

(19)



Europäisches Patentamt
European Patent Office
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(11) Publication number:

0 569 612 A1

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **92108168.3**(51) Int. Cl.⁵: **B66F 1/02, B66C 23/32**(22) Date of filing: **14.05.92**(43) Date of publication of application:
18.11.93 Bulletin 93/46(84) Designated Contracting States:
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D-80331 München (DE)(54) **Hydraulic movement method and object moving hydraulic system.**

(57) The invention belongs to the field of testing machinery and can be used in strength tests of constructions and for simulation of construction motions. In addition, the invention can be used in production processes for shaping panels and bars and for making sophisticated-shape parts of flat and straight-line blanks.

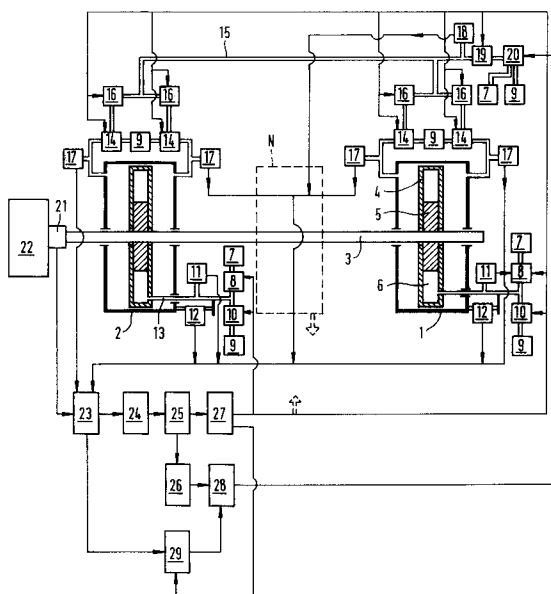
The specific features of the construction loading, deformation, and movement method being advanced are as follows:

(a) As soon as a certain travel length that is close to the maximum permissible value for a particular drive is over, the load is passed to the second drive while the first drive returns to the initial position.

(b) When the load is being passed from one drive to the other, the sum of the loads applied to the first and second drives remains equal to the program-controlled value.

The method advanced provides a considerable expansion of the construction movement range, a unification of the long movement drives, and an increase of the loading accuracy.

Fig. 1

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This invention belongs to the field of testing equipment and can be used for moving various constructions during construction strength tests and during construction motion simulation. In addition, it can be used during industrial shaping processes in making sophisticated-shape parts composed of flat and straight-blanks.

Well-known is a method of moving, loading, and deforming a construction according to which a portion of that construction or some part connected to it is automatically locked by the clamping device of a testing machine drive. In that clamping device, the construction to be loaded or deformed is secured on one side in the fixed grip of the testing machine and on the other the movable grip is brought to that construction or to the part connected to that construction. When the movable grip reaches the specified position, the construction or the part becomes locked in that grip. Then, the construction is subjected to loading and deformation by means of the drive that moves the movable grip (see "Means of Tension and Compression Tests" by A.S.Bol'shykh, V.V.Klyuev, et al in the "Testing Equipment" Reference Book, Volume 1, Moscow, MASHINOSTROENIE Publishers, 1982, pp 31, 32, 82, and 83).

Known also is a method of moving, loading, and deforming a construction according to which the range of construction movement is expanded through the use of several drives. When the range of movement of one drive is completed, the second drive is started, then the third one, and so on. In this case, the maximum travel length of a construction is equal to a sum of the travel lengths of all drives. This method is realized in devices composed of hydraulic cylinders series-connected mechanically one to another (see the US Patent No. 1279460, 1969 "Multi stage Hoist and Control System").

The above US patent is used as a prototype because it is most close to the invention as far as the engineering essence of the invention and the invention results achieved are concerned.

The disadvantageous feature of this method is that it is necessary to increase the number of drive for expanding the range of movement. In addition, this results in an increase of the overall dimensions of the device (especially, its lateral dimensions) and in complication of the device design owing to the increased number of the device links.

