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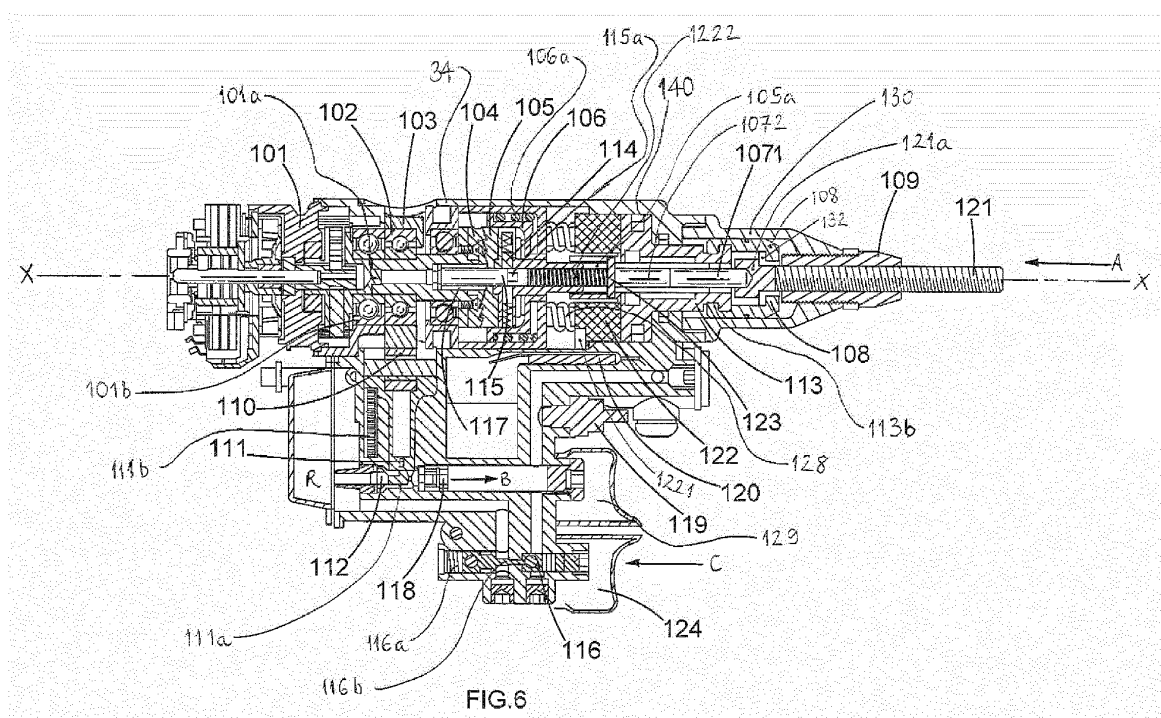
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(54) **A battery powered crimping tool**

(57) A crimping tool for a rivet nut or an earth bond, comprising: a housing (34) adapted to receive an electrical battery; an electrical motor (101); a support (109,130) for supporting movement of a traction rod (121) in relation to the housing; a first mechanical drive train (104,105,106,106a,1071) drivable by the motor to cause rotation of a traction rod (121) about a longitudinal axis X-X in a screwing direction or an unscrewing direction; a second drive train (102,103,108,109,110,111,111a,

111b,112,113,116,118,140) comprising a hydraulic pump (111,111a,111b,112,118) fluidly coupled to a piston chamber (140) containing a traction piston (113) wherein the traction piston is movable from an initial position in the piston chamber by way of fluid pressure from the pump to cause axial displacement of a traction rod towards the housing and wherein the pump of the second drive train is drivable by the motor to deliver fluid pressure to the piston chamber.



Description

[0001] The present invention concerns a battery powered crimping tool.

[0002] Typically, a blind rivet nut is made of metal and it has a generally cylindrical shape, a partially threaded axial bore, an abutment collar at a head end thereof and a specially weakened region at an unthreaded portion of the axial bore. Plastic deformation occurs at the weakened region when the rivet nut is subjected to an axial pulling force applied by a threaded rod engaged with the threaded portion of the axial bore.

[0003] In use, a blind rivet nut is threaded onto the threaded rod of a crimping tool and placed in a hole in a material. The crimping tool retracts its threaded rod to cause the weakened region to expand behind the material thereby riveting itself in place. The rivet nut may be used in sheet metal, plastics and tubular materials. The rivet nut may be used as a rivet to assemble two or more material or as a nut for the attachment of a fastener.

[0004] Typically, an earth bond is used for fixing a cable connection to a mass. An example of an earth bond is disclosed by European patent publication EP 1 376 766 in the name of the applicant. The earth bond is made of metal and it has a tubular portion with an outer collar and an internal conical bore flaring outwards from the collar. The earth bond has a conical socket portion with a threaded axial bore to be inserted in the tubular portion. Plastic deformation occurs at the tubular portion when the socket is subjected to an axial pulling force applied by a threaded rod engaged with the threaded the axial bore.

[0005] In use, an earth bond is threaded onto the threaded rod of a crimping tool and placed in a hole in a material having a thickness comparable to the length tubular portion. The crimping tool retracts its threaded rod to cause the tubular portion to expand against the material thereby fastening itself in place.

[0006] US patent publication No. 5,605,070 discloses a battery-powered crimping tool comprising a housing, an electric motor and a traction rod adapted to receive a rivet nut or an earth bond. The crimping tool comprises a first drive train between the motor and the traction rod for producing a rotation of the traction rod in the direction of screwing or unscrewing and a second drive train between the motor and the traction rod for axial displacement of the traction rod to cause crimping. The crimping tool has mechanical stop to limit any surplus pulling force applied to the threaded rod. A maximum force is always applied to the threaded rod.

[0007] US patent publication No. 2011/0271504 discloses a battery-powered crimping tool comprising a housing, a traction rod adapted to receive a rivet nut or an earth bond and a first drive train between a first motor and the traction rod for producing a rotation of the traction rod in the direction of screwing or unscrewing. The crimping tool comprises a second drive train for axial displacement of the traction rod to cause crimping. Air-powered crimping tools normally have a pneumatic control system

which supplies air to an air chamber that acts upon an air / oil pressure intensifier piston. A large displacement stroke of the air piston will create, by ratio between sections, an oil pressure about thirty six times greater in the oil part. The oil pressure is delivered to a chamber where it acts upon a piston to pull of the traction rod. The second drive train replaces the force exerted by pneumatic air with a screw jack which pushes an oil plunger to develop oil pressure in the chamber. The screw jack is operated by a second electric motor.

[0008] According to the present invention there is provided a crimping tool, comprising: a housing adapted to receive an electrical battery; an electrical motor energizable by an electrical battery; a support for supporting movement of a traction rod in relation to the housing; a first mechanical drive train drivable by the motor to cause rotation of a traction rod about a longitudinal axis X-X of the traction rod in a screwing direction or an unscrewing direction; a second drive train comprising a hydraulic pump fluidly coupled to a piston chamber containing a traction piston wherein the traction piston is movable from an initial position in the piston chamber by way of fluid pressure from the pump to cause axial displacement of a traction rod towards the housing, wherein the pump of the second drive train is drivable by the motor to deliver fluid pressure to the piston chamber. The crimping tool may be used with a rivet nut or an earth bond. The crimping tool is battery-powered. Advantageously, it can exercise a motorized screwing and unscrewing action to the end of a traction screw and also exercise an adjustable and repeatable tensile force on the traction screw. The tool of the invention uses hydraulic power which may facilitate management of the tensile force directly proportional to the oil pressure in the tool. The tool of the present invention has only one motor to perform two distinct functions. The motor can be a classic brushed motor or a brushless motor.

[0009] Preferably, the first drive train comprises an automatic coupler adapted to disengage the motor from rotation of a traction rod when a predetermined resistive torque is encountered by the traction rod. This reduces exposure of the traction screw to unduly large torques and helps prevent or at least reduce failure and replacement of the traction screw.

[0010] Preferably, the automatic coupler comprises a locking mechanism operable by way of disengagement of the automatic coupler to lock the automatic coupler in a disengaged position. This helps to avoid rattling noises generated by a cycle of engagement and disengagement of the automatic coupler caused by slippage at the point of disengagement.

