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- (73) Patenthaver: **ITH GmbH & Co. Kg, Auf'm Brinke 18, 59872 Meschede, Tyskland**
- (72) Opfinder: **KÄSTNE, Lars, Kamenzer Str. 58, 01099 Dresden, Tyskland**
- (74) Fuldmægtig i Danmark: **Plougmann Vingtoft A/S, Strandvejen 70, 2900 Hellerup, Danmark**
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SCREW TENSIONING DEVICE

This invention relates to an innovative screw tensioning device having a bolt tensioning cylinder having a high-strength preloadable threaded connection pressure hydraulic pump for preloading bolts and releasing high-strength preloadable threaded connections and a method for controlling this screw tensioning device.

In addition to the basic forms of different threaded connections, so-called high-strength preloadable threaded connections have been used for years already, predominantly in steel construction. For this, there are various screw tensioning devices. These screw tensioning devices all function as a rule according to the same known principle on the basis of torque-free preloading methods. To this end, a bolt tensioning cylinder supported on the component or machine component to be preloaded is screwed onto the thread end, protruding beyond the nut, of a threaded shank to be preloaded, with a movable working piston or a threaded bushing located in the working piston. To the bolt tensioning cylinder is subsequently connected a high-pressure hydraulic pump which applies pressure to the piston ring side and thereby affects a retraction of the working piston and the preloading of the threaded bolt. By turning the nut onto the machine component up until abutment, the threaded shank retains its preload force after the pressure release of the piston ring side and preloads the machine component. Hydraulic screw tensioning devices of this sort in multistage construction are described for example in DE 10 2004 043 145 B3, in DE 196 38 901 A1 and in GB 22 91 155 A. The single-stage construction is described in detail for example in EP 0 200 459 A2. In EP 2 014 932 A2 is accomplished a method for connecting or fastening components by using a high-strength preloadable connection, which is supposed to facilitate an especially advantageous dosed preloading. In this regard is suggested a special dimensioning of the protruding threading shaft, the nut, with the aid of an over-dimensioned washer. Also in this technical solution, the as screw tensioning device is received onto a hydraulically-acting bolt tensioning cylinder. Admittedly, this design is suitable only for certain specially preloaded threaded connections and cannot be used universally.

The advantages of the high-strength preloading method over the tightening of the threaded connection by the application of only a torque onto the nut is basically that the threaded shank is not stressed to torsion during the tightening procedure and that no friction forces arise in the threading and on the nut support. Thus, it is possible to realise substantially greater preloading forces in the threaded connection than in the case of a normal tightening of the nut, and to effectively increase its load-bearing capacity. Particularly in the case of larger threading diameters

of more than 30 mm, from experience, very large dispersions of friction forces occur, as a result of which the load-bearing capacity is significantly reduced when the tightening of the screw is carried out using only a torque.

In addition to the described advantages, a substantial disadvantage of the hydraulic screw tensioning devices according to the prior art involves additional cost-intensive high-pressure hydraulic pumps being required to operate the devices. In the same way, high-pressure resistant hydraulic lines and frequently even very long hydraulic lines are required to connect pump and screw tensioning device. Especially in the event of confined spaces, such as for example in the nacelle of a wind turbine, where such systems are frequently used, the bulky hydraulic lines cause problems and result in complicated preparation procedures. The lines can be laid only in relatively large radii, since they may not be bent, which results in a large space requirement.

Frequently, also several high-strength threaded connections must be drawn with likewise many screw tensioning devices, as a result of which significant complications can occur in the preparation of the hydraulic lines and in their installation on site. In addition, also the pump must be transported to the respective installation location and must there be supplied accordingly with sufficient energy. The problem of the additional equipment becomes particularly evident in projects under water, such as are frequently carried out for example in the offshore industry. Here, very long high-pressure lines are required from the pump of a ship or a platform to the installation location under water. Hydraulic fluids are as a rule additionally harmful to the environment and require for this reason a whole series of complicated and expensive measures in certain application cases. There are also application cases when the use of hydraulic fluids is approved in general only when subjected to strict security measures.

GB 1 511 300 shows a bolt tensioning device having an attached, pneumatically driven hydraulic pump unit.

The task upon which the invention is based is the creation of an innovative bolt tensioning device, which is able to generate the same high tensioning forces as bolt tensioning devices which have previously worked on a hydraulic basis, for high-strength preloadable threaded connections, which requires less expenditure of energy, which is easily usable for all application locations and to create an associated control method which facilitates a precisely dosed preloading.

