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(54) **ELECTRO-HYDRAULIC DEVICE WITH AN ELECTRONIC CONTROL FOR DEFORMING FASTENING ELEMENTS**

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(57) **ABSTRACT**

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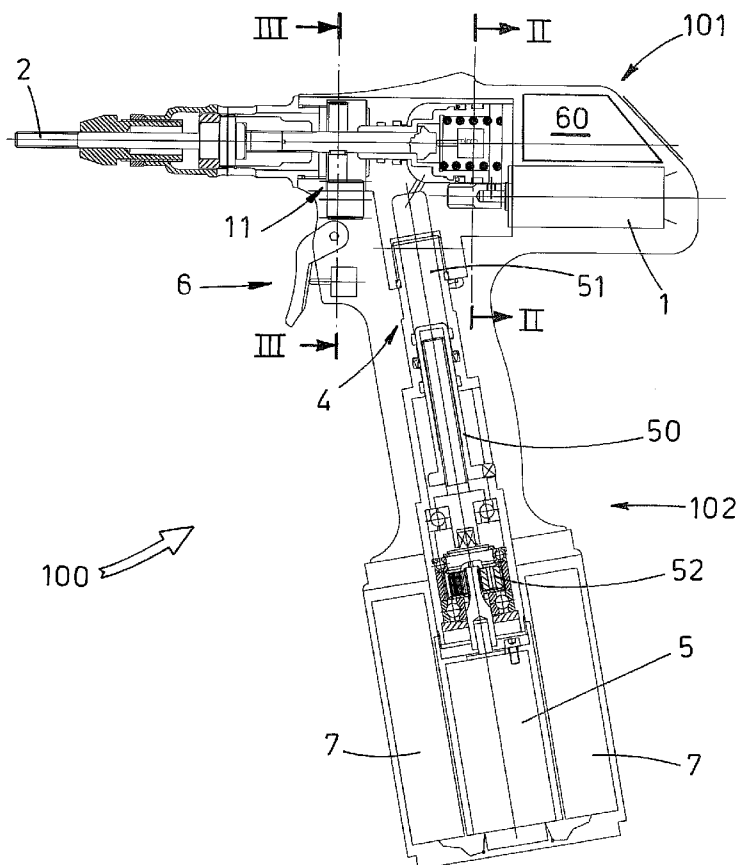
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The electro-hydraulic pistol device (**100**) comprises: a first electric micro-motor (**1**), for setting in right-wise or left-wise rotation a threaded rod (**2**), respectively for engaging or disengaging the rod (**2**) from a rivet (**3**); a hydraulic system (**4**) in which a fluid (F) pushes a cursor (**40**), associated to the rod (**2**) for impressing thereon an axial translation which causes plastic deformation of a predetermined portion of the rivet (**3**), such as to block the rivet (**3**) to a corresponding wall (P); a second electric micro-motor (**5**), for commanding a piston (**50**) destined to compress the fluid (F). An electrical circuit (**6**) is associated to the above organs, which electrical circuit (**6**) is managed by a control unit (**60**), to which are connected: a first micro-switch (**61**) activated by tie rod (**2**) for activation of the first micro-motor (**1**) in a right-wise direction; a second micro-switch (**62**), destined to be activated by a trigger (**63**) after deactivation of the first micro-switch (**61**), for activating the second micro-motor (**5**), first in a direction, for compressing the fluid (F), and then in another direction, for reducing the pressure of the fluid (F), as well as for activating, in gl phase relation, the first micro-motor (**1**) in a left-wise rotation; supply means (**7**) for the circuit (**6**) and the micro-motors (**1**, **5**). The left-wise rotation of the first micro-motor (**1**) and the rod (**2**) proceeds as long as the trigger (**63**) is kept pressed.



