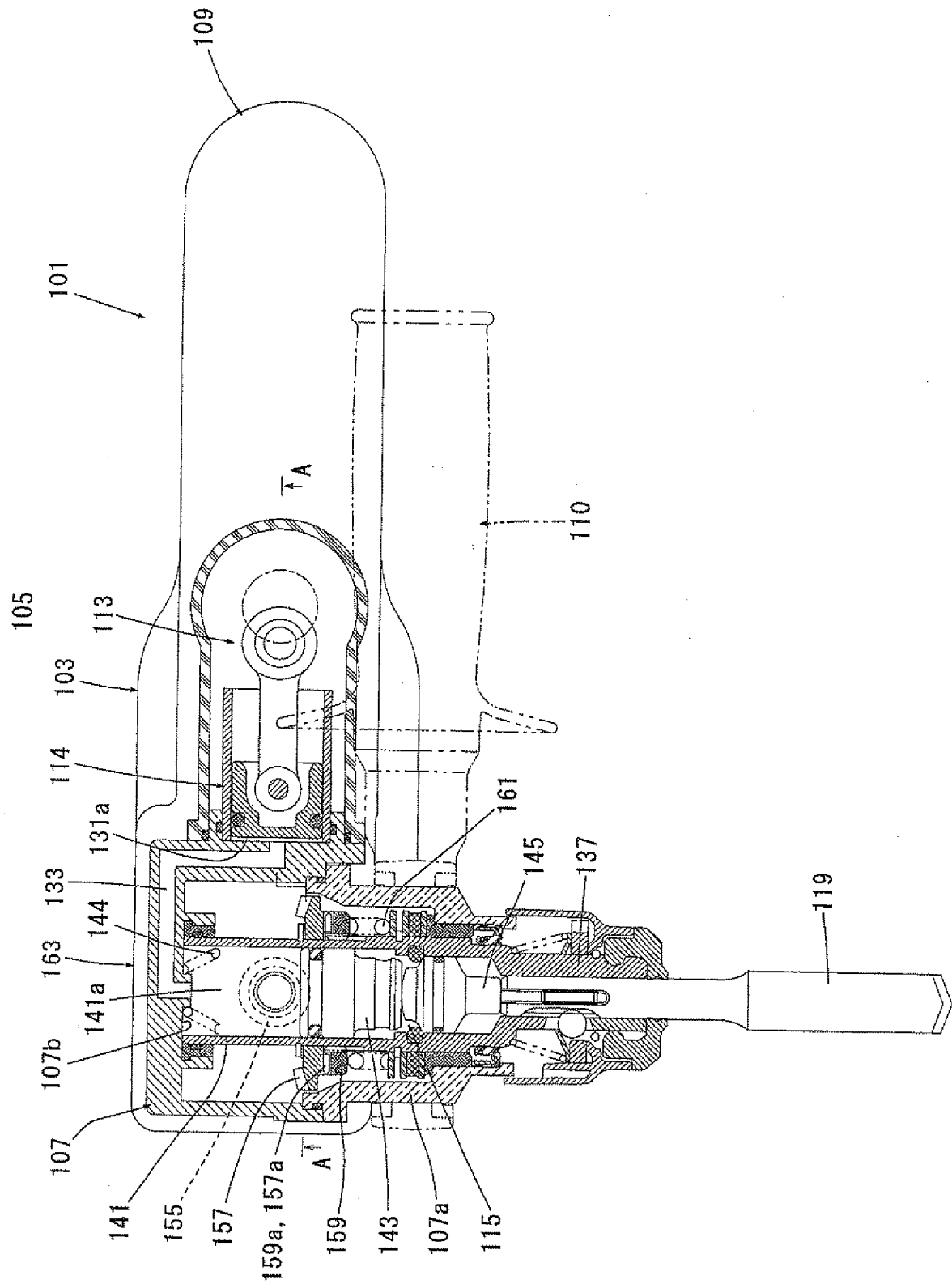
dans lequel la longueur du corps d'outil (103) dans la direction axiale de la mèche d'outil (119) est la somme de la longueur du support d'outil (137), la longueur du cylindre à percussion (141), la largeur de parois d'extrémité du logement extérieur (105) et du logement d'engrenage (107) respectivement, sur l'extrémité du cylindre à percussion (141) en regard de la mèche d'outil (119), et en option la largeur d'un passage d'air (133) formé dans la paroi d'extrémité du logement d'engrenage (107).