The purpose of the invention is an increase of the construction movement range without changing the overall dimensions of the hydraulic device.

Another purpose is an expansion of the functional capabilities of the hydraulic devices by providing them with hoisting functions.

The purpose is achieved through the use of the hydraulic movement method according to which

the object movement is based on the "rope climbing" principle. In this case, the object and moves it in the longitudinal direction to a certain length. Then, that clamp releases the object and returns to the initial position. The second clamp starts moving the object in the same direction, moves it to a certain length, and returns to the initial position. In this manner, the hydraulic clamps alternate in moving the object to the required distance.

The other purpose can be achieved by mounting the "object of movement" in the fixed position and by moving the system consisting of the pairs of hydraulic clamps (along with the new object of movement) over it.

Known is the device described in the US patent No.1279460 ("Telescopic Piston and Cylinder Assembly"). That device is a telescopic cylinder connected to an oil plant.

The disadvantageous feature of that device is that the range of movement is limited by the length of the telescopic device and it is necessary to increase the number of drives for increasing the range of movement. The range of movement is limited by a sum of the maximum movements of the drives. Increasing the number of drives results in an increase of the device overall dimensions and in complication of the device design. In addition, multi range loading is impossible during the loading process because the drives act on the same load one after another.

The device is most suitable as far as the engineering essence is concerned and used as a prototype.

The device is shown in Figs 1 through 6.

Fig.1 contains the line diagram of the hydraulic system used to move and load a construction.

Fig.2 is the same diagram for nonstationary loading, movement, and deformation of a construction.

Fig.3 is the multirange-loading hydraulic system.

Fig.4 is the construction moving hydraulic system with a common noncircular-section rod.

Fig.5 is the hydraulic system used as a hoist.

Fig.6 is the hydraulic clamp located on a remote rod in the hydraulic system shown in Fig.5.

As is shown in the above drawings, the hydraulic system consists of master cylinder 1, additional cylinder 2, and common rod 3. The hydraulic cylinder have pistons 4. The pistons are equipped with a hydraulic module made in the form of two hydraulic cylinders with pistons. In that drawing, the module is combined with the casing of piston 4 and is actually hydraulic clamp 5. The module hydraulic cylinders have ends 6. The hydraulic system has an oil plant consisting of delivery line 7, solenoid-operated hydraulic valve 8, return line 9, solenoid-operated hydraulic valve 10, pickups 11

and 12, pipe 13, solenoid-operated hydraulic valve 14, loading line 15, solenoid-operated hydraulic valve 16, pickup 18, solenoid-operated hydraulic valve 19, and solenoid-operated hydraulic booster 20.

The other parts are as follows: 21 - load gauge; 22 - construction being moved or loaded; 23 - normalizing transducers unit; 24 - analog signal input device consisting of a commutator and an analog transducer; 25 - microcomputer; 26 - analog signal output device; 27 - discrete signal output device; 28 - regulator; 29 - feedback commutator (Fig. 1); 30 - solenoid-operated hydraulic valve (Fig. 2); 31 - movable rod (Fig. 3,4 and 5); 32 - remote hydraulic module casing (Fig.3,4,5, and 6); 33 - additional load gauge (Fig.3,4, and 5); 34 - frame used to mount master and additional hydraulic cylinders 1 and 2; 35 - reducers 36 - clamps; the nth cylinder for multirange loading.

The assemblies and parts are connected as follows.

