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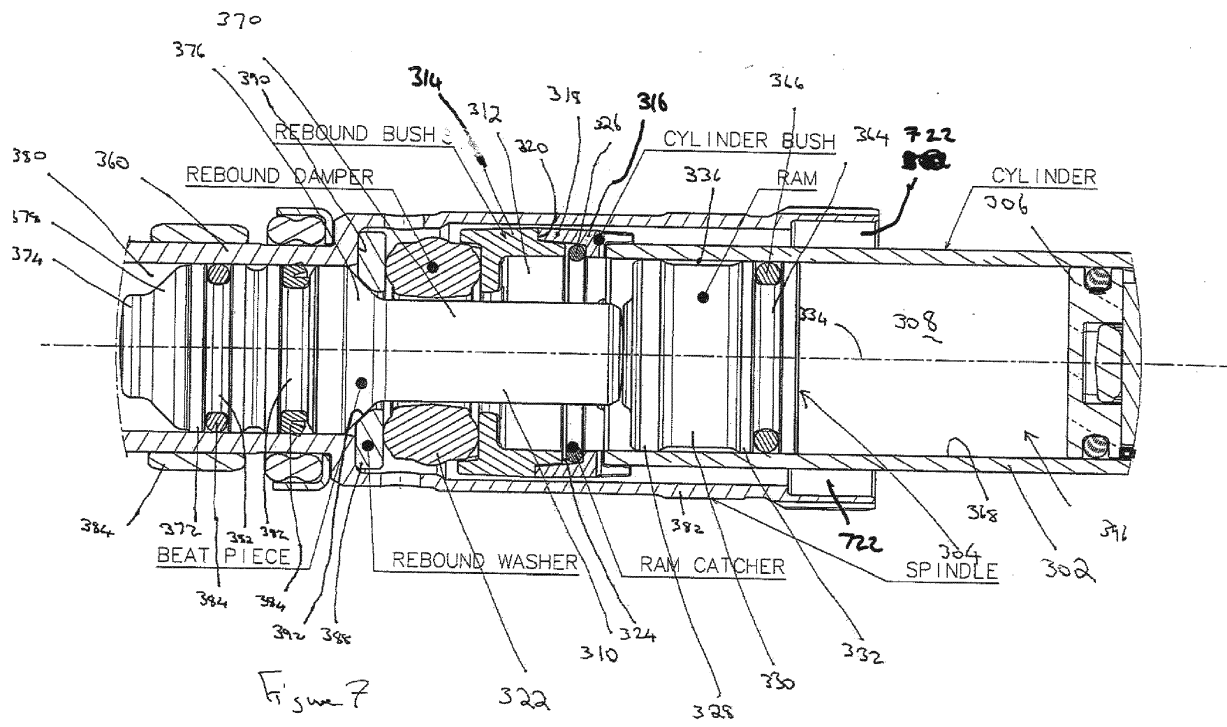
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(54) **HAMMER**

(57) A hammer drill comprising: a housing (340); a tool holder (358) mounted on the front of the housing (340); a motor (344) mounted with the housing (340); a cylinder (302) comprising a passage (396) mounted inside of the housing (340), the cylinder (302) comprising as longitudinal axis (334); a piston (306) slideably mounted within the passage (396) of the cylinder (302); a transmission mechanism (352) which is capable of converting the rotary movement of the motor (344) into a reciprocating movement of the piston (306), the motor (344) reciprocatingly driving the piston (306) via the transmission mechanism (352) in the passage (396) of the cylinder (302) when activated; a ram (304) slideably mounted within the passage (396) of the cylinder (304) which is capable of being reciprocatingly driven by the piston via an air spring (308) when the piston (306) is reciprocatingly driven by the motor, the ram (304) comprising at least one circumferential receiving groove (336); a beat piece support structure (360) mounted within the housing (340) forward of the cylinder (302); a beat piece (310) mounted in the beat piece support structure (360) which is capable of being struck by the reciprocating ram (304), the beat piece (310) capable of transferring the impact

onto the end of a cutting tool (356) when held by the tool holder (358); a ram catcher (362) mounted in the housing between the front of the cylinder and the beat piece support structure; characterised in that the ram catcher comprises: a second ring (316) comprising a passage which aligns with the passage (396) of the cylinder (302); a first ring (314) arranged next to the second ring (316) in succession along the longitudinal axis (334) with the second ring (316), the first ring (314) comprising a passage which aligns with the passage of the second ring (316); a radially inward facing groove (324) formed by the two rings (314; 316) at the junction of the first and second rings (314; 316); and a resiliently deformable member (326) mounted in the groove (324) which projects radially inwardly from the radially inward facing groove (324); wherein, when the ram (304) travels to a forward position within the passage (396) of the cylinder (302), the resiliently deformable member (326) engages with the circumferential receiving groove (336) to hold the ram (304) in the forward position.

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Description

[0001] The present invention relates to a ram catcher for a ram in a hammer drill.

[0002] A typical hammer drill comprises a body in which is mounted an electric motor and a hammer mechanism. A tool holder is mounted on the front of the body which holds a cutting tool, such as a drill bit or a chisel. The hammer mechanism typically comprises a ram, slideably mounted in a cylinder, reciprocatingly driven by a piston via an air spring, the piston being reciprocatingly driven by the motor via a set of gears and a crank mechanism or wobble bearing. The ram in turn repeatedly strikes the end of the cutting tool via a beat piece. When the only action on the tool bit is the repetitive striking of its end by the beat piece, the hammer drill is operating in a hammer only mode.

[0003] Certain types of hammer drill also comprise a rotary drive mechanism which enables the tool holder to rotatingly drive the cutting tool held within the tool holder. In such constructions, the cylinder is the form of a rotatable spindle. This can be in addition to the repetitive striking of the end of the cutting tool by the beat piece (in which case, the hammer drill is operating in a hammer and drill mode) or as an alternative to the repetitive striking of the end of the cutting tool by the beat piece by switching off the hammer mechanism (in which case, the hammer drill is operating in a drill only mode).

[0004] EP1157788 discloses such a hammer drill.

[0005] During the operation of a hammer either in hammer only mode or in hammer and drill mode, when the cutting tool held by the tool holder is pressed against a work piece to cut the work piece, the reciprocating piston, driven by the motor, reciprocatingly drives the ram in order to repetitively strike the beat piece which in turn strikes the end of a cutting tool to cause the cutting tool to strike the work piece. When the cutting tool is removed from the work piece whilst the hammer drill is still activated, the piston continues to be reciprocatingly driven by the motor. However, it is desirable to stop the ram from continuing to repetitively strike the beat piece as it will result in damaging the support structure for the beat piece and/or tool holder as the energy of the impacts are no longer being absorbed by the work piece.

[0006] One way of achieving this is to provide a ram catcher. US20090277659 describes such a ram catcher.

[0007] A prior art design of hammer mechanism will now be described with reference to Figures 1 to 5.

[0008] Referring to Figure 1, a hammer drill comprises a body 2 having a rear handle 4 moveably mounted to the rear of the body 2. The rear handle 4 comprises a centre grip section 90 and two end connection sections 92, 94, one end connection section being attached to one end of the centre grip section, the other end connection section being connected to the other end of the centre grip section. The handle 4 is connected to the rear of the body 2 by the two end connection sections 92, 94. The rear handle is constructed from a plastic clam shell 100

and a rear end cap 102 which is attached to the clam shell 100 using screws (not shown). The rear of the body is formed by three plastic clam shells 6, 70, 72 which attach to each other and to the remainder of the body 2 using screws (not shown).

[0009] An SDS tool holder 8 is mounted onto the front 10 of the body 2. The tool holder can hold a cutting tool 12, such as a drill bit. A motor (shown generally by dashed lines 48) is mounted within the body 2 which is powered by a mains electricity supply via a cable 14. A trigger switch 16 is mounted on the rear handle 4. Depression of the trigger switch 16 activates the motor in the normal manner. The motor drives a hammer mechanism (shown generally by dashed lines 46 in Figure 1), which comprises a piston 204 reciprocatingly driven by the motor via a crank shaft 206 within a spindle 150, which in turn reciprocatingly drives a ram 152 via an air spring 170 which in turn strikes, via a beat piece 156, the end of the cutting tool 12. The motor can rotationally drive the spindle 150 via a bevel gear 200 and torque clutch 202. A mode change mechanism (not shown) can switch the hammer drill between three modes of operation, namely hammer only mode, drill only mode or hammer and drill mode. A rotatable knob 18 is mounted on the top of the body 2. Rotation of the knob 18 changes the mode of operation of the hammer drill in well known manner.

[0010] Referring to the Figure 2, the spindle 150 has a longitudinal axis 154. In side of the spindle 150 is located the ram 152, forward of the piston 204, a beat piece 156, forward of the ram 152, a ram catcher located between the ram 152 and the beat piece 156 and a beat piece support structure.