[0011] Preferably, the locking mechanism is operable by way of disengagement of the automatic coupler when a traction rod is rotating in the screwing direction. The rattling noises may cease automatically after the coupler's initial disengagement upon encountering resistive torque during screwing action.

[0012] Preferably, the locking mechanism is operable

by way of reverse rotation of the motor to unlock the automatic coupler from the disengaged position. This may provide a simple way of resetting the automatic coupler to its initial position so that rotation of the motor is engaged with whole of the first drive train.

[0013] Preferably, the second drive train comprises a free wheel configured to decouple the motor from the hydraulic pump when the first drive train rotates a traction rod in the unscrewing direction wherein the free wheel is configured couple the motor to the pump when the first drive train rotates a traction rod in the screwing direction. The second drive train is inactive when the tool is unscrewing the traction screw. This economises on use of battery electrical energy.

[0014] Preferably, the hydraulic pump is fluidly coupled to a fluid reservoir via a normally-open valve and wherein the normally-open valve is closable by way of operation of a crimping start switch coupled to the normally-open valve. Closure of the normally-open valve prevents fluid flow to the reservoir and instead diverts it to the piston chamber where fluid pressure may act against the traction piston and start the crimping action. Preferably, the start switch comprises a trigger. A trigger may be more easily grasped by an operator. Preferably, closure of the normally-open valve is sustainable by fluid pressure from the hydraulic pump. Thus, the fluid pressure acts as an automatic latch that keeps the normally-open valve closed until the fluid pressure decreases to the point where it may be overcome by the opening bias of the normally-open valve.

[0015] Preferably, the normally-open valve is openable by way of operation of an auxiliary switch coupled to the normally-open valve. The auxiliary switch acts as a fail-safe to help, in the unusual event that such help is required, the opening bias of the normally-open valve overcome resistance. Preferably, the auxiliary switch comprises an auxiliary trigger operable by an operator.

[0016] Preferably, the traction piston is biased to return to the initial position to cause axial displacement of a traction rod away from the housing. The traction piston and, by connection, a traction rod are normally ready for crimping action.

[0017] Preferably, the piston chamber is fluidly coupled to a reservoir via a normally-closed valve and wherein the normally closed valve is openable by way of an over-pressure of fluid pressure P in the piston chamber. The tool's hydraulic power facilitates management of the tensile force acting on the traction screw. This may be directly proportional to the oil pressure in the piston chamber. Preferably, the over-pressure at which normally-closed valve opens is adjustable.

[0018] Preferably, the tool comprises a traction rod comprising a screw with a head for engagement with the second drive train wherein the head comprises a recess for engagement with the first drive train and optionally wherein the tool comprises an adapter ring around the traction screw adjacent the head. The threaded traction screws are wearing, or consumable, parts that may

break. In order to avoid expensive machined parts, the threaded traction screws may be commercially available screws comprising a head with a standard internal recess like, for example, a hexagonal recess for keyed engagement with a hex bit of the first drive train. The adapter rings may be sized according to traction screw diameter and compensate for positional offsets caused by non-identical screw head heights.

[0019] The invention and its advantages will be better understood from the reading of the following description, given by way of example only and with reference to the accompanying drawings, of which:

Figure 1 is a perspective view of a rivet nut crimping tool in the prior art;

Figures 2A and 2D show a series of views of a method of screwing, crimping then unscrewing of the rivet nut;

Figure 3 shows a side elevation view of a rivet nut crimping tool energized by battery according to the invention;

Figure 4 is a side elevation view of the tool of Figure 3 in the opposite direction;

Figure 5 is an end view of the tool of Figure 3;

Figure 6 is a longitudinal cross-sectional view VI-VI of the tool of Figure 3;

Figure 7 is a longitudinal cross-sectional view VII-VII of the tool of Figure 3; and

Figure 8 shows the changing of threaded traction screws at the nose of the tool of Figure 3.

[0020] The crimping tool according to the invention may replace existing tools which function with a pneumatic power supply. The applicant is already a manufacturer of this type of tool like the one shown in Figure 1. The multi-dimensional oleo-pneumatic installation tool of Figure 1 has the following characteristics: a) screwing by "push-pull" upon contact with the rivet nut or earth bond; b) oleo-pneumatic crimping process; c) crimping by operation of the trigger; d) automatic unscrewing by a single press of the trigger; and e) adjustment of the crimping stroke. This tool is supplied by an exterior air source delivering 6 bar air pressure to the tool. This permits an operator to crimp rivet nuts and earth bonds.

[0021] With reference to Figures 2A to 2D, a cycle of crimping a blind rivet nut 10 with a flange 12 is described. This is the most recommended method. It comprises the screwing, crimping and then the unscrewing of the rivet nut. The rivet nut is destined to join two walls, for example in place of spot welding, or for constituting a threaded anchoring bush of an adequate strength, for structures made of a material which is too soft or brittle to support sufficiently-robust threads. The rivet nut can be of many different dimensions to suit many different uses and materials.

[0022] The operator pushes the rivet nut 10 on a threaded traction rod 14 of the tool shown in Figure 1. The threaded rod retracts a short distance from its initial

position (about 0.5mm). This causes a pneumatic control system to start a pneumatic motor which turns in the direction of screwing SD, as is shown in Figure 2A. The motor stops automatically when the flange 12 of the rivet nut 10 comes into contact with the anvil 20 of the tool. The screwing action returns the threaded rod of the tool to its initial position. This causes the pneumatic control system to stop the motor.

[0023] Referring to Figure 2B, the operator places the rivet nut 10 into a hole through a pair of pierced metal sheets 16a, 16b while it remains engaged to the threaded rod 14 of the tool. It is understood that the operator may place the rivet nut 10 into a hole through a single pierced sheet of metal, or other material, if the rivet nut is to be used as threaded anchoring bush, for example.

[0024] Referring to Figure 2C, the operator starts the automatic rivet nut crimping cycle by squeezing a single trigger. This activates another pneumatic control system which supplies air to an air chamber that acts upon an air / oil pressure intensifier piston. A large displacement stroke of the air piston will create, by ratio between sections, an oil pressure about thirty six times greater in the oil part. This variation of pressurized oil volume will create a traction force of about 20kN on the rivet nut 10. The rivet nut 10 bulges at a deliberately weakened region which has the effect of crimping the rivet nut upon the metal sheets by formation of a bead 18. The metal sheets 16a, 16b are crimped firmly together between the flange 12 and the bead 18 of the rivet nut 18.

[0025] Referring to Figure 2D, when the predetermined traction stroke is reached in the tool, a pneumatic system valve system automatically switches to start, at the same time, the unscrewing (in the unscrewing direction USD) by the pneumatic motor as well as the return of the threaded traction rod 14 to its initial position. The traction rod 14 disengages the rivet nut 10 and leaves it crimped upon the metal sheets 16a, 16b.

[0026] The crimping tool of Figure 1 can be used on a production line in the automobile sector. This implies a high rate of usage (ten crimpings per minute) and a life span in the order of a million cycles. An objective of the crimping tool according to the invention is to perform at least as well as a pneumatic crimping tool albeit using an electrical battery source of energy. Also, the crimping tool according to the invention comprises a traction force control. This is to enable effortless crimping of rivet nuts or earth bonds.

[0027] With reference to Figures 3 to 7, a tool T according to the present invention comprises certain advantageous features and principles.

[0028] The tool T comprises an outer housing 30 with a handle 32 and a rechargeable electrical battery B detachably connected to the foot of the handle 32. The tool T comprises inner housing 34 supported by the outer housing 30. The outer housing 30 is made of plastics material or other suitably lightweight, rigid and/or moldable material. The inner housing 34 is made of suitably rigid material, such as steel, to support its internal mech-

anisms which include pressurized hydraulic circuits. Protruding from the nose of the inner housing 34 is a traction screw 121 performing the role of threaded traction rod upon which an operator may place a rivet nut 10 or, as the case may be, an earth bond. The traction screw 121 is supported by the inner housing 34 for rotation in a screwing direction SD or an unscrewing direction USD about its longitudinal central axis X-X and for movement in relation to the inner housing along its longitudinal axis X-X.

