



(11) **EP 2 093 430 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**26.08.2009 Bulletin 2009/35**

(51) Int Cl.:  
**F15B 7/00 (2006.01)**

(21) Application number: **08101963.0**

(22) Date of filing: **25.02.2008**

(84) Designated Contracting States:  
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR  
HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT  
RO SE SI SK TR**  
Designated Extension States:  
**AL BA MK RS**

(30) Priority: **21.02.2008 IT BO20080116**

(71) Applicant: **OBER S.p.A.**  
**40057 Cadriano Di Granarolo (Bologna) (IT)**

(72) Inventor: **Preti, Giuseppe**  
**40127 Bologna (IT)**

(74) Representative: **Dall'Olio, Giancarlo**  
**Invention S.r.l.**  
**Via delle Armi 1**  
**40137 Bologna (IT)**

(54) **An electro-hydraulic device with an electronic control and regulation system of a hydraulic actuator for deforming fastening elements**

(57) An electro-hydraulic device with an electronic control and regulation system of a hydraulic actuator (21) for deforming fastening elements, comprising: a covering and protecting casing (3); at least a supply chamber (4), contained in the casing (3), for receiving an incompressible fluid and comprising at least an opening (41) for hydraulic communication thereof with at least a respective receiving chamber, comprised in the hydraulic actuator (21); at least a presser element (5), contained in the casing (3), operated by kinematic means (6) for inducing a

pressure change to which the incompressible fluid is subjected; the kinematic means (6) being electro-mechanical and being destined to produce a determined change in the mechanical force to which the presser element (5) is subjected, according to predetermined parameters, such that a specific variation of the pressure to which the incompressible fluid results, such as to obtain a regulation of the functioning of the hydraulic actuator (21).

**EP 2 093 430 A1**



## Description

**[0001]** The present invention relates to the technical sector concerning the activation, control and regulation of hydraulic actuators, with special reference to hydraulic actuators comprised in riveting machines.

**[0002]** The prior art comprises hydraulic actuators of very different types, designed for performing many and various technical/industrial operations, which have in common the fact that they necessitate controlled supply of pressurised incompressible fluid, usually oil, which is used for the respective technical functions.

**[0003]** In the following description special reference is made to the supply, activation and control of hydraulic actuators comprised in riveting machines, or riveters, without these limiting the applicational scope to the technical solution set herein.

**[0004]** Normally riveters are used for plastic deformation of rivets exhibiting a cylindrical shape, a partially-threaded axial hole and a specially weakened portion, in which the plastic deformation is made, the rivets being frequently used for stably joining at least two walls, for example two sheets.

**[0005]** To realise the above-mentioned plastic deformation, the rivet must first be stably connected to mechanical deforming organs, comprised in the riveter, which is done with a male threaded element for the purpose, which is located at the mouth of the threaded hole of the rivet and set in right-directed rotation by a special pneumatic motor.

**[0006]** In particular, pneumatic-hydraulic type riveters are widely used i.e. riveters which are structured such that they exhibit a hydraulic section for the riveting operation actuation and a pneumatic section for activation and control of the hydraulic part, the pneumatic section also comprising the pneumatic motor.

**[0007]** The pneumatic section is connected to a source of compressed air and comprises a plurality of special valves activated by a user, by means of special control means, such as to enable the compressed air both to supply the pneumatic motor and, later, to act on an internal thrust element in the riveter, for example a piston, such as to move it in order for it to press on a hydraulic fluid, contained in the hydraulic section, producing an abrupt increase in pressure, which is transformed by the deforming organs into mechanical force in order to produce, in ways which are widely known by experts in the field, the deformation of the rivet which had previously been inserted in a special hole made in two or more sheets, so as to complete the riveting operation.

**[0008]** The pneumatic section represents an excellent activation and deactivation device for the hydraulic actuator, in the example the hydraulic section described above, but cannot constitute an effective and even efficient regulation device of the functioning of the hydraulic actuator.

**[0009]** The functioning of the pneumatic activating device of the above-described type is substantially based

on a predetermined switching plan of the valves comprised therein and on a specific volume of air at a given pressure introduced therein with the consequence that the device itself can be controlled effectively by the user only in terms of its passage from the non-active state to the active state and vice versa, while its intermediate operative states can be established only approximatively by the user, by varying the volume of compressed air or the relative thermodynamic properties. In practice, the known type of activation device can be controlled to excellent effect only in the context of an "all or nothing" operating mode.