2. Outil à percussion selon la revendication 1, comprenant en outre un cylindre d'alimentation à air comprimé (131) pour fournir de l'air comprimé à la chambre d'air du cylindre à percussion, dans lequel le cylindre d'alimentation à air comprimé s'étend dans une direction différente d'une direction d'extension du cylindre à percussion (141).
3. Outil à percussion selon la revendication 2, dans lequel une direction de largeur de la poignée coïncide avec la direction d'extension du cylindre à percussion (141).
4. Outil à percussion selon la revendication 3, dans lequel la direction d'extension du cylindre d'alimentation à air comprimé croise la direction axiale de la mèche d'outil, et la direction d'extension du cylindre d'alimentation à air comprimé croise la direction

d'extension de la poignée.

5. Outil à percussion selon la revendication 1, dans lequel le mécanisme de conversion de mouvement (113) est disposé parallèlement au cylindre à percussion (141) dans une région prédéterminée le long de la direction d'extension du cylindre à percussion.
6. Outil à percussion selon la revendication 5, dans lequel l'axe de rotation d'un arbre de rotation (125) du mécanisme de conversion de mouvement (113) croise la direction d'extension du cylindre à percussion (141).
7. Outil à percussion selon la revendication 5 ou 6, dans lequel les directions d'extension du cylindre à percussion (141) et de la poignée (109, 109a) sont parallèles.