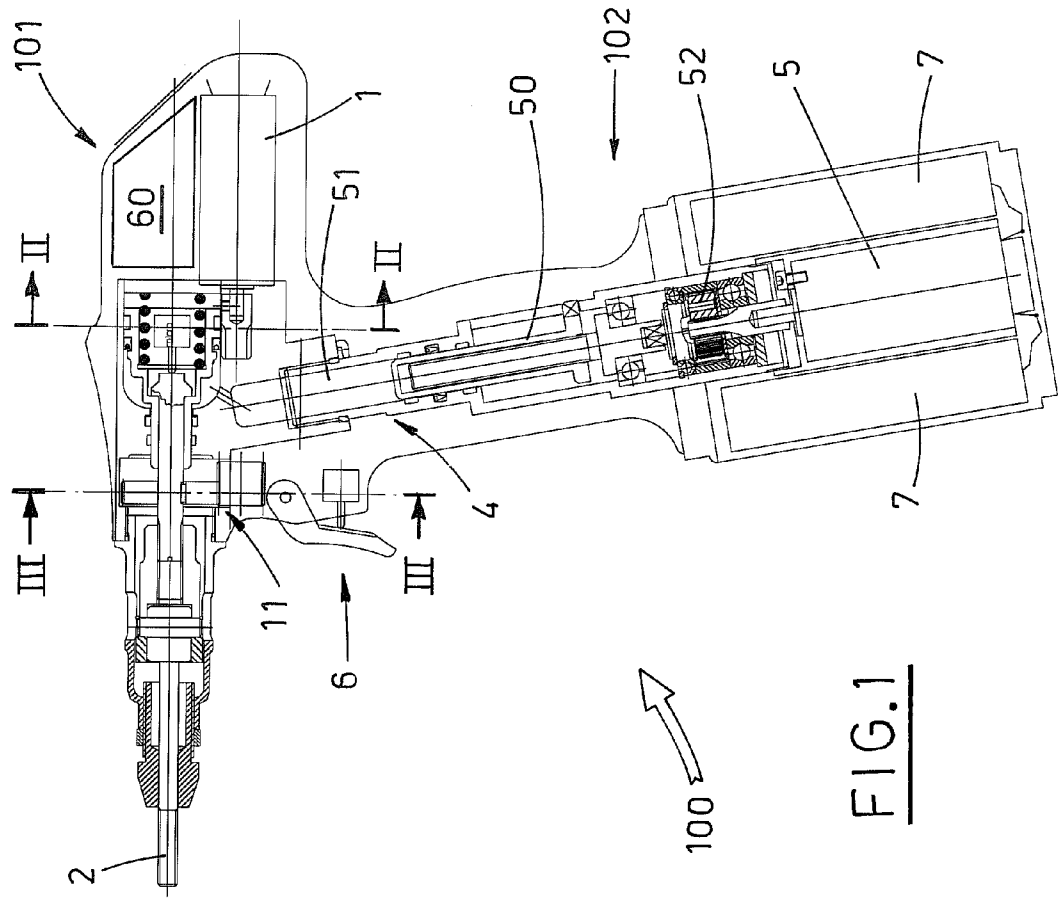


FIG.1

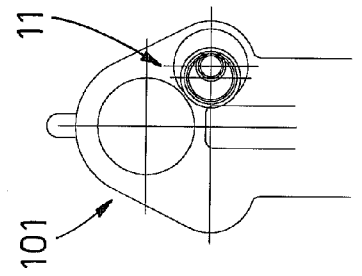


FIG.2

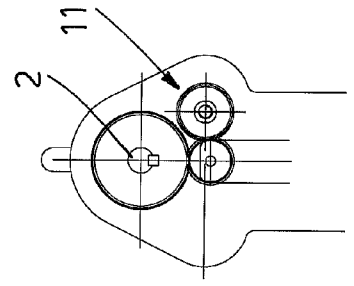


