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Rotary hammer.

A rotary hammer with a pneumatic hammer mechanism, the ram (25) of which, to generate impacts acting on the hammer bit (11) arranged in a tool holder (10), is moved by a driven reciprocating piston (22), the paths of the reciprocating movement of ram and piston lying on a common straight line (50) and the hammer bit (11) being held coaxial to the tool holder axis in the tool holder (10), has an area (24) of its piston lying eccentric to the tool holder axis (50), said area being moved along an endless orbit about the tool holder axis when the piston is driven. The orbit, which has one point at a minimum and one point at a maximum distance from the tool holder (10), is inclined to the tool holder axis (50).

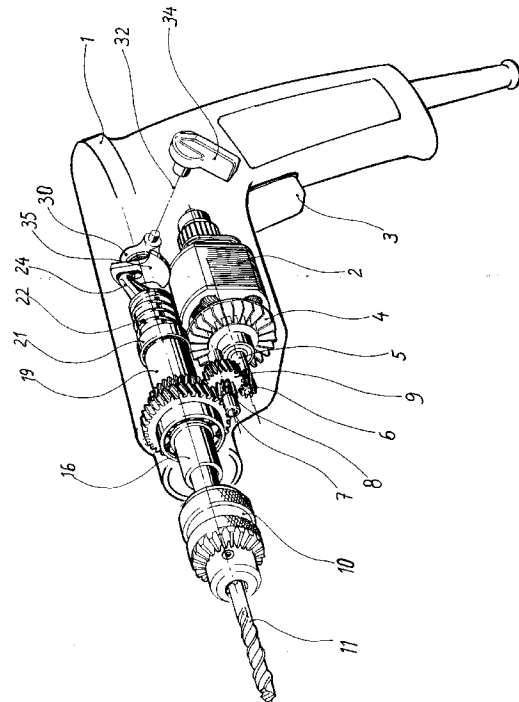


Fig. 1

The invention relates to a rotary hammer with a pneumatic hammer mechanism, the ram of which, in order to generate impacts acting on the hammer bit arranged in a tool holder, is moved by a driven reciprocating piston, an overpressure and an under-pressure being built up alternately between the rear surface of the ram and the piston, the paths of the reciprocating movement of ram and piston lying on a common straight line and the hammer bit being held coaxially to the tool holder axis in the tool holder.

Such rotary hammers with a pneumatic hammer mechanism are known in many forms.

In a prior rotary hammer (U.S.-Patent No. 3 280 359) a driven intermediate shaft arranged parallel to the common straight line of the movement path of ram and piston is provided, and mounted on said intermediate shaft is a swash plate which is connected by a swash plate finger to the rear end of the piston designed as a hollow piston. By rotation of the intermediate shaft the position of the swash plate is thus changed in such a way that the swash plate finger describes a reciprocating movement on an arc section and thus reciprocates the hollow piston inside a guide tube, to create the reciprocating movement of the ram. This structure requires a driven intermediate shaft which, because of its arrangement parallel to the common straight line of the movement paths of ram and piston, results in an enlargement of the dimensions of the rotary hammer housing in peripheral direction and which, because of the necessary bearings, also necessitates a relatively large mechanical outlay.

In another known rotary hammer (U.S. Patent No. 4 712 625), a groove which surrounds the outer periphery and is inclined to the longitudinal axis is formed in the driven reciprocating hollow piston accommodating the ram, in which groove a ball engages which is mounted in a rotary-driven spindle element. Through rotation of this spindle element about its longitudinal axis, which extends coaxial to the longitudinal axis of the hollow piston, the non-rotatably arranged hollow piston is moved axially to and fro as a result of engagement of the ball with the inclined groove. Although such a design is compact, it is in many cases not suitable for the relatively large impact loads which occur during operation of the hammer mechanism of the rotary hammer.

In another known rotary hammer (German Patent No. 33 22 964), instead of a ball or sphere mounted in a driven spindle element and engaging with a tilted groove of the piston to be reciprocated, a swash plate drive is provided which has a swash plate arranged coaxial to the common straight line of the reciprocating movement of piston and ram, said swash plate engaging with its rotatably housed outer ring by means of a swash finger attached to the latter with the rotary-driven spindle element, so that in this way, upon rotation of the spindle element, a reciprocating movement of the piston is achieved. This structure also requires numerous bearings and is structurally expensive.

Finally, it is known with such rotary hammers (German Patent Application P 35 05 544) to effect the drive of the piston by means of a crank drive, to which end a rearwardly extending piston rod is swivelably attached at the piston, said piston rod lying essentially in a plane with the common straight line of the movements of piston and ram and its rear end being swivelably coupled with an eccentric pin which is held in a gear which meshes with a pinion formed on the armature shaft of the drive motor. Such a structure is relatively bulky and generally requires an arrangement of the drive motor with its armature shaft perpendicular to the common straight line of the movement of piston and ram.

It is the object of the invention to provide for a rotary hammer which, through the design of its hammer mechanism, permits as simple and compact a structure as possible.

To achieve this object, a rotary hammer of the type mentioned initially is developed according to the invention in such a way that the piston has an area arranged eccentrically to the tool holder axis, said area being moved along an endless orbit about the tool holder axis when the piston is driven, and that the orbit is inclined to the tool holder axis with one point of the orbit at a minimum and one point of the orbit at a maximum distance from the tool holder.

With the rotary hammer according to the invention, the reciprocating movement of the piston of the hammer mechanism is thus generated because an area of the piston describes a rotary movement about the tool holder axis and moves along an orbit which is inclined to the tool holder axis. This movement along the orbit of the area of the piston lying eccentric to the tool holder axis causes a reciprocating movement of the piston along the common straight line of the movement paths of piston and ram and thus the alternating generation, customary for pneumatic hammer mechanisms, of overpressure and underpressure between piston and ram.

To effect the circular movement of the area of the piston lying eccentric to the tool holder axis, the guide tube non-rotatably accommodating the piston can be rotatably driven about the common straight line of the movement path of piston and orbit.

The orbit is preferably elliptical, and the tool holder axis passes through the centre of this ellipse.

In a preferred embodiment of the invention, the common straight line of the movement of piston and ram coincides with the tool holder axis, and the eccentrically arranged area can be a support area, provided at the rear end of the piston and offset laterally relative to the common straight line.

The advantage of such a structure is that the piston used to generate the drive forces for the ram and the

ram are reciprocated on that axis on which the hammer bit is also held, so that on the one hand a simple structure results and on the other the ram transmits its impact energy precisely in the direction of the longitudinal extension of the hammer bit. The reciprocating movement of the piston is produced by an orbital movement of the support area, i.e. by a rotary movement of the piston about the common straight line of the movement of piston and ram, to which end the support area is moved along the inclined orbit.

With such a structure, the support area can be kept engaged, e. g. by means of spring force, with a support part which is inclined to the common straight line and defines the orbit.

The support part can be pivotable between a piston-drive position inclined to the tool holder axis and a piston-rest position lying perpendicular to the tool holder axis, so that, through suitable adjustment of the support part, the reciprocating movement of the piston can be set between a maximum stroke and a standstill (= piston-rest position).

The support area can have the form of a rearwardly extending finger.

The finger can be connected in swivellable and positive manner to the support part, thus producing a defined and uncritical coupling.

In another embodiment of the invention, the common straight line of the movement of ram and piston is inclined to the tool holder axis, and the eccentrically arranged area is formed by the rear end of the piston lying on the common straight line.

With this structure, the movement paths of piston and ram do not coincide with the tool holder axis, but are inclined to it, so that a circular movement of the common straight line about the tool holder axis, i.e. a movement of the common straight line on a cone-envelope line, permits the piston to be reciprocated by guiding its rear end along an inclined orbit. To this end, the guide tube which contains the piston and the ram and whose longitudinal axis coincides with the common straight line can for example be rotary-driven about the tool holder axis.

If the piston is a hollow piston accommodating the ram, its rear end can be kept engaged by means of spring force with an annular support surface defining the orbit.

To set the piston stroke, the support surface can be pivotable about a point lying on the tool holder axis between a piston-drive position inclined the tool holder axis and a piston-rest position lying normal to the tool holder axis.

However, it is also possible to attach at the rear end of the piston, by means of a ball-and-socket or universal joint, one end of a piston rod whose other end is connected to a support rod which is inclined to the tool holder axis and intersects it. If the other end of the piston rod is then arranged at a point on the inclined support rod which lies at a distance from the point of intersection of support rod and tool holder axis, the reciprocating movement of the piston necessary for impact generation results upon the orbital movement of the piston about the tool holder axis.