FIG. 1



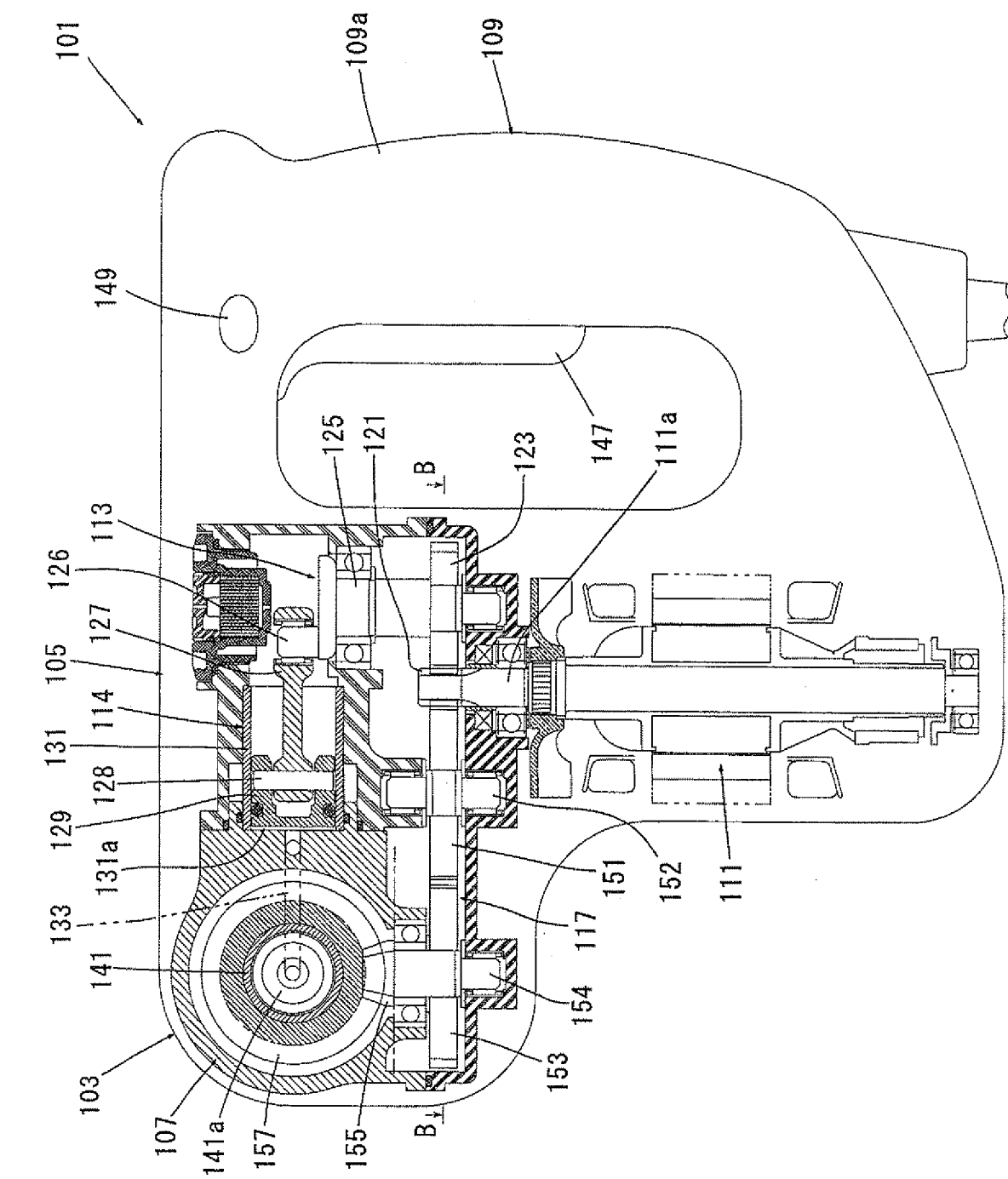


FIG. 2

FIG. 3

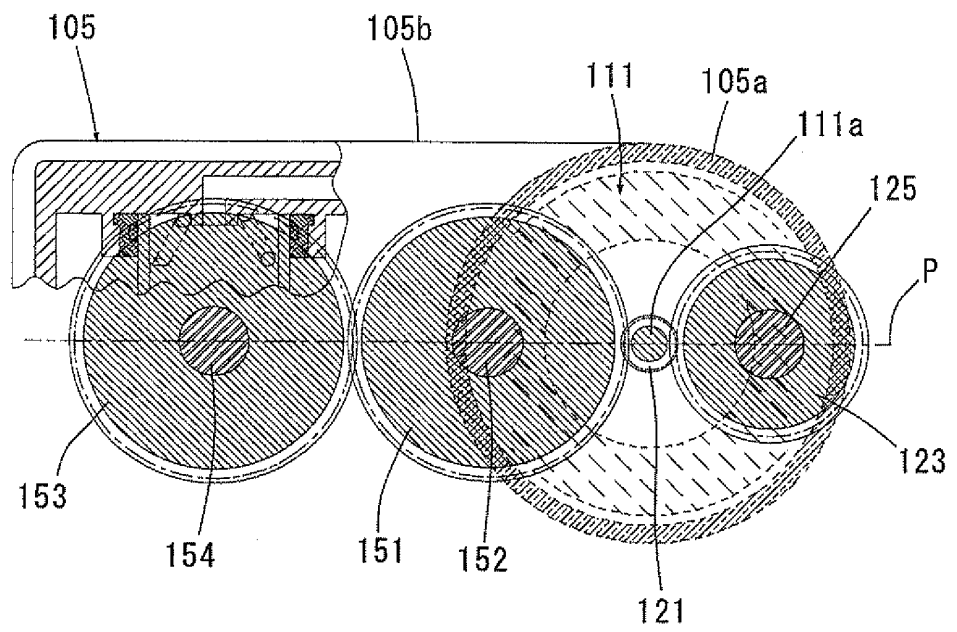