[0011] The forward end 162 of the spindle 150 forms part of the tool holder 8. During normal use, the cutting tool 12 (shown in dashed lines in Figure 2) is held within the forward end 162 of the spindle 150 by the tool holder. The cutting tool 12 is prevented from rotating relative to the spindle 150 whilst being capable of moving axially over a limited range of movement within the forward end 162 of the spindle 150 in well known manner.

[0012] The piston 204 is mounted directly in the rear of the spindle 150 and comprises an O ring 208 which locates in a groove formed around the main body of the piston and which provides an air tight seal between the piston and the inner wall of the spindle 150.

[0013] The ram 152 is mounted directly in the spindle 150 and comprises a main body 166 attached to an end cap 160, via a neck 168, of smaller diameter than the main body 166 of the ram 152, located at the forward end of the ram 152. The ram is circular in cross section in any plane which extends perpendicularly from the longitudinal axis 154 (which is co-axial with the longitudinal axis of the spindle 150 when the ram is located inside of the spindle) of the ram 152 along its length. The ram 152 comprises an O ring 158 which locates in a groove formed around the main body 166 of the ram and which provides an air tight seal between the ram 152 and the inner wall of the spindle 150. During normal operation of the ham-

mer, the ram 152 is reciprocatingly driven by the piston 204 via an air spring 170 formed between the piston 204 and ram 152 in well known manner along the longitudinal axis 154. The air spring 170 between the ram 152 and the piston 204 is maintained by the air in the air spring 170 being prevented from escaping from (or air external of the air spring entering into) the space between the piston 204 and ram 152 due to the two O rings 208, 158.

[0014] The ram catcher comprises a rubber ring 214 which locates against the inner wall of the spindle 150 and is axially held in position inside of the spindle by being sandwiched between a ring retainer, comprising a circlip 216 and metal washer 218, and a metal tubular insert 210 of the beat piece support structure, both being located inside of the spindle 150. The rubber ring 214 provides a lip which projects radially inwardly into spindle 150 towards the longitudinal axis 154. The diameter of the aperture formed by the rubber ring 214 is less than that of the end cap 160 of the ram 152 but similar to that of the neck 168 of the ram 152. A series of holes 220 are formed around the circumference of the spindle rearward of the circlip 216 which each extend through the wall of the spindle 150.

[0015] During the normal operation of the hammer drill, when the cutting tool is engaged with a work piece, the ram 152 is reciprocatingly driven over a range of axial positions (one of which is shown in Figure 2) inside of the spindle located to the rear of the ram catcher, the ram 152 being prevented from engaging the ram catcher due to the position of the beat piece 156. The ring 214 has no contact with any part of the ram 152 during the normal operation of the tool. When the ram 152 is able to move forward, due to the position of the beat piece, the end cap 160 engages with the rubber ring 214 and passes through the aperture due to the ring deforming, allowing the lip to flex to enable the cap 160 to pass through it. Once the cap 160 has passed through the ring 214, the lip returns to its original shape, locating in the neck 168 of the ram to hold the ram 152 stationary (as shown in Figures 3 and 4).

[0016] The beat piece 156 is supported by a beat piece support structure formed in part by the spindle 150 and in part by a support structure inside the spindle 150 comprising a metal tubular insert 210 sandwiched between an O ring 212 and the rubber ring 214 of the ram catcher. The beat piece 156 is circular in cross section in any plane which extends perpendicularly from the longitudinal axis 154 (which is co-axial with the longitudinal axis of the spindle 150 when the beat piece is located inside of the spindle) of the beat piece 156 along its length, the centre of the circular cross section being located on the longitudinal axis.

[0017] The beat piece 156 comprises a middle section 172, a front section 174 and a rear section 176.

[0018] The middle section 172 has a uniform diametered circular cross section along its length, the centre of the circular cross section being located on the longitudinal axis 154.

[0019] The rear section 176 has a uniform diametered circular cross section along its length, the centre of the circular cross section being located on the longitudinal axis 154. The rear end 240 of the rear section 176 is flat and is impacted by the cap 160 of the ram 152 during normal operation. The rear section 176 is joined to the middle section 172 via a first angled region 242. The first angled region 242 engages with a correspondingly shaped first angled shoulder 244 formed on the metal insert 210 located inside the spindle when the beat piece is in its most rearward position, limiting the amount of rearward movement of the beat piece 156. The wall of the angled shoulder 244 is circular in cross section in any plane which extends perpendicularly from the longitudinal axis 154 of the spindle 150, the centre of the circular cross section being located on the longitudinal axis. When the first angled region 242 is in engagement with the first angled shoulder 244, there is a uniform amount of contact between the two surfaces around the longitudinal axis 154.

[0020] The front section 174 is frusto conical in shape centred around the longitudinal axis 154 of the beat piece 156. The front end 246 of the front section 174 is flat and impacts the cutting tool 12 during normal operation. The front section 174 is joined to the middle section 172 via a second angled region 248 which is frusto conical in shape centred around the longitudinal axis 154 of the beat piece 156. The second angled region 248 engages with a correspondingly shaped second angled shoulder 250 formed on the inner wall of the spindle 150 when the beat piece is in its most forward position, limiting the amount of forward movement of the beat piece 156. The wall of the second angled shoulder 250 is circular in cross section in any plane which extends perpendicularly from the longitudinal axis 154 of the spindle 150, the centre of the circular cross section being located on the longitudinal axis 154. When the second angled region 248 is in engagement with the second angled shoulder 250, there is a uniform amount of contact between the two surfaces around the longitudinal axis 154.

[0021] When the hammer drill is operating in the normal manner with the cutting tool 12 cutting a work piece, the ram strikes the beat piece 156 which in turn strikes the end of cutting tool 12 in the tool holder 8. The ram 152 is reciprocatingly driven over a limited range of axial movement within the spindle, the maximum distance from the piston being limited by the position of the beat piece 156 which it impacts, the position of which in turn is controlled by the end of the cutting tool 12. Whilst traveling within this range of axial movement, the O ring 158 of the ram 152 does not pass the holes 220. As such, the air spring 170 between the piston 204 and ram 152 is maintained. The rear section 176 projects rearwardly through the aperture of the ring 214 of the ram catcher, to enable the cap 160 of the ram 152 to strike it as shown in Figure 2.

[0022] When the cutting tool 12 is removed from the work piece, the beat piece 156 is able to move forward

as the cutting tool 12 can extend out of the tool holder 8 to its maximum position. If the motor is still running, the piston 204 is able to drive the ram 152 via the air spring 170 further along the spindle 150, as the beat piece 156 can move forward, passing the air holes 220. Once the O ring 158 of the ram 152 has passed the air holes 220, the air is able to freely pass into and out of the spindle 150 in the space between the piston 204 and ram 152, causing the air spring 170 to be broken and thus disconnecting the drive between the piston 204 and ram 152. As the air spring 170 is broken, the ram 152 is able freely continue to travel along the length of the spindle 150. The ram 152 engages with the ram catcher, the cap 160 passing through the ring 214 allowing the neck 168 to engage with the ring, to secure the ram in the ram catcher, as seen in Figure 3 and 4. The reciprocating movement of the piston 204 has no effect on the ram 152 as the air spring 170 is broken due to the holes 220 which allow air in and out of the spindle 170 in the space between the piston 204 and ram 152. The beat piece 156 is pushed forward in the spindle 150 by the ram 152 in the ram catcher. In order to release the ram 152 from the ram catcher, the cutting tool 12 is pressed against a work piece causing it to be pushed into the tool holder 8, which in turn pushes the beat piece 156 rearwardly into engagement with the cap 160 of the ram 152, pushing it out of the ram catcher and past the holes 220. In such a position, the air spring 170 is reformed and the piston 204 is able to reciprocatingly drive the ram 152 again.

[0023] A problem associated with the ram 152 and ram catcher of the hammer mechanism described above with reference to Figures 1 to 5 is that the ram 152 comprises an end cap 160 and neck 168. This increases the length of the ram 152. In particular, the part (the end cap 160) of the ram 152 which strikes the beat piece 156 has to be located a significant distance forward of the main body 166 of the ram 152 resulting in an overall longer hammer mechanism.

[0024] Referring to Figure 11, another prior art design of hammer mechanism is disclosed. The hammer mechanism is that used in the DEWALT D25600 hammer drill. In Figure 11, the ram 152, which is slideably mounted in a cylinder 702 (which in turn is mounted in a rotatable spindle 150), comprises an end cap 160 attached to a main body 166 by a neck 168. The ram catcher comprises two O rings 700 which locate within the neck 168 of the ram 152, to hold the ram 152, when the beat piece 156 (which is supported by the spindle 150) has moved to a forward position and the end cap 160 has passed forward (left) through the O rings 700. As there are two O rings 700, the length of the neck 168 has to be long to accommodate both O rings 700 resulting in the end cap 160 being located a considerable distance forward of the main body 166 resulting in an overall longer hammer mechanism.