Here, too, the piston stroke can be set easily by changing the connection point of the other end of the piston rod to the support rod between a piston-drive position lying outside the tool holder axis and a piston-rest position lying on the tool holder axis.

The invention is explained in more detail below with reference to the figures which show embodiments.

- Figure 1 shows a rotary hammer in simplified perspective representation.
- Figure 2 shows the electric motor, the hammer mechanism and the hammer mechanism of the rotary hammer from Figure 1 in diagrammatic perspective representation.
- Figure 3 shows, in simplified form in an exploded representation, the essential parts of the arrangement of Figure 2.
- Figure 4 shows, in a representation according to Figure 2, a modification of the drive arrangement for the hammer mechanism.
- Figure 5 shows, in an exploded representation according to Figure 3, the essential parts of the hammer mechanism of Figure 4.
- Figure 6 shows, in a diagrammatic partial representation, a modified drive for the hammer mechanism.
- Figure 7 shows, in a representation according to Figure 6, a further modification of the drive for the hammer mechanism.
- Figure 8 shows, in a diagrammatic partial representation, a modified structure of the hammer mechanism, in which the common straight line of the reciprocating movement of piston and ram is inclined to the tool holder axis.
- Figure 9 shows, in a representation according to Figure 8, a hammer mechanism modified compared with the hammer mechanism of Figure 8.

The rotary hammer shown in Figure 1 has a conventional housing 1 with pistol grip and switch actuator 3, provided in the transition area between pistol grip and upper part of the housing, for the activation of the electric motor 2. At the front end of the housing 1 there is provided a tool holder 10 which is in the form of a chuck

and into which a hammer bit 11 is inserted.

As can be seen in Figure 3 in particular, at the rear end of the tool holder 10 a threaded socket is provided which is screwed into a connection part 12 which, through engagement of longitudinal grooves 13 with corresponding ribs in the spindle element 16, is held non-rotatably in said spindle element. Extending into the rear end of spindle element 16 is the front section of a guide tube 19 which accommodates, in sealing and axially reciprocable manner, a hollow piston 22 closed at the rear end, said hollow piston 22 having on its outside axially extending grooves which engage with rib-like projections of the guide tube 19, so that hollow piston 22 and guide tube 19 are not rotatable relative to each other. The hammer bit 11, the tool holder 10, connection part 12, the spindle element 16, the guide tube 19 and the hollow piston 22 lie with their centre axes all on a common axis 50 which forms the tool holder axis.

Axially and reciprocably arranged in known manner in the hollow piston 22 is a ram 25 which is reciprocated, in a manner likewise known for pneumatic hammer mechanisms, by reciprocating movement of the hollow piston and the resultant build-up of an overpressure between the rear end of the hollow piston and the rear end of the ram and subsequent build-up of an underpressure at this point, and thereby transmits impacts to the rear end of the axially reciprocable anvil 15, which transmits these impacts onto the rear end of the threaded socket of the tool holder 10, from where they reach the hammer bit 11. The hammer bit 11 could of course also extend rearwards through the tool holder and be impinged upon directly by the anvil.

The spindle element 16 is rotatably held in the housing 1 by means of a bearing 18, in a manner not shown in more detail, and accordingly the guide tube 19 is also rotatably positioned in the housing 1 by means of a bearing 21. Spindle element 16 and guide tube 19 are rotatable relative to each other. For the drive of these two elements, a gear 17 is formed on the rear end section of spindle element 16 and a gear 20 in the central section of guide tube 19, said gears lying immediately adjacent to each other in the assembled state (Figures 1 and 2). Arranged parallel to the centre axis of the gears 17 and 20, and thus parallel to the axis 50, is an auxiliary shaft 7 on which are provided a gear 8 meshing with gear 17 and a gear 9 meshing with gear 20. Gear 9 also meshes with the pinion 6 formed at the outer end of the armature shaft 5, lying parallel to the axis 50, of the electric motor 2. A fan wheel 4 is secured in the usual way to the armature shaft 5 between pinion 6 and the stator of the electric motor 2.

If the electric motor 2 is powered by shifting the switch actuator 3, its armature shaft 5 rotates and thus drives the gears 17 and 20 via gears 8 and 9. The rotation of gear 17 and the associated rotation of the spindle element 16 results in a rotation of the connection part 12 and thus to a rotary movement of the tool holder 10, as a result of which the hammer bit 11 is rotated.

The rotation of the gear 20 effects a rotation of the guide tube 19, which, because of the different dimensions of the gears, also results in a relative rotation of tube 19 and spindle element 16. As already mentioned, the hollow piston 22 extends into the guide tube 19, and arranged between an annular shoulder 23 formed at the rear end of the hollow piston 22 and the inner race of bearing 21 is a helical spring 26 which exerts an rearwardly directed force on the hollow piston 22.

Provided at the rear end of the hollow piston 22 is a support area in the form of a finger 24, which is offset laterally vis-à-vis the longitudinal axis of the hollow piston 22 and thus also laterally vis-à-vis axis 50. The rear end of the finger 24 engages with a slot 37 of a support part 35 which has a guide pin 36 at its side facing away from the piston 22. The guide pin 36 extends into a bearing 33 which is arranged in a bearing holder 30. The bearing holder 30 is mounted, in a way which is not shown, by means of lateral securing projections 31 pivotable about an axis 32 in the housing 1, the pivot movement being effected by a hand knob 34 provided at the outside of the housing 1. The pivot axis 32 of bearing holder 30 intersects axis 50.

When the bearing holder 30 is in a position in which bearing 33 is not positioned perpendicular to axis 50, but is inclined relative to the latter, the guide pin 36 of support part 35 is also correspondingly inclined to axis 50. If, in this position, the so-called piston-drive position, the guide tube 19 is rotated by rotation of the armature shaft 5 of the electric motor 2, and the hollow piston 22, as a result of engagement of longitudinal grooves provided at its outside with corresponding axial ribs at the inside of guide tube 19, rotates with the latter, the finger 24 describes an elliptical movement about axis 50. As a result of the action of the helical spring 26, it is always kept engaged with the slot 37 of the support part 35, which thereby likewise describes a rotary movement about axis 50. The result is that, because of its inclination to axis 50, the end of the inclined guide pin 36 of support part 35 which is near support part 35 describes a circular movement about axis 50, so that the section of support part 35 provided with the slot 37 describes a pendulum movement because of the pre-set inclination of bearing holder 30 and thus of bearing 33 in respect of axis 50. The effect of this pendulum movement is that the finger 24 orbiting about axis 50 performs an axial reciprocating movement, i.e. hollow piston 22 is reciprocated in axial direction and thus as known from pneumatic hammer mechanisms, produces a reciprocating movement of the ram 25. As can be recognized, the stroke of the reciprocating movement of hollow piston 22 depends on the inclination of support part 35 and can be altered by the user, using hand knob 37,

by rotation about the pivot axis 32 between a maximum inclination and thus between a maximum stroke and a perpendicular alignment of bearing holder 30 in relation to axis 50 and thus an "axial standstill" of hollow piston 22, the so-called piston-rest position. The user can in this way adjust between combined drill and hammer operation with desired piston stroke and pure drill operation.

5 It should be noted that piston axis 32 intersects axis 50 and that a particularly compact structure results if the centre line extending perpendicular to axis 50 and passing through the swivel connection between finger 24 and support part 35 passes through the point of intersection of pivot axis 32 and axis 50 when the support part 35 is in the piston-rest position.

10 In the embodiment according to Figures 4 and 5, identical components have been designated with the same reference numerals as in Figures 1 to 3, corresponding components with the same reference numerals as in Figures 1 to 3, suffixed by ', and differing components or those not present at all in the embodiment according to Figures 1 to 3 with other reference numerals.

The essential difference between the embodiment according to Figures 4 and 5 and that according to Figures 1 to 3 is the form of the drive for the reciprocating movement of the hollow piston 22 which, in the same way as in the embodiment according to Figures 1 to 3, engages with its eccentric finger 24 with a groove 37' in the support part 35' which extends with a securing pin 36' into a bearing 33'. Bearing 33' is secured in a bearing holder 30' which is held, pivotable about an axis 32', in the housing 1, whereas axis 32' extends through the centre of bearing 33' and intersects axis 50.