FIG. 4

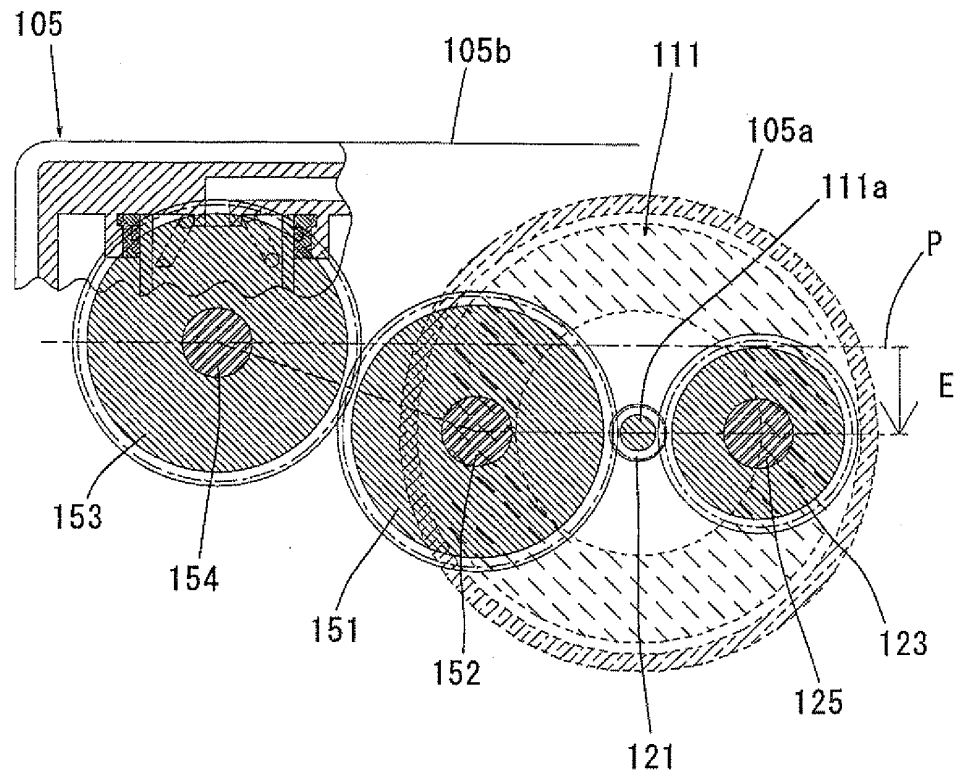


FIG. 5

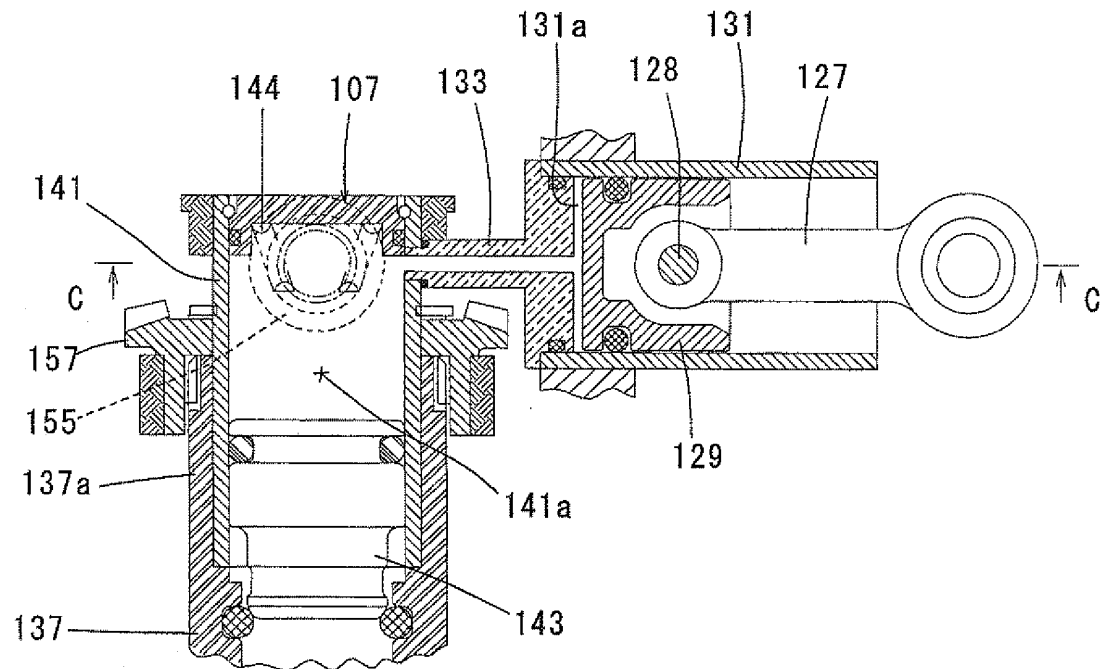