The task is solved according to the invention by the characteristics of the first and the sixth claim. The innovative bolt tensioning device for the preloading and releasing of high-strength preloadable threaded connections consists of a bolt tensioning cylinder 38 and a high-pressure hydraulic pump 39. The bolt tensioning cylinder 38 is in this regard designed and constructed such

that in the interior of the bolt tensioning cylinder 38 is designed in integrated manner a high-pressure hydraulic pump 39. This high-pressure hydraulic pump 39 is coupled with a sealed hydraulic accumulator. On or in the bolt tensioning cylinder 38 is disposed a pneumatically operable drive 40. The pneumatic drive 40 can be designed optionally on the constructional basis of a diaphragm cylinder 42 or also on the basis of a piston cylinder. For operating the pneumatic drive 40, said drive is connected with a compressed air feeding device. In the case of the innovative bolt tensioning device according to the invention, tightening and releasing takes place according to the method already known per se, to load the screw by means of a hydraulic bolt tensioning device precisely to the desired preloading force, wherein the bolt tensioning device rests on the component 1 or machine component to be tensioned, and the nut of the high-strength preloadable threaded connection is subsequently tightened or released to be load-free. The difference of the bolt tensioning device according to the invention as opposed to the known devices involves the required high hydraulic pressure of up to 1000 bar and, where appropriate, more, is not made available by an additional expensive separate high-pressure apparatus, but is rather is itself generated in the specially constructively designed bolt tensioning cylinder 38. The construction and the constructive design of the high-pressure hydraulic pump 39 driven by means of compressed air results in an innovative construction of the bolt tensioning cylinder 38. For driving the innovative bolt tensioning cylinder 38, compressed air of only up to approximately 10 bar is required. The supply of compressed air can here be achieved via a simple and economic compressor or via a manageable appropriately filled compressed air canister.

The integrated high-pressure hydraulic pump 39 is realised in that on the upper end of the bolt tensioning cylinder 38 is mounted a pneumatic cylinder which can be in the form of a diaphragm cylinder 41 or piston cylinder. On this pneumatic cylinder is mounted a piston rod which plunges in the movable working piston 15 of the bolt tensioning cylinder 38 and functions there as a displacement piston or high-pressure piston 9. By means of the surface ratio between pneumatic cylinder and displacement piston, thus the ratio of the pressure amplification between hydraulic and pneumatic pressure is determined.

In the movable working piston 15, two non-return valves 16 and 19 are mounted such that the displaced hydraulic volume is pumped into the piston ring chamber 43 and at the return lift of the displacement piston hydraulic fluid flows from the piston chamber 44 into the working piston 15. Thus, a pump effect is achieved and the working piston 15 retracts until a pressure equalisation is achieved in the system. By setting the respective air pressure, the tension force on the working piston 15 and therewith the preloading force in the threaded shank 2 can be defined.

By means of the bolt tensioning cylinders 38 driven with compressed air designed according to the invention, the external hydraulic high-pressure pump and the high-pressure lines are redundant. Thus, the work is substantially simplified and costs can be significantly reduced. Instead of the external high-pressure hydraulic pump, now an internal high-pressure pump of very small construction is integrated in the specially designed bolt tensioning cylinder 38.

In a preferred embodiment of the bolt tensioning device according to the invention for preloading and loosening high-strength preloadable threaded connections, as a compressed air supply device an appropriately filled compressed air canister is connected via a compressed air-regulating and compressed air-setting valve. This has the advantage that on the one hand pneumatic hoses no longer need to be used and there is absolutely no need for an external energy source.

In another embodiment of the bolt tensioning device according to the invention for preloading and loosening high-strength preloadable threaded connections, as a compressed air supply device a compressed air compressor is connected via a compressed air compressor-regulating and compressed air-setting valve. This is inter alia useful when e.g. several bolt tensioning devices need to be pressurised simultaneously.

The advantages are that instead of the external-pressure hydraulic pump only a manageable compressed air canister having an appropriate pressure regulating valve, or a correspondingly high-performance pressurised air compressor is required, or instead of the cumbersome hydraulic high-pressure lines only manageable and economical pressurised air hoses are required for connecting bolt tensioning device to the pressurised air supply. With the simultaneous use of several bolt tensioning devices, the required connections be carried out also with easily handleable pressurised air hoses, which can inter alia also be cut with little effort on site and connected via standard plug connections. The compressed air hoses can be more tightly bent than hydraulic hoses and require in this regard significantly less space during transport and during use can be laid in narrow radii and even around corners also when pressurised.