15 At the bearing holder 30' there is formed an extension 38 which has a reception aperture 39 located at a distance from axis 32'. A diagrammatically represented rod system 42, which is coupled with a slide element 40, engages in the reception aperture 39. Slide element 40 is held axially displaceable, in a manner not shown, in the housing 1 by means of guide pins 41 extending parallel to axis 50 and engages with the edge area of an arcuate cutout in positive manner with an annular groove 13' which is formed in the connection part 12' attached at the rear end of tool holder 10.

20 If, while the rotary hammer is operating, the hammer bit inserted in tool holder 10 does not engage with a workpiece, or no hammer drill at all is inserted in tool holder 10, bearing holder 30' is pressed by the force of springs, not shown, which act at slide element 40, into a piston-rest position arranged perpendicular to axis 50, so that, although the rotation of the armature shaft 5 of the electric motor 2 effects a rotation of spindle element 16 and thus of tool holder 10 and also a rotation of guide tube 19 and thus of hollow piston 22, the coaxial alignment of guide pin 36' to axis 50 means that no reciprocating movement of hollow piston 22 and thus no drive of ram 25 in axial direction is produced. If the hammer bit inserted in tool holder 10 is brought into engagement with a workpiece, the applied pressure causes an axial displacement of tool holder 10 and connection part 12' attached to it further into spindle element 16. Because of the positive coupling of annular groove 13' of connection part 12' and slide element 40, this displacement movement results in a corresponding displacement of slide element 40 against spring force, so that a displacement of the lower end of the extension 38 of bearing holder 30', and thus a pivoting of bearing holder 30' about the axis 32', takes place via rod system 42. This results in the tilted position, already described in connection with the embodiment according to Figures 1 and 2, of support part 35' in relation to axis 50, the piston-drive position, and thus to a pendulum movement of the section of support element 35' comprising slot 37' upon rotation of hollow piston 22 about axis 50, i.e. to a reciprocating movement, described in connection with the embodiment according to Figures 1 and 2, of hollow piston 22 and thus to the generation of impacts onto the rear end of the hammer bit.

25 As soon as the pressure on the hammer drill is released, slide element 40 reverts to its starting position as a result of spring action, as does bearing holder 30', in which position bearing 30' lies coaxial to axis 50, and the hammer mechanism ceases to generate impacts.

30 In the embodiment according to Figure 6, identical or corresponding parts are designated by the same reference numerals as in the embodiment according to Figures 1 to 3, except that the numerals are increased by 100.

The embodiment according to Figure 6 shows a modification of the arrangement for the generation of the reciprocating movement of the hollow piston 122, for which purpose an inclined finger 124 is formed at the rear end of hollow piston 122, said finger extending rearwards and its rear, fork-shaped end lying at a distance from the axis 150 on which the hollow piston 122 and the ram 125 reciprocate and which is the common rotation axis of hollow piston 122, guide tube 19 (Figures 1 to 3), spindle element 16 (Figures 1 to 3) and tool holder 10 (Figures 1 to 3). Bearing holder 130 is housed, pivotable about axis 132, in the housing by means of lateral securing projections 131, and a hand knob 134 is provided at bearing holder 130 for the pivoting of same. The support part 135, which is mounted in bearing 133, has a pin 137 which, together with the fork-shaped end of finger 124, forms a swivel connection 143. The pivot axis 132 of bearing holder 130 intersects axis 150 at the point where the longitudinal axis of pin 137 intersects axis 150.

55 If pin 137 is in a plane which extends perpendicular to axis 150, rotation of guide tube 119, and thus of the

hollow piston 122 non-rotatably arranged in it, about axis 150 is accompanied by an orbital movement of swivel connection 143 about axis 150 on a circular path which lies in a plane which is normal relative to axis 150, i.e. there is a rotary movement of hollow piston 122 without reciprocating movement in the direction of axis 150.

5 If bearing holder 130 is pivoted about axis 132 by corresponding pivoting of hand knob 134 and thus brought into a piston-drive position inclined to axis 150, pin 137 is pivoted vis-à-vis the fork-shaped outer end of the finger 124 of hollow piston 122, and there results an elliptical orbit, inclined to axis 150, for swivel connection 143 and thus for the fork-shaped end of finger 124. A rotation of guide tube 119 and thus of hollow piston 122 then results in a corresponding reciprocating movement of hollow piston 122 in the direction of axis 150, so that a reciprocating movement of ram 125 is generated and impacts are transmitted onto the rear end
10 of the hammer bit located in the tool holder.

The embodiment according to Figure 7 is essentially similar to that of Figure 6, identical and corresponding parts being designated, respectively, by the same reference numerals as for the embodiment according to Figures 1 to 3 with such numerals increased by 200.

15 As shown, a ball 243 is formed at the rear end of the finger 224 which is provided at the rear end of hollow piston 222 and inclined relative to axis 250 and thus to the centre axis of hollow piston 222, said ball engaging with a cylindrical reception recess 237 of support part 235, which support part 235 has, in the area of the cylindrical reception recess 237, a slot for the through passage of finger 224.

20 As can be recognized, the arrangement according to Figure 7 allows a support element 235 to be pivoted, in the same way as in the embodiment according to Figure 6, between a piston-rest position and a piston-drive position. In the piston-rest position, the connection section formed by ball 243 and recess 237 travels about a circular path upon rotation of hollow piston 222, said path lying in a plane which is normal relative to axis 250, so that hollow piston 222 is not reciprocated in the direction of axis 250. The centre line extending perpendicular to axis 250 and through ball 243 passes through the intersection point of axis 250 and axis 232. In the piston-drive position, bearing holder 230 is pivoted about axis 232 in such a way that the connection area comprising ball 243 and recess 237 moves, upon rotation of hollow piston 222, on an elliptical orbit inclined to
25 axis 250, which results in a reciprocating movement of hollow piston 222 in the direction of axis 250.

In the diagrammatically represented embodiment according to Figure 8, identical parts and those corresponding to the embodiment according to Figures 1 to 3 are designated by the same reference numerals, except that the numerals are increased by 300.

30 By way of variation from the embodiments described above, in the embodiment according to Figure 8 the common straight line 351 on which the hollow piston 322 and the ram 325, spherical in this case, are reciprocated is inclined to axis 350 which forms the rotation axis of the spindle element 316 and of the tool holder. To this end, the guide tube 319 arranged behind spindle element 316 is inclined to the centre and rotation axis 350, but carries a gear 320 which lies coaxial to axis 350 and meshes with gear 309 which is driven by the pinion 306 of the armature shaft 305. The hollow piston 322 which is provided in guide tube 319 and can be reciprocated along the straight line 351 forming the centre axis of guide tube 319, which hollow piston can in this case be rotatable relative to guide tube 319, is rounded at the rear end and is kept in engagement with an inclined support part 335 by a coil spring 326 which is supported on the hand at the rear end of guide tube 319 and on the other hand at an annular shoulder of hollow piston 322. Arranged on this inclined support part
40 is an annular bearing 337 which engages with the rounded rear end of hollow piston 322.

If spindle element 316 and guide tube 319 are driven via gears 317 and 320, spindle elements 316 rotates in the manner described above about axis 350 and thus effects a rotary movement of the tool holder and of the hammer bit contained in it. The rotation of gear 320 about axis 350 results in a circular movement of guide tube 319 about axis 350. As a result of the inclination of support part 335 to axis 350, the rear end of hollow piston 322 not only orbits about axis 350 with guide tube 319, but is also reciprocated in the direction of the straight line 351 forming the centre axis of hollow piston 322. This results, in the manner usual for pneumatic hammer mechanisms, in a reciprocating movement of the ram 325 provided in hollow piston 322, so that this transmits impacts onto the rear end of anvil 315, from which these impacts are transmitted onto the rear end of the hammer bit which is not shown.
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50 Through pivoting of support part 335 about the point of intersection of centre of the orbit formed by bearing 337 and axis 350, support part 335 can, as indicated, be brought into a perpendicular position relative to axis 350, so that, as explained above in connection with the other embodiments, circular movement of the rear end of hollow piston 322 about axis 350 does not result in a reciprocating movement of hollow piston 322 in the direction of axis 350, i.e. support part 335 is then in the piston-rest position.

55 The embodiment according to Figure 9 is essentially similar to the embodiment according to Figure 8, the reference numerals for identical and corresponding parts being as in the embodiment according to Figures 1 to 3, except the numerals have been increased by 400.