FIG.3

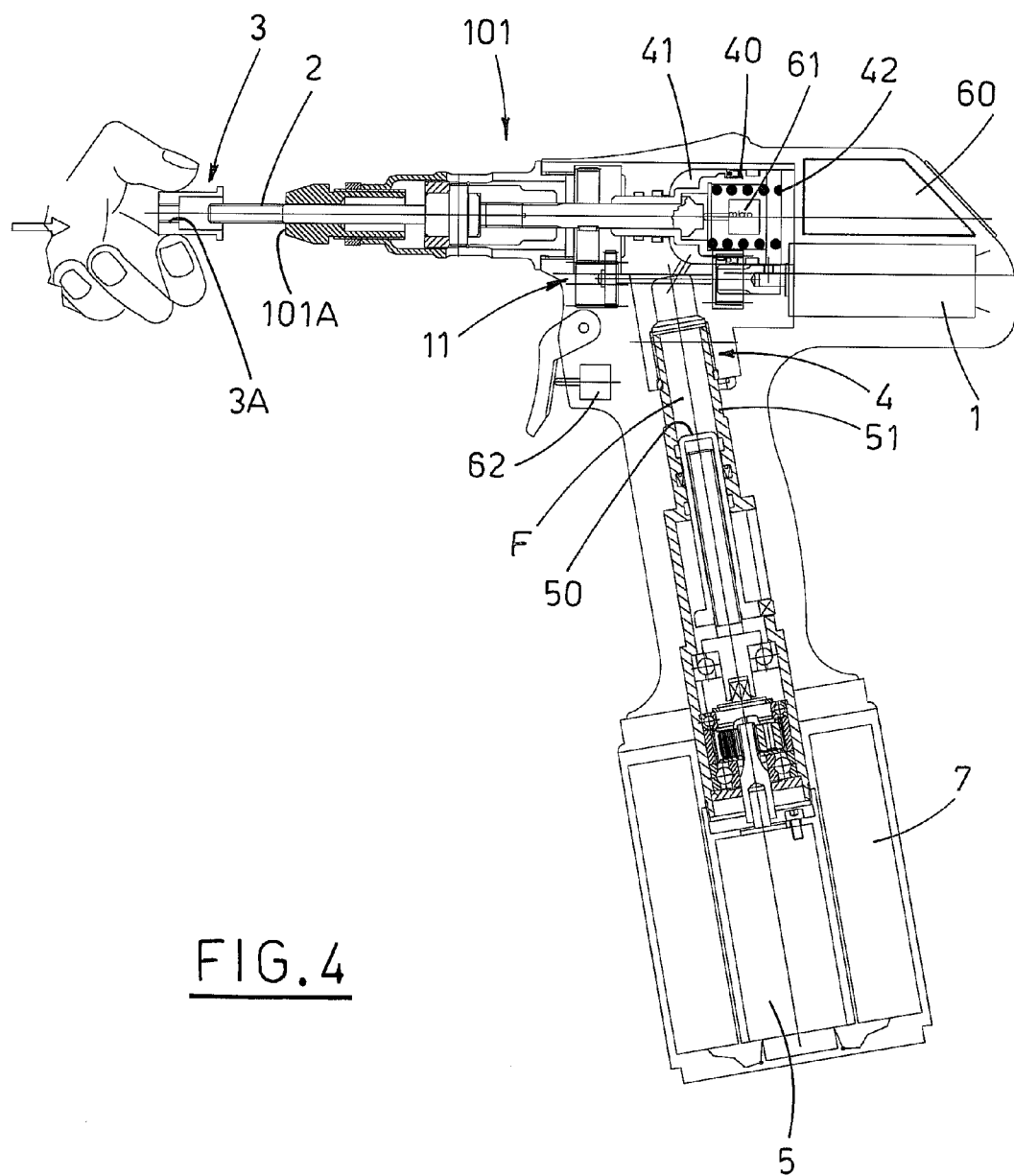


FIG. 4

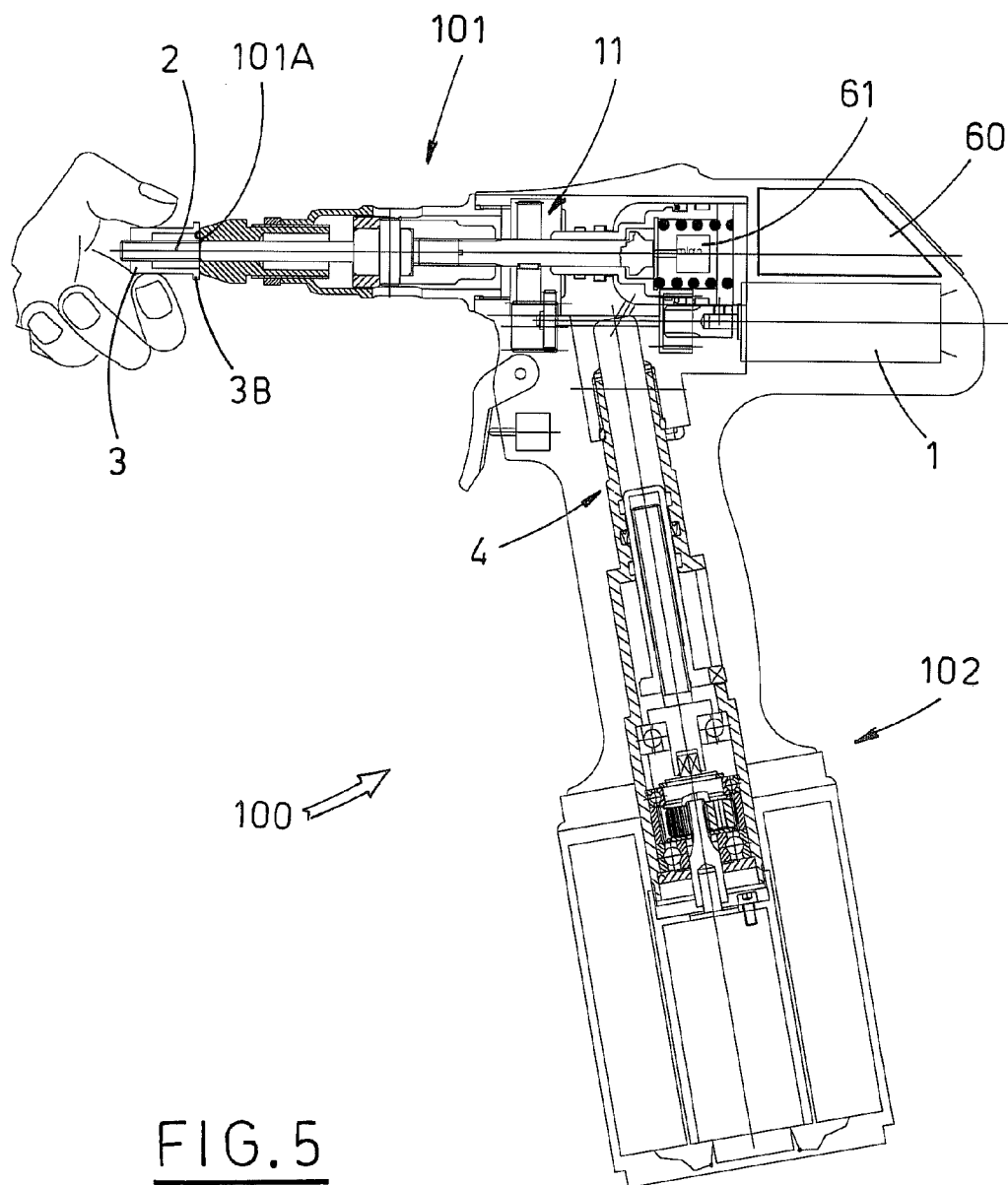
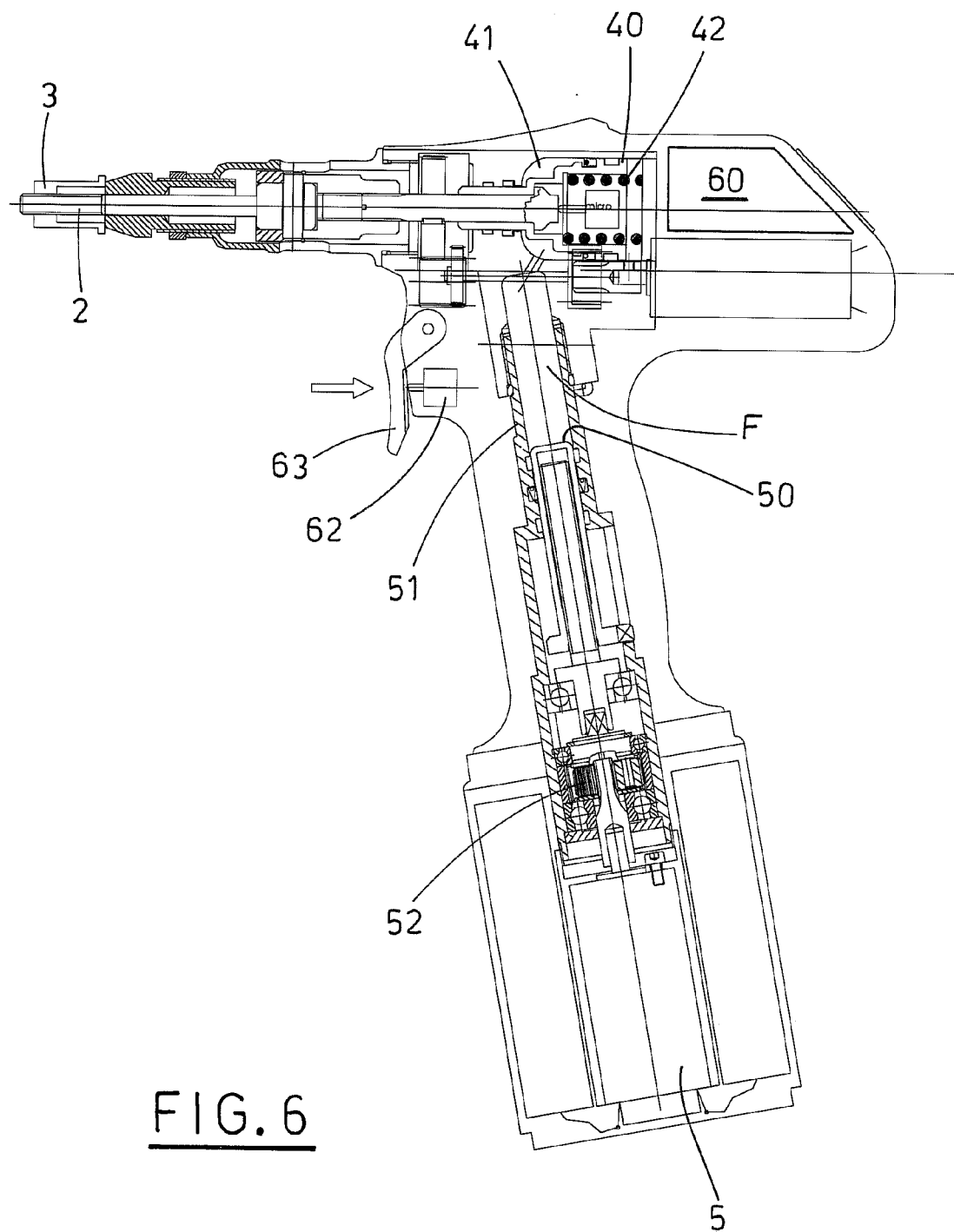