The bolt tensioning device according to the invention for preloading and releasing high-strength preloadable threaded connections can be designed in an especially manageable manner when the hydraulic accumulator 42 for the integrated hydraulic pump inside the bolt tensioning cylinder 38 is itself disposed at a suitable position. This is predominantly advantageous for being able to achieve a hermetic encapsulation of the hydraulic pump.

The method according to the invention for controlling a bolt tensioning device for preloading and loosening threaded connections works, as known per se, with a hydraulic pump.

However, the hydraulic pump is in the form of a high-pressure pump 39 specially constructed inside the bolt tensioning cylinder 38, and is pneumatically pressurised in a cyclical manner. Here, a high-pressure piston 9 is disposed centrally such that on the one side pneumatic pressure is applied to it via the diaphragm cylinder 41, this carries out a pump movement and presses on the other side the hydraulic fluid of the high-pressure pump 39 out of the borehole in the working piston 45 into the piston ring chamber and effects an extension of the working piston 15. By means of the repeated application of pressure in the diaphragm cylinder 41, an oscillating movement of the pressurised piston 9 is generated and the desired pressure is built up in the piston ring chamber 43 by closing by means of the non-return valves 19 and 16. The cyclical pressure is generated by means of a signal which via the control line 46 switches a pneumatic valve 47 and therewith interrupts the compressed air supply to the diaphragm cylinder 41 and vents it. When the diaphragm cylinder 41 reaches its end position, the switching signal is in this regard generated in that the valve disc 12 is lifted by the opening pins 18 and releases the vent boreholes 14.

Via the control line 46, the generated switching signal is guided to the pneumatic valve 47. The non-return valve 48 disposed in the control line 46 prevents a backflow of the compressed air. Via an adjustable throttle valve 49, the time duration of the pressure drop in the control line 46 is adjusted, wherein therewith the repeated resetting of the pneumatic valve 47 is achieved. The pump procedure is repeated until an equilibrium of forces is achieved between the force in the diaphragm cylinder 41 and at the pressurised piston 9 in the borehole in the working piston 45. The switching-on and switching-off of the pneumatic drive 40 is carried out by means of a manually operable pneumatic valve 50 connected to the pneumatic valve 47, wherein the pressure is set via a pressure regulating valve connected upstream.

The significant advantage of the bolt tensioning device according to the invention and of the associated control method is most importantly that no broad externally disposed hydraulic pumps and no cumbersome high-pressure hydraulic lines are required, that very high tensioning forces can be generated in an energy-efficient manner, the desired preloading force can be achieved very simply and extremely precisely by setting the pneumatic pressure on location and a very compact universally manageable tensioning device has been created for use at any usage locations, such as for example also under water or in confined installation spaces or in locations without additional energy supply. Unlike the previously used devices, only very little environmentally harmful hydraulic fluid is used. In addition, a hermetic encapsulation is present, such that no hydraulic fluid can escape into the environment.

The invention will be described in more detail hereinafter with reference to an embodiment example. To this end serve the sectional views shown in figure 1, figure 2 and figure 3.

Figure 1 shows a sectional view of a bolt tensioning device

Figure 2 shows a pneumatic drive 40 on the basis of a diaphragm cylinder 41 in upper end
5 position of the diaphragm 11

Figure 3 shows a pneumatic drive 40 on the basis of a diaphragm cylinder 41 with the associated control elements in the upper end position of the working piston 15 of the high-pressure hydraulic pump 39

A component 1 to be tensioned at high-strength, which can for example be the connection
10 of a rotor blade of a wind turbine or the associated roller bearing, is to be tensioned via the threaded shank 2 the nut 3. To this end, the nut 3 with an optionally usable washer 4 is first screwed manually onto the threaded shank 2. Subsequently, the socket 5 equipped with an internal hexagon is pushed over the nut 3 for the later turning of the nuts 3 and thereafter the entire bolt tensioning device is screwed onto the protruding end of the threaded shank 2. The counter bearing 6, with
15 which the bolt tensioning device rests against the component 1 to be tensioned, is in this regard equipped in the direction of the bolt tensioning cylinder 38 with permanent magnets 35, dimensioned accordingly depending on the constructional size of the bolt tensioning device, distributed over the circumference, as a result of which the counter bearing 6 adheres to the bolt tensioning cylinder 38 and therewith the handling is simplified. In the same way, it is possible to
20 exchange in a simple manner differently dimensioned counter bearings 6 for different embodiments of the threaded connection in the length of the protruding threaded part of the threaded shank 2 or of the corresponding nut height or of the washer 4. The counter bearing 6 is equipped with suitable openings in order to be able to turn the nut 3, after preloading has been carried out, onto the component or machine component 1 to be tensioned. The bolt tensioning
25 device consists of the counter bearing 6 and the actual specially designed bolt tensioning cylinder 38. The bolt tensioning cylinder 38 consists of a housing, in the interior of which are disposed integrally a high-pressure hydraulic pump 39 including hydraulic accumulator 42 and in the part in the head part a pneumatic drive 40. On top of the bolt tensioning cylinder 38 on the pneumatic drive 40 is disposed centrally a compressed air connection 7 to which is attached a compressed air
30 supply device. Via this, the air pressure required in each case for the high-strength preloading is supplied. The preloading force required in each case is defined by the air pressure set correspondingly at the pneumatic drive 40.