[0029] The tool T comprises an electronic control circuit board (not shown) for controlling a geared motor 101 connected to one end of the inner housing 34. The geared motor 101 is composed of an electric motor and a gear box with a motor output shaft 101 a which is supported for rotation about the longitudinal central axis X-X by a bearing 101 b in the inner housing 34. Under the control of the electronic control circuit board, the geared motor 101 is energized by the electrical battery B during operation. The motor output shaft 101 a is turned by the geared motor 101 to operate a first drive train for producing a rotation of the traction screw in screwing direction SD or unscrewing direction USD of a rivet nut 10 and a second drive train for crimping a nut screw 10 by axial displacement of the traction screw 121.

[0030] The first drive train comprises an automatic coupler mechanism with a male coupler plate 104 and female coupler plate 105 biased into engagement with the male coupler plate 104 by a coupler support spring 106a. The male coupler plate 104 is directly coupled to the motor output shaft 101 a. The female coupler plate 105 has an axial bore most of which has an internal cylindrical profile except for a front portion which has an internal hexagonal profile matching a commercially available hex bit 1071. The hex bit 1071 is keyed to the axial bore of the female coupler plate 105 and will rotate therewith. The hex bit 1071 may slide a small distance within the axial bore of the female coupler plate 105 as is explained in more detail below. Rotation of motor output shaft 101 a is transmitted, via the female coupler plate 105, to the hex bit 1071 when the male coupler plate 104 and the female coupler plate 105 are engaged. Rotation of the hex bit 1071 is transmitted to a traction screw 121 when the hex bit 1071 is engaged with a head 121 a of the traction screw 121.

[0031] Torque resistance encountered by the traction screw 121 is transmitted to the automatic coupler mechanism and may cause disengagement between the male coupler plate 104 and the female coupler plate 105 above a certain torque threshold. This occurs when a rivet nut 10 has been screwed the whole way onto the threaded traction screw 121 and encounters a stationary anvil 109 which is connected to the nose end of the inner housing 34. Rotation in the screwing direction SD slows rapidly and stops. Disengagement causes the female coupler plate 105 to move a short distance along the longitudinal central axis X-X in the opposite direction to arrow A. While the coupler plates move apart, the female coupler plate 105 acts upon a coupler support 106 which compresses

the coupler support spring 106a. The stiffness of the coupler support spring 106a determines the torque threshold at which the male and female coupler plates disengage.

[0032] An axle 115 protrudes from within the male coupler plate 104 to a short distance inside the axial bore of the female coupler plate 105. The female coupler plate 105 comprises a plurality of locking sliders 114 arranged as radial spokes about the axle 115. Each locking slider 114 is biased by its own respective spring toward the axle 115. To avoid the rattling noises generated by the engagement and disengagement of teeth of the male and female coupler plates, upon first disengagement, the locking sliders 114 are biased to fall into a machined recess 115a in the axle 115. Engagement between the locking sliders 114 and axle 115 locks the female coupler plate 105 in a disengaged position with respect to the male coupler plate 104.

[0033] Most of the axle 115 is fixed in an axial bore of a second free wheel 117. The second free wheel 117 is accommodated within an axial bore of the male coupler plate 104. The second free wheel 117 is decoupled from the male coupler plate 104 when the latter is rotating in the screwing direction SD. Thus, the axle 115 may remain stationary within the female coupler plate 105 when the latter is also disengaged from the male coupler plate 104.

[0034] When the geared motor 101 drives rotation of the male coupler plate 104 in the unscrewing direction USD, the second free wheel 117 is coupled to the male coupler plate 104. The male coupler plate 104 turns the second free wheel 117 which turns the axle 115 in the same rotational direction. The machined recess 115a in the axle 115 is shaped to push the locking sliders 114 radially outwardly against the bias of their respective springs and retract into their respective seats in the female coupler plate 105. This unlocks the female coupler plate 105 from its advanced position with respect to the axle 115. The female coupler plate 105 moves a small way in the direction of arrow A to automatically re-engage with the male coupler plate 104 under the thrust effect of the coupler support spring 106a.

[0035] The second drive train comprises a first free wheel 102 which is mounted on cylindrical portion of the male coupler plate 104 adjacent the motor output shaft 101 a. The first free wheel 102 is coupled to the male coupler plate 104 to rotate therewith when turned by the motor output shaft 101 a in a screwing direction SD. Note that the first free wheel 102 is decoupled from the male coupler plate 104 when the motor output shaft 101 a is rotating in the unscrewing direction USD.

[0036] The second drive train comprises an eccentric cam 103 rotatably driven by the first free wheel 102 and a roller 110 coupled to a piston 111 located in a pump chamber 111 a in the inner housing 34. The roller 110 is biased into rolling abutment with the eccentric cam 103 by a piston spring 111 b seated in a recess in the inner housing 34. The piston 111, the piston spring 111 b and the pump chamber 111 a combine to form a hydraulic pump with a suction valve 112 on one side of the pump

chamber and an outlet valve 118 on the other side of the pump chamber. The rotating cam 103 acting against the roller 110 oscillates the pump piston 111 between top dead centre and bottom dead centre. This oscillation of the pump piston 111 creates a hydraulic oil flow in the pump chamber 111 a from the suction valve 112 to the outlet valve 118 in the direction of arrow B. The hydraulic oil flows in direction of arrow B so long as the geared motor 101 turns the motor output shaft 101 a in the screwing direction SD.

[0037] The tool comprises a first hydraulic oil circuit leading from a reservoir R to the suction valve 112, through the pump chamber 111 a, past the outlet valve 118 to a normally-open ball valve 116. The ball valve 116 is biased into an open position by a ball valve spring 116a acting on a ball valve pusher 116b. After the ball valve 116, the hydraulic oil circuit returns to the reservoir R. The pump is effectively disengaged when the ball valve 116 is open because it allows hydraulic oil to circulate relatively freely around the hydraulic circuit with a minimum of pressure loss.

[0038] The tool comprises a second hydraulic oil circuit which has, in common with the first hydraulic oil circuit, a path leading from the reservoir R to the suction valve 112, through the pump chamber 111 a and past the outlet valve 118. The second hydraulic oil circuit branches away from the first hydraulic oil circuit at a point between the outlet valve 118 and the ball valve 116. From there, it leads to a traction piston 113 seated for sliding movement along the longitudinal axis X-X in a piston chamber 140 in the inner housing 34. After, the second hydraulic oil circuit continues from the piston chamber 140, via an automatic return valve 126, to the reservoir R.

[0039] When a crimping action is required, as is explained in more detail below, the operator diverts hydraulic oil flow from the first hydraulic oil circuit to the second hydraulic oil circuit by squeezing a start cycle trigger 124. The start cycle trigger 124 displaces the normally open ball valve 116 in the direction of an arrow C against the ball valve pusher 116b and the bias of the ball valve spring 116a. The ball valve 116 closes the first hydraulic oil circuit so long as the operator squeezes the start cycle trigger 124. Also, once the ball valve 116 has been closed by the start cycle trigger 124, hydraulic oil pressure P developed by the hydraulic pump is transmitted to the piston chamber 140. The hydraulic oil pressure P is distributed around chamber 140 and acts upon an annular face of the traction piston's crown 113a to force the traction piston 113 to move along the chamber 140 in the direction to arrow A.

[0040] The second drive train comprises the traction piston 113 and a pair of half-shells 108 clasped around a throat groove 113b in the traction piston 113 and around a head 121 a of the threaded screw 121. The half-shells 108 couple the traction piston 113 to the traction screw 121. When the traction piston 113 is forced to move in the direction of arrow A it applies a pulling force on the traction screw 121 in the same direction, thereby deform-

ing and crimping the rivet nut 10 in the manner shown in Figure 2D.

[0041] The start cycle trigger 124 is coupled to a position sensor 125. The stroke of the trigger 124 activates the position sensor 125 which supplies this information to the electronic control circuit board. The hydraulic oil pressure P in the chamber 140 is experienced at the ball valve 116. The more the hydraulic oil pressure P increases the more the ball valve 116 remains closed against the ball valve pusher 116b and the bias of the ball valve spring 116a.