FIG. 6

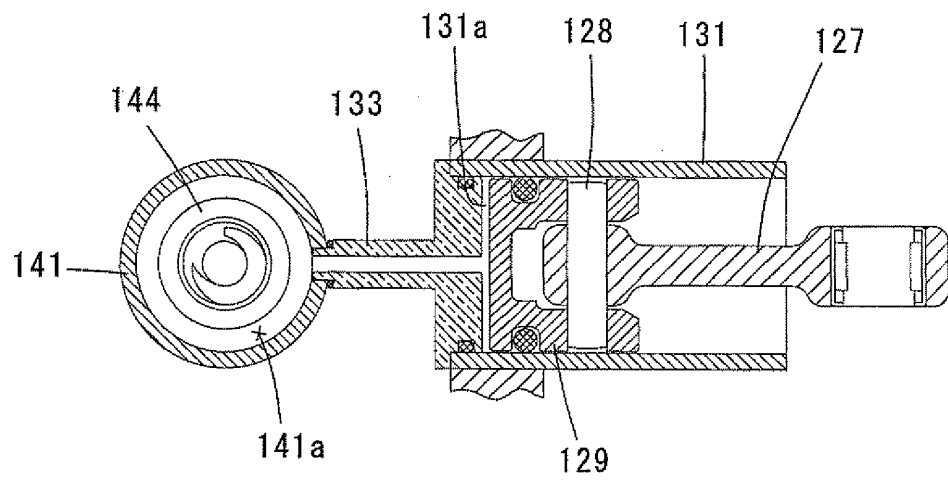


FIG. 7

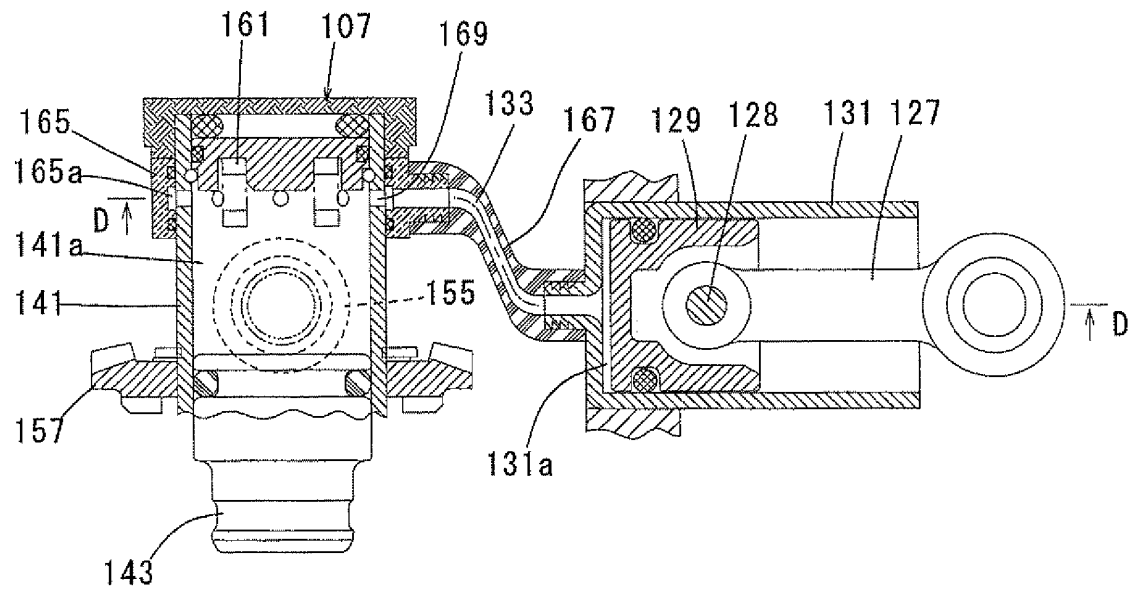