An advantage involves the preloading force being able to be adjusted steplessly in a very simple manner. By means of the compressed air acting on the valve disc 12 and the membrane 11 in the diaphragm piston 41, a pressure is exerted on these parts, wherein the plate 8 fixed to the pressurised piston 9 and therewith the pressurised piston 9 of the pneumatic drive 40 moves
5 downwards against the force of the preloaded pressure spring 10. Here, the diaphragm 11 made of an elastomer seals the pressurised chamber of the diaphragm cylinder 41 to the outside and to the inner chamber in the diaphragm cylinder 41. The valve disc 12, also consisting of an elastomer, is equipped with a support ring 13 and is pressed by the air pressure onto the diaphragm 11 and thereby seals the vent boreholes 14. By means of the plunging movement of the pressurised piston
10 9, the hydraulic fluid is displaced in the borehole (45) of the working piston 15 and pumped via the opening non-return valve 16 into the piston ring chamber 43. In the movable working piston 15 act preferably two non-return valves 16 and 19 such that at the plunging of the pressurised piston 9 the one non-return valve 19 is closed and the other non-return valve 16 is opened, such that the displaced hydraulic fluid is pressed into the piston ring chamber 43 of the bolt tensioning cylinder
15 38. At the return lift of the pressurised piston 9, the non-return valve 16 now closes and the non-return valve 19 opens, such that hydraulic fluid can flow out of the working piston chamber into the borehole 45 of the working piston 15.

After the plunging procedure is ended, the non-return valve 16 is in this regard reclosed by the elastomer ring 17 abutting on the sealing body and the pressure generated in the piston ring
20 chamber 43. The plunging movement of the pressurised piston 9 is ended when, as shown in figure 3, the opening pins 18 lift the valve disc 12 from the diaphragm 11 and release the vent boreholes 14. In the control line 46, a pressure signal is thus generated, by means of which the pneumatic valve 47 is closed and the compressed air connection 7 is vented, such that the air in the diaphragm cylinder 41 can escape. Here, the preloaded pressure spring 10 now presses the pressurised piston
25 9 having the plate 8 fixed thereto, the diaphragm 11 the valve disc 12 and the support ring 13 back into the upper end position, as shown in figure 2. The external non-return valve 48 here prevents the control line 46 from also being vented and the pneumatic valve 47 from being opened again too early. By means of the throttle valve 49, the time duration for the venting of the control line and therewith the time instant for the opening of the pneumatic valve 47 can be precisely set.

30 In this manner, the speed of the pump procedure in the internal high-pressure hydraulic pump 39 can be regulated. For the switching-on and switching-off of the pump procedure serves the, optionally also manually operable, pneumatic valve 50. To this manually operable pneumatic valve 50 is connected upstream a further pressure regulating valve with which the desired working

pressure and therewith the preloading force of the entire bolt tensioning device can be precisely set (in the drawing in figure 3 not numbered). When the upper end position is reached, the valve disc 12 is again pressed onto the diaphragm 11 and again closes the vent boreholes 14. In consequence, the air pressure in the chamber of the diaphragm cylinder 41 can again build and the procedure restarts. By means of the reciprocating motion of the pressurised piston 9 is achieved a pumping effect, as a result of which hydraulic fluid piston chamber 44 is pumped into the piston ring chamber 43 and the movable working piston 15 is moved away from the threaded shank and therewith generates the desired high preloading force. By means of a throttle valve, the airflow at the compressed air connection 7 is set such that the desired working speed of the system is achieved. During the extension movement of the pressurised piston 9, an underpressure is generated in the borehole 45 of the working piston 15. By means of this underpressure and the hydraulic primary pressure on the piston chamber 44, the non-return valve 19 opens, as a result of which hydraulic fluid can flow into the borehole 45 of the working piston 15. The primary pressure acting via the supply connection 24 thus also effects the quick filling of the borehole 45 in the working piston 15 by means of the non-return valve 19 at the extension movement (return lift) of the pressurised piston 9.