Hydraulic cylinders 1 and 2 have common rod 3. Hydraulic cylinder pistons 4 are equipped with hydraulic clamps 5 used to lock the pistons in relation to the rod. The casings of the hydraulic cylinders are permanently fixed to a bearing structure. Ends 6 of the hydraulic clamps are coupled with delivery line 7 of the hydraulic system by means of solenoid-operated hydraulic valve 8 and with return line 9 by means of solenoid-operated hydraulic valve 10. The pressure in the hydraulic clamps is measured by pickups 11. The movement of the piston is measured by pickup 12 mounted on the hydraulic cylinder casing. The pickup sensing element is connected to pipe 13 used to transmit piston movement. Flexible hoses are used to connect the movable and fixed parts of the hydraulic clamp pipe lines. The ends of each hydraulic cylinder are coupled with return line 9 by means of solenoid-operated valve 14 and with loading line 15 by means of solenoid-operated hydraulic valve 16. The pressure in the ends of the hydraulic cylinder is measured by pickup 17 and in the loading line by means of pickup 18. The loading line to which all the hydraulic cylinders are connected is coupled via solenoid-operated valve 19 with solenoid-operated hydraulic booster 20. Mounted on the rod end is load gauge 21 to which construction 22 being moved or loaded is connected. The electric outputs of the load gauge and all the pressure and movement pickups are connected to the inputs of normalizing transducers unit 23 that is connected to analog signal input device 24 consisting of a commutator and an analog-to-digital transducer. Device 24 is connected to microcomputer 25 to which analog signal output device 26 and discrete signal output device 27 are connected. Connected to the output of device 26 is the program-controlled

input of analog regulator 28 and to the inputs of commutator 29, the other normalized output of the load gauge and the other outputs of the normalizing transducers of the other pickups. The control inputs of the regulator feedback commutator are connected to the respective outputs of device 27. The other outputs of device 27 are connected to solenoid-operated hydraulic valves 8,10,14,16, and 19. The analog regulator output is connected to the control input of solenoid-operated hydraulic booster 20.

The device shown in Fig. 1 operated as follows.

At the initial moment, in response to the instruction coming from microcomputer 25 via discrete signal output device 27, hydraulic clamps 5 of piston 4 of hydraulic cylinder 1 become connected by means of solenoid-operated hydraulic valve 8 to delivery line 7 via ends 6. The pressure in hydraulic clamps 5 is measured by pickup 11. Depending on the sign of the program-controlled value of the load or movement, the left-hand or right-hand end of hydraulic cylinder 1 becomes connected to loading line 15 and the opposite end becomes connected to return line 9. To this end, solenoid-operated valve 19 is switched on, the pressure in loading line 15 is measured by pickup 18 and in the operating end by pickup 17, pickup 18 is connected to the input of the regulator feedback commutator (by means of devices 27 and 29), the value of the pressure measured by pickup 17 is set as a program-controlled value, and when the regulator (Ref.No.28) and solenoid-operated hydraulic booster 20 bring the pressure in the loading line to the point preset, microcomputer 25 sends the instruction (via device 27) in response to which solenoid-operated hydraulic valve 16 is switched on and solenoid-operated valve 14 is set to the position at which communication with the working end is provided and the return line is out off. In the opposite end, solenoid-operated valve 14 is set to the position at which access to the loading line is cut off and communication with the return line is provided. After the working end of the hydraulic cylinder is connected, the feedback transducer changes over. If the force control program is used, load gauge 21 is connected to the regulator feedback input. If the movement program is used, movement pickups 12 are connected. Connection is carried out by means of device 27 in response to the instructions coming from microcomputer 25. According to the program preset by microcomputer 25, regulator 28 generates the control signal that goes to solenoid-operated hydraulic booster 20. The construction loading or movement program continues being executed until the travel of the piston in hydraulic cylinder 1 is over. The movement of the piston is continuously measured by