Corresponding to the embodiment according to Figure 8, in the embodiment according to Figure 9 the com-

mon axis 451 of guide tube 419, piston 422 and ram 425, along which piston 422 and ram 425 are reciprocated, is inclined to the rotation axis 450 of spindle element 416 and tool holder. However, ram 425 is designed in the form shown in the embodiment according to Figures 1 to 3, while piston 422 is not a hollow piston but a conventional piston which can be reciprocated axially in guide tube 419 for the alternate building up of overpressure and underpressure between the front surface of piston 422 and the rear surface of ram 425.

Attached to the rear end of piston 422 via a universal or ball-and-socket joint 446 is a piston rod 445 whose outer end is swivellably attached to a slide 447 which is mounted on a support rod 435. While the universal joint 446 at the rear end of piston 422 is at a distance from axis 450 in every operating position, the swivel connection between the outer end of piston rod 445 and slide 447 lies on axis 450 in the piston-rest position shown. A rotary drive of gears 417 and 420 thus results in a rotary movement of the spindle element 416 and thus of the tool holder about axis 450 and to a circular movement of guide tube 419 about axis 450. However, piston 422 is not reciprocated in the direction of axis 451, as the circular orbit of universal joint 446 lies in a plane perpendicular to axis 450.

To achieve a reciprocating movement of piston 422 and thus a hammer operation, slide 447 is displaced along support rod 435 so that the swivel connection no longer lies on axis 450, so that an elliptical orbit, inclined to axis 450, of the universal joint 446 of piston 422 about axis 450 and thus an impact-generating reciprocating movement of piston 422 is produced.

Claims

1. Rotary hammer with a pneumatic hammer mechanism, the ram (25; 125; 225; 325; 425) of which, in order to generate impacts acting on the hammer bit (11) arranged in a tool holder (10), is moved by a driven reciprocating piston (22; 122; 222; 322; 422), an overpressure and an under-pressure being built up alternately between the rear surface of the ram (25; 125; 225; 325; 425) and the piston (22; 122; 222; 322; 422), the paths of the reciprocating movement of ram (25; 125; 225; 325; 425) and piston (22; 122; 222; 322; 422) lying on a common straight line (50; 150; 250; 351; 451) and the hammer bit (11) being held coaxially to the tool holder axis (50; 150; 250; 350; 450) in the tool holder (10) **characterized** in that the piston (22; 122; 222; 322; 422) has an area (24; 124; 224; 446) arranged eccentrically to the tool holder axis (50; 150; 250; 350; 450), said area being moved along an endless orbit about the tool holder axis (50; 150; 250; 350; 450) when the piston (22; 122; 222; 322; 422) is driven, and that the orbit is inclined to the tool holder axis (50; 150; 250; 350; 450) with one point of the orbit at a minimum and one point of the orbit at a maximum distance from the tool holder (10).
2. Rotary hammer according to claim 1, **characterized** in that the guide tube (19; 119; 219; 319; 419.) non-rotatably accommodating the piston (22; 122; 222; 322; 422) is rotatably driveable about the common straight line (50; 150; 250; 351; 451).
3. Rotary hammer according to claim 1 or 2, **characterized** in that the orbit is elliptical and the tool holder axis (50; 150; 250; 350; 450) extends through the centre point of the ellipse.
4. Rotary hammer according to one of claims 1 to 3, **characterized** in that the common straight line of the movement of piston (22; 122; 222) and ram (25; 125; 225) coincides with the tool holder axis (50; 150; 250).
5. Rotary hammer according to claim 4, **characterized** in that the eccentrically lying area is a support area (24; 124; 224) provided at the rear end of the piston (22; 122; 222) and offset laterally relative to the common straight line (50; 150; 250).
6. Rotary hammer according to claim 5, **characterized** in that the support area (24; 124; 224) is kept engaged with a support part (35; 35'; 135; 137; 235; 237), inclined to the common straight line (50; 150; 250), which defines the orbit.
7. Rotary hammer according to claim 6, **characterized** in that the support part (35; 35'; 135; 137; 235; 237) is pivotable between a piston-drive position inclined to the tool holder axis (50; 150; 250) and a piston-rest position lying perpendicular to the tool holder axis (50; 150; 250).
8. Rotary hammer according to claim 7, **characterized** in that the support part (35; 35'; 135; 137; 235; 237) is pivotable about a pivot axis (32; 132; 232) intersecting the tool holder axis (50; 150; 250).

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9. Rotary hammer according to claim 8, **characterized** in that the centre line, extending perpendicular to the tool holder axis (50; 150; 250) and passing through the swivel connection between support area (24; 124; 224, 243) and support part (35; 35'; 135, 137; 235, 237), in the piston-rest position of the support part (35; 35'; 135, 137; 235, 237) passes through the point of intersection of tool holder axis (50; 150; 250) and pivot axis (32; 132; 232).
- 10
10. Rotary hammer according to one of claims 5 to 9, **characterized** in that the support area is in the form of a rearward-extending finger (24; 124; 224).
11. Rotary hammer according to claim 10 **characterized** in that the finger (24) engages with its rear end through spring force with a recess (37) provided in the support part (35).
12. Rotary hammer according to claim 10, **characterized** in that the finger (124; 224) is connected in pivotable and positive manner with the support part (135, 137; 235, 237).
- 15
13. Rotary hammer according to one of claims 1 to 3, **characterized** in that the common straight line (351; 451) of the movement of ram (325; 425) and piston (322; 422) is inclined to the tool holder axis (350; 450), and that the eccentrically lying area is formed by the rear end of the piston (322; 422) lying on the common straight line (351; 451).
- 20
14. Rotary hammer according to claim 13, **characterized** in that the piston is a hollow piston (322) which accommodates the ram (322) and whose rear end is kept in engagement, by means of spring force, with an annular support surface (337) defining the orbit.
- 25
15. Rotary hammer according to claim 14, **characterized** in that the support surface (337) is pivotable, about a point lying on the tool holder axis (350), between a piston-drive position inclined to the tool holder axis (350) and a piston-rest position lying normal relative to the tool holder axis (350).
- 30
16. Rotary hammer according to claim 13, **characterized** in that a piston rod (445) is attached to the rear end of the piston (422) by means of a universal joint (446), the other end of said piston rod being connected to a support rod (435) which is inclined to, and intersects, the tool holder axis (450).
- 35
17. Rotary hammer according to claim 16, **characterized** in that the connection point of the other end of the piston rod (445) to the support rod (435) is displaceable between a piston-drive position lying outside the tool holder axis (450) and a piston-rest position lying on the tool holder axis (450).
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- 45
- 50
- 55
18. Rotary hammer according to one of claims 1 to 17, **characterized** in that the drive is formed by an electric motor (2) and that the armature shaft (5) of the electric motor (2) extends parallel to the tool holder axis (50).