FIG. 5



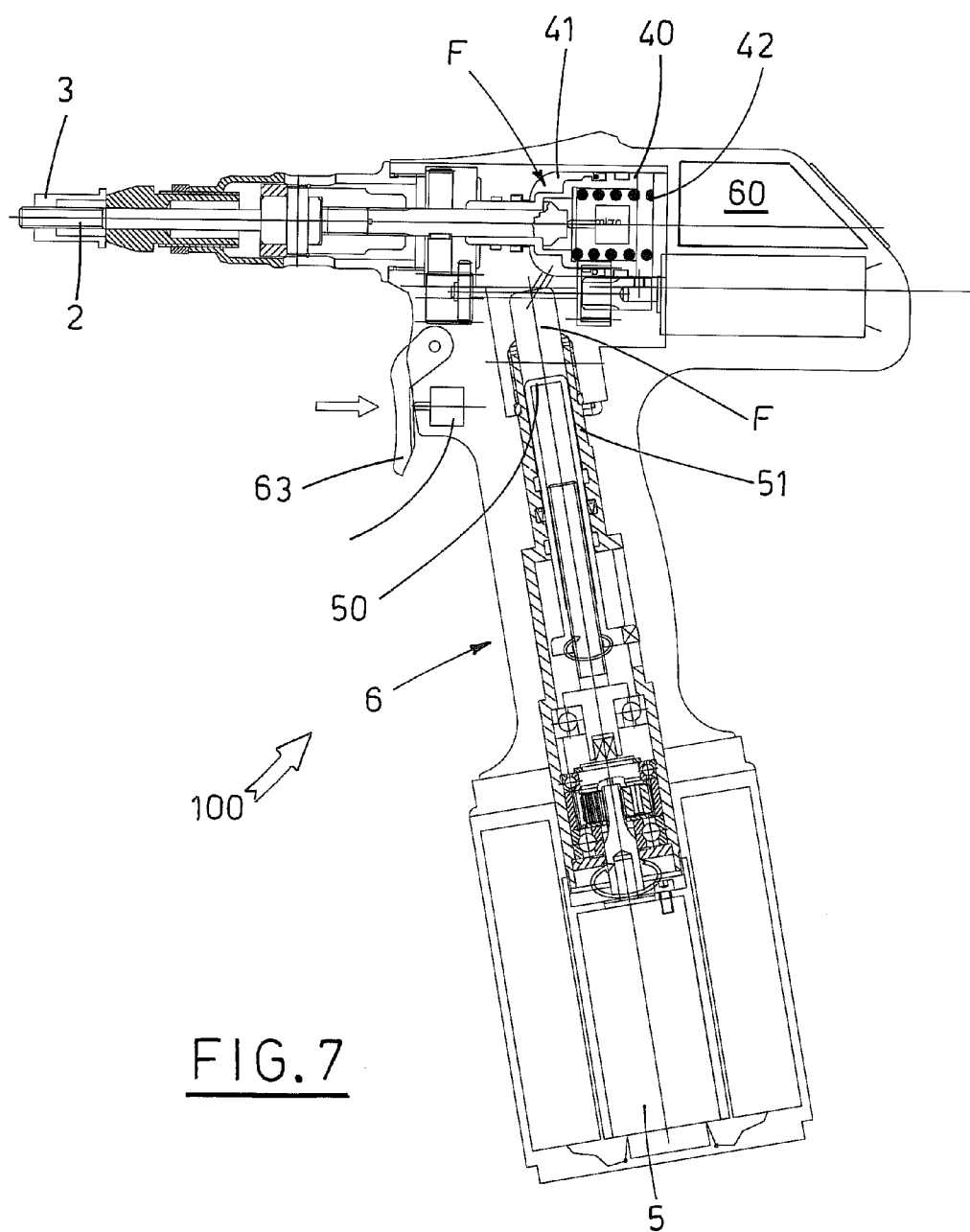
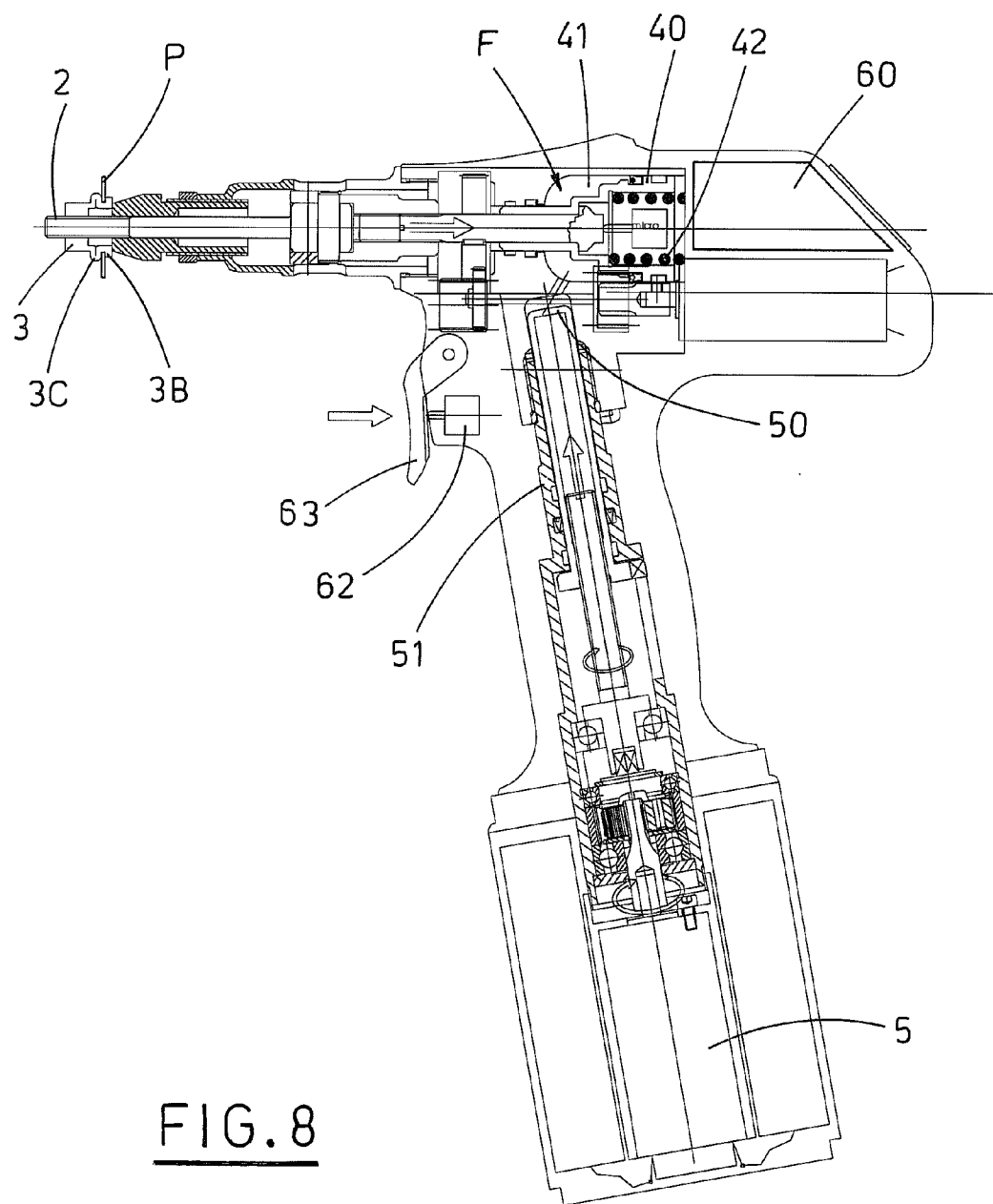
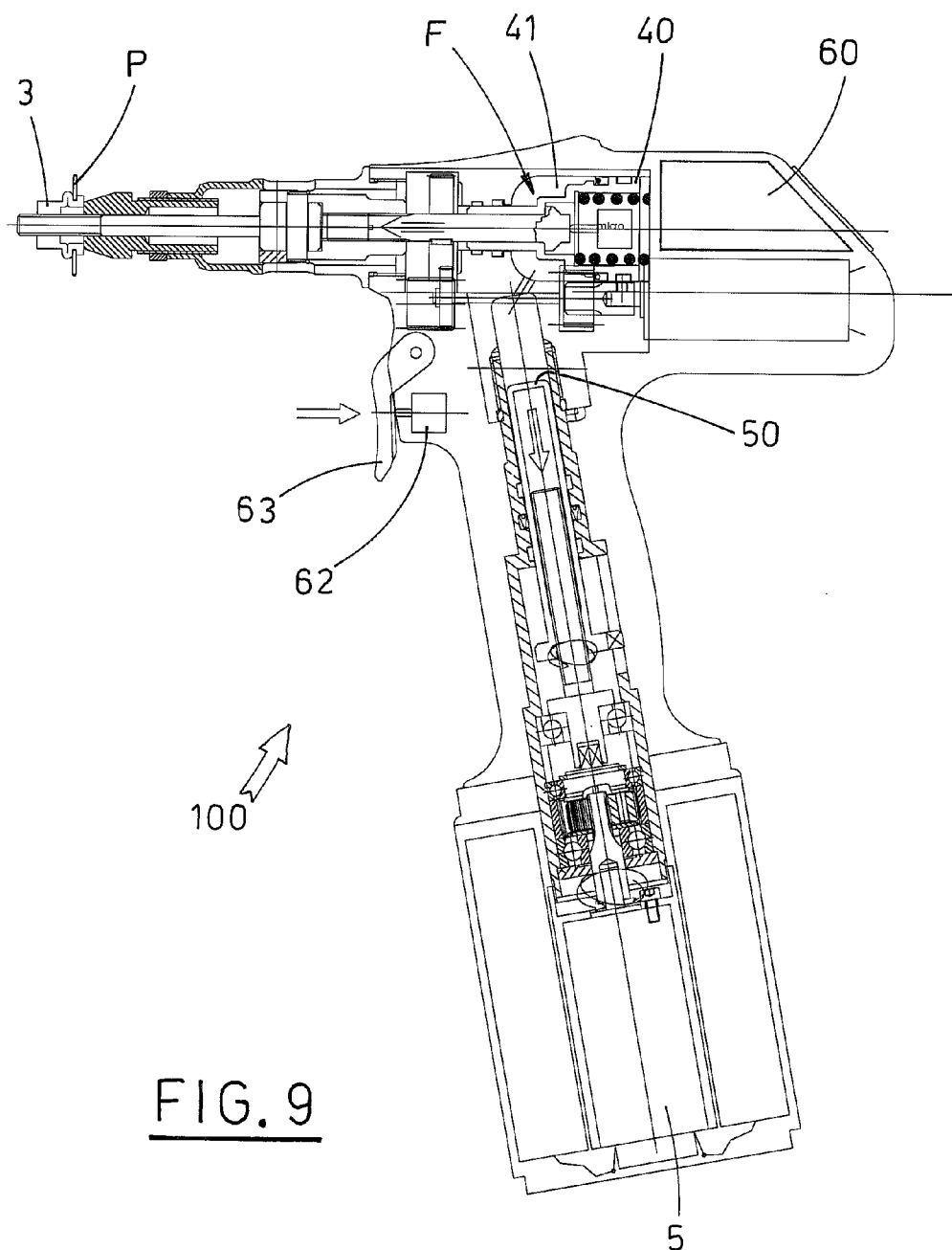