[0025] The present invention overcomes this problem by avoiding the use of an end cap and neck on the ram.

[0026] Referring to Figure 12, another prior art design

of hammer mechanism is disclosed. The hammer mechanism is that used in the DEWALT 7-12 kg hammer drill range. In Figure 12, the ram 152, which is slideably mounted in a cylinder 702 (which in turn is mounted in a rotatable spindle 150), comprises a main body 166 only. The front end 704 of the main body 166 directly strikes the rear section end 240 of the rear section 176 of a beat piece 156. This results in an overall reduction in the length of the hammer mechanism. The hammer mechanism comprises a ram catcher having an O ring 706. The O ring 706 locates inside of a narrow central section 710 of the ram 152, to hold the ram 152, when the beat piece 156 has moved to a forward position and the front end 704 has passed forward (left) through the O ring 706. However, the O ring 706 is mounted within a groove 708 formed in the internal wall 712 of the cylinder 702. The manufacture of a cylinder 702 with an internal groove 708 and the insertion of an O ring 706 during production is both difficult and expensive.

[0027] The present invention overcomes this problem by mounting an O ring outside and forward of the cylinder thus avoiding the complexity and expense. Furthermore, by mounting the O ring forward of the cylinder, the length of the cylinder can be reduced.

[0028] Accordingly, there is provided a hammer drill in accordance with claim 1.

[0029] An embodiment of the invention will now be described, by way of example only and not in any limitative sense, with reference to the accompanying drawings, in which:-

Figure 1 shows a sketch of a side view of a prior art hammer drill;

Figure 2 shows a cross sectional view of the hammer mechanism with the ram in a position where it can freely slide within the spindle;

Figure 3 shows a cross sectional view of the hammer mechanism with the ram in the ram catcher and the beat piece sliding in the spindle;

Figure 4 shows a cross sectional view of the hammer mechanism with the ram in the ram catcher and the beat piece in its furthest forward position in the spindle;

Figure 5 shows the beat piece;

Figure 6 shows a schematic sketch of a hammer drill having a ram catcher in accordance with the present invention;

Figure 7 a vertical cross section of the ram catcher in accordance with an embodiment of the present invention;

Figure 8 shows an exploded view of the cylinder, ram, beat piece and ram catcher of the hammer mechanism shown in Figure 7;

Figure 9 shows a cross sectional view of the cylinder, ram, beat piece and ram catcher of the hammer mechanism of Figure 7 with the ram and beat piece in their working positions;

Figure 10 shows a cross sectional view of the cylinder

der, ram, beat piece and ram catcher of the hammer mechanism of Figure 7 with the ram caught by the ram catcher;

Figure 11 shows a cross sectional view of the DEWALT D25600 hammer drill (prior art); and

Figure 12 shows a cross sectional view of the DEWALT 7-12 kg hammer drill range (prior art).

[0030] An embodiment of the present invention will now be described with reference to Figures 6 to 10.

[0031] Referring to Figure 6, the hammer comprises a housing 340 in which is mounted a cylinder 302 and an electric motor 344 in well known manner. The cylinder 302 has a longitudinal axis 334 and forms a passage 396 along its length. Mounted inside the passage 396 at one end of the cylinder 302 is a piston 306. The piston 306 is reciprocatingly driven by a crank shaft 348 which connects to an eccentric pin 350 of a crank mechanism 352. The crank mechanism 352 forms part of a transmission mechanism which converts the rotary motion of the motor 344 in a reciprocating motion of the piston 302. The crank mechanism 352 is rotationally driven by the electric motor 344. Mounted inside of the passage 396 of the cylinder 302 in front of the piston 306 is a ram 304. The ram 354 is reciprocatingly driven by the reciprocating piston 302 via an air spring 308. The reciprocating ram 306 repetitively strikes the rear end of a beat piece 310, which in turn transfers the impact onto the rear end of a cutting tool 356 held in a tool holder 358 mounted on the front of the housing 340. The beat piece 310 is held in a beat piece support structure 360 which is located forward of the cylinder 302. Located between the front of the cylinder 302 and the beat piece support structure 360 is a ram catcher 362 which is described in more detail below. The operation of a hammer drill is well known and therefore will not be described in any more detail.

[0032] Referring to Figures 7 to 10, during the normal operation of the hammer drill, the ram 304 is reciprocatingly driven by the oscillating piston 306 via the air spring 308. The ram 304 repetitively strikes the beat piece 310 which in turn transfers the impact to the cutting tool 356 in well-known manner. Figure 9 shows the ram 304 and beat piece 310 in their normal working positions. However, when the cutting tool 356 of the hammer drill disengages from a work piece, the beat piece 310 moves to its most forward position (left in Figure 7) allowing the ram 304 to move to a forward space 312 where it is caught by the ram catcher 362. Figure 10 shows the ram 304 and beat piece 310 when the beat piece 310 is in a forward position and the ram 304 is held by the ram catcher 362.

[0033] The ram 304 comprises a front section 328 having a diameter equal to that of the inner diameter of the cylinder 302, a middle section 330 of reduced diameter, and a rear section 332 having a diameter equal to that of the front section and the inner diameter of the cylinder 302. A space 336 is formed adjacent the middle section 330 between the front section 328 and the rear section

332 which acts as a circumferential receiving groove for an O ring 326 of the ram catcher 362. A second circumferential groove 364 is formed around the rear section 332 in which is located an O ring 366. The O ring 366 acts as a seal between the ram 304 and the inner wall 368 of the cylinder 302.

[0034] The beat piece 310 comprises rear section 370, a middle section 372 of greater diameter, and a front section 374. A rear angled section 376 connects the rear section 370 with the middle section 372. A front angled section 378 connects the middle section 372 with the front section 374. During normal operation, the rear end of the rear section 370 is struck by the ram 304. The middle section 372 locates inside of a passage 380 formed inside of the front end 360 of a tubular spindle 382. The inner passage 380 has a circular cross section with a constant diameter along its length. Two circumferential grooves 382 are formed around the middle section 372 in each of which is located an O ring 384. The O rings 384 act as seals. The front end 360 of the spindle 382 acts as the beat piece support structure. The rear end of the spindle 382 surrounds the front half of the cylinder 302. The front of the spindle 382 is mounted in bearings 384 in the housing. The rear of the spindle 382 is mounted on bearings 722 on the cylinder 302. The spindle 382 is capable of being rotationally driven, to transfer rotary movement to the cutting tool 356, in well-known manner.

[0035] Located between front end of the spindle 382 and the cylinder 302 is a beat piece dampener 386 and a ram catcher 362, the ram catcher 362 being located adjacent the front end of the cylinder 302 and the beat piece dampener 386 being located adjacent the front end 360 of the spindle 382.

[0036] The beat piece dampener 386 comprises a metal washer 388 and a rebound dampener 322. The rebound dampener 322 comprises a large rubber ring which is sandwiched between the ram catcher 362 and the washer 388 in a compressed state, the rebound dampener 322 urging the washer 388 towards and into contact with a rear wall 390 of the front end 360 of the spindle 382. The washer 388 extends radially inwards so that its inner diameter is less than the inner diameter of the passage formed in the front end 360 of the spindle 382. The radial inner end 392 of washer 388 is tapered in a forward direction in a corresponding manner to the rear angled section 376 of the beat piece 310. During normal operation, the middle section 372 of the beat piece 310 is located forward of the washer 388. As such, the washer 388 abuts against the rear wall 390 of the front end 360 of the spindle 382. However, when the beat piece 310 is allowed to travel rearwardly, the rear angled section 376 makes contact with the tapered part 392 of the washer 388 and prevents further rearward movement of the beat piece 310. When the rear angled section 376 makes contact with the tapered part 392 of the washer 388, the washer 388 can move rearwardly slightly, compressing the rebound dampener 322 as it does so. The

rebound dampener 322 absorbs the energy of the moving beat piece 310, stopping it from making any further rearward movement.