**[0010]** For a long time now, in the field of technical-industrial applications of hydraulic actuators, the need has been felt to avail of activation devices for the actuators which are able to regulate the pressure of the hydraulic fluid, under user control, in order (for example) to adapt the functioning of the actuator to its various operative objectives, or more in particular in order to modulate the mechanical force when it is used to produce plastic deformation of a rivet.

**[0011]** To satisfy this need, an electrical-hydraulic device is provided, as described in claim 1, with a electronic control and regulation system of a hydraulic actuator for deforming fastening elements, which device comprises:

a protective and covering casing;

a supply chamber, contained in the casing, for receiving an incompressible fluid and comprising an opening for hydraulic communication thereof with a respective receiving chamber comprised in the hydraulic actuator;

a presser element, contained in the casing, which can be activated by kinematic means in order to induce a change in the pressure to which the incompressible fluid is subjected;

the kinematic means being of an electro-mechanical type and being destined to produce a determined variation in a mechanical force to which the presser element is subjected, according to predetermined parameters, such that a specific pressure change is obtained to which the incompressible fluid is subjected, such as to obtain a regulation of the functioning of the hydraulic actuator.

**[0012]** A first advantageous technical result which can be attained with the use of the present technical solution, thanks to which the device represents a considerable technical advance with respect to the prior art, consists in the fact that the device itself is able to control a hydraulic actuator such as to obtain a true and proper regulation of the functioning thereof, differently to the prior art, in which a user is only able to activate or deactivate a given hydraulic actuator.

**[0013]** This is made possible by the fact that the inven-



tion, during its operation, produces a specific variation in the incompressible fluid, for example oil, used in the hydraulic actuator, which variation is a function (as previously mentioned) of predetermined parameters, which can, for example, be established by the user of the device using the normal piloting and interfacing means, known to an expert in the field.

**[0014]** Further, the device can be advantageously used for controlling and regulating almost any type of hydraulic actuator comprised in a very wide range of industrial or domestic utensils. Indeed, the device can produce a graduation of the pressure to which the above-mentioned incompressible fluid is subjected, in a way which is regulated by the user, all of which means that this device does not have to be destined for and implemented for a single specific type of hydraulic actuator requiring a respective and special pressure range for the incompressible fluid used therein.

**[0015]** The characteristics of the invention which do not emerge from the above will better emerge in the following description, made in accordance with what is set out in the claims and with the aid of the accompanying figures of the drawings, in which:

figure 1 is a longitudinal section of the device of the invention associated to a riveter, in which the presser element is in a particular operating position;

figure 2 is the same longitudinal section as figure 1, with the presser element in a different operating position.

**[0016]** With reference to the figures of the drawings, 1 denotes an electrical/hydraulic device equipped with an electronic control and regulation system of a hydraulic actuator 21 for deforming fastening elements, which device 1 comprises:

a covering and protective casing 3;

a supply chamber 4, contained in the casing 3, for receiving an incompressible fluid, for example oil, and comprising an opening 41 for hydraulic communication thereof with at least a respective receiving chamber comprised in the hydraulic actuator 21;

a presser element 5, contained in the casing 3, which can be activated by kinematic means 6 in order to induce a change in the pressure to which the incompressible fluid is subjected;

the kinematic means 6 being of an electro-mechanical type and being destined to produce a determined variation in a mechanical force to which the presser element 5 is subjected, according to predetermined parameters, such that a specific pressure change is obtained on the incompressible fluid, such as to obtain a regulation of the functioning of the hydraulic

actuator 21.

**[0017]** As shown in both figures of the drawings, purely by way of example, and as mentioned herein above, a type of hydraulic actuator 21 to which the device 1 of the invention can be associated is the actuator comprised in an electro-hydraulic riveter 2, to which receiving chamber the supply chamber 4 is hydraulically connected by means of, for example, a tube 22. In this case, naturally, the fastening elements to which reference is made are common rivets.