FIG. 7





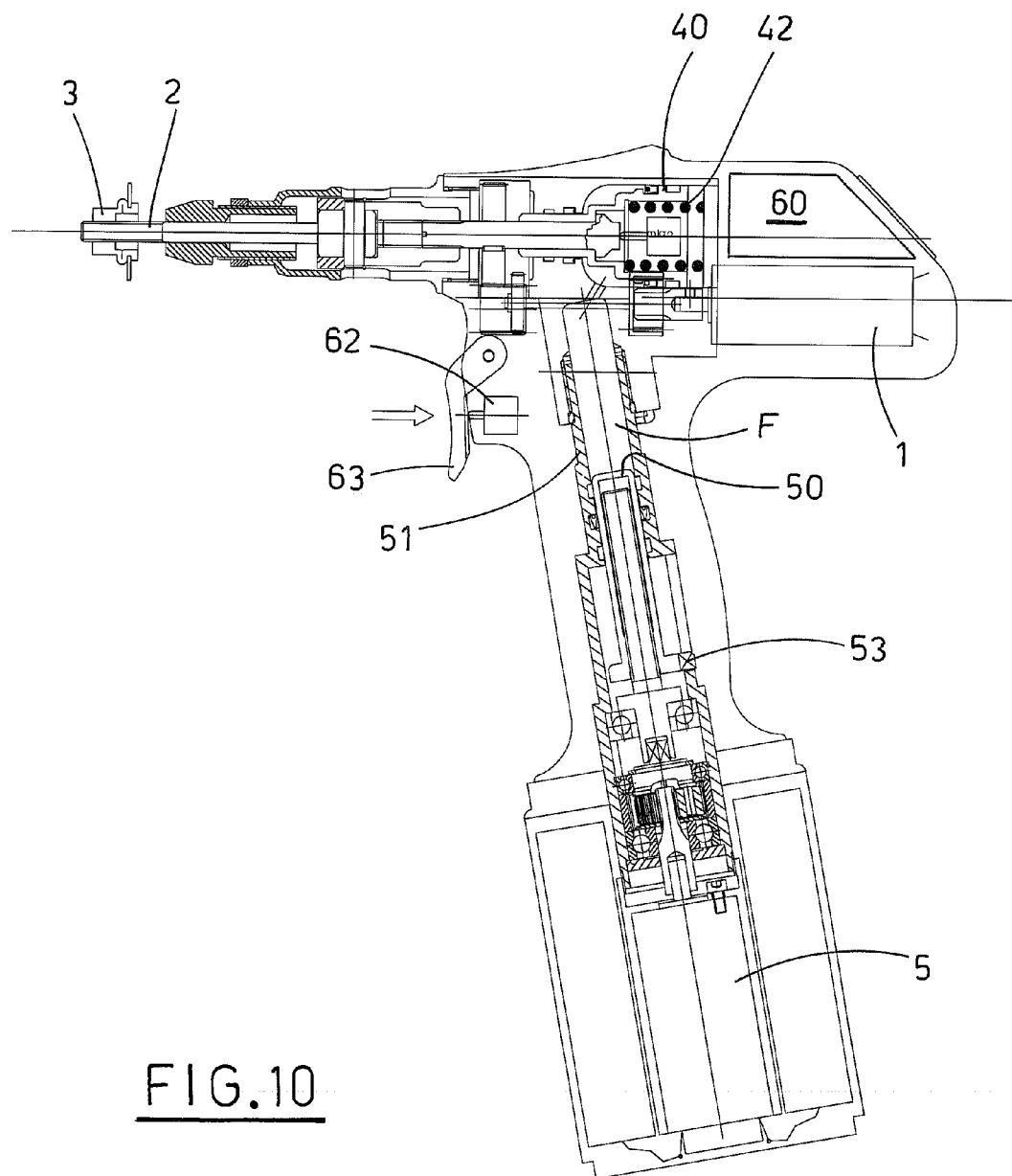
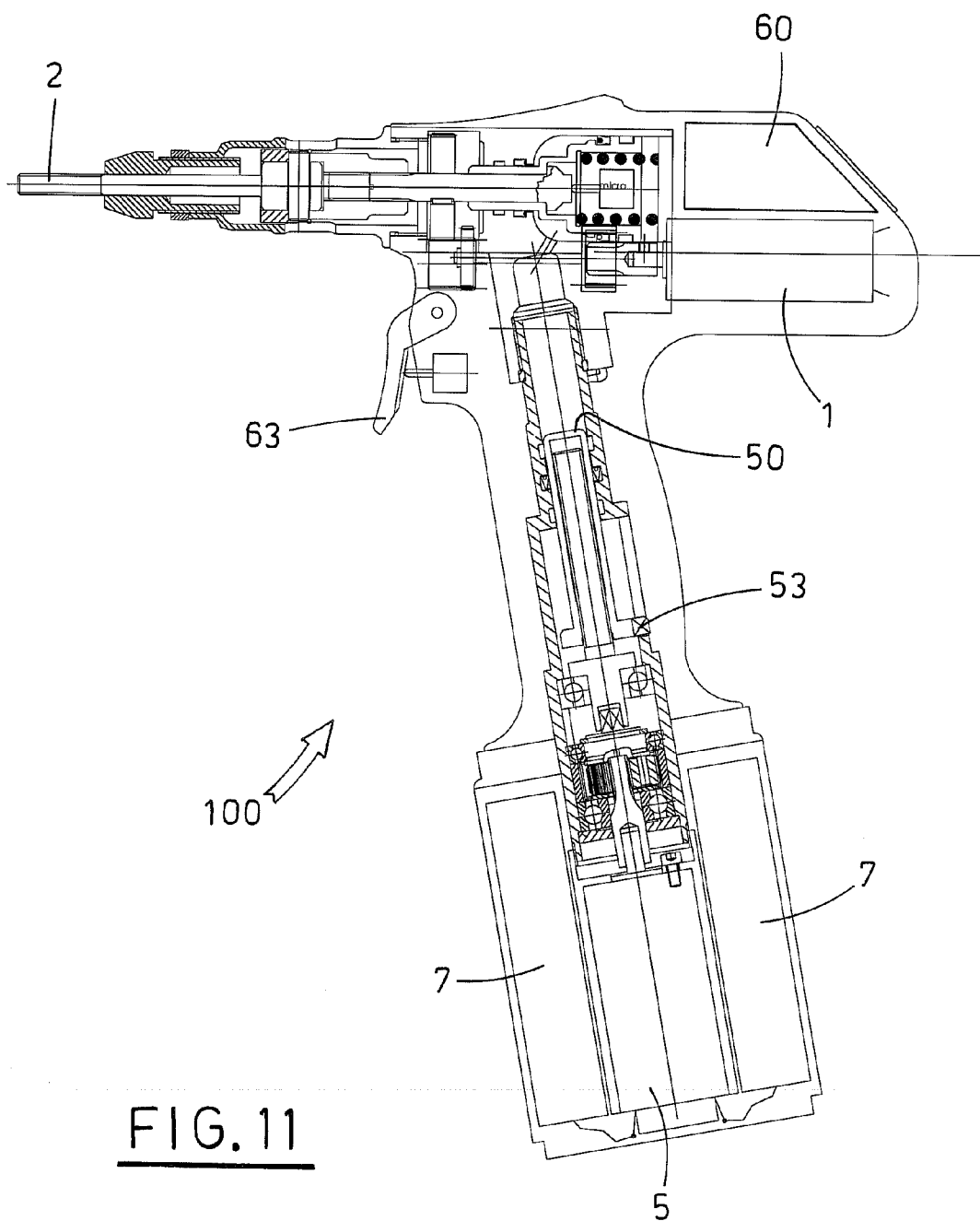