[0037] The ram catcher 362 comprises a first plastic ring 314 which mates with a second plastic ring 316 by a rim 318 on the second plastic ring 316 locating within a recess 320 of the first plastic ring 314. The first plastic ring 314 comprises a passage. The second plastic ring 316 also comprises a passage. The two rings 314, 316 are arranged so that they locate next to each other in succession along the longitudinal axis 334 of the cylinder 302. The passage of the second ring 316 aligns with the passage 396 of the cylinder 304 and the passage of the first ring 314 aligns with the passage of the second ring 316. The second ring 316 is located adjacent the end of the cylinder 302. The first ring 314 is located adjacent the second ring 316, the second ring being located between the first ring 314 and the end of the cylinder 302. The plastic rings 314, 316 are held in position by being sandwiched between the rebound dampener 322 and the end of the cylinder 302. A circumferential groove 324 is formed at the junction between the two rings 314, 316 which faces radially inwards. An O ring 326 locates within the groove 324. A radial inner side of the O ring 326 projects inwardly towards the central axis 34 of the cylinder 2. The diameter, from the central axis 334, of the radial inner side of the O ring 326 is less than the outer diameter of the front section 328 of the ram 304 but greater than the middle section 330 of the ram 304. The groove 324 is wide enough in an axial direction to avoid squeezing the O ring 326 as well as providing enough space to allow the O ring 326 to be compressed by the ram 304 when it passes through the O ring 326.

[0038] During normal operation of the hammer drill, the ram 304 is located to the rear (right) of the O ring 326 with rear section 370 of the beat piece 310 passing through it as shown in Figure 7. However, when the cutting tool 356 is disengaged from a work piece whilst the motor 344 is still activated, the ram 304 and beat piece 310 move forward (left in Figure 7), the ram 304 moving into the forward space 312. As it does so, the front section 328 engages with the O ring 326 causing it to compress as the front section 328 passes over the O ring 326. Once the front section 328 has passed the O ring 326, the O ring 326 reverts to its normal shape, the radial inner side of the O ring 326 projecting inwardly towards the central axis 334 of the cylinder 302 and entering the space 336 adjacent the middle section 330 between the front section 328 and the rear section 332. The O ring 326 is sufficiently resilient to hold the ram 304 if it rebounds, preventing the front section 328 passing back over the O ring 326 as the ram 304 will have lost a lot of momentum. The O ring 326 then holds the ram 304 in the forward position.

[0039] In order to disengage the ram 304, from the ram catcher, the ram 304 is pushed rearwardly by the beat piece 310, for example when the cutting tool 356 engages with a work surface, the front section 328 engaging with

and passing over the O ring 326 as it moves rearwardly, causing the O ring 326 to compress as the front section 328 passes over the O ring 326. Once the front section 328 has passed the O ring 326, the O ring 326 reverts to its normal shape. The O ring 326 is then located forward of the ram 304, the ram then be able to freely move.

[0040] The second ring 316 comprises a series of notches 720 (as best seen in Figure 8). The notches 720 perform a venting function when the hammer mechanism is switched off. During the normal operation of the hammer mechanism, an air cushion forms in the space 312 between the beat piece 310 and ram 304. The notches 720 allow for the pressurized air in the air spring to dissipate when the ram 304 approaches the ram catcher 362 and/or after the ram 304 has been caught by the ram catcher 362. Without the notches 720, the air spring would remain intact and therefore, the ram 304 would be accelerated back out of the ram catcher 362 by the force of the air spring (which would be greater than the holding force of the O ring 326) towards the piston 306. A further function of the notches 720 is to allow lubrication to pass around and/or through the ram catcher. This provides access for lubrication to the front of the cylinder 302 where the cylinder 302 supports the spindle 382 via bearings 722.

[0041] The first ring 314 comprises a series of tabs 714 separated by gaps 716 (as best seen in Figure 8). The rebound dampener 322 comprises a series of castellations 718 which engage with the gaps 716, the tabs 714 locating between the castellations. The tabs 714 centre and guide the rebound dampener 322. In addition, the gaps 716 provide for additional venting of the air spring between the ram 304 and beat piece 310 as well as reducing the amount of accumulation of debris in that region generated during the operation of the hammer drill.

Claims

1. A hammer drill comprising:

- a housing (340);
- a tool holder (358) mounted on the front of the housing (340);
- a motor (344) mounted with the housing (340);
- a cylinder (302) comprising a passage (396) mounted inside of the housing (340), the cylinder (302) comprising a longitudinal axis (334);
- a piston (306) slideably mounted within the passage (396) of the cylinder (302);
- a transmission mechanism (352) which is capable of converting the rotary movement of the motor (344) into a reciprocating movement of the piston (306), the motor (344) reciprocatingly driving the piston (306) via the transmission mechanism (352) in the passage (396) of the cylinder (302) when activated;
- a ram (304) slideably mounted within the pas-

sage (396) of the cylinder (304) which is capable of being reciprocatingly driven by the piston via an air spring (308) when the piston (306) is reciprocatingly driven by the motor, the ram (304) comprising at least one circumferential receiving groove (336);

a beat piece support structure (360) mounted within the housing (340) forward of the cylinder (302);

a beat piece (310) mounted in the beat piece support structure (360) which is capable of being struck by the reciprocating ram (304), the beat piece (310) capable of transferring the impact onto the end of a cutting tool (356) when held by the tool holder (358);

a ram catcher (362) mounted in the housing between the front of the cylinder and the beat piece support structure;

characterised in that the ram catcher comprises:

a second ring (316) comprising a passage which aligns with the passage (396) of the cylinder (302);

a first ring (314) arranged next to the second ring (316) in succession along the longitudinal axis (334) with the second ring (316), the first ring (314) comprising a passage which aligns with the passage of the second ring (316);

a radially inward facing groove (324) formed by the two rings (314; 316) at the junction of the first and second rings (314; 316); and a resiliently deformable member (326) mounted in the groove (324) which projects radially inwardly from the radially inward facing groove (324);

wherein, when the ram (304) travels to a forward position within the passage (396) of the cylinder (302), the resiliently deformable member (326) engages with the circumferential receiving groove (336) to hold the ram (304) in the forward position.

2. A hammer drill as claimed in claim 1 wherein the first ring (314) mates with the second ring (316).
3. A hammer drill as claimed in claim 2 wherein one ring (316) comprises a rim (318), the other ring (314) comprises a recess (320), the first ring (314) mating with the second ring (316) by the rim (318) locating within the recess (320).
4. A hammer drill as claimed in any of the previous claims wherein the resiliently deformable member is an O ring (326).
5. A hammer drill as claimed in any of the previous

claims wherein the width of the radially inward facing groove (324) in an axial direction is greater than the width of the resiliently deformable member (326).

6. A hammer drill as claimed in any of the previous claims wherein the ram (304) comprises a front section (328) having a diameter equal to that of the inner diameter of the cylinder (302), a middle section (330) of reduced diameter, and a rear section (332) having a diameter equal to that of the front section and the inner diameter of the cylinder (302); Wherein a space (336) is formed adjacent the middle section (330) between the front section (328) and the rear section (332) which forms the receiving groove.
7. A hammer drill as claimed in claim 6 wherein the radial inner diameter of the resiliently deformable member (324) is less than the diameter of the front section (2324) of the ram (304) but is greater than the diameter of the middle section (330).
8. A hammer drill as claimed in any of the previous claims wherein the second ring (316) is located adjacent the end of the cylinder (302).
9. A hammer drill as claimed in any of the previous claims wherein the first ring (314) is located adjacent the second ring (316), the second ring (316) being located between the first ring (314) and the end of the cylinder (302).
10. A hammer drill as claimed in any of the previous claims wherein the ram catcher sandwiched between a part of the housing and the end of a cylinder (304).
11. A hammer drill as claimed in any of the previous claims wherein there is provided a spindle rotationally mounted in the housing; wherein a part of the spindle forms the beat piece (310) support structure; wherein the ram catcher (362) is sandwiched between the part of the spindle which forms the beat piece support structure and the end of a cylinder (302).
12. A hammer drill as claimed in claim 11 wherein there is provided a beat piece dampener (386) sandwiched between the part of the spindle which forms the beat piece support structure and the ram catcher (362).
13. A hammer drill as claimed in any of the previous claims wherein the second ring (316) comprises a series of notches (720), wherein the notches (720) perform a venting function to allow for the pressurized air in an air spring formed in a space (312) between the beat piece (310) and ram (304) to dissipate when the ram 304 approaches the ram catcher

er 362 and/or after the ram (304) has been caught
be the ram catcher 362.