FIG. 8

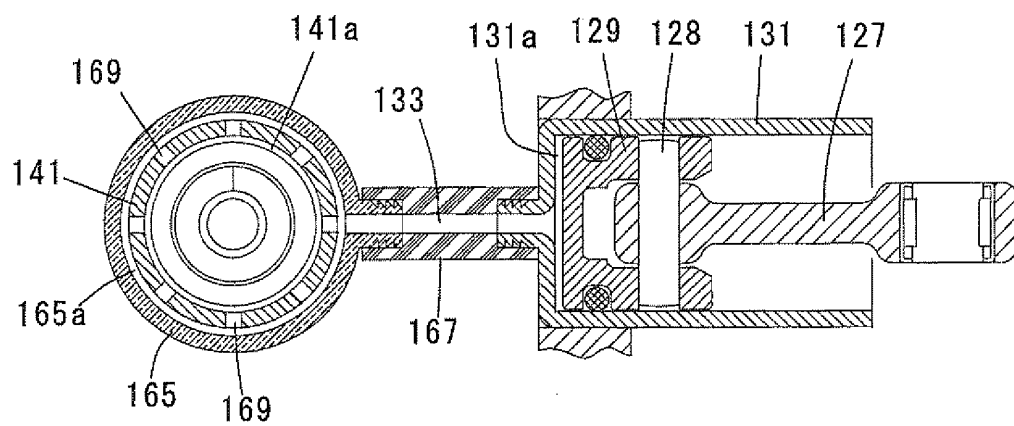
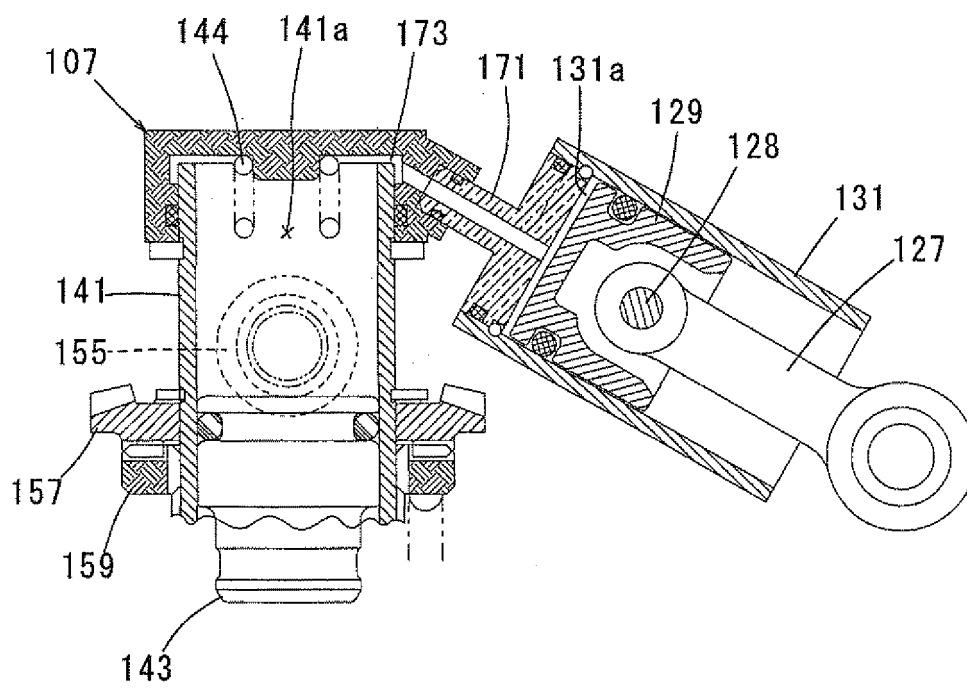