[0042] The amount of the hydraulic oil pressure P needed to deform the rivet nut 10 is pre-set by the operator by turning a pressure regulator screw 135 to compress a calibration spring 135a in the cartridge of the automatic return valve 126. The crimping action is performed until the internal hydraulic oil pressure P in the piston chamber 140 corresponds to the pre-set pressure in the automatic return valve 126. When the pre-set pressure is exceeded, in other words there is an over-pressure in the piston chamber 140, the automatic return valve 126 opens. When the automatic return valve 126 opens, it remains open to allow the hydraulic oil to return to the reservoir R. The automatic return valve 126 is the subject of European patent publication No. EP 2 626 608 which is in the name of the applicant.

[0043] The tool T comprises traction piston return springs 128 held in compression between the coupler support 106 and the traction piston 113. At the end of crimping, and when automatic return valve 126 has opened, the traction piston return springs 128 apply a force in the opposite direction to arrow A against the traction piston 113 thus provoking return of the traction piston 113 to its initial position. The traction screw 121 moves with the traction piston 113. At the end of the return, the traction piston 113 pushes the toggle lever 127 which pushes against and closes the automatic return valve 126. At the time of the return of the traction piston 113 this movement is detected by a position sensor 120. This information is communicated to the electronic control circuit board.

[0044] The axial bore of the female coupler plate 105 accommodates a cylindrical push-pull rod 1072 and a compression spring 1222 held in compression between the axle 115 and the push-pull rod 1072. The push-pull rod 1072 abuts the hex bit 1071 and the two parts may slide together in unison. Through an end of the push-pull rod 1072 opposite to the hex bit 1071 is a dowel pin 123. The tips of the dowel pin 123 extend a short distance beyond the cylindrical diameter of the push-pull rod 1072. The dowel pin 123 may slide along the longitudinal axis X-X in diametrically opposed slots 105a through the female coupler plate 105. The push-pull rod 1072 is rotatably coupled to, via the dowel pin 123, to the female coupler plate 105.

[0045] Inward displacement of the traction screw 121 along its longitudinal central axis X-X in the direction of arrow A pushes the hex bit 1071 and the push-pull rod

1072 in the same direction. The displacement of the push-pull rod 1072 in either direction along the longitudinal central axis X-X is communicated via the dowel pin 123 to a magnet support 122 upon which is located a magnet 1221. Movement of the magnet 1221 in the direction of arrow A to the retracted position changes the state of a magnetic position sensor 120 in the tool. The magnetic position sensor 120 communicates this information to an electronic control circuit board in the tool.

[0046] The tool T comprises an auxiliary trigger 129 for use in a 'failsafe' mode. The operator squeezes the auxiliary trigger 129 when failsafe mode is required. The pivoting lever 136 between the two triggers 124, 129 acts directly on the ball valve 116 by displacing the ball valve pusher 116b in the opposite direction to arrow C. This overcomes the pressurized hydraulic oil circuit and pushes the ball valve 116 open. This provides a return route to the reservoir R if, despite the pre-set pressure having been exceeded, the automatic return valve 126 does not open. Fluid pressure drops in the piston chamber 140 until it is overcome by the traction piston return springs 128. This allows the traction piston 113 to return to its initial position under the bias of the traction piston return springs 128. The position sensor 125 shared between the two triggers 124, 129 detects the squeeze on the auxiliary trigger 129 and passes this information to the electronic control circuit board. In this case, the tool adopts the unscrewing action. The geared motor 101 rotates the output shaft 101 a in the unscrewing direction USD for as long as the auxiliary trigger 129 is being squeezed.

[0047] With reference to Figure 8, the changing of threaded traction screws 121 is described. Each threaded traction screw 121 must be adapted to the inner diameter of the threaded axial bore in the respective rivet nut 10 which it engages. Thus, different traction screws are needed for different shapes and sizes of rivet nuts 10 or, as the case may be, earth bonds. The threaded traction screws are wearing, or consumable, parts that may break frequently. In order to avoid expensive machined parts, the threaded traction screws 121 are commercially available screws comprising a cap head 121 a with a hexagonal internal recess adapted for keyed engagement with the hex bit 1071 of the tool T. An adapter ring 132 made according to the diameter of the traction screw 121 surrounds the neck of the traction screw 121 adjacent where it abuts the head 121 a of the traction screw 121. Special sets of traction half-shells 108 are conceived. Each pair of traction half-shells 108 may be held together by a ring 133 to make a complete traction shell having the shape of a hollow generally cylindrical collar. The cap 130 then surrounds the traction half-shells 108 to maintain their clasp about the throat groove 113b of the traction piston 113 and their clasp about the adapter ring 132 and the head 121 a of the traction screw 121. The rotational drive of the traction screw 121 rod is achieved by a standard commercially available hex bit 107. The choice of anvil 109 is specific to the diameter

of the threaded traction screw 121. The adapter rings 132 are sized according to traction screw diameter and compensate for positional offsets caused by non-identical screw head heights.

[0048] In an alternative embodiment of the tool there is provided a process control. This consists of verifying that the stroke and the force required for crimping a rivet nut 10 or earth bond has been properly reached. The traction piston position sensor 120 and a hydraulic oil pressure sensor 119 detect operation of the tool T and communicate this information to the electronic control circuit board in real time. If the traction piston 113 is not correctly positioned or the oil pressure is incorrect then the operator is warned by an alarm.

[0049] A description of the tool's operation is as follows.

[0050] Start of screwing action.

[0051] The traction screw 121 in its initial, or extended, position. The operator places a rivet nut 10 or, as the case may be, an earth bond upon the end of the traction screw 121 and pushes it inwardly in the direction of arrow A. Inward displacement of the traction screw 121 along its longitudinal central axis X-X pushes the hex bit 1071 and the push-pull rod 1072 in the same direction of arrow A to a retracted position. The displacement of the push-pull rod 1072 is transmitted, via the dowel pin 123 and the magnet support 122, to the magnet 1221. Movement of the magnet 1221 in the direction of arrow A to the retracted position changes the state of the magnetic position sensor 120 which is communicated to the electronic control circuit board. Under the control of the electronic control circuit board, and with electrical power from the battery B, the geared motor 101 initiates turning of the motor output shaft 101 a in the screwing direction SD. The motor output shaft 101 a is coupled to the hex bit 1071 via the automatic coupler mechanism. Rotation of the motor output shaft 101 a in the screwing direction SD is transmitted to the traction screw 121 by the first drive mechanism.

[0052] The first free wheel 102 is coupled to the motor output shaft 101 a as it rotates in the screwing direction SD. The eccentric cam 103 is rotatably driven by first free wheel 102 as it rotates in the screwing direction SD. Rotation of the motor output shaft 101a drives the hydraulic pump via the intermediary of the eccentric cam 103. Hydraulic oil flows in the pump chamber 111 a from the suction valve 112 to the outlet valve 118 in the direction of arrow B. The hydraulic oil circulates relatively freely around the first hydraulic oil circuit because the ball valve 116 is open. The second drive mechanism is effectively disengaged during the screwing action.

End of the screwing action.

[0053] When the flange 12 of the rivet nut 10 contacts the anvil 109, the traction screw 121 continues to rotate in the screwing direction SD for a short while. This causes outward displacement of the traction screw 121 along its

longitudinal central axis X-X in the opposite direction to arrow A to its initial position. This allows the magnet support 122 and its magnet 1221 to move, under the bias of the compression spring 1222, in the opposite direction to arrow A, to return to their initial position. This movement of the magnet 1221 changes the state of the magnetic position sensor 120 which is communicated to the electronic control circuit board. The electronic control circuit board stops the geared motor 101. The first drive mechanism is inactive at the end of the screwing action.

[0054] Start of rivet nut crimping action.

[0055] The operator inserts the rivet nut 10 into the hole of a metal sheet, or metal sheets, to which the rivet nut will be crimped. The operator starts the automatic crimping action by squeezing the start cycle trigger 124 to displace the normally open ball valve 116 in the direction of an arrow C. The ball valve 116 closes the first hydraulic oil circuit so long as the operator squeezes the start cycle trigger 124. This diverts hydraulic oil to the second hydraulic oil circuit. Hydraulic oil is ready to flow to the piston chamber 140.