14. A hammer drill as claimed in any of the previous
claims wherein the second ring (316) comprises a
series of notches (720), wherein the notches (720)
allow lubrication to pass around and/or through the
ram catcher. 5
15. A hammer drill as claimed in any of the previous
claims wherein the first ring (314) comprises a series
of tabs (714) separated by gaps (716), wherein there
is provided a beat piece dampener comprising a re-
bound dampener (322) wherein the rebound damp-
ener comprises a series of castellations (718) which
are capable of engaging with the gaps (716) of the
first ring (314), the tabs (714) locating between the
castellations, the tabs centring and guiding any
movement of the rebound dampener (322). 10
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16. A hammer drill as claimed in claim 13 wherein the
first ring (314) comprises a series of tabs (714) sep-
arated by gaps (716), wherein the gaps (716) per-
form an additional venting function to allow for the
pressurized air in an air spring formed in a space
(312) between the beat piece (310) and ram (304)
to dissipate when the ram (304) approaches the ram
catcher 362 and/or after the ram (304) has been
caught be the ram catcher (362). 25
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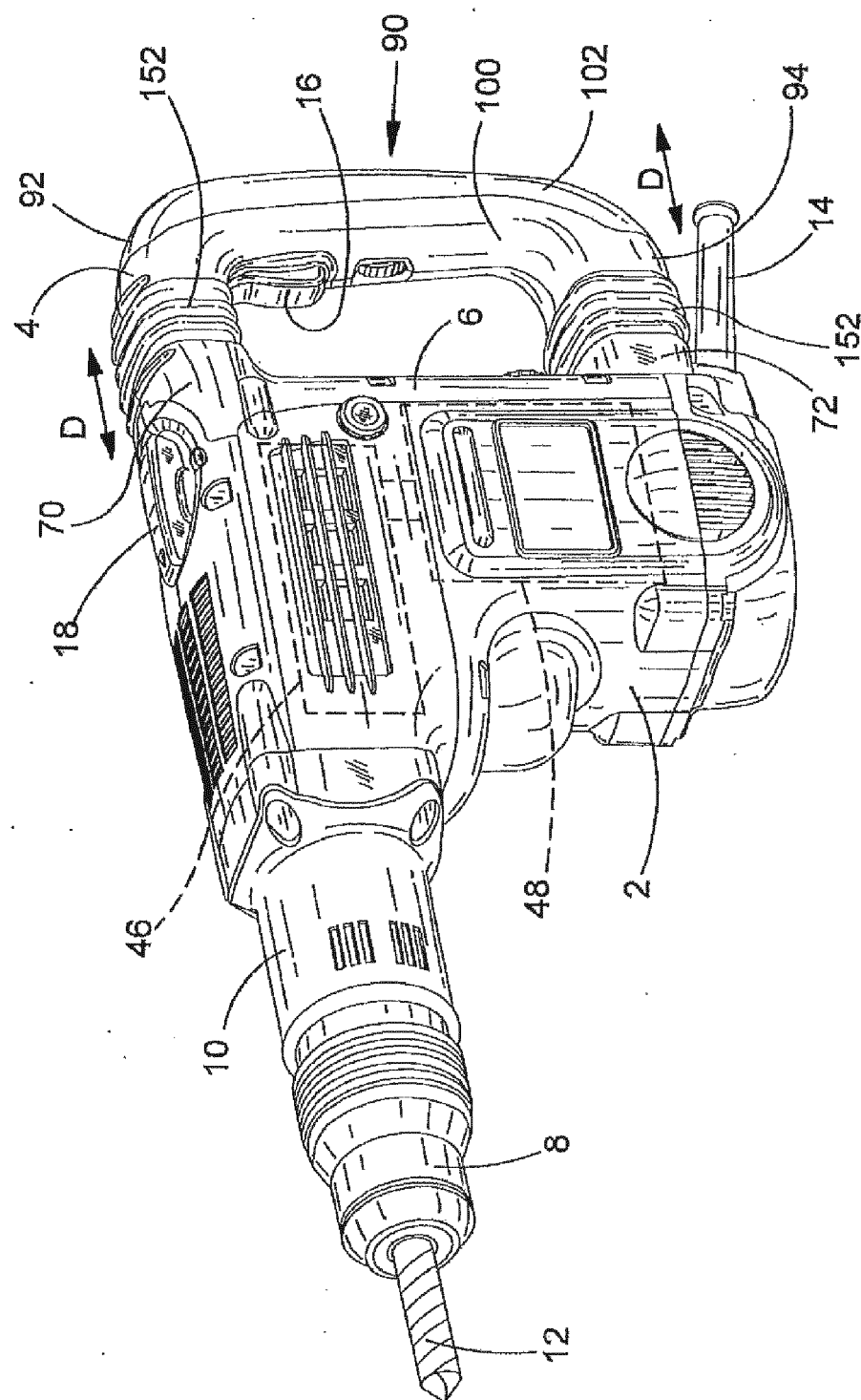


FIG. 1
(PRIOR ART)

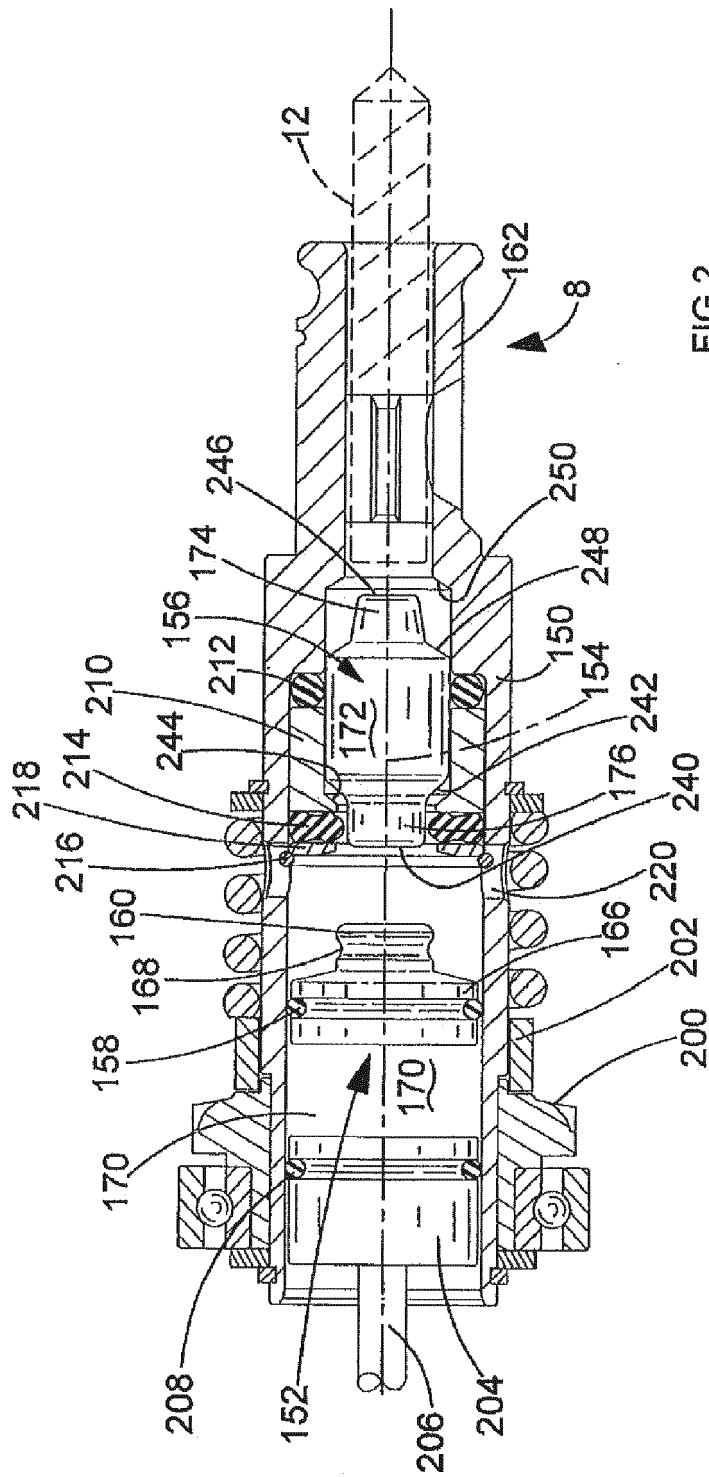


FIG.2
(PRIOR ART)