FIG. 10



ELECTRO-HYDRAULIC DEVICE WITH AN ELECTRONIC CONTROL FOR DEFORMING FASTENING ELEMENTS

TECHNICAL FIELD

[0001] The invention relates to the technical sector of riveting pistols, with special reference to servo-assisted pistols, used for rivets having a cylindrical shape, a partially-threaded axial hole, an abutment collar at a head thereof and a specially-weakened portion at which the plastic deformation will occur.

BACKGROUND ART

[0002] The rivets are destined to join two walls stably, for example in place of spot welding, or for constituting a threaded anchoring bush of an adequate sturdiness, for structures made of too-soft or too-thin materials for fashioning sufficiently-resistant threads.

[0003] The above-described rivets can be of considerable dimensions, and for their application it is necessary to avail of the necessary equipment, which must be able to exert thereon a high compression force.

[0004] A known-type riveting pistol, constructed by the same applicant in accordance with an Italian patent application for industrial invention no. B02007A000311, comprises a body and a grip wherein are housed:

[0005] a pneumatic motor, for rotating a threaded rod either right-wise or left-wise, respectively for engaging or disengaging the rod from the threaded axial hole of one of the rivets;

[0006] a hydraulic system for impressing an axial translation on the motor-rod group, for causing a plastic deformation of a predetermined portion of the rivet, such as to block the rivet to a structure;

[0007] a pneumatic thrust amplifier, activating a piston for compressing the fluid of the hydraulic system;

[0008] a pneumatic system, in which are comprised: an auxiliary valve activated to open by the rod; a main valve, activated to open by a trigger;

[0009] a hydro-pneumatic exchange valve, connected to the hydraulic and pneumatic systems, comprising: first organs for detecting a pressure of the hydraulic fluid; second organs for switching delivery of compressed air from the pneumatic thrust amplifier to the pneumatic motor, upon reaching a predetermined maximum pressure of the hydraulic fluid;

[0010] an emergency control for setting the pneumatic motor in left-wise rotation.

[0011] The pistol functions as follows:

[0012] the rivet is arranged in the hole afforded for it in the structure, with the relative collar contacting thereon, or, alternatively, the rivet is manually positioned before the rod of the pistol;

[0013] the rod is placed in the axial hole of the rivet, up to the start of the thread thereof, thus determining an axial thrust on the rod towards the body of the pistol, which causes the opening of the auxiliary valve, which auxiliary valve enables compressed air to be sent to the motor, setting it in right-wise rotation in order to screw in the rivet; when the collar thereof strikes against the front head of the body, the auxiliary valve is automatically closed and the motor stopped;

[0014] by pressing the trigger the main valve is opened, which enables sending compressed air to the thrust amplifier, through the hydro-pneumatic exchange valve, with a consequent increase in pressure of the hydraulic fluid and a starting of the axial translation of the motor-rod group;

[0015] by keeping the trigger pressed, the translation proceeds, causing a progressive compression of the rivet which is thus deformed in an external direction, in the weakened portion, defining an annular edge that adheres to the surface of the opposite structure to the structure on which the collar rests, thus determining the blocking of the rivet;

[0016] still by keeping the trigger pressed, on reaching the maximum pressure determined for the hydraulic fluid, the second organs of the hydro-pneumatic exchange valve intervene and interrupt the inflow of compressed air towards the thrust amplifier and send it to the pneumatic motor, setting the motor in left-wise rotation; at the same time the air contained in the thrust amplifier is discharged to the outside;

[0017] the left-wise rotation of the motor is transmitted to the threaded rod which unscrews from the rivet, now blocked to the structure;

[0018] the operator releases the trigger when the rod is disengaged from the rivet.

[0019] The riveting pistol described above functions excellently, but requires a compressed air source to which it can be collected; it cannot therefore be used when the air source is not available.

DISCLOSURE OF INVENTION

[0020] The aim of the present invention is to provide an electro-hydraulic pistol device having an electronic control for deforming the fastening element, which therefore does not require a connection with a source of compressed air.

[0021] A further aim of the invention is to provide an electro-hydraulic pistol device which exhibits an operating logic which is entirely similar to that of the known pistol described in the preamble hereto.

[0022] A further aim of the invention relates to the desire to provide an electro-hydraulic pistol device which can be realized in numerous variant embodiments, different in the type of electrical supply provided and/or in the constructive design, with components that can be housed in the body and the grip, or that can be external thereof.