[0056] Meanwhile, the stroke of the start cycle trigger 124 activates the position sensor 125 which communicates this information to the electronic control circuit board. The electronic control circuit board activates the geared motor 101 which turns the motor output shaft 101 a in the same screwing direction SD as in the screwing action mentioned above. However, with the rivet nut 10 having already been screwed onto the threaded traction screw 121, and in abutment with the anvil 109, further rotation of the traction screw 121 is not possible. The resistant torque causes disengagement between the male coupler plate 104 and the female coupler plate 105. The female coupler plate 105 moves a short distance along the longitudinal central axis X-X in the opposite direction to arrow A. The locking sliders 114 engage the machined recess 115a in the axle 115 to lock the female coupler plate 105 in the disengaged position with respect to the male coupler plate 104. The second free wheel 117 is decoupled from the male coupler plate 104 when the latter is rotating in the screwing direction SD. The first drive mechanism is effectively inactive.

[0057] The hydraulic pump is operational and can create a pressure P in the second hydraulic oil circuit which is transmitted to the crown 113a of the traction piston 113. The more the hydraulic oil pressure P increases in the piston chamber 140 the more the ball valve 116 remains closed. The hydraulic oil pressure applies itself directly on the crown 113a of the traction piston 113 which applies a pulling force on the two traction half-shells 108 in the direction of arrow A. The traction piston 113 approaches its retracted position. The traction half-shells 108 pull the adapter ring 132 and the head 121 a of the threaded screw 121 into the tool in the direction of arrow A thereby deforming the rivet nut 10 in the manner shown in Figure 2D. The second drive mechanism is active. The hydraulic oil pressure for deforming the rivet nut 10 is pre-set by the operator by rotating the pressure regulator

screw 135 to the desired amount. The crimping action is performed until the internal hydraulic oil pressure P corresponds to the pre-set pressure in the automatic return valve 126.

[0058] The start of the unscrewing action and return of the traction screw to its initial position.

[0059] When the pre-set hydraulic oil pressure is exceeded, the automatic return valve 126 opens and it remains open to allow the hydraulic oil to return to the reservoir R. The traction piston return springs 128 return of the traction piston 113 to its initial position and, in doing so, pump the hydraulic oil back to the reservoir R. At the end of the return, the traction piston 113 pushes the toggle lever 127 which closes the automatic return valve 126 ready for another rivet nut crimping action. Return of the traction piston 113 to its initial position is detected by the position sensor 120. The electronic control circuit board stops the geared motor 101 and then initiates reverse rotational operation of the geared motor 101 in the unscrewing direction USD.

[0060] The first free wheel 102 is disengaged from the motor output shaft 101 a when it turns in the unscrewing direction USD. Rotation of the cam 103 ceases. The hydraulic pump is inactive during this phase of the tool's operation. The second drive mechanism is effectively inactive.

[0061] The geared motor 101 drives rotation of the male coupler plate 104 in the unscrewing direction USD. The second free wheel 117 is coupled to the male coupler plate 104 when the latter is rotating in the unscrewing direction USD. The male coupler plate 104 drives the second free wheel 117 which drives the axle 115 in the same rotational direction. The machined recess 115a pushes the locking sliders 114 radially outwardly to unlock the female coupler plate 105 from its advanced position with respect to the axle 115. The female coupler plate 105 moves a small way in the direction of arrow A to automatically re-engage with the male coupler plate 104 under the thrust effect of the coupler support spring 106a. The compression spring 1222 biases the push-pull rod 1072 and the hex bit 1071 in the opposite direction to arrow A relative to the female coupler plate 105. The hex bit 1071 remains engaged with the head 121 a of the threaded traction screw 121. Once the female coupler plate 105 is re-engaged with the male coupler plate 104, the motor output shaft 101 a transmits rotation in the unscrewing direction USD to the threaded traction screw 121. The first drive mechanism is active.

[0062] So long as the operator squeezes the trigger 124 the geared motor 101 will continue to turn the motor output shaft 101 a in the unscrewing direction USD. If the unscrewing ends before the complete return of the traction piston 113 the operator can release the trigger 124 and the hydraulic traction piston 113 will continue, under the bias of the traction piston return spring 1222, its return in the opposite direction to the arrow A until it reaches its initial position.

Claims

1. A crimping tool (T), comprising:

a housing (30,34) adapted to receive an electrical battery (B);
an electrical motor (101) energizable by an electrical battery;
a support (109,130) for supporting movement of a traction rod (121) in relation to the housing;
a first mechanical drive train (104,105,106,106a,1071) drivable by the motor to cause rotation of a traction rod (121) about a longitudinal axis X-X of the traction rod in a screwing direction (SD) or an unscrewing direction (USD);
a second drive train (102,103,108,109,110,111,111a,111b,112,113,116,118,140) comprising a hydraulic pump (111,111a,111b,112,118) fluidly coupled to a piston chamber (140) containing a traction piston (113) wherein the traction piston is movable from an initial position in the piston chamber by way of fluid pressure from the pump to cause axial displacement of a traction rod towards the housing,
characterized in that the pump of the second drive train is drivable by the motor to deliver fluid pressure to the piston chamber.

2. As tool as claimed in claim 1, wherein the first drive train comprises an automatic coupler (104,105,106,106a) adapted to disengage the motor (101) from rotation of a traction rod (121) when a predetermined resistive torque is encountered by the traction rod.

3. As tool as claimed in claim 2, wherein the automatic coupler (104,105,106,106a) comprises a locking mechanism (114,115,115a) operable by way of disengagement of the automatic coupler to lock the automatic coupler in a disengaged position.

4. As tool as claimed in claim 3, wherein the locking mechanism (114,115,115a) is operable by way of disengagement of the automatic coupler (104,105,106,106a) when a traction rod (121) is rotating in the screwing direction (SD).

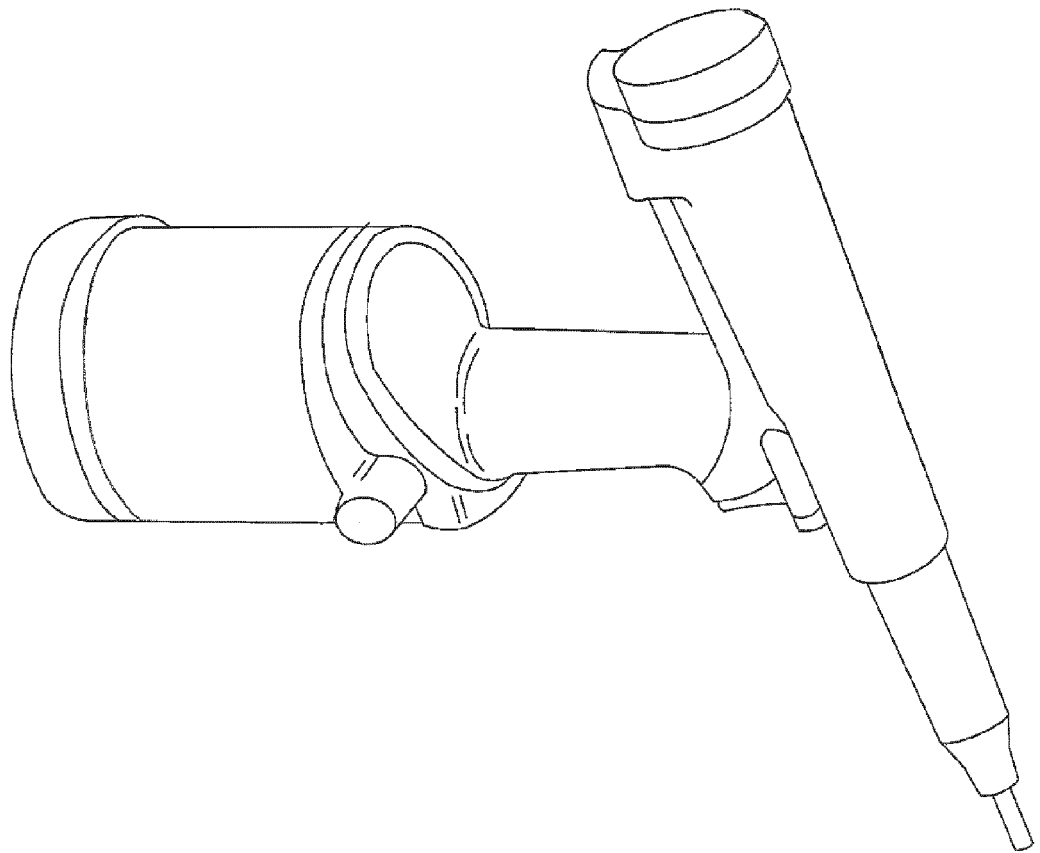
5. As tool as claimed in claim 4, wherein the locking mechanism (114,115,115a) is operable by way of reverse rotation of the motor (101) to unlock the automatic coupler (104,105,106,106a) from the disengaged position.