pickup 12 via pipe 13 and via analog signal input device 24 and entered into microcomputer 25 in which it is compared with the maximum permissible value. When the movement reaches the maximum permissible value, the loading or movement discontinues. In response to the instruction coming from the microcomputer, solenoid-operated hydraulic valve 16 cuts off hydraulic cylinder 1. The working end of hydraulic cylinder 2 is connected in the same manner as described above using valves 14 and 16 of hydraulic cylinder 2. Movement pickup 12 of hydraulic cylinder 2 is connected to the regulator in case of movement control. If the force control program is used, load gauge 21 is connected to regulator 28. In response to the instructions coming from microcomputer 25, solenoid-operated hydraulic valve 8 of the hydraulic clamp of cylinder 2 is switched on and solenoid-operated hydraulic valve 10 of that hydraulic clamp is switched off. In response to the instruction coming from microcomputer 25, valves 14 of hydraulic cylinder 1 are switched on for a short time to provide return flow and then they are switched off again. At the same time, the servo system is increasing the load on hydraulic cylinder 2. The program-set value of the force or movement is kept constant through the use of microcomputer 25. The process of unloading of hydraulic cylinder 1 is repeated until the pressure measured by pickups 17 drops down to atmospheric pressure. Then, in response to the instruction coming from microcomputer 25 via device 27, valve 8 of the hydraulic clamp of cylinder 1 is switched off and valve 10 of the same hydraulic clamp is switched on so as to relieve that valve from loading. Depending on the side in which the piston of hydraulic cylinder 1 is located, which is determined by the readings of pickup 12, valves 16 and 14 of the respective and of hydraulic cylinder 1 are switched on in response to the instruction coming from the microcomputer so as to communicate that end with the loading line in order to move the piston of hydraulic cylinder 1 to the initial position. When the piston of cylinder 1 reaches the initial position, which is determined by the readings of pickup 12, the microcomputer issues the instruction in response to which valves 16 and 14 of cylinder 1 become cut off. Then, construction 22 starts being loaded or moved by means of hydraulic cylinder 2 until the travel of the piston of that hydraulic cylinder is over. Then, the process discontinues.

To continue that process, the operations described above are repeated with the numbers of the hydraulic cylinders interchanged.

The testing machine can employ more than two cylinders combined in groups for building up various loads. For instance, the loading range can be subdivided into several subranges in each of

which an appropriate pair of cylinders is used for loading. In addition, cylinders can be combined in groups for increasing a total force with the cylinder diameter left unchanged.

Fig. 2 shows the diagram of the device that employs the above method for nonstationary loading, deformation, and movement of constructions.

Hydraulic cylinders 1 and 2 have common rod 3. Inside the cylinders, there are pistons 4 with hydraulic clamps 5. Ends 6 of the hydraulic clamps are coupled by means of the pipes with delivery line 7 via solenoid-operated hydraulic valve 8 and with return line 9 via solenoid-operated hydraulic valve 10. The pressure in the hydraulic clamps is measured by pickups 11. The movement of the piston is measured by pickup 12 mounted on the hydraulic cylinder casing. The sensing element of the pickup is connected to pipe 13 that transmits piston motion. Flexible hoses are used to connect the movable parts of pipe lines 13 to the fixed ones. The working ends of the hydraulic cylinders can be connected to the return line via solenoid-operated hydraulic valve 14 and to the delivery line via solenoid-operated hydraulic valves 14 and 16 and servovalve 20. To each other, they are connected via solenoid-operated hydraulic valve 30. The pressure in the loading lines upstream of solenoid-operated hydraulic valve 16 is measured by pickups 18. The pressure in the cylinder ends is measured by pickups 18 and 17. The common rod of the cylinders is connected, via load gauge 21, to construction 22 that takes up a load or moves. The outputs of all the pickups are connected to normalizing transducers unit 23 whose outputs are connected to microcomputer 25 via analog signal input device 24 and to regulators 28 via feedback commutators 29. The program-controlled inputs of regulators 28 are connected via analog signal output device 26 to microcomputer 25 and the outputs of the regulators are connected to the control inputs of servovalve 20. The outputs of discrete signal output device 27 are connected to all the solenoid-operated hydraulic valves and to the feedback commutators and the input of that device is connected to microcomputer 25.

The device shown in Fig. 2 operates as follows.

Before loading or moving a construction, all the pistons of the cylinders must be moved to their initial positions. In this case, in response to the instructions coming from the microcomputer, solenoid-operated valve 10 is switched on and solenoid-operated valve 8 is switched off so that the hydraulic clamps become released. Pickups 12 are