[0023] A further aim of the invention consists in the possibility of offering versions of the electro-hydraulic pistol device which are particularly compact and light, thanks to the external location of components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The characteristics of the invention will better emerge from the following description of preferred embodiments thereof, in agreement with what is set out in the appended claims and with the aid of the accompanying figures of the drawings, in which:

[0025] FIG. 1 illustrates an embodiment of the electro-hydraulic pistol device of the invention, in a sectioned schematic lateral view;

[0026] FIG. 2 is a section made along plane II-II of FIG. 1;

[0027] FIG. 3 is a section made along plane III-III of FIG. 1;

[0028] FIGS. 4 from 11 illustrates views similar to FIG. 1, with the electro-hydraulic device in the most important operating stages.

BEST MODE FOR CARRYING OUT THE INVENTION

[0029] With reference to the figures of the drawings, 100 denotes a first embodiment of the electro-hydraulic pistol device of the invention, in its entirety; in the following description, for the sake of simplicity, the device 100 will be known simply as a pistol.

[0030] The pistol 100 comprises a body 101 and a grip 102 in which the following are housed:

[0031] a first electric micro-motor 1, for rotating leftwise or rightwise, via first transmission organs 11, a threaded rod 2, respectively for engaging or disengaging the rod 2 in the threaded axial hole 3A of one of the rivets 3;

[0032] a hydraulic system 4 comprising a cylinder 51, containing a fluid F and connected to a chamber 41, in which a cursor 40 slides, the cursor impressing an axial translation to the rod 2, in order to determine plastic deformation of a predetermined portion of the rivet 3, such as to block it to a corresponding wall P;

[0033] a second electric micro-motor 5, for commanding, by means of second transmission organs 52, an outward and return run of a piston 50, which compresses, during the outward run, the fluid F of the hydraulic system 4 in the cylinder 51;

[0034] an electric circuit 6, comprising the following: a control unit 60; a first micro-switch 61, activated by the rod 2 to switch the first micro-motor 1 such that the rod 2 rotates towards the right; a second micro-switch 62 activated by a trigger 63, for activating the second micro-motor 5 first in one direction and then in the other and, in a phase relation determined by the control unit 60, for activating the first micro-motor 1 in left-wise rotation;

[0035] batteries 7, associated to an ON/OFF switch, not illustrated, for supplying electrical energy to the electric circuit 6 and, via this, to the first and second micro-motor 1, 5.

[0036] The pistol 100 further comprises an emergency button control, not illustrated in detail but preferably arranged with a position and/or conformation protected from accidental activation, associated to the electric circuit 6 and destined to activate the first micro-switch 1 such that the rod 2 rotates to the left, in a way which will be described herein below.

[0037] The first transmission organs 11 are constituted, for example, by a plurality of gears also functioning as speed reducer; preferably these organs 11 cause the micro-motor 1 and the rod 2 to rotate in a same direction (FIGS. 2 and 3).

[0038] The second transmission organs 52 are constituted, for example, by an epicyclical gear reducer.

[0039] There follows a description of the operation of the pistol 100 for application of a rivet 3 to a wall P, starting from the inoperative position of FIG. 4, in which:

[0040] the first and the second micro-motor 1, 5, are stationary;

[0041] the pressure in the hydraulic system 4 is at the minimum, with the piston 50 in the lowered position of the cylinder 51 and the cursor 40 advanced in the chamber 41, towards the front head 101a of the body 101, due to the action of relative contrast spring 42;

[0042] the switch associated to the batteries 7 is in the ON position.

[0043] The rivet 3 is arranged in the hole in the wall P therefore, with the relative collar 3B striking against the wall; or, alternatively, the rivet 3 is manually positioned before the rod 2 of the pistol 100 (see FIG. 4).

[0044] Similarly to the known riveter pistol, mentioned in the preamble hereto, the rod 4 is inserted into the axial hole 3A of the rivet 3 up to the start of the threading thereof, thus determining an axial thrust on the threaded rod 2, towards the body 101 of the pistol 100, which causes activation of the first micro-switch 61; the closing of the contact therein provides the signal to the control unit 60 to activate the first micro-motor 1 in a suitable direction, rotating the rod 2 in right-wise rotation in order to screw up the rivet 3.

[0045] When the collar 3B of the rivet 3 strikes against the front head 101A of the body 100, the rod 2 is recalled in an external wise direction, releasing the first micro-switch 61 and thus causing the first micro-motor 1 to stop (FIG. 5).

[0046] By pressing the trigger 63, the second micro-switch 62 is activated and the control unit 60 starts up the automatic operating cycle of the pistol 100 (FIG. 6).

[0047] The second micro-motor 5 is then activated in the suitable direction, in order to determine the outward run of the piston 50 in the cylinder 51, with a consequent increase in the pressure of the hydraulic fluid F into the chamber 41 of the cursor 40 (FIG. 7).

[0048] By keeping the trigger pressed 63, the piston 50 continues to rise, while the pressurized fluid F overcomes the resistance of the contrast spring 42 and pushes the cursor 40 to retreat, together with the associated threaded rod 2.

[0049] The translation continues, causing a progressive compression of the rivet 3 which deforms towards the outside, in the weakened portion, to define an annular edge 3C adhering to the surface of the wall P opposite the surface on which the collar 3B is resting, thus determining a blocking of the rivet 3 (FIG. 8).

[0050] The increase in the pressure in the hydraulic system 4 increases the resistance to rising of the piston 50, which leads to a proportional increase in the absorption of power on the part of the second micro-motor 5.

[0051] The value of this absorption is constantly monitored by the control unit 60, since the force exerted on the rod 2 to deform the rivet 3 is calculated in relation thereto, by means of suitable parameters.

[0052] On the basis of the maximum force the pistol is to be calibrated for the maximum peak of absorption the second micro-switch 5 has to reach is calculated and the relative datum is stored in the control unit 60.

[0053] When the instantaneous absorption detected equals the maximum value foreseen, and with this the predetermined deformation thrust having been reached, the control unit 60 inverts the rotation of the second micro-motor 5, with consequent inversion of the movement of the piston 50 (FIG. 9).

[0054] The above leads to a sharp drop in hydraulic fluid pressure F, with a consequent interruption of the retraction of the cursor-rod group and thus of the stressed on the rivet 3.

[0055] While the piston 50 proceeds in its descent, due to the action of the second micro-motor 5, the contrast spring 42 newly prevails on the force determined by the fluid pressure F and advances the cursor 40 and the rod 2.

[0056] The control unit 60, in a suitable phase relation with the descent of the piston 50, starts up the first micro-motor 1 too, setting the threaded rod 2 in leftwise rotation so that it unscrews from the rivet 3 which by now is blocked to the wall (FIG. 10).

[0057] The second micro-motor **5** is maintained in motion until the piston **50** reaches the lowered start position, after which it is automatically deactivated by the control unit **60** (see FIG. **10** once more); the signal which attests to the reaching of the position can be given by an end-run sensor (not illustrated), or by the increase of absorption of the micro-motor **5** consequent upon the intercepting of a mechanical end-run stop **53** which is integral with the piston **50**.

[0058] The rotation of the first micro-motor **1**, on the other hand, continues as long as tie trigger **63** is kept depressed, such that the rotation of the rod **2**, for unscrewing the just-applied rivet **3**, proceeds for the time decided by the operator.

[0059] On release of the trigger **63**, with a consequent stop of the first micro-motor **1**, tie foreseen functioning program is completed (FIG. **11**).