When the working piston 15 is retracted, the difference between piston surface and piston ring surface must be compensated. This means, the volume of the retracting piston rod of the working piston 15 must be compensated on the piston chamber side. This is achieved by the volume compensating chamber 20, which serves as hydraulic accumulator 42 and which is filled with hydraulic fluid and connected via the boreholes 21 with the piston chamber 44. Via the volume compensating chamber 20, the compensating membrane 22, consisting of an elastomer, serves to seal-off the hydraulic accumulator 42 against the air accumulator 23. In the air accumulator 23, via the supply connection 24 a desired air pressure is applied up to maximum 10 bar. In this manner, also the hydraulic fluid is subjected to this primary pressure via the compensating membrane 22. The by means of the retraction movement of the working piston 15, that means a moving away from the threaded shank 2, the displaced hydraulic fluid can now be accommodated in the volume compensating chamber 20 and accumulated.

When the upper end position of the working piston 15 is reached, the elastomer disc 35 serves for the reliable interruption of the inflow of hydraulic fluid to the non-return valve 19 and that thereby no more hydraulic fluid can be pumped into the piston ring chamber 43. A further retraction of the working piston 15 or a pressure buildup, connected therewith, in the active piston ring chamber 43 is prevented and the pressure in the piston ring chamber 43 remains intact until

the nut 3 is turned. Thus it is prevented that any overlarge forces are exerted onto the flange joints on the bolt tensioning cylinder, which facilitates an easier and compact construction.

After a completed high-strength preloading of the bolt 2 and the turning of the nut 3 by means of a suitable tool engaging through the openings, the compressed air connection 7 is shut and via the bypass valve 25 the seat valve 26 is opened, as a result of which the hydraulic fluid can escape out of the piston ring chamber 43 and flows via the groove 27 to the piston chamber 44. Thus, the generated preloading force at the movable working piston 15 drops. By means of the, primary pressure set in the system of the air accumulator 23 and the difference of piston surface to piston ring surface arises a sufficient pressure, which drives the working piston 15 after the relaxing by means of the bypass valve 25 finally into the start position with respect to the cylinder floor 28. By means of this pressure, it is also achieved that the working piston 15 preloads itself in its start position with respect to the cylinder floor 28 and is thereby secured per se against twisting. This anti-twist protection is always required when the bolt tensioning cylinder 38 is screwed onto the threaded shank 2 or unscrewed again after the preloading procedure.

For sealing the entire hydraulic system within the high-pressure hydraulic pump 39 in its interior and to the outside serve different seals 29, 30, 31, 32, 33, which seal reliably despite the high pressures. The primary pressure seal 34 is obliged in contrast to withstand only the set pressure of up to 10 bar. For the additional protection against contamination of the seals and the hydraulic fluid serves the scraper 36.

List of reference signs

	1	component to be preloaded
	2	threaded shank
	3	nut
5	4	washer
	5	socket with internal hexagon
	6	counterbearing
	7	compressed air connection
	8	plate
10	9	pressurised piston
	10	pressure spring
	11	diaphragm
	12	valve disc
	13	support ring
15	14	vent borehole
	15	working piston
	16	non-return valve
	17	elastomer ring
	18	opening pins
20	19	non-return valve
	20	volume compensating chamber
	21	boreholes between piston chamber and volume compensating chamber
	22	compensating diaphragm
	23	air accumulator
25	24	supply connection
	25	bypass valve
	26	seat valve
	27	groove
	28	cylinder floor
30	29	seal
	30	seal
	31	seal
	32	seal

	33	seal
	34	primary pressure seal
	35	elastomer disc
	36	scraper
5	37	permanent magnets
	38	bolt tensioning cylinder
	39	high-pressure pump
	40	pneumatic drive
	41	diaphragm cylinder
10	42	hydraulic accumulator
	43	piston ring chamber
	44	piston chamber
	45	bore in working piston
	46	control line
15	47	pneumatic valve
	48	non-return valve
	49	throttle valve
	50	manually operable pneumatic valve

Patentkrav

1. Boltspændingsindretning til at forspænde og løsne boltforbindelser forspændt med høj styrke bestående af en hydraulisk højtrykspumpe (39) og en

5 boltspændingscylinder (38) med et arbejdsstempel (15), som kan skrues på en gevindbolt (2) af bolten, som skal spændes,

kendetegnet ved,

at en hydraulisk højtrykspumpe (39) er integreret inde i boltspændingscylinderen (38),

10 den hydrauliske højtrykspumpe (39) er forbundet med en hydraulisk akkumulator (42),

at et pneumatisk aktiveret drev (40) er anbragt på eller inde i boltspændingscylinderen (38),

idet det pneumatiske drev (40) er udformet på basis af en membrancylinder (42)

15 eller en stempelcylinder,

det pneumatisk aktiverede drev (40) driver et højtryksstempel (9), og det pneumatiske drev (40) er forbundet med en tryklufttilførselsindretning.