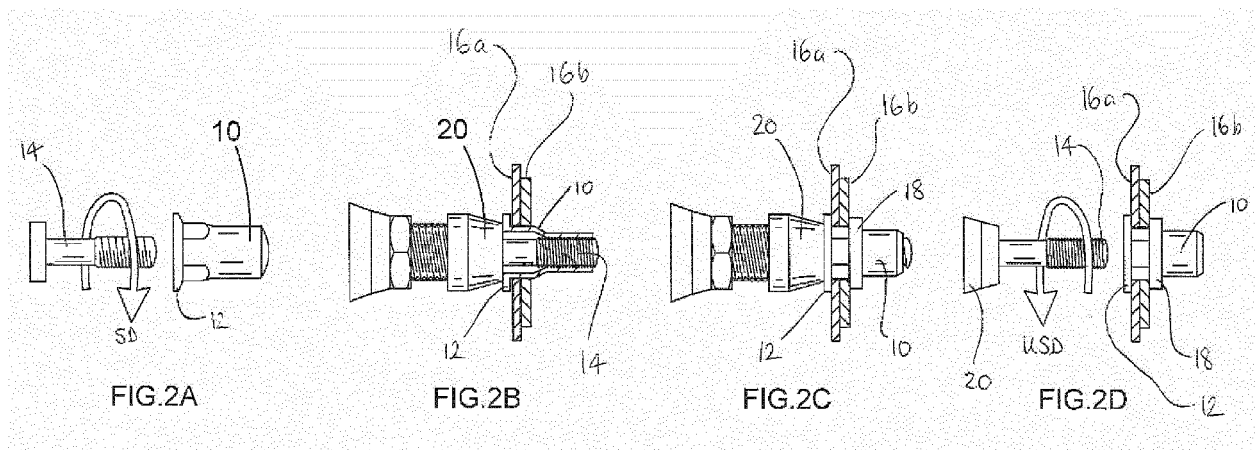
6. A tool as claimed in any one of previous claims, wherein the second drive train comprises a free wheel (102) configured to decouple the motor (101) from the hydraulic pump (111,111a,111b,112,118) when the first drive train rotates a traction rod (121) in the unscrewing direction (USD) wherein the free

wheel (102) is configured couple the motor to the pump when the first drive train rotates a traction rod (121) in the screwing direction (SD).

7. A tool as claimed in any one of previous claims, wherein an outlet (112) of the hydraulic pump (111,111a,111b,112,118) is fluidly coupled to a fluid reservoir (R) via a normally-open valve (116) and wherein the normally-open valve is closable by way of operation of a crimping start switch (124) coupled to the normally-open valve (116). 5
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8. A tool as claimed in claim 7, wherein the crimping start switch comprises a trigger (124). 15
9. A tool as claimed in either one of claims 7 or 8, wherein closure of the normally-open valve (116) is sustainable by fluid pressure from the hydraulic pump (111,111a,111b,112,118). 20
10. A tool as claimed in any one of claims 7 to 9, wherein the normally-open valve (116) is openable by way of operation of an auxiliary switch (129) coupled to the normally-open valve. 25
11. A tool as claimed in claim 10, wherein the auxiliary switch comprises an auxiliary trigger (124) operable by an operator.
12. A tool as claimed in any one of the previous claims, wherein the traction piston (113) is biased to return to the initial position to cause axial displacement of a traction rod (121) away from the housing. 30
13. A tool as claimed in any one of the previous claims, wherein the piston chamber (140) is fluidly coupled to a reservoir (R) via a normally-closed valve (126) and wherein the normally closed valve is openable by way of an over-pressure of fluid pressure P in the piston chamber. 35
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14. A tool as claimed claim 14, wherein the over-pressure at which normally-closed valve (126) opens is adjustable. 45
15. A tool as claimed in any one of the previous claims, wherein the tool comprises a traction rod comprising a screw (121) with a head (121 a) for engagement with the second drive train wherein the head (121 a) comprises a recess for engagement with the first drive train and optionally wherein the tool comprises an adapter ring (132) around the traction screw (121) adjacent the head (121 a). 50
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FIG.1