[0060] At this point the pistol **100** is newly in the condition described with reference to FIG. **4**, with the control unit **60** predisposed for a new cycle.

[0061] A particularly able operator, therefore, can optimally synchronize the disengagement of the rod **2** with the halting of the micro-motor **1**, such as to render the pistol **100** immediately ready for another rivet **3**, previously positioned on the wall **P**.

[0062] If the trigger **63**, due to error or another reason, is released before the disengagement of the rod **2**, the unscrewing can be completed by pressing the emergency command, in order to reactivate the micro-motor **1** with a further leftwise rotation of the rod **2**.

[0063] Worthy of note is the fact that the pistol **100**, as described, does not minimally suffer from any maneuvering error which might be committed if, following an early release of the trigger **63**, pressure is newly placed thereon.

[0064] The control logic of the control unit **60** can be programmed to continue the interrupted cycle if, for example, release occurs during the stage of deformation of the rivet **3**.

[0065] In a case where the maneuvering error is in the final stage of unscrewing, with a subsequent pressure on the trigger **63**, instead of the activating of the emergency control, the pistol repeats the automatic traction cycle on the rod **2** Without causing undesired stress on the rivet **3** applied, as on reaching the preceding maximum fluid pressure **F**, the control unit **60** interrupts the action and starts unscrewing, so that the only drawback that obtains is a slight waste of time.

[0066] Other embodiments of the electro-hydraulic pistol device are envisaged, apart from the one illustrated and described herein above.

[0067] In a second embodiment, not illustrated, the batteries **7** and possibly also the control unit **60** can be housed in a module which is external of the body of the pistol; this is to contain the weight and size of the pistol, making it easier to use.

[0068] In a third embodiment, also not illustrated, the batteries are eliminated and electrical energy is sourced from a network, with the interposing of a suitable transformer/rectifier, with the aim of obtaining unlimited working autonomy, together (in this case too) with a considerable reduction in weight.

[0069] Certainly, with reference to the last solution, total device independence of external energy sources is lost, but it is extremely evident that having a current tap available is much more likely than having a handy source of compressed air.

[0070] In a further embodiment, not illustrated, the constructional characteristics of the two above-mentioned

embodiments are combined, thus providing a module which is external of the body of the pistol which contains, apart from the batteries and the control unit, the transformer/rectifier for network-sourced power and possibly a device for recharging the batteries.

[0071] From the above it can be understood how the electro-hydraulic pistol device fully reaches the set aims, in particular for obtaining a functioning logic which is entirely similar to that of the known-type pistol cited in the preamble hereto, without there being any need for supply of compressed air.

[0072] The constructional possibilities given by the choice of electrical workings leans that it is easy to set up numerous constructional variations, without there being any negative effect on the functioning of the device, which variations can respond to needs that otherwise would be destined to remain unaddressed.

[0073] Thanks to the external locating of the components such as the batteries, it is possible to attain considerable benefits in terms of compactness and lightness of the device, with obvious advantages in the use thereof.

1. An electro-hydraulic pistol device with an electronic control for deformation of fastening elements, of a type comprising: a threaded rod (**2**) which engages with a threaded axial hole (**3A**) of a rivet (**3**); a hydraulic system (**4**), which impresses an axial translation on the threaded rod (**2**), for determining a elastic deformation of a predetermined portion of the rivet (**3**), such as to block tie rivet (**3**) to a corresponding wall (**P**), the device (**100**) being characterised in that it comprises: a first electric micro-motor (**1**), for setting the threaded rod **2** in right-wise or left-wise rotation, respectively for engaging or disengaging the threaded rod (**2**) from the threaded axial hole (**3A**); means (**40**) associated D the rod (**2**) for impressing the axial translation on the rod (**2**), by action of the hydraulic fluid (**F**) of the system (**4**); a second electric micro-motor (**5**), for controlling compression and discharge runs of a piston (**50**) located internally of a cylinder (**51**), so as to determine, respectively, a raising of the pressure of the fluid (**F**) of the hydraulic system (**4**), up to a maximum predetermined, value, and a reduction of the pressure; an electrical circuit (**6**), managed by a control unit (**60**), comprising a first micro-switch (**61**) which is activated by the rod (**2**) for activation of the first micro-motor (**1**), such that the rod (**2**) rotates in rightwise direction, and a second micro-switch (**62**), activated by a trigger **63** after deactivation of the first micro-switch (**61**), for activating the second micro-motor (**5**) first in a direction and then in another direction as well as for activating the first micro-motor (**1**) in phase relation with activation of a discharge run of the piston (**50**), such that the rod (**2**) rotates left-wise; supply means (**7**) for supplying electrical energy to the electric circuit (**6**) and, through the circuit (**6**), to the first micro-motor (**1**) and the second micro-motor (**5**).

2. The device of claim **1**, characterised in that the means (**40**) are constituted by a cursor which is slidably inserted in a chamber (**41**) and subjected at a side thereof to action of a contrast spring (**42**) and at another side thereof to action of the hydraulic fluid (**F**) of the system (**4**).

3. The device of claim **1**, characterized in that the control unit (**60**) is provided with means for instantaneously detecting absorption of power of the second micro-motor (**5**), and calculating means for relating a value of the absorption with the pressure of the hydraulic fluid (**F**).

4. The device of claim 1, characterised in that first transmission organs (11) re interposed between the first micro-motor (1) and the threaded rod (2).

5. The device of claim 4, characterised in that the first transmission organs (11) are constituted by a plurality of gears which reduce a number of rotations from an input to an output of the motion.

6. The device of claim 1, characterised in that second transmission organs (52) are interposed between the second micro-motor (5) and the piston (50).

7. The device of claim 6, characterised in that the second transmission organs (52) are constituted by an epicyclical reducer.

8). The device of claim 1, characterised in that a button-operated emergency command is included, associated to the electric circuit (6) and activating the first micro-switch (1) such that the rod (2) rotates left-wise.

9. The device of claim 1, characterised in that a two-way switch is associated to the supply means (7), positions of the two-way switch being respectively for connecting and disconnecting the means (7) to and from the electrical circuit (6).

10. The device of claim 1, characterised in that the supply means (7) are housed in the body (101) and the grip (102) of the device (100).

11. The device of claim 1, characterised in that the supply means (7) are housed in a module which is external of the device (100).

12. The device of claim 1, characterised in that the supply means (7) are constituted by batteries.

13. The device of claim 1, characterized in that the supply means (7) are constituted by a transformer/rectifier which can be connected to an external electricity source line.

14. The device of claim 1, characterised in that the control unit (60) is housed in the body (101) and the grip (102) of the device (100).

15. The device of claim 1, characterised in that the control unit (60) is housed in a module which is external of the device (100).

16. The device of claim 9, characterised in that the supply means (7) are housed in the body (101) and the grip (102) of the device (100).

17. The device of claim 9, characterised in that the supply means (7) are housed in a module which is external of the device (100).

18. The device of claim 9, characterised in that the supply means (7) are constituted by batteries.

19. The device of claim 9, characterized in that the supply means (7) are constituted by a transformer/rectifier which can be connected to an external electricity source line.

* * * * *