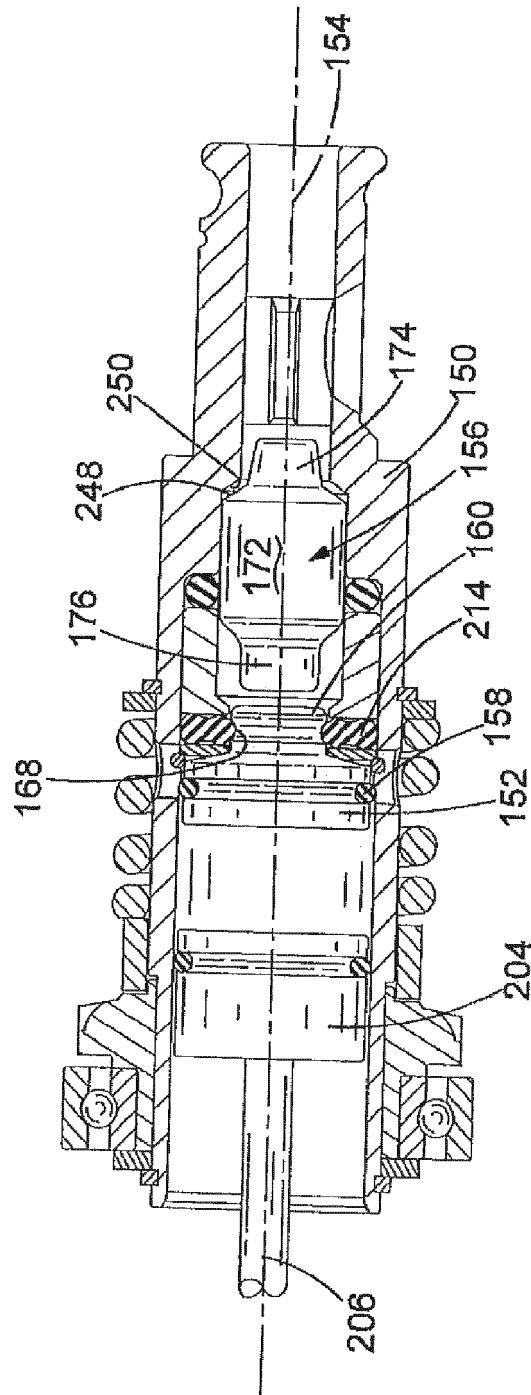


FIG.3

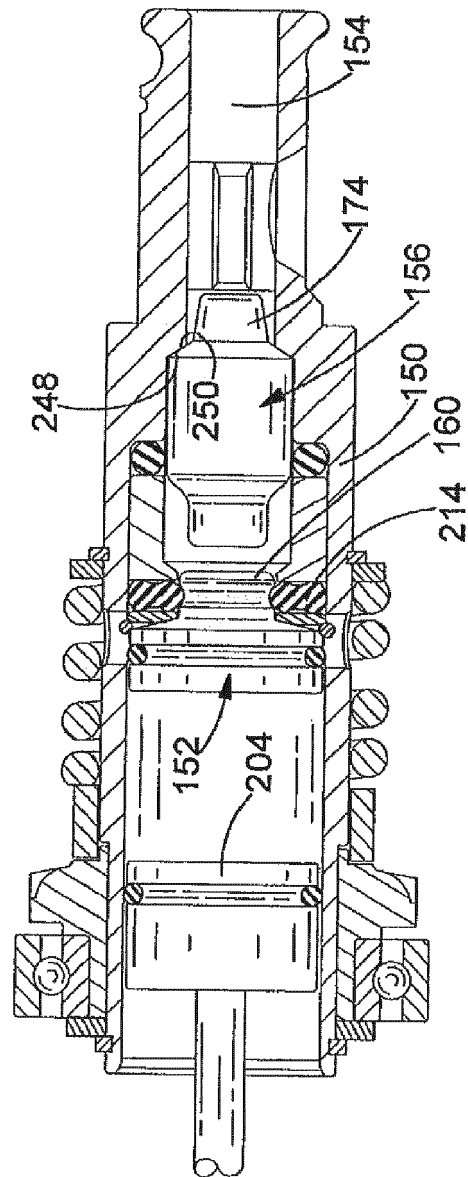


FIG.4

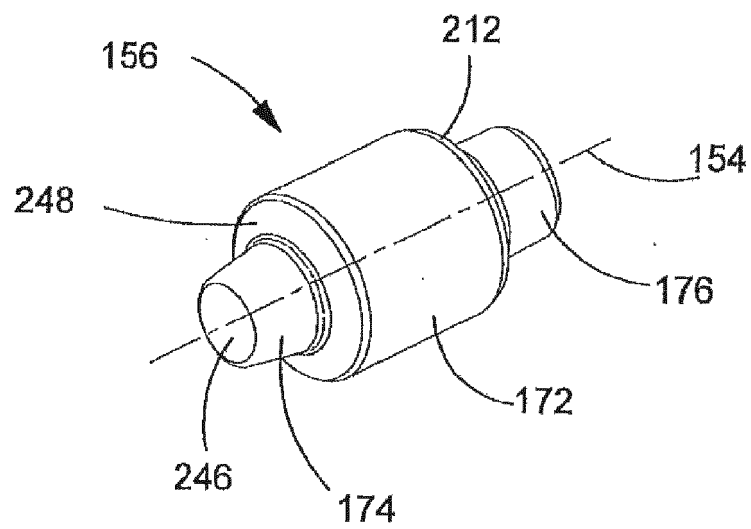
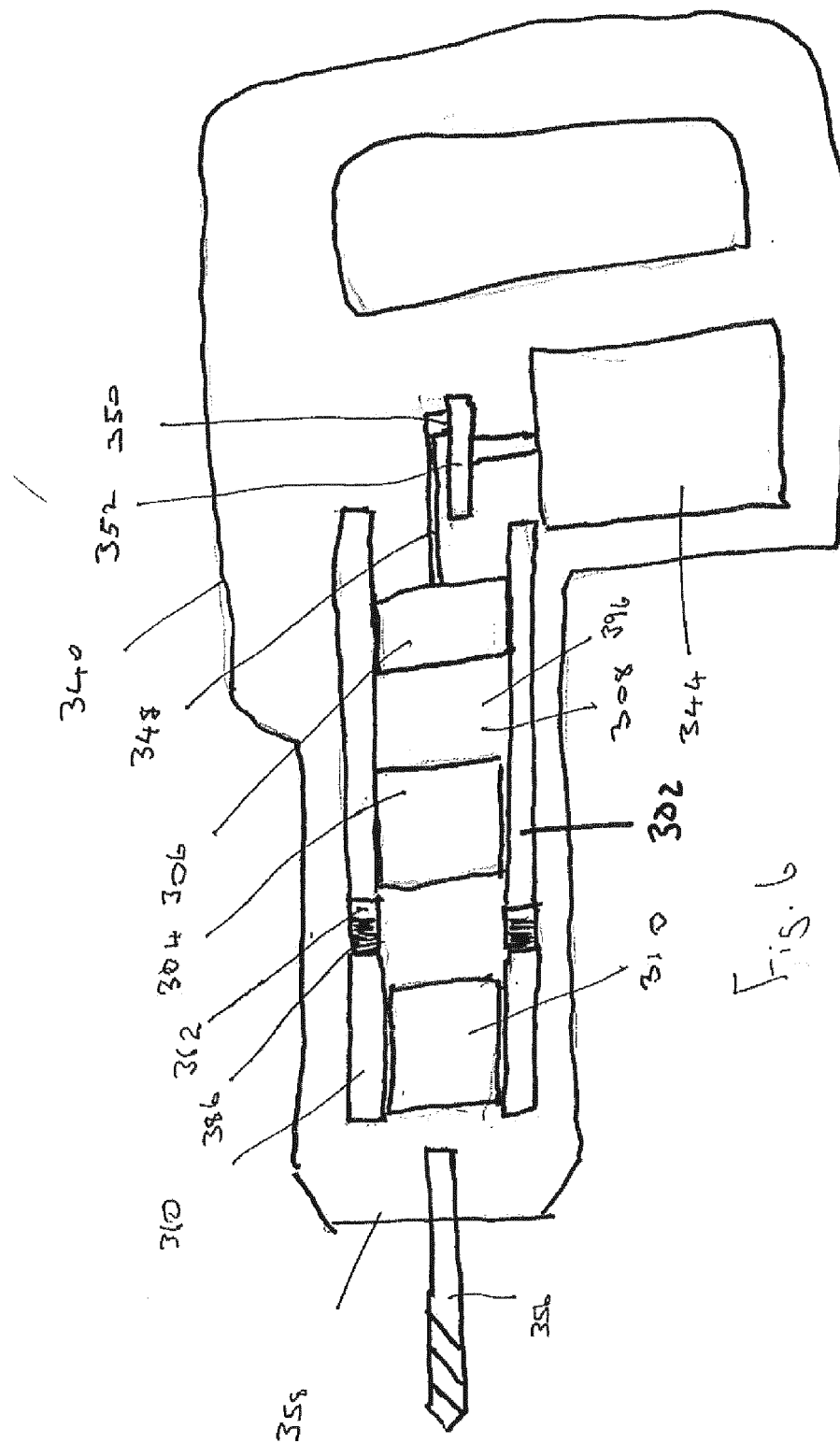