FIG. 9



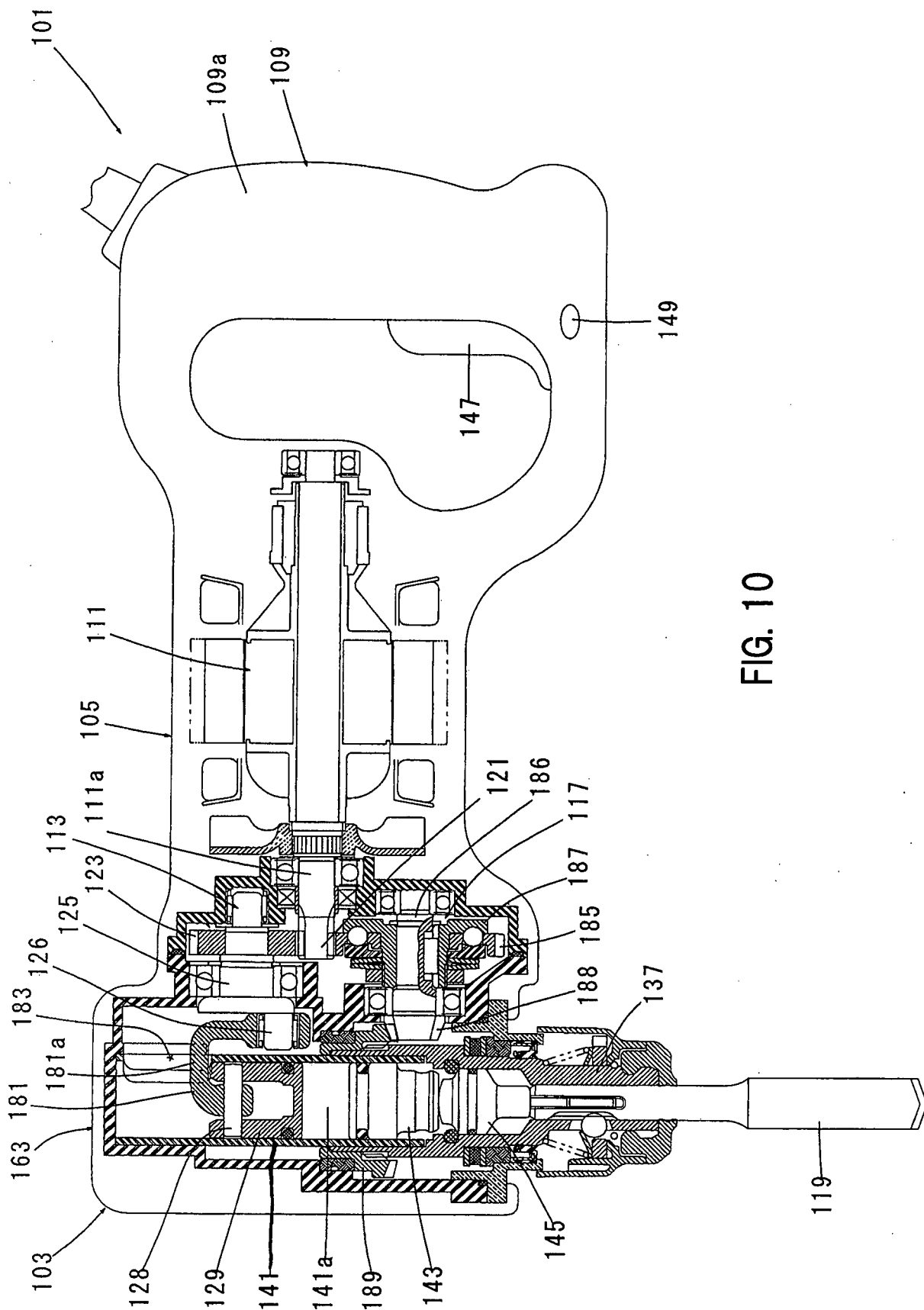


FIG. 10

FIG. 11

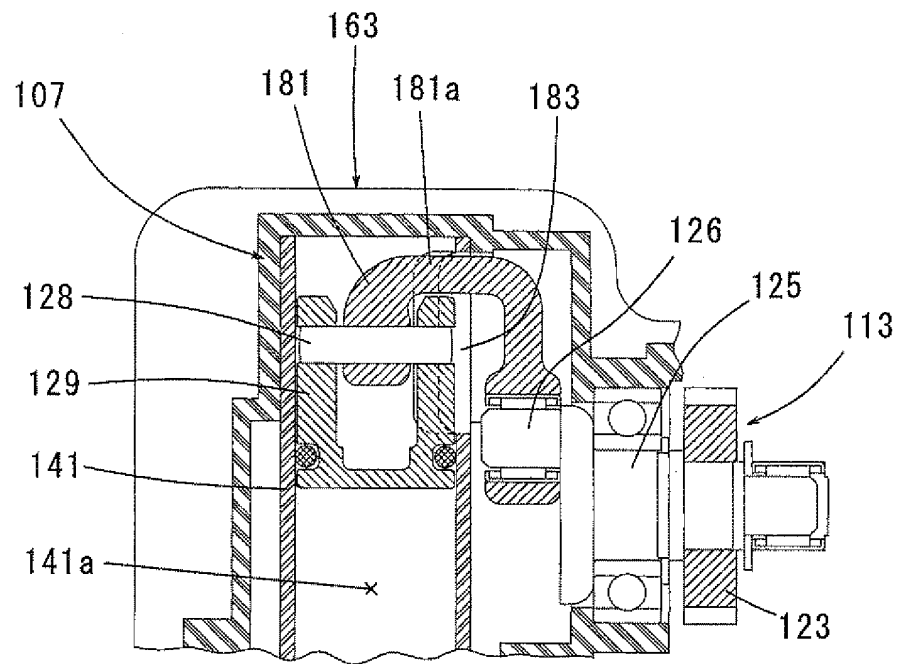


FIG. 12

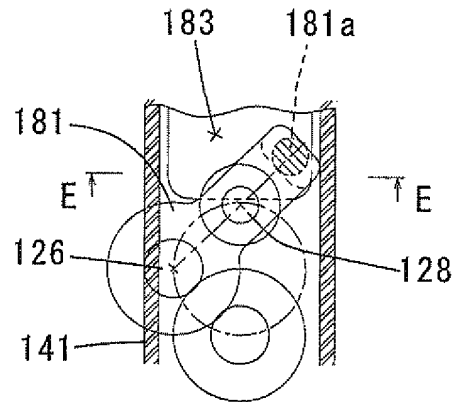
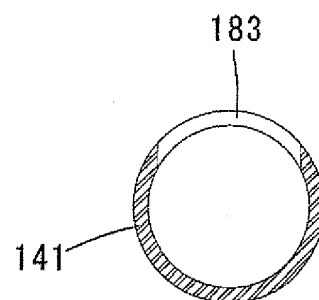