**[0018]** Thereafter, a preferred embodiment of the invention will be described, illustrated in both the accompanying figures of the drawings, in which preferred embodiment:

the predetermined parameters include a value of an electrical signal at inlet to the kinematic means 6;

the supply chamber 4 affords an access opening 42 and an inspection opening 43;

the presser element 5 comprises a stem 51,

the stem 51 being destined to insert sealingly in the access opening 42 and being activatable by kinematic means 6 for varying the pressure to which the incompressible fluid is subjected, according to the electrical input signal.

**[0019]** In this way, a modulation of pressure to which the oil is subjected is realised, under user control, for example by means of usual piloting and interfacing means, not represented in the enclosed figures since amply known to the expert in the field.

**[0020]** In the preferred embodiment of the invention, the kinematic means 6 comprise:

a brushless motor 61, the electric supply current of which constitutes the input electrical signal,

a screw 62, substantially fixed with respect to the casing 3 which contains the screw 62, and

means for connecting 63 for associating the screw 62 to the brushless motor 61, such that a torsional torque can be applied to the screw 62 thereby.

**[0021]** In more detail the screw 62 is engaged with a nut screw 52, for example of a re-circulating ball type, solidly constrained to the stem 51 and also comprised in the presser element 5 as described above, in such a way that according to the input electrical signal the brushless motor 61 impresses a torsional torque on the screw 62 which torsional torque produces a corresponding variation in the mechanical force to which the nut screw 52, and therefore the stem, is subjected, causing a specific change in pressure acting on the incompressible fluid.



**[0022]** As illustrated, albeit schematically, in the figures of the drawings, the means for connecting 63 comprise:

a joint 631, for transmitting the torsional torque, connected at an end thereof to the brushless motor 61;

a rotation shaft 632, connected at an end thereof to the joint 631, such that it is subjected to the torsional torque impressed thereon by the motor 61, and connected at another end thereof to the screw 62, such as to transmit the torsional torque thereto;

at least a bearing element 633 for the rotation shaft 632 positioned at the connection between the rotation shaft 632 and the joint 631.

**[0023]** The joint 631 can, for example, comprise a gear reducer.

**[0024]** There now follows a description of the functioning of the device 1, when associated to the riveter 2.

**[0025]** According to the oil pressure necessary in order that the riveter 2 can deform a given rivet, rivets being different, as is known, in physical properties and shape characteristics, a specific value of the supply current of the motor 61 is set, so that the motor 61 impresses a respective and predetermined torsional torque on the screw 62, via the means for connecting 63, to which torsional torque corresponds a change in the force applied to the stem 51, with a consequent and abrupt change in the oil pressure.

**[0026]** When the oil pressure has reached a sufficient level to deform the rivet, the rivet is subjected to a progressive reduction in the longitudinal dimension thereof, due to the deformation mentioned above, to which corresponds a progressive increase in the volume available for receiving the oil of the receiving chamber, comprised in the hydraulic actuator 21; which is followed by a progressive reduction in the oil contained in the supply chamber 4, which passes into the receiving chamber through the tube 22, during which reduction the screw 62 rotates, causing the nut screw to translate along the longitudinal development thereof, enabling penetration of the stem 51 internally of the chamber 4, which stem 51 goes to occupy the internal volume which is gradually left emptied of oil.

**[0027]** From the above, it is clear that a given longitudinal shortening of the rivet corresponds to a specific advance of the nut screw 52, along the screw 62, which advancing is obviously determined by the number of revolutions performed by the screw 62, which can be indirectly though univocally determined, as is known to the expert in the field, by connecting a usual transducer of angular position (i.e. an encoder) to the motor 61.

**[0028]** This, for example, enables *a priori* determination of the degree of tolerance in fastening between walls joined by rivets, which leads, among other things, to the new and surprising possibility of using the riveting in order

to fix sheets which are used in applications in which they are put under great stress, such as in sheets making up the frames of competition automobiles.

**[0029]** Obviously the motor 61 can be controlled to impress on the screw 62 an inverse torsional torque to the torsional torque which produces the riveting operation, producing a translation of the nut screw 52 along the screw 62, such as to bring the stem 51 to progressively translate from the inside of the chamber 4, through the opening 42.

**[0030]** Note that, on the basis of the functioning of the above-described device 1, the stem 51 is moveable in order to be arranged in any position comprised between an extreme position of minimum volume occupation of the supply chamber 4 and an extreme position of maximum volume occupation of the chamber 4.