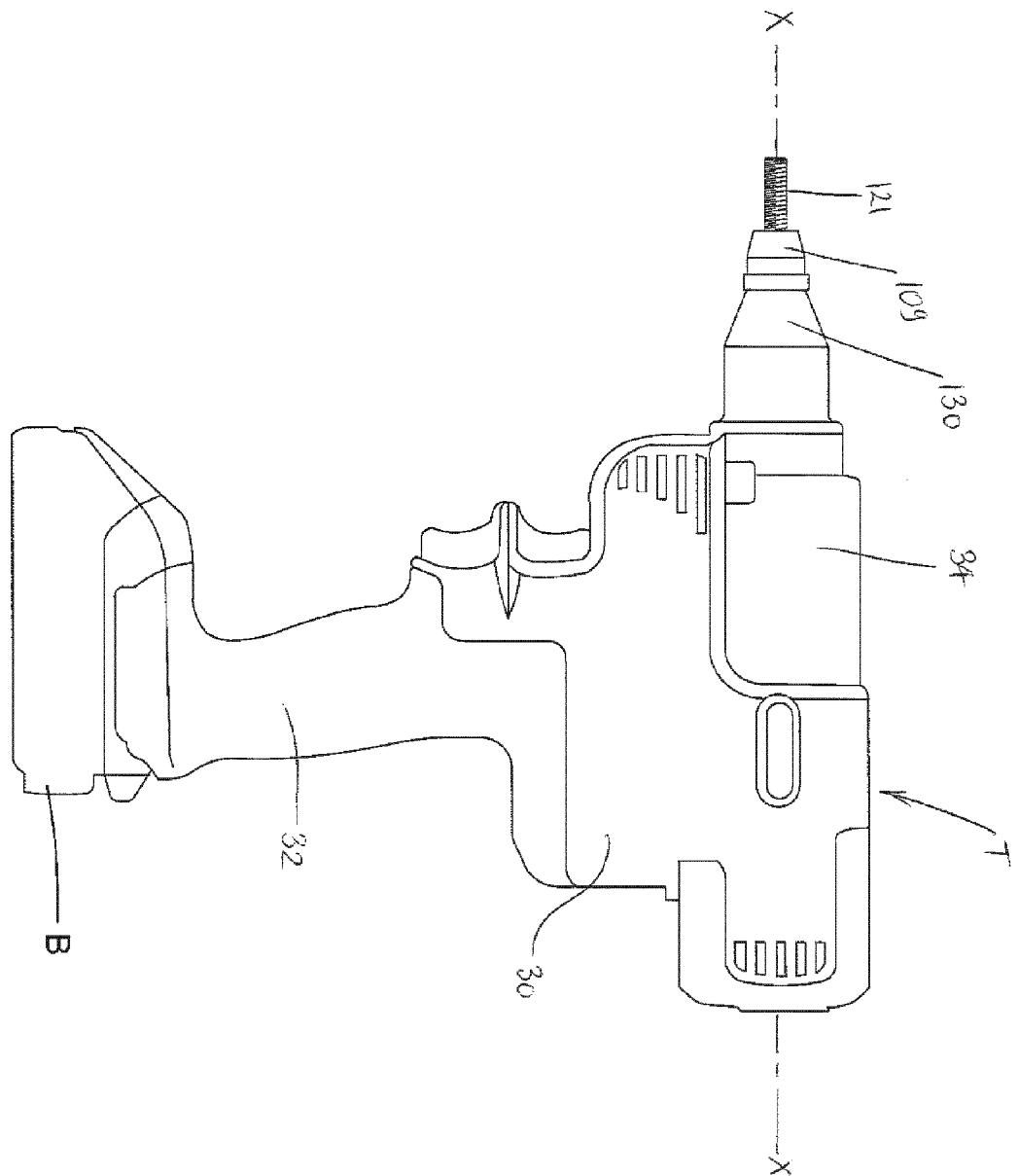
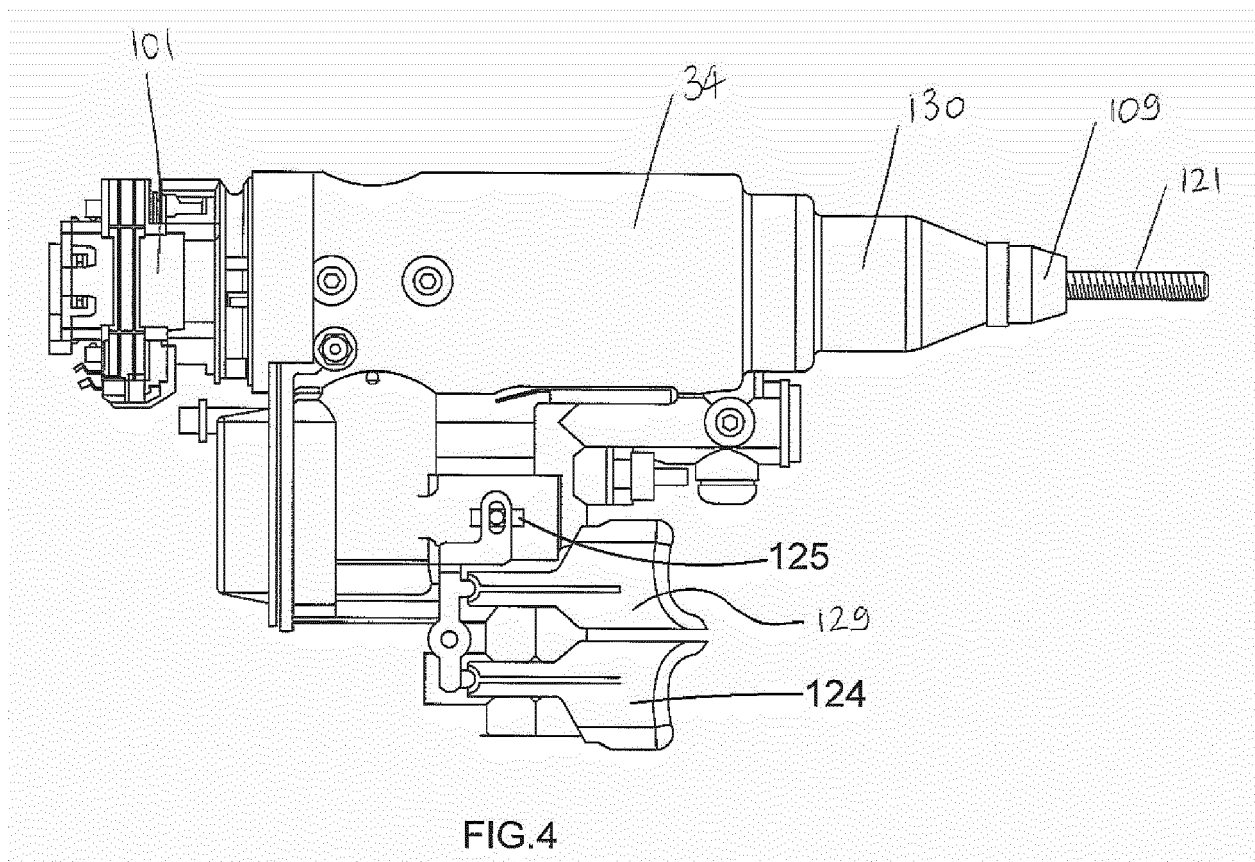
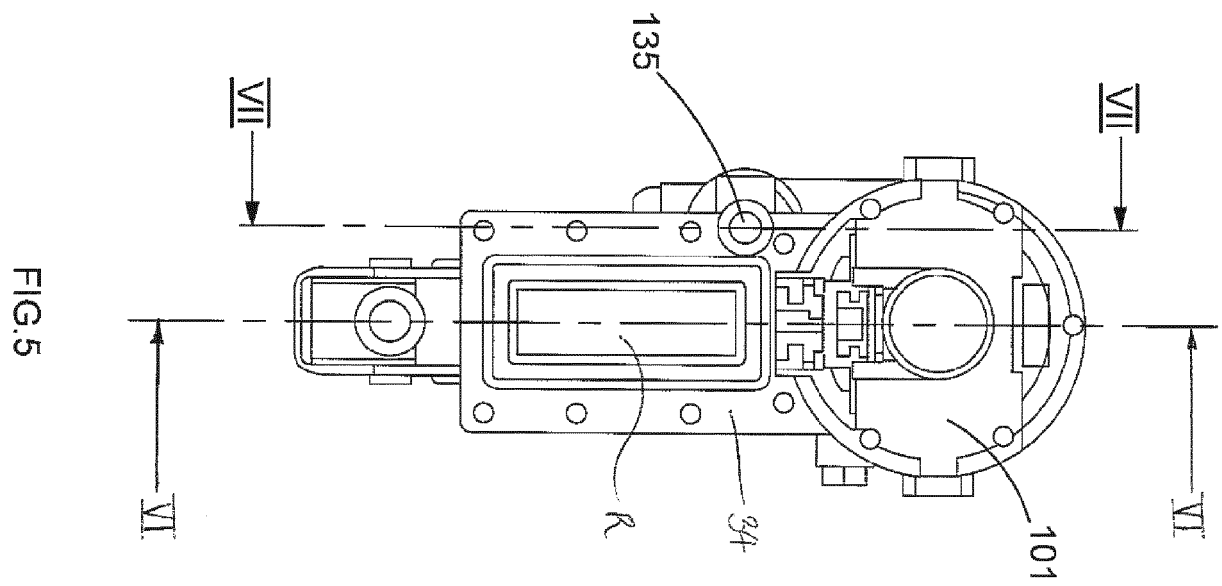
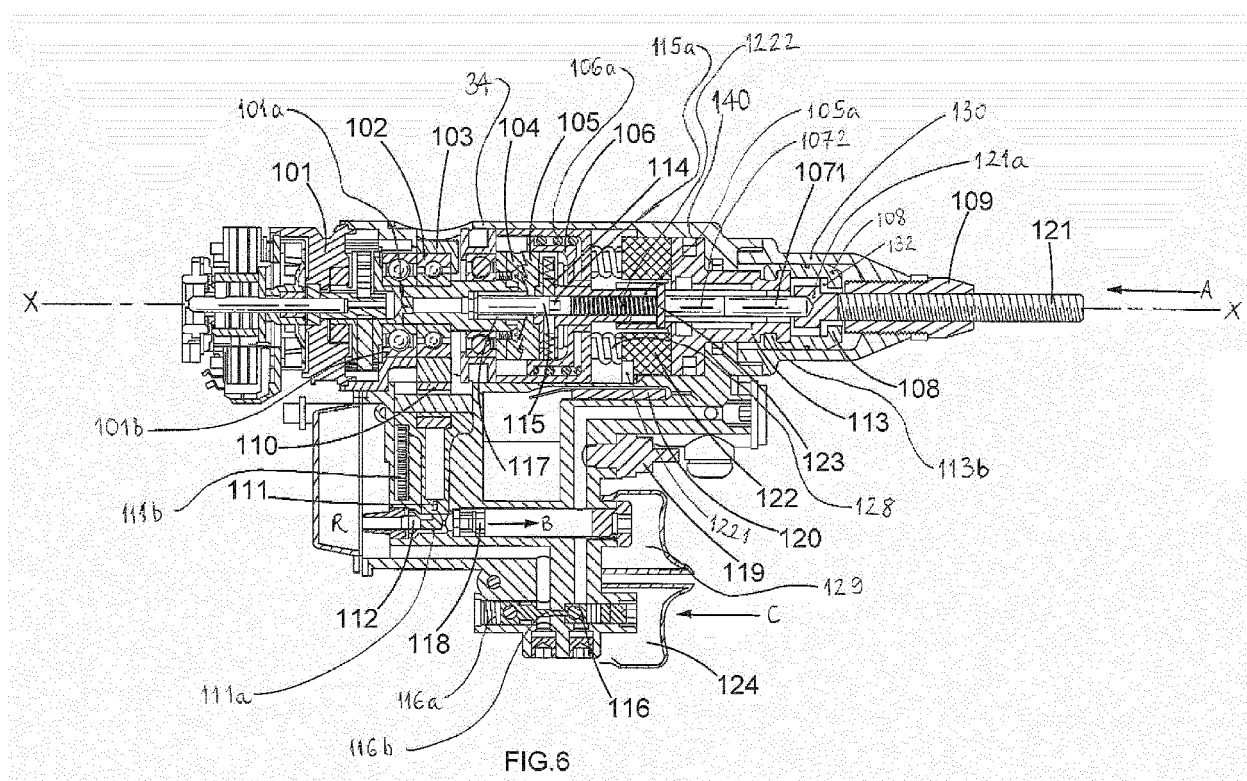
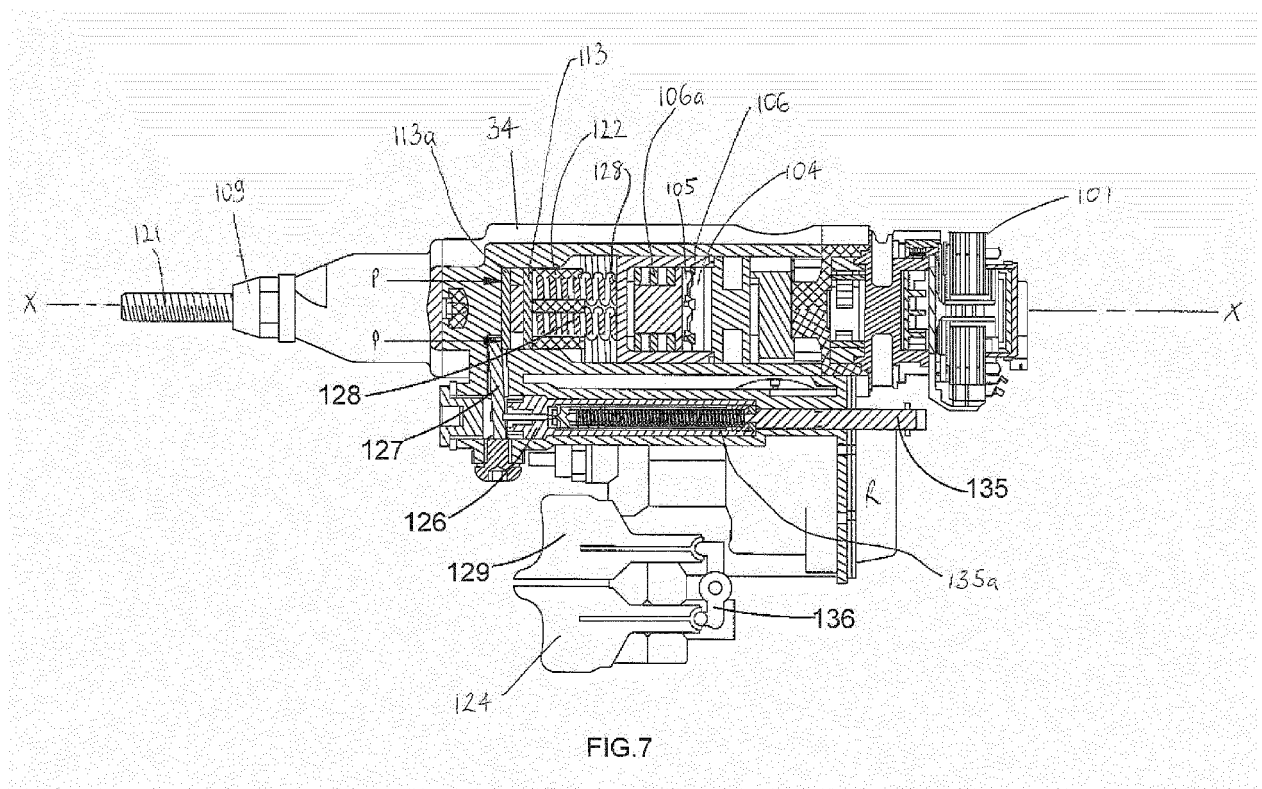