FIG. 13



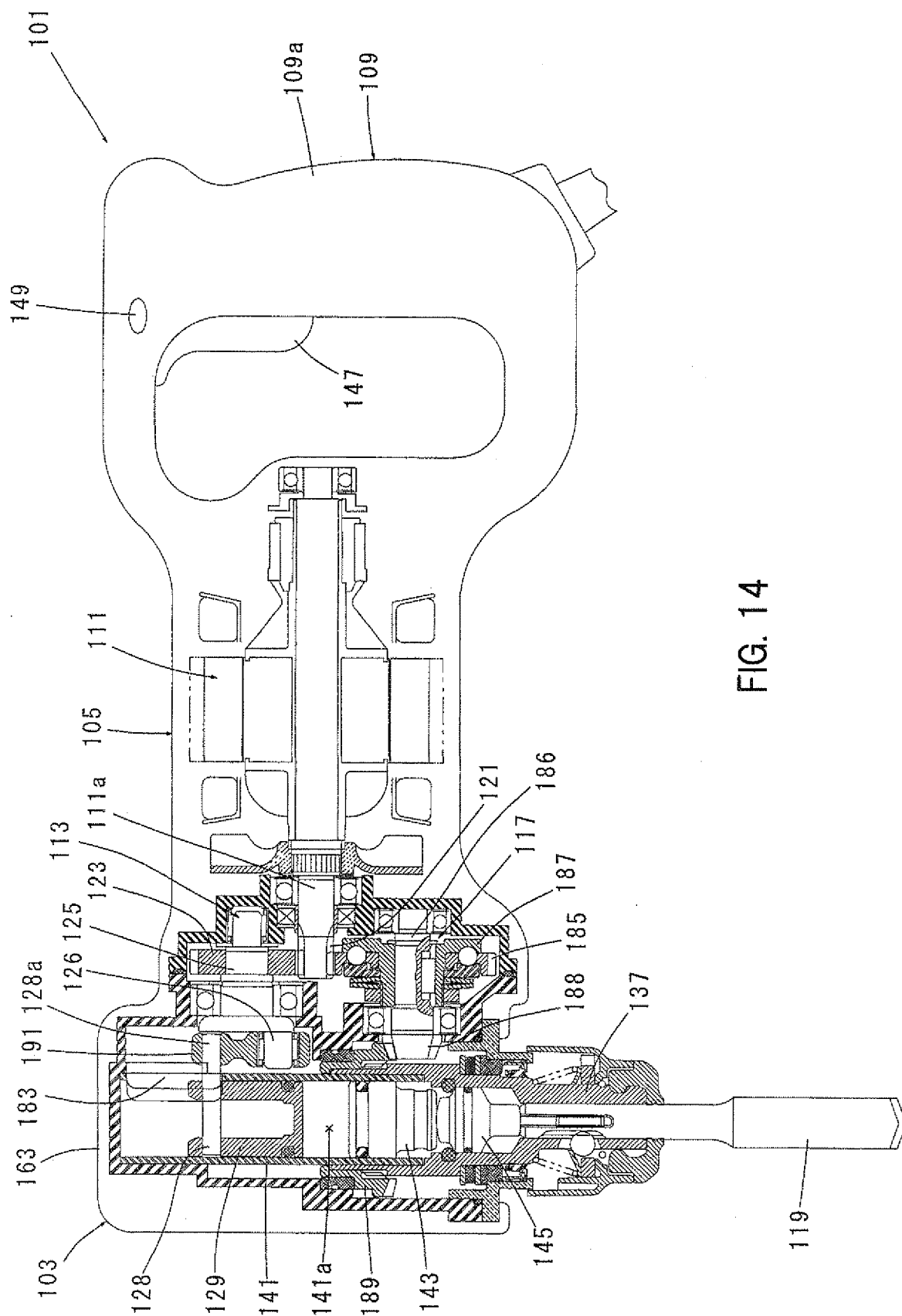
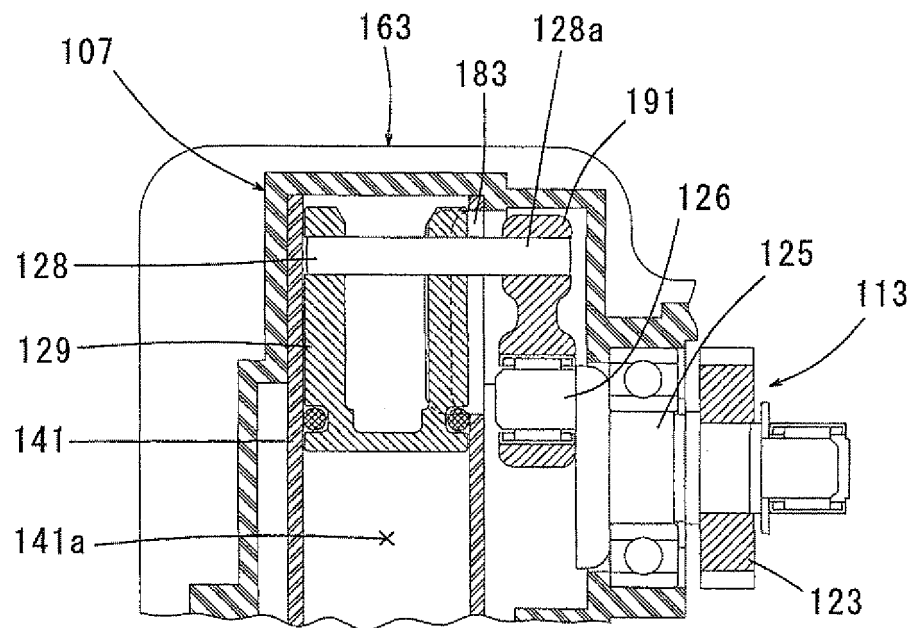


FIG. 14

FIG. 15



REFERENCES CITED IN THE DESCRIPTION

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