**[0031]** In more detail, for reasons of safety, in order to prevent hypothetical malfunctioning or calibration errors from causing damage to the device 1, or to the riveter 2, the device 1 can include, in the preferred embodiment, two end-run sensors 31 and 32 associated to the casing 3 and respectively detecting the position of the nut screw 52, along the screw 62, corresponding to the minimum volume occupation position of the stem 51, and the position of the nut screw 52 corresponding to the position of the maximum volume occupation.

**[0032]** In the preferred embodiment of the proposed technical solution, at least an anti-rotation element 521 is associated to the nut screw 52, which anti-rotation element 521 engages with a guide afforded in the casing 3, such that the rotation of the screw 62 produces an exclusively-translating movement of the nut screw 52 along the screw 62, during which movement the nut screw 52 is rotationally fixed with respect to the casing 3.

**[0033]** With the aim of rendering the controlled graduating of the oil pressure as efficient as possible, and with the aim of having a response which is as ready as possible on the part of the riveter 2 on the impulse given by the stem 51 movement, the invention advantageously includes a tank 8, associated to the casing 3, containing a determined quantity of oil and destined to be placed in hydraulic communication with the inside of the chamber 4 via an opening 44, in order to supply the chamber 4 with oil contained in the tank 8, such that the operator can predetermine or establish how much oil should be present in the chamber 4, the receiving chamber and the tube.

**[0034]** The opening 44, as shown in the figures, is preferably arranged in proximity of the access opening 42, such that when the stem 51 is moved to progressively penetrate internally of the chamber 4, starting from the minimum volume occupation position, as mentioned above, the hydraulic communication between the tank 8 and the chamber 4 is interrupted by the passage of a predetermined portion of the stem 52 through the opening 42; in this way there is the complete certainty that during functioning of the device 1 the quantity of oil is kept constant, such as to ensure absolute correspond-



ence between the electric input signal and a respective functioning mode of the riveter 2, on the basis of a special calibration of the device 1 made for a specific riveter associated thereto.

**[0035]** Obviously when the stem 51 returns into the above-mentioned minimum volume position, the hydraulic communication between the tank 8 and the chamber 4 is reset.

**[0036]** The supply chamber 4, as shown in the accompanying figures of the drawings, further comprises an inspection opening 43 for hydraulic communication with at least a manostat 7, for example of a digital type, which continuously monitors the pressure of the oil contained internally of the supply chamber 4 itself. This detail can be used for periodic control of the oil pressure, for detecting malfunctioning, for calibration or for connecting an outlet of the manostat with a special control unit (not illustrated) which pilots the inlet current of the motor 61, so as to obtain a negative retroacting device which can optimise and stabilise the current value in input to the motor 61, with respect to the consequent oil pressure level, according to the specific regulation of the functioning of the riveter which the user of the device of the invention intends to obtain.

## Claims

1. An electro-hydraulic device with an electronic control and regulation system of a hydraulic actuator (21) for deforming fastening elements, comprising:

a covering and protection casing (3);

at least a supply chamber (4), contained in the casing (3), for receiving an incompressible fluid and comprising at least an opening (41) for fluid dynamic communication thereof with at least a respective receiving chamber, comprised in the hydraulic actuator (21);

at least a presser element (5), contained in the casing (3), which can be operated by kinematic means (6) for inducing a pressure change to which the incompressible fluid is subjected;

the device being **characterised in that** the kinematic means (6) are electro-mechanical and are destined to produce a determined change in the mechanical force to which the pressor element is subjected (5), according to predetermined parameters, such that a specific variation of the pressure to which the incompressible fluid is subjected results, such as to obtain a regulation of the functioning of the hydraulic actuator (21).

2. The device of claim 1, **characterised in that** the predetermined parameters comprise a value of an electric signal in input to the kinematic means (6).

3. The device of claim 2, **characterised in that** the kinematic means (6) comprise a brushless motor (61) and that the electric signal in input is the electric current supplying the brushless motor (61).

4. The device of claim 1, **characterised in that** the supply chamber (4) comprises at least an access opening (42) and **in that** the presser element (5) comprises at least a stem (51), which stem (51) sealingly inserts in the access opening (42) and is operated by the kinematic means (6) for varying the pressure to which the incompressible fluid is subjected, according to the predetermined parameters.