FIG.5



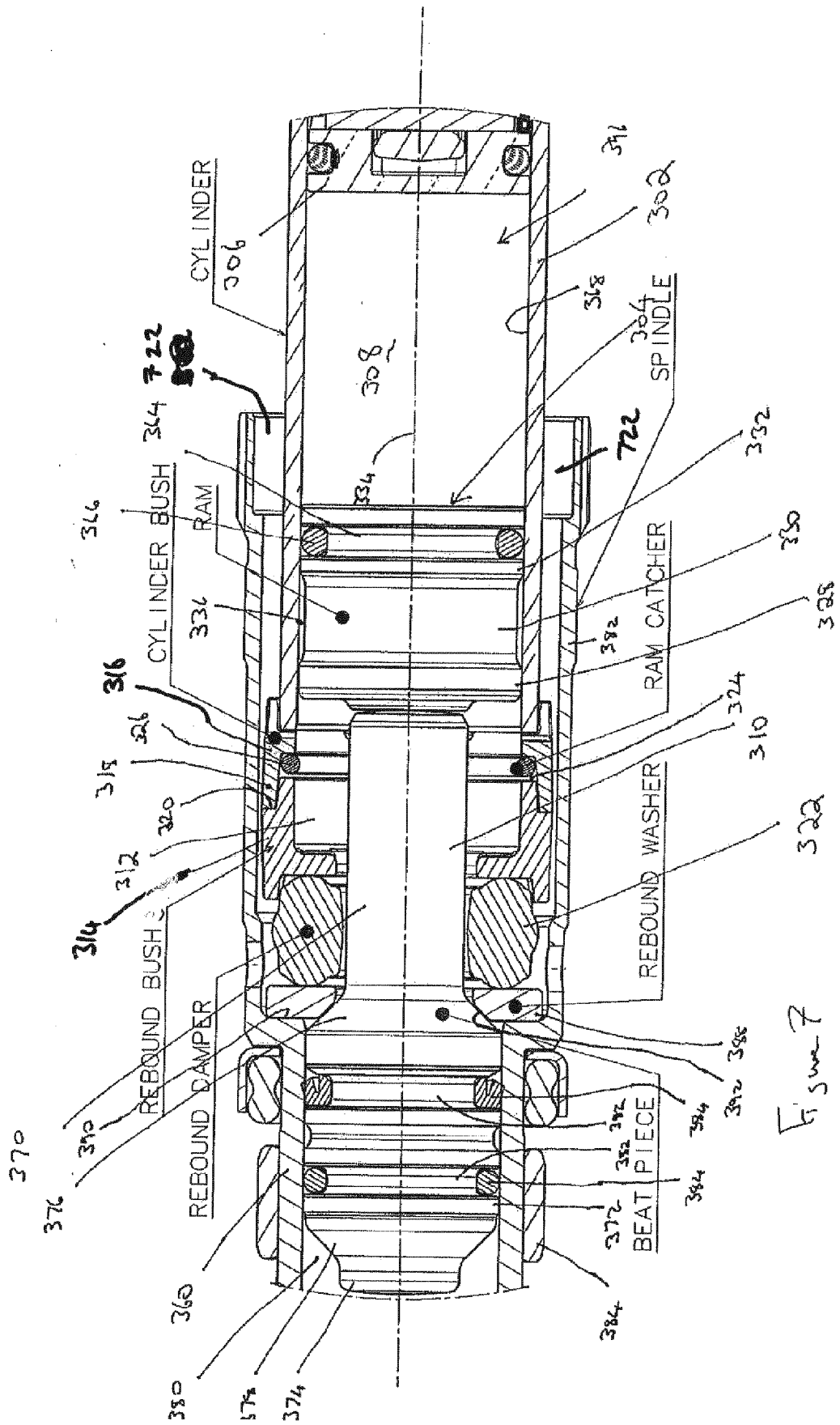
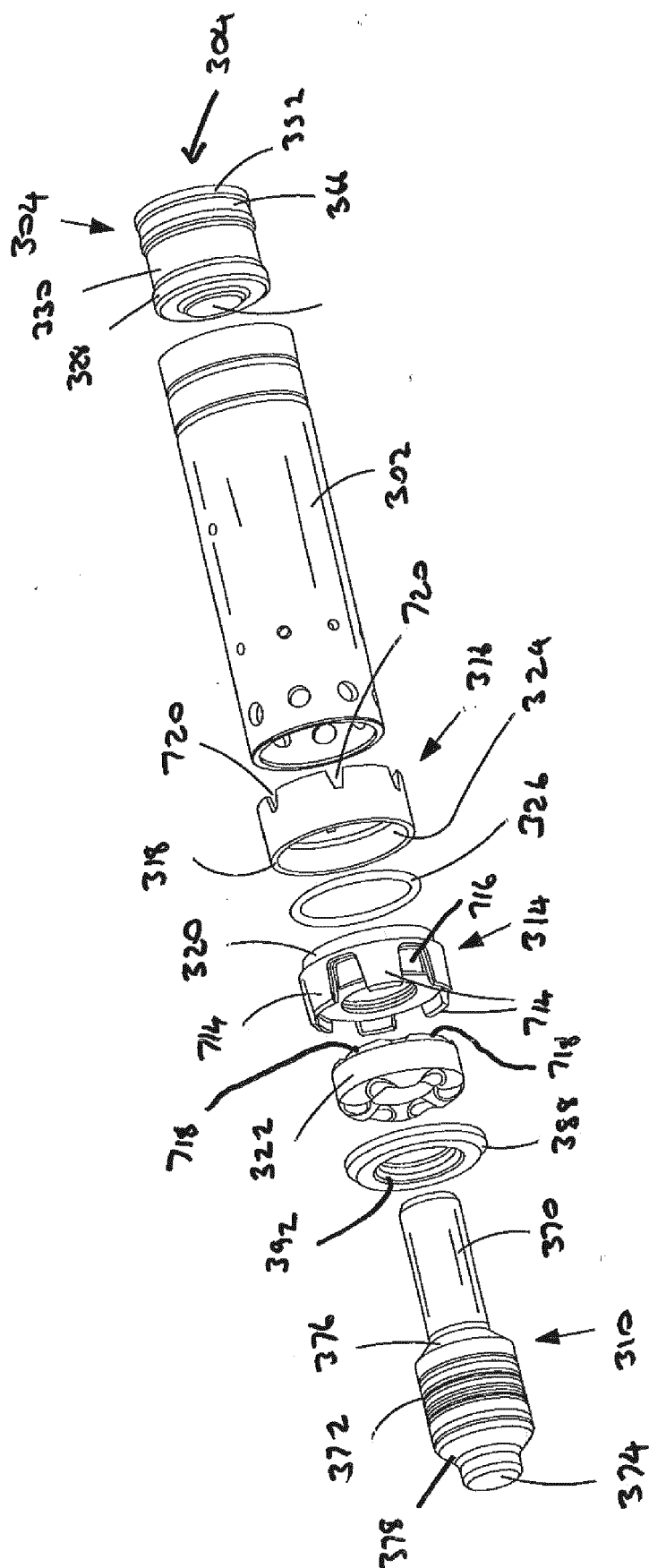
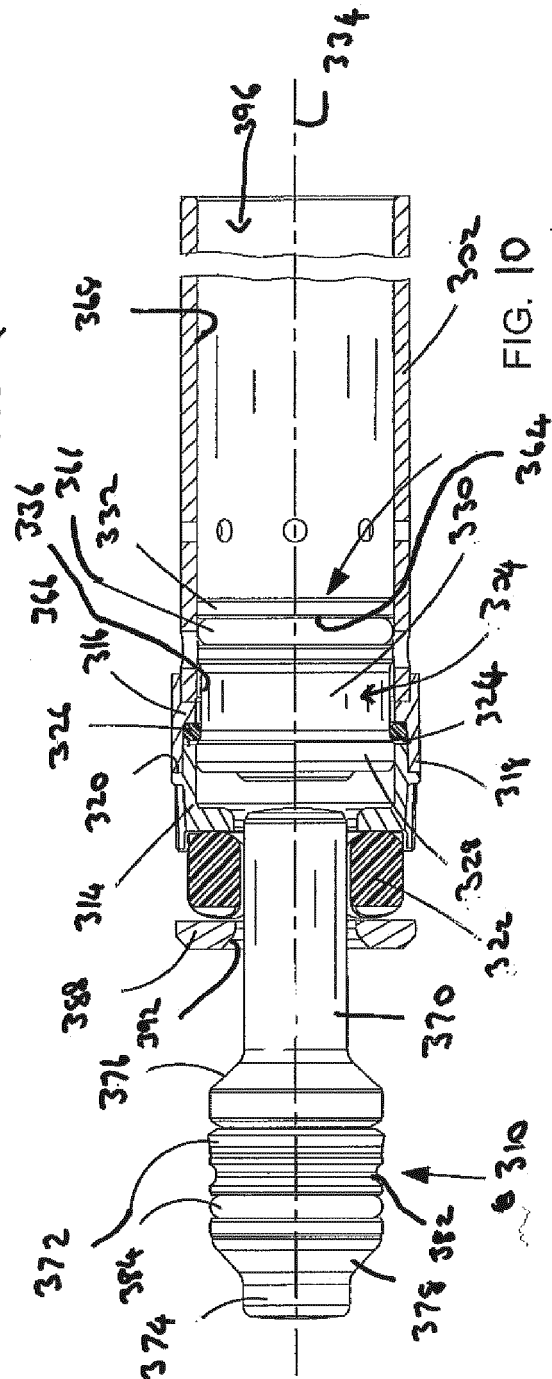
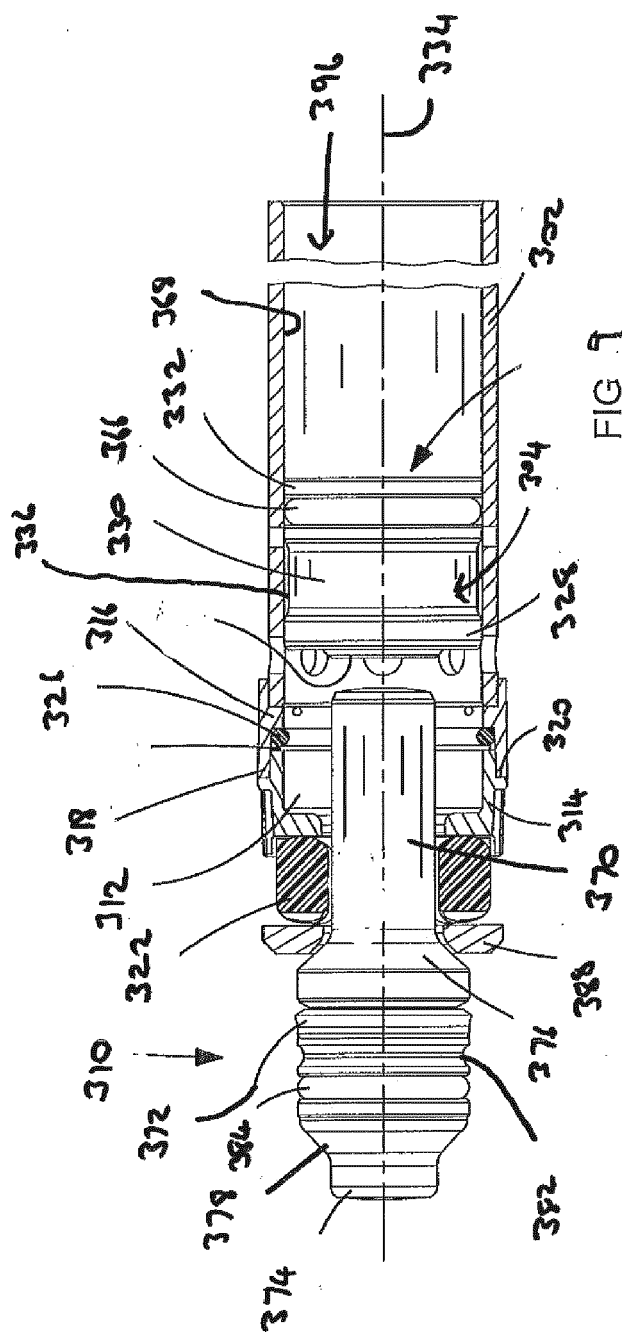