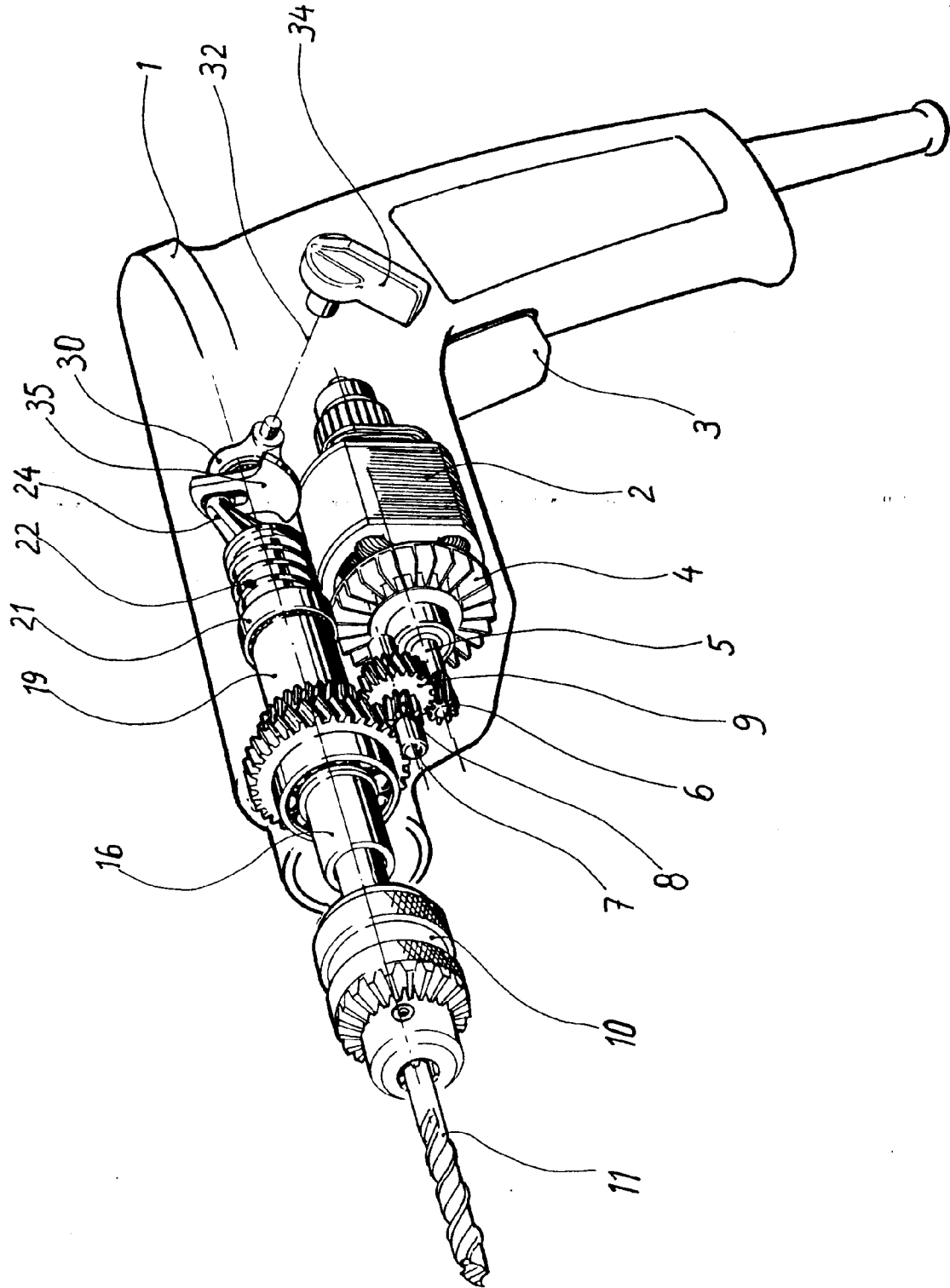


Fig. 1

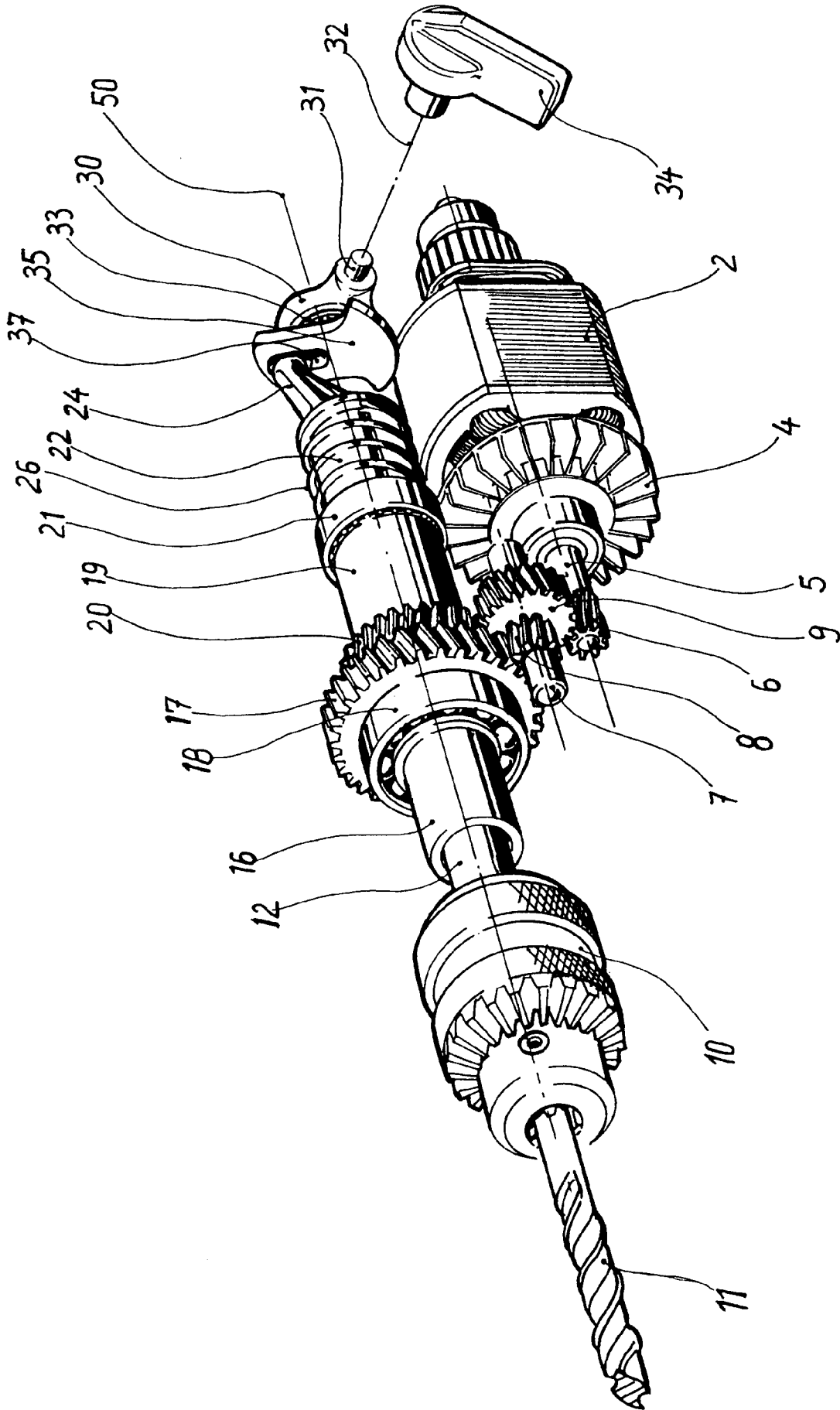


Fig. 2

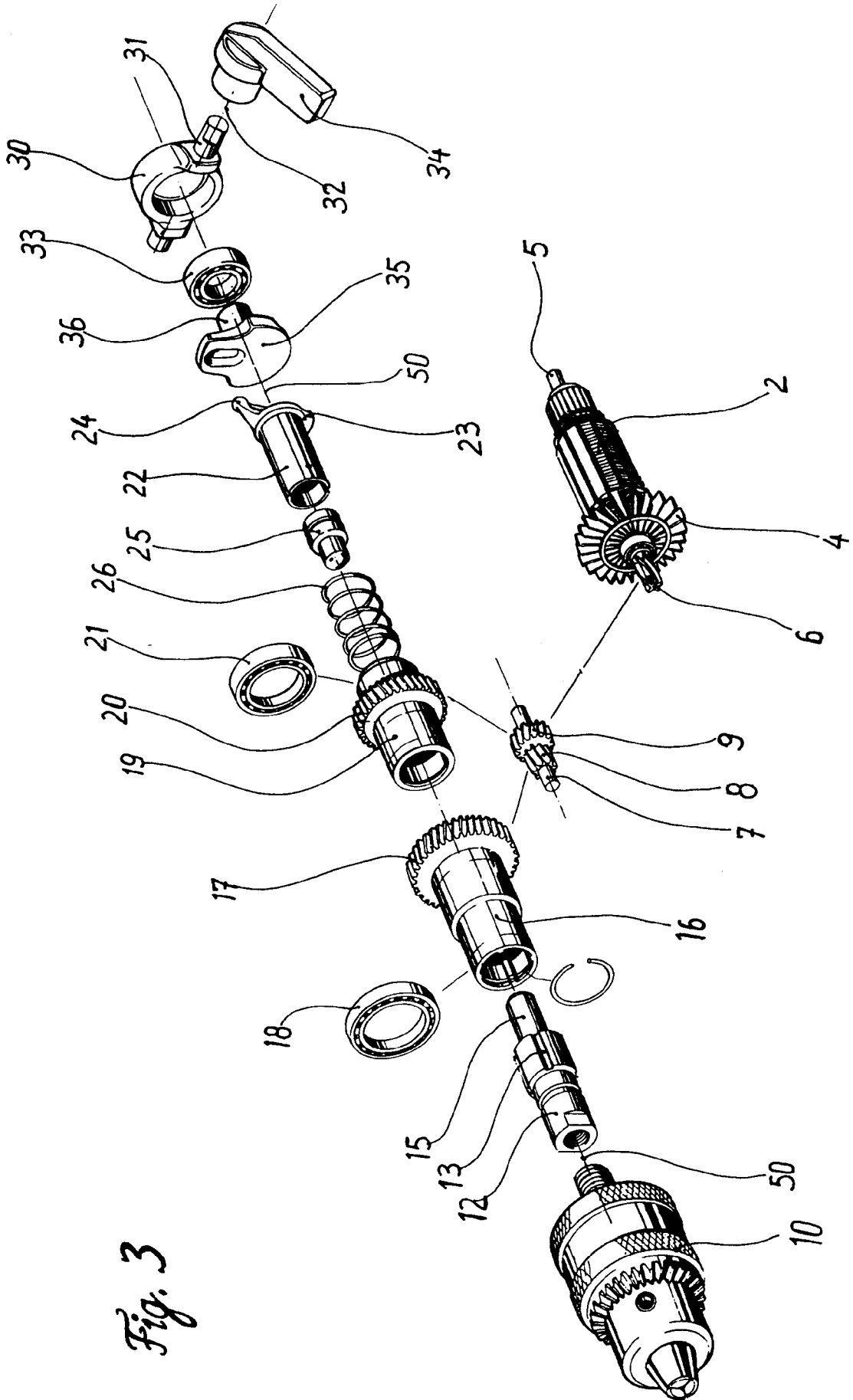


Fig. 3

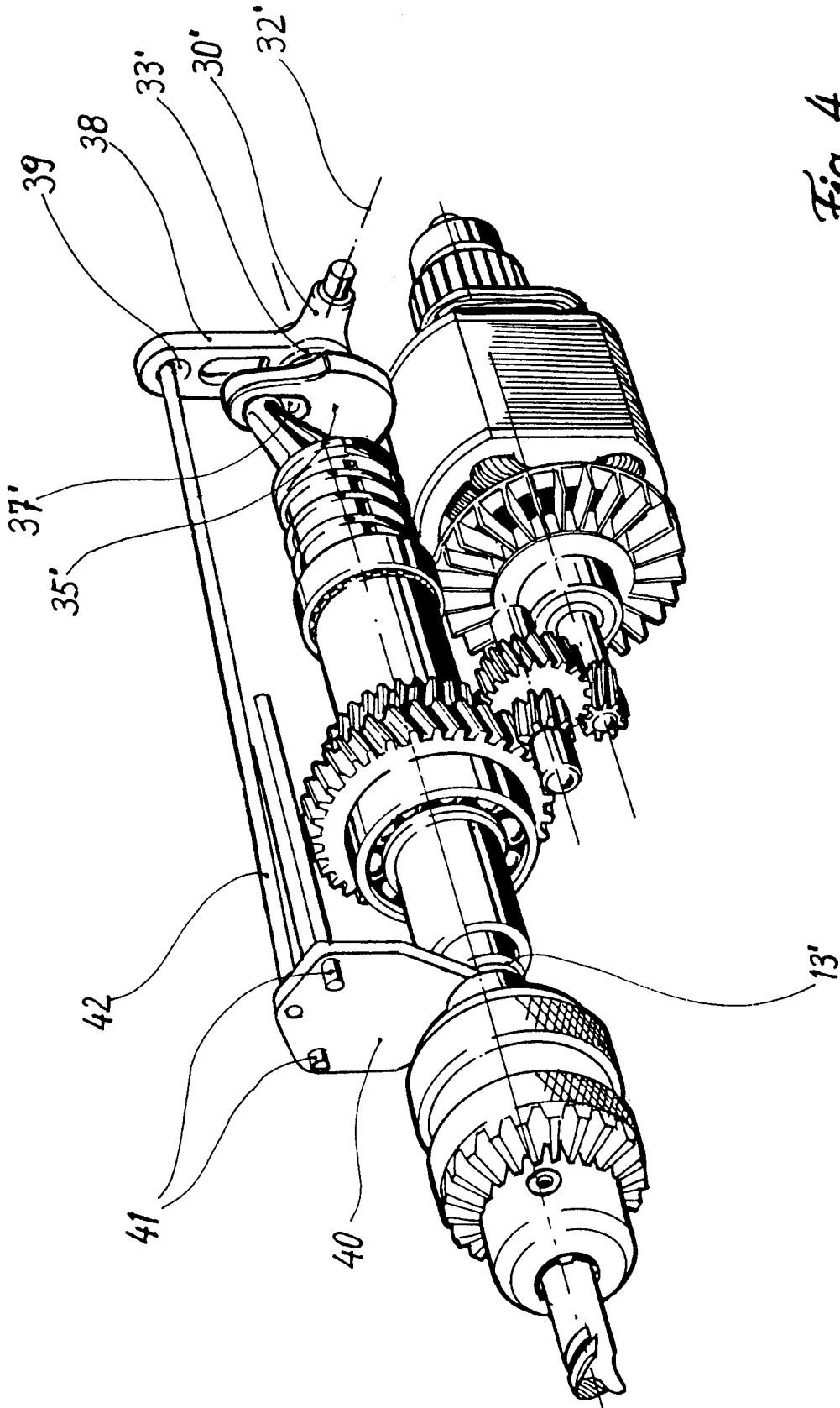


Fig. 4

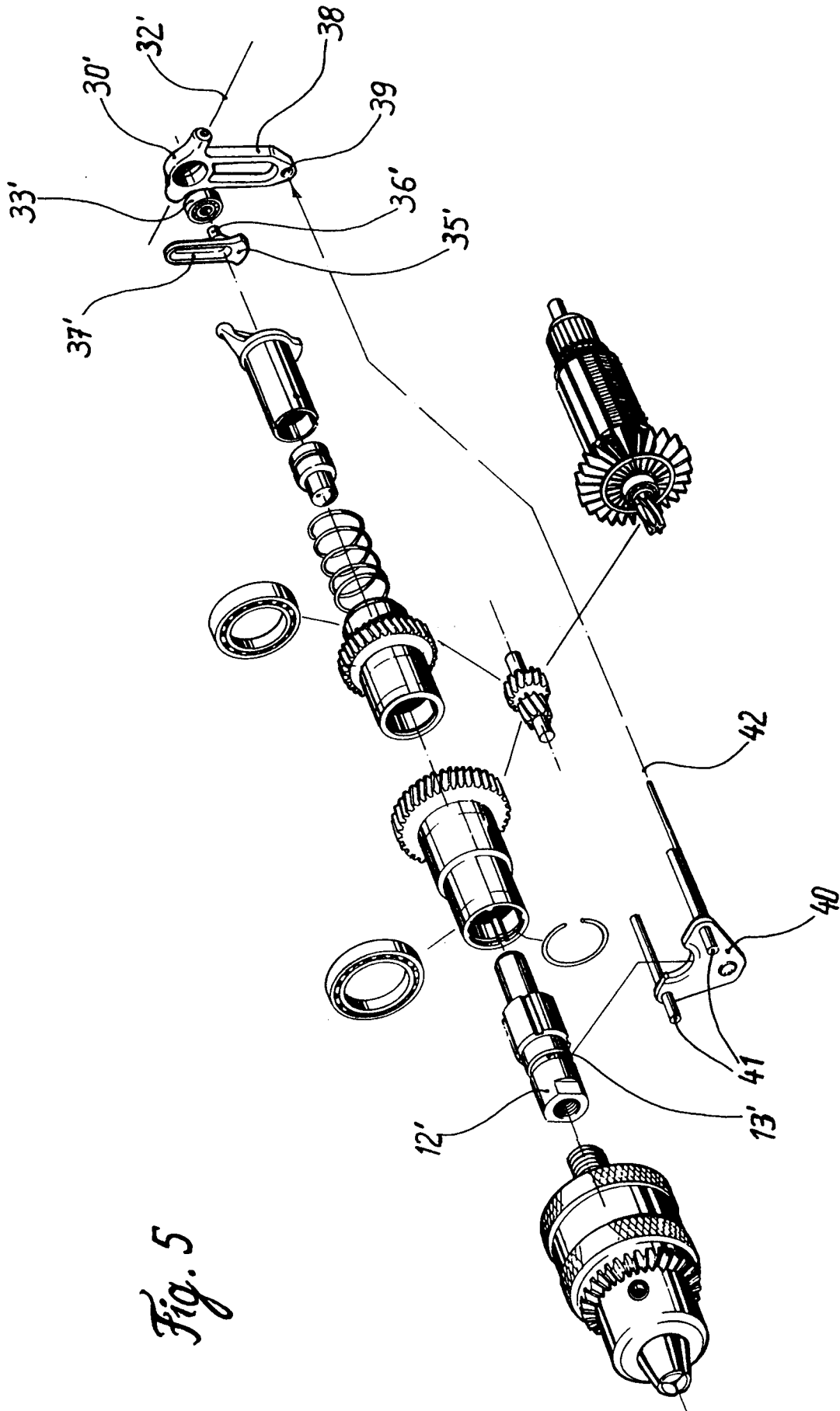


Fig. 5

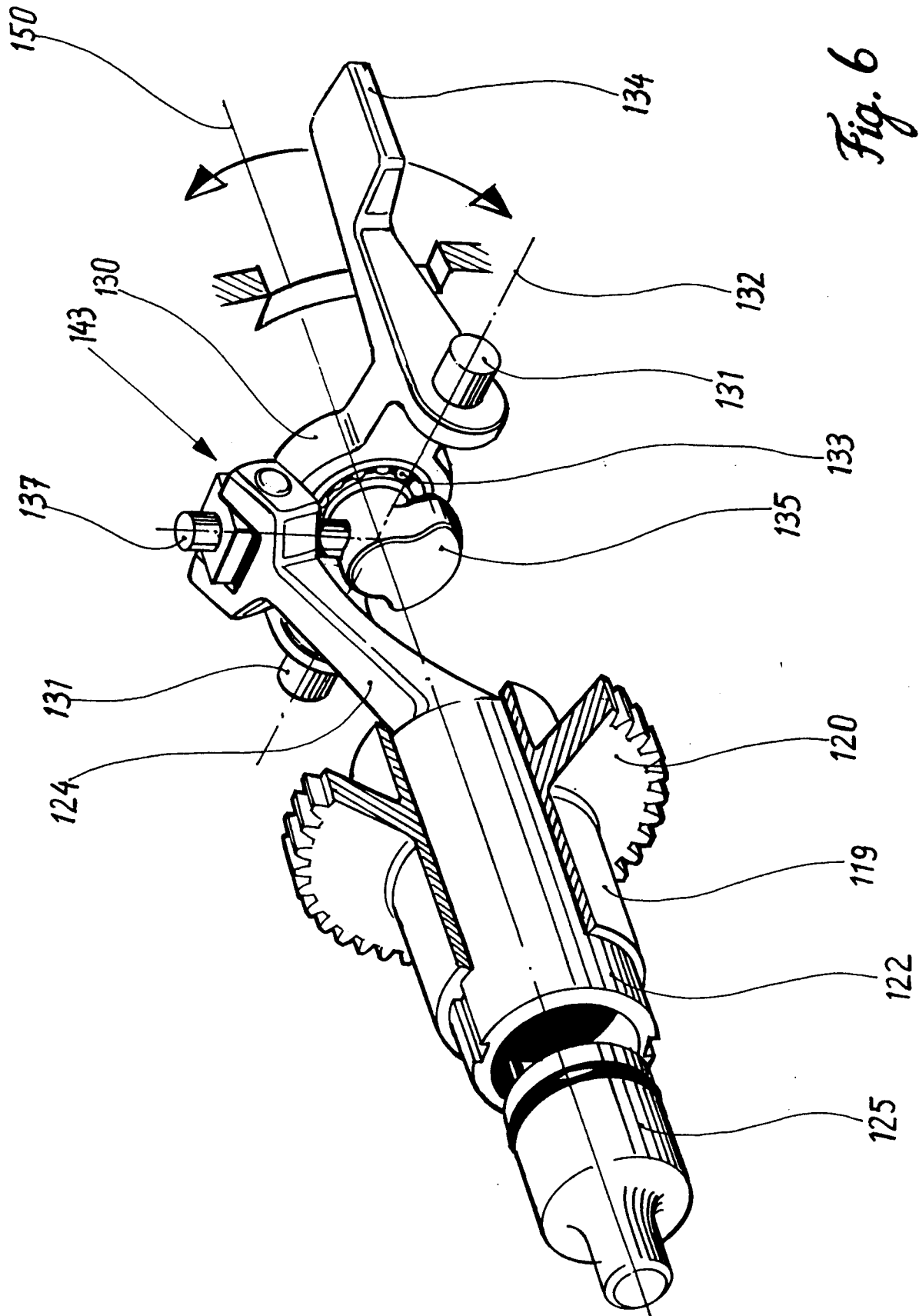


Fig. 6