2. Boltspændingsindretning til at forspænde og løsne boltforbindelser forspændt

20 med høj styrke ifølge krav 1,

kendetegnet ved,

at en trykluftflaske er tilsluttet som en tryklufttilførselsindretning via en trykluftregulerings- og trykluftjusteringsventil.

25 **3.** Boltspændingsindretning til at forspænde og løsne boltforbindelser forspændt med høj styrke ifølge krav 1,

kendetegnet ved,

at en trykluftkompressor er tilsluttet som en tryklufttilførselsindretning via en trykluftkompressorregulerings- og trykluftjusteringsventil.

30

4. Boltspændingsindretning til at forspænde og løsne boltforbindelser forspændt med høj styrke ifølge krav 1,

kendetegnet ved, at

den hydrauliske akkumulator (42) er anbragt inde i boltspændingscylinderen (38).

5. Boltspændingsindretning til at forspænde og løsne boltforbindelser forspændt med høj styrke ifølge krav 4,

5 kendetegnet ved,

at den hydrauliske højtrykspumpe (39) består af et arbejdsstempel (15) styret i et hus,

et borehul (45) er anbragt centralt i arbejdsstemplet (15),

et trykreguleret højtryksstempel (9) er i indgreb med borehullet (45),

10 borehullet (45) er forbundet med stempelkammeret (44) og stempelringkammeret (43) via to tilbageslagsventiler (16 og 19),

stempelringkammeret (43) er indbyrdes forbundet med stempelkammeret (44)

via en sædeventil (25) og ved hjælp af en not (27),

og et volumenudligningskammer (20) er anbragt i huset.

15

6. Fremgangsmåde til at styre en boltspændingsindretning til at forspænde og løsne boltforbindelser med en hydraulikpumpe,

kendetegnet ved,

at et højtryksstempel (9) i en højtrykspumpe (39) anbragt inde i en

20 boltspændingscylinder (38) gentagne gange bliver tryksat på en cyklisk måde ved hjælp af et pneumatisk drev (40),

at i en yderstilling og ved hjælp af en pneumatisk ventil (47) via en styreledning (46) indvirker en tilbageslagsventil (48),

en trykreguleret membrancylinder (41) danner ved åbning af et

25 udluftningsborehul et cyklisk tryksignal og bevirker en tilbageførsel af

højtryksstemplet (9), og pumpeprocessen gentages,

varigheden af trykfaldet i en styreledning (46) er justerbart ved hjælp af en drosselventil (49), hvor den pneumatiske ventil (47) dermed tilbagestilles, og hvor det pneumatiske drev (40) slukkes og tændes ved hjælp af en manuelt

30 aktiveret pneumatisk ventil (50) anbragt ovenpå den pneumatiske ventil (47), hvor pumpeprocessen gentages, indtil en kraftligevægt indstilles mellem kræfterne i membrancylinderen (41) og ved højtryksstemplet (9) i borehullet i arbejdsstemplet (45).