5. The device of claims 3 and 4, **characterised in that** the kinematic means (6) comprise at least a screw (62), substantially fixed with respect to the casing (3) containing the screw (62), and means for connecting (63) for associating the screw (62) to the brushless motor (61), such that the brushless motor (61) impresses a torsional torque on the screw (62), and **in that** the screw (62) is engageable to at least a nut screw (52) solidly constrained to the stem (51), and comprised in the presser element (5) such that in accordance with the input electrical signal, the brushless motor (61) impresses a predetermined torsional torque on the screw (62), which torsional torque produces a change in the mechanical force to which the nut screw (52), and therefore the stem (51), is subjected, consequently causing a specific variation in pressure to which the incompressible fluid is subjected.

6. The device of claim 5, **characterised in that** the means for connecting (63) comprise:

at least a joint (631) for transmitting a torsional torque, connected at an end thereof to the brushless motor (61);

at least a rotating shaft (632) connected at an end thereof to the joint (631) such as to be subjected to the torsional torque impressed thereon by the motor (61), and connected at another end thereof to the screw (62) such as to transmit the torsional torque thereto;

at least a bearing element (633) for the rotation shaft (632), positioned at the connection between the shaft (632) and the joint (631).

7. The device of claim 6, **characterised in that** the joint (631) comprises a gear reducer.

8. The device of claim 5, **characterised in that** it comprises at least an endrun sensor (31) for detecting a position of the nut screw (52), along the screw (62), corresponding to the position of minimum volume occupation of the inside of the supply chamber (4) of the stem (51).



9. The device of claim 5, **characterised in that** the nut screw (52) is of a re-circulating ball type.
10. The device of claim 5, **characterised in that** at least an antirotation element (521) is associated to the nut screw (52), which antirotation element (521) engages with a guide fashioned in the casing (3), in such a way that a rotation of the screw (62) produces a translating movement of the nut screw (52) along the screw (62), during which movement the nut screw (52) is rotationally fixed with respect to the casing (3).
11. The device of claim 1, **characterised in that** the supply chamber (4) comprises at least an inspection opening (43) for fluid dynamic communication with at least a manostat (7), for detecting a pressure value of the incompressible fluid contained in the supply chamber (4).
12. The device of claim 11, **characterised in that** it comprises a control unit which connects, by means of a negative retroaction, an outlet of the manostat (7) with an inlet of the kinematic means (6).