Figure 7



GE



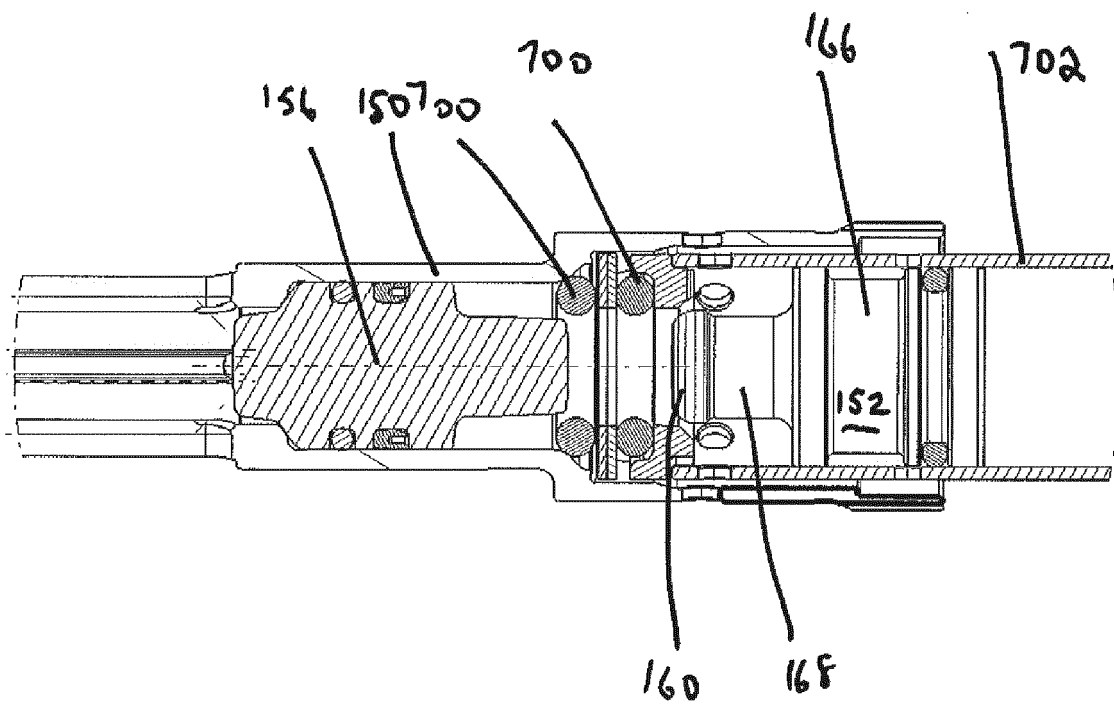


Fig. 11 (prior art)

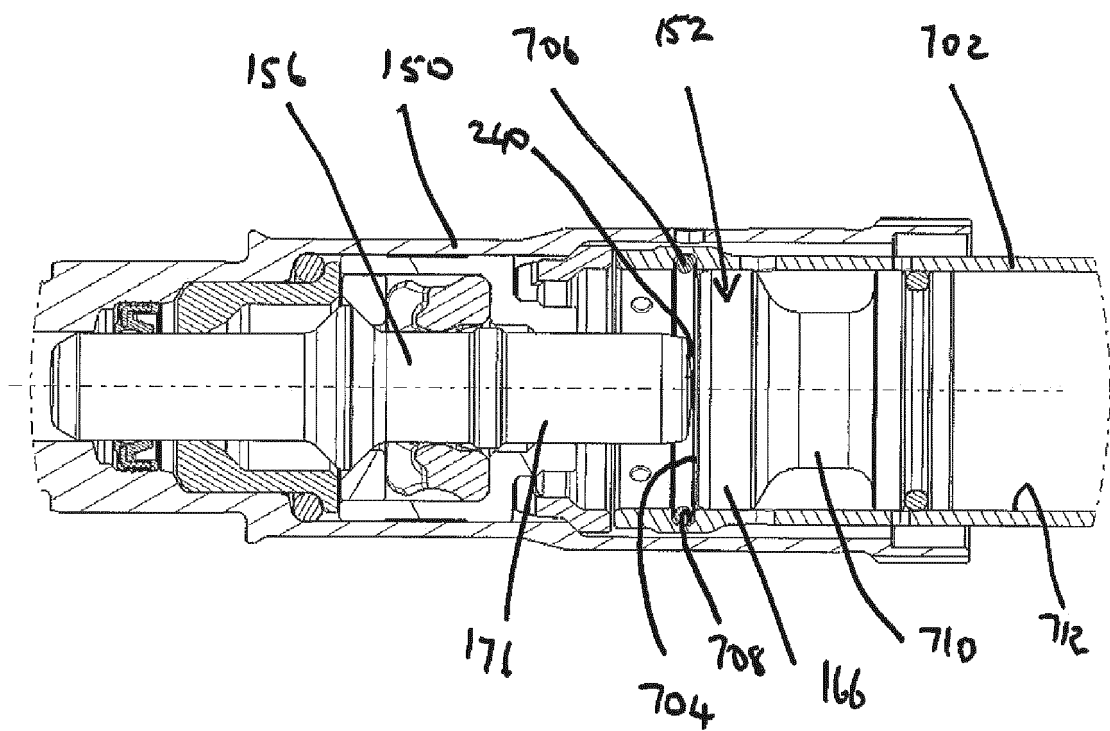


Fig. 12. (prior art)



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Application Number
EP 20 15 1879

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	* paragraphs [0010] - [0025]; figures 1-5 *		

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 27 May 2020	Examiner Lorence, Xavier
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EPO FORM 1503 03/82 (P04C01)

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EP 20 15 1879

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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