1

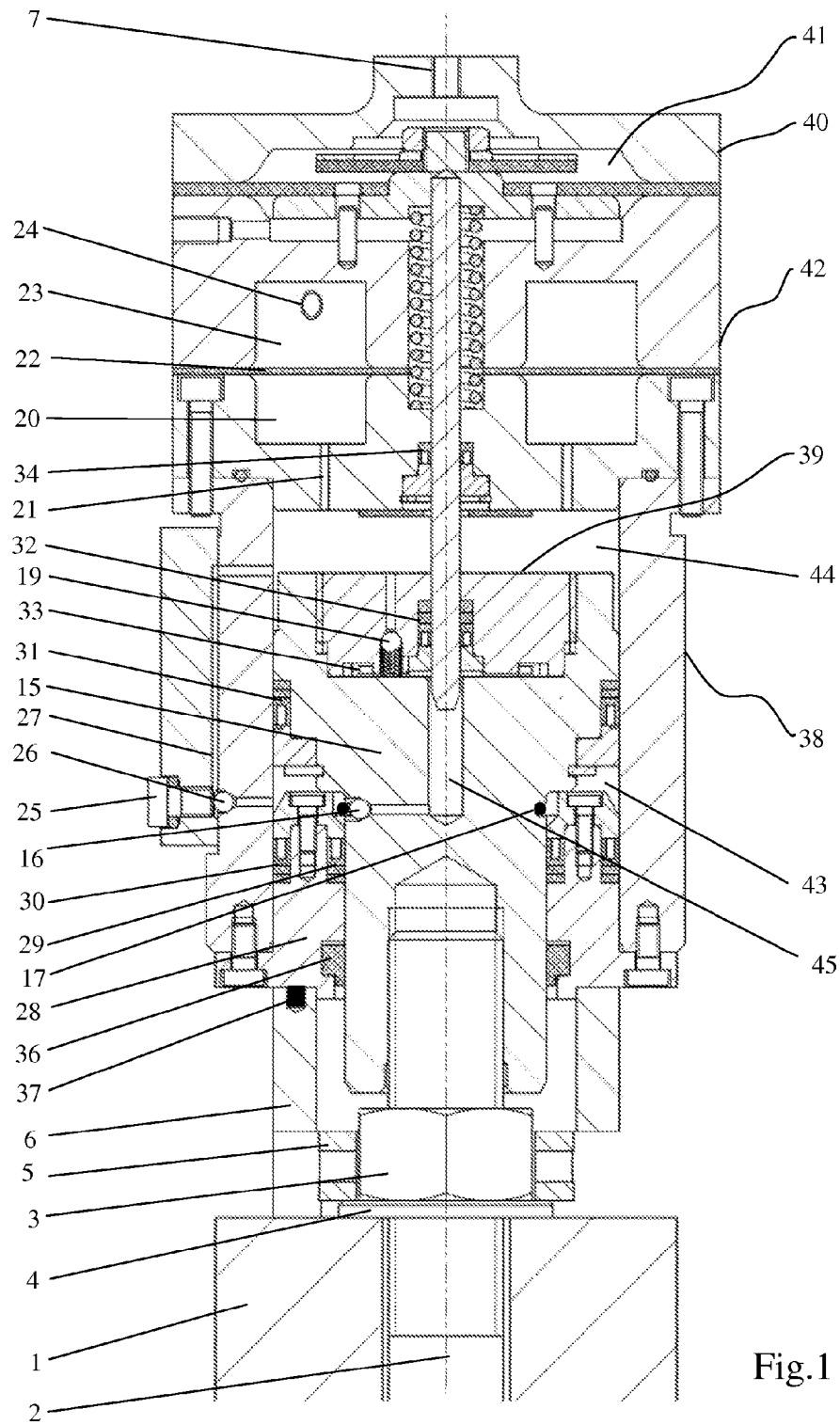


Fig.1

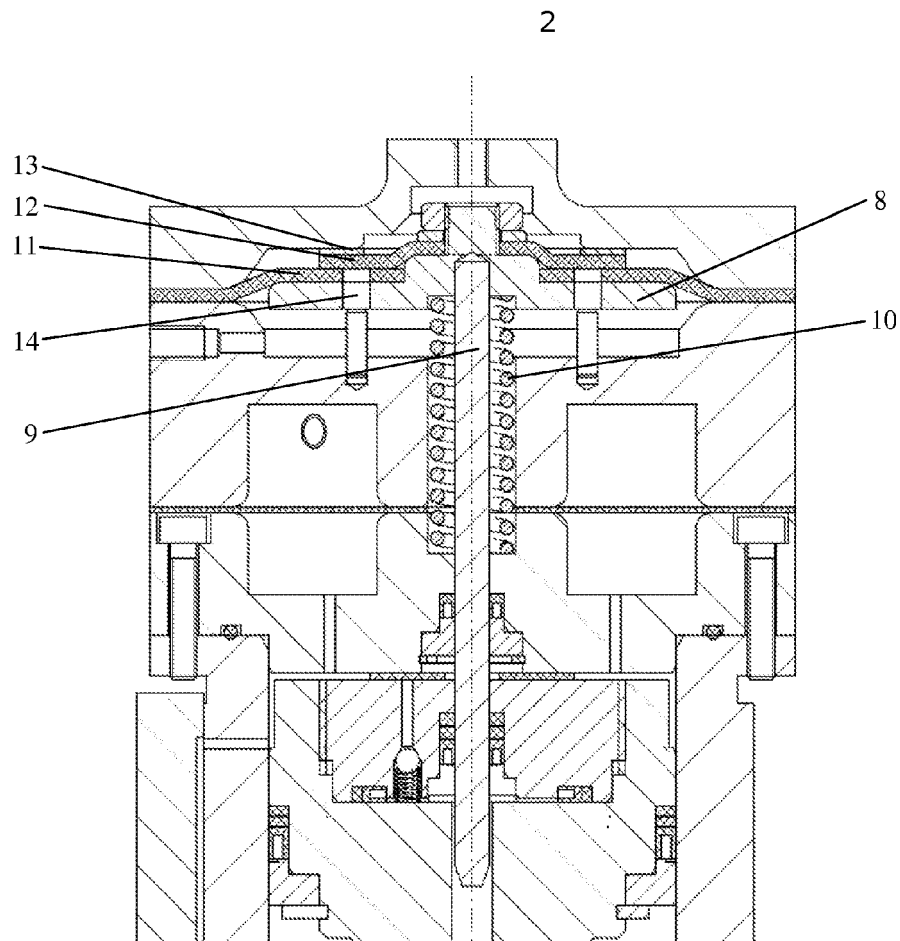