25

30

35

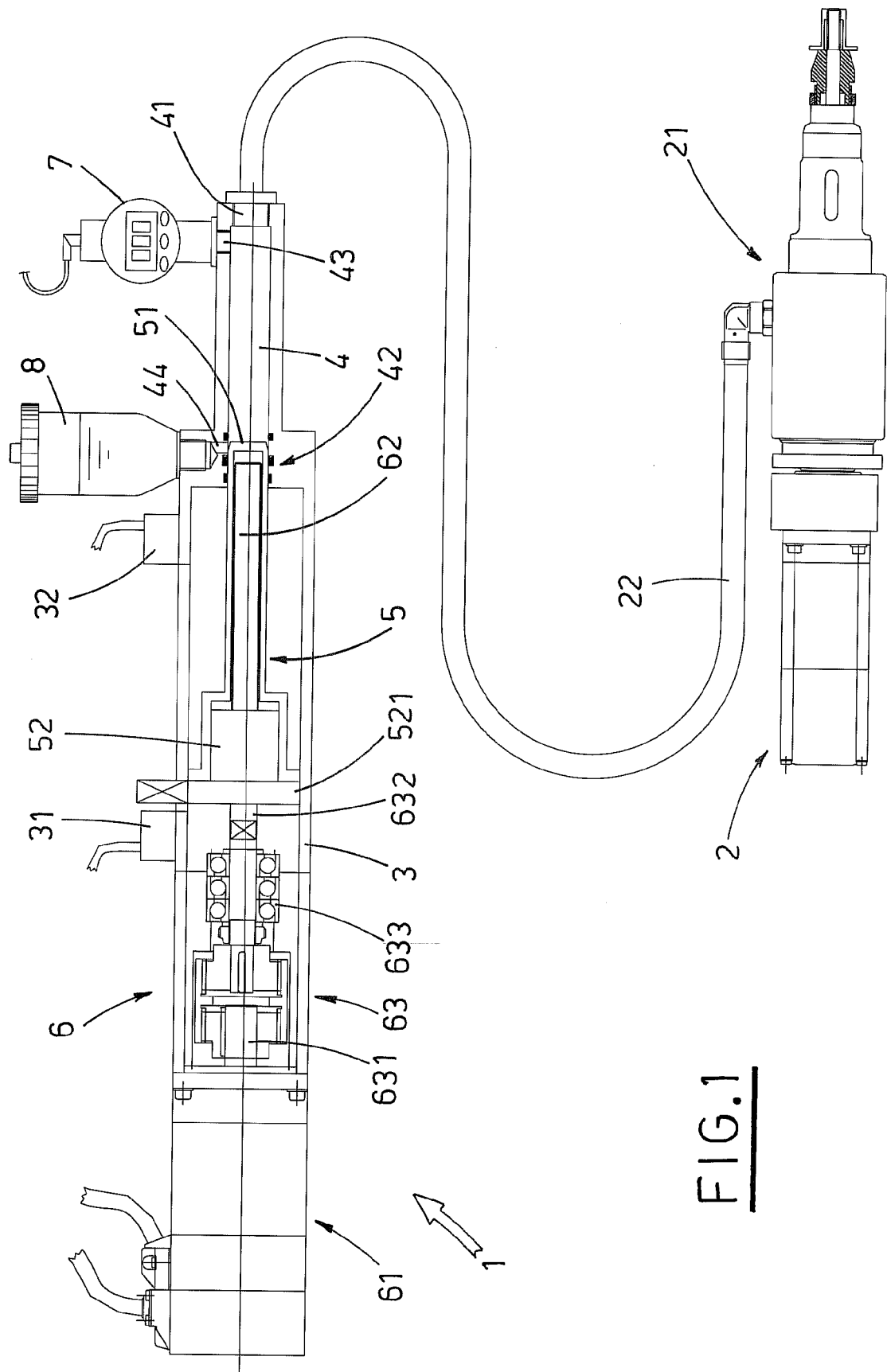
40

45

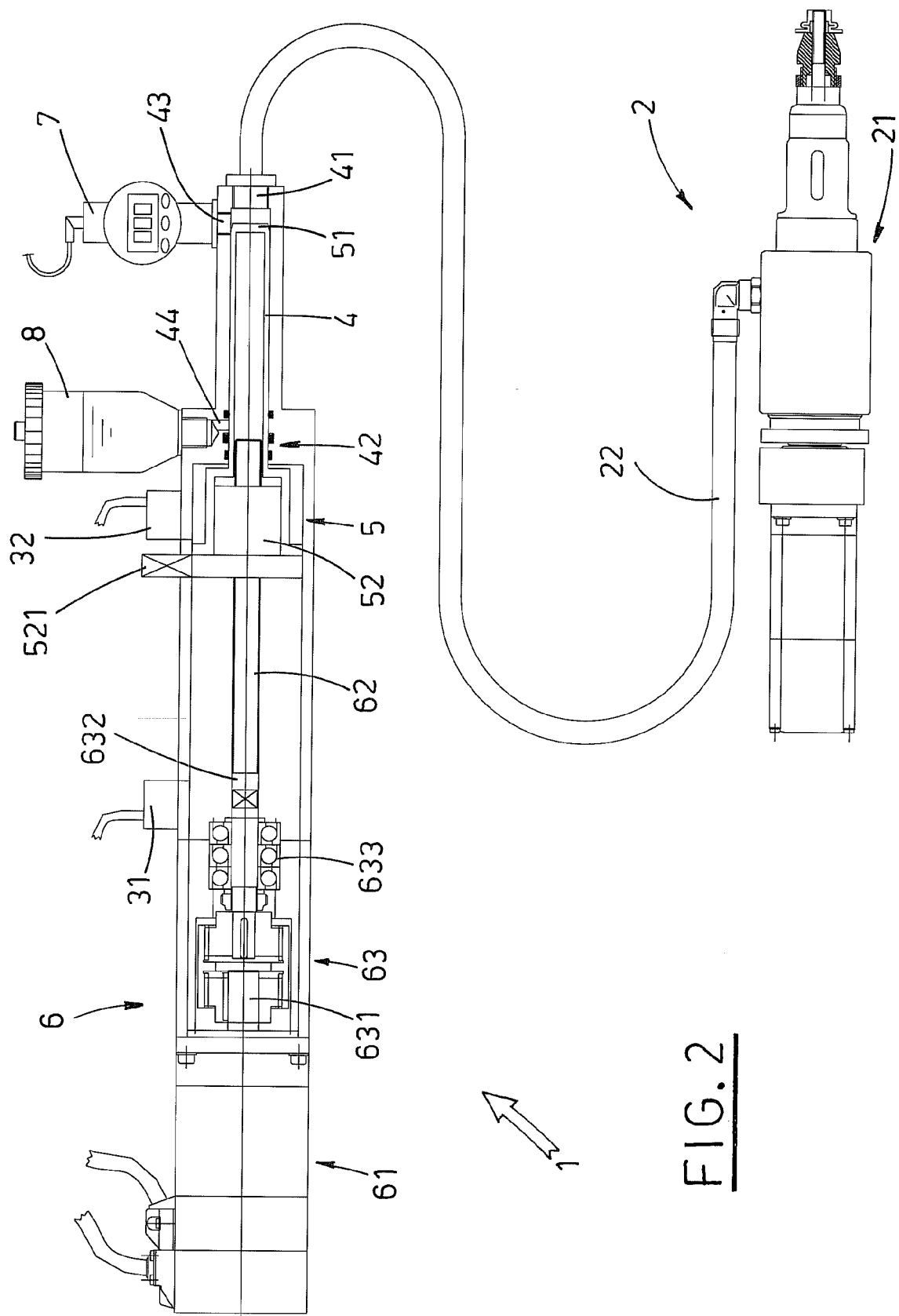
50

55













## EUROPEAN SEARCH REPORT

Application Number  
EP 08 10 1963

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 000 649 A (HAWKES GRAHAM S [US]) 19 March 1991 (1991-03-19) * column 3, lines 46-56 * * column 4, lines 5-31 * * column 6, lines 4-32 * * column 6, lines 54-64; figure 1 *	1,2,4-7, 9	INV. F15B7/00
Y	-----	3,8,10	
X	JP 10 148201 A (KOYO SEIKO CO) 2 June 1998 (1998-06-02) * abstract; figure 1 *	1,2,11, 12	
A	US 6 230 492 B1 (KINGSTON ANDREW W [DE] ET AL) 15 May 2001 (2001-05-15) * column 3, lines 18-27; figure 1 *	1,2 3	
Y	-----		
A	US 4 872 310 A (KAYE ARTHUR [GB]) 10 October 1989 (1989-10-10) * column 3, lines 63-68; figure 2 *	1-5 8	
Y	-----		
A	DE 20 40 001 A1 (HANNING ELEKTRO WERKE) 17 February 1972 (1972-02-17) * page 3, paragraph 3 - page 4, paragraph 1 * * page 5, paragraph 2 - page 7, paragraph 1; figure 1 *	1-5 10	TECHNICAL FIELDS SEARCHED (IPC) F15B B25B B25J
Y	-----		
A	DE 36 06 103 A1 (FESTO KG [DE]) 27 August 1987 (1987-08-27) * column 3, lines 22-57 * * column 4, lines 35-56; figures 1,2 *	1	
Y	-----		
A	DE 40 17 960 A1 (FIBRON GMBH [DE]) 12 December 1991 (1991-12-12) * the whole document *	1	
Y	-----		
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 June 2009	Examiner Busto, Mario
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

1  
EPO FORM 1503 03.82 (P4/C01)



**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 10 1963

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  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-06-2009

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5000649	A	19-03-1991	NONE	
JP 10148201	A	02-06-1998	JP 3688831 B2	31-08-2005
US 6230492	B1	15-05-2001	NONE	
US 4872310	A	10-10-1989	NONE	
DE 2040001	A1	17-02-1972	NONE	
DE 3606103	A1	27-08-1987	JP 62200002 A	03-09-1987
DE 4017960	A1	12-12-1991	NONE	