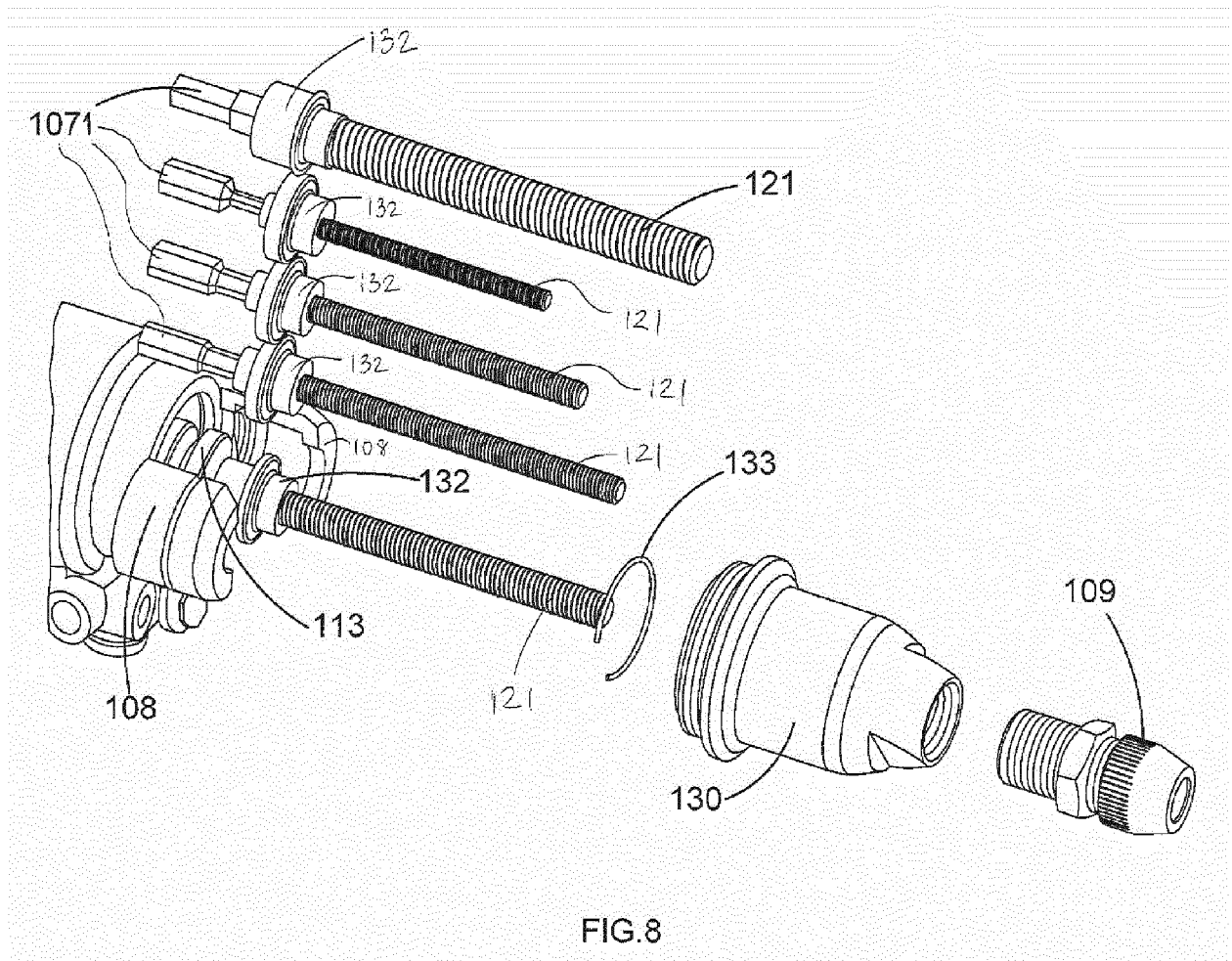
FIG.3











REFERENCES CITED IN THE DESCRIPTION

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