Fig. 2

3

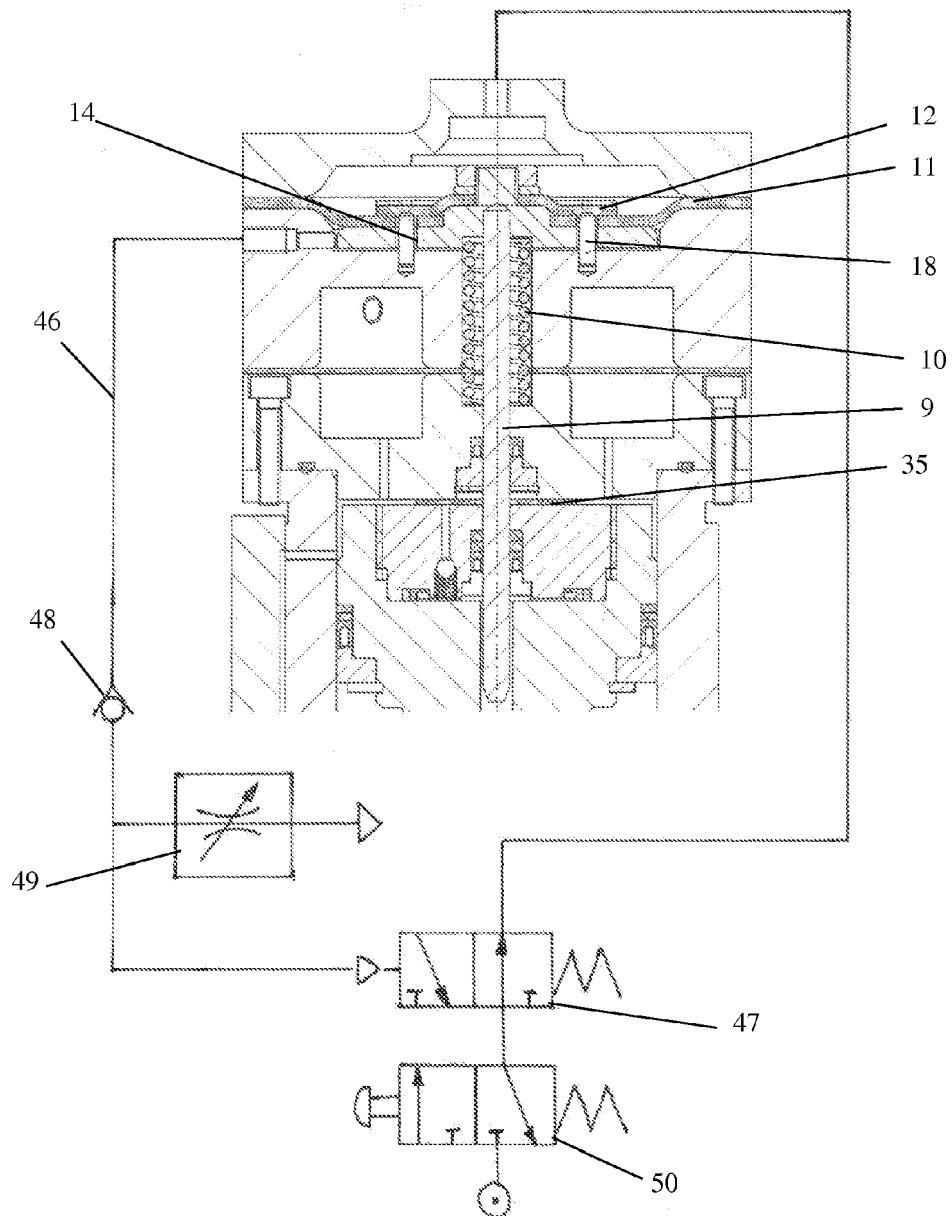


Fig. 3