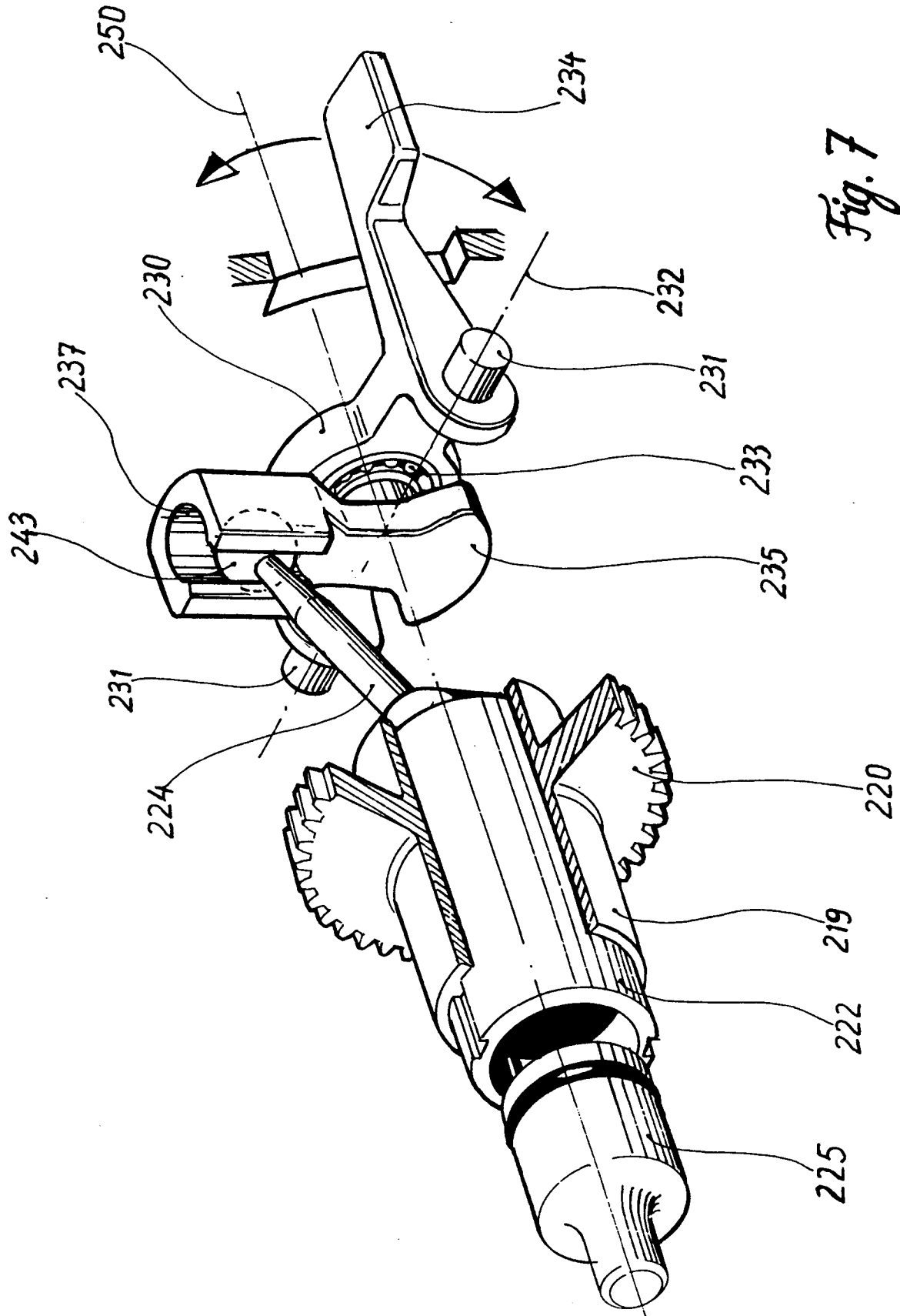


Fig. 7

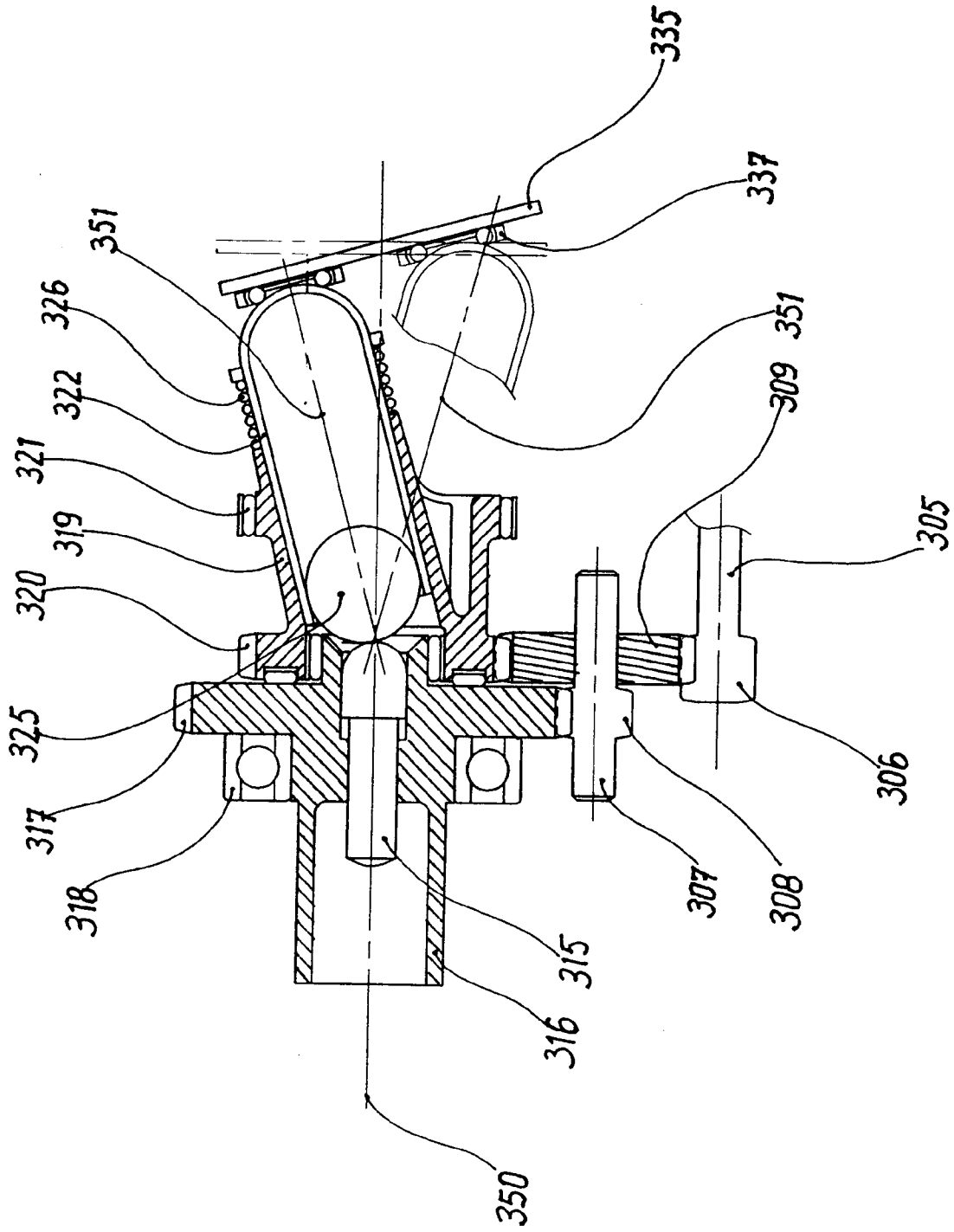


Fig. 8

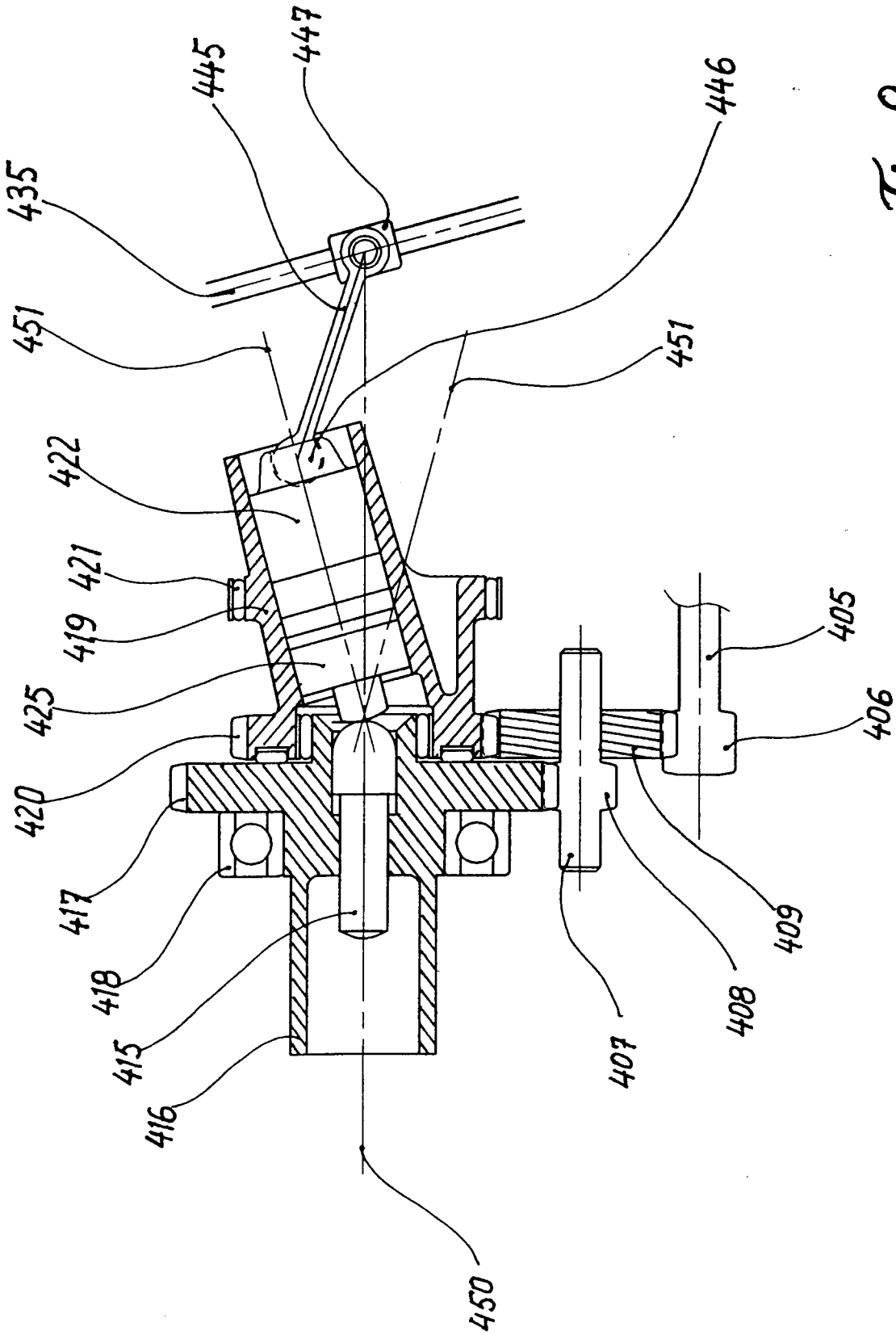


Fig. 9



European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 93 30 1443

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	DE-A-449 947 (HARA) 15 September 1927 * page 1, line 55 - line 64; figures * * page 2, line 23 - line 73 * ---	1-5, 10, 12, 18	B25D11/06 B25D9/26
Y,D	DE-A-3 322 964 (LUTZ) * page 9, line 14 - line 27; figures * ---	1-5, 10, 12, 18	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B25D
A	US-A-2 024 684 (ERFASS) 17 December 1935 * figures * ---	6	
A	CH-A-588 632 (BOSCH) * figures 1,2 * ---	1	
A,D	DE-A-3 505 544 (HILTI AG) * abstract; figures * ---	1	
A,D	US-A-4 712 625 (KRESS) * abstract; figures * -----	1	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 21 JUNE 1993	Examiner WEIAND T.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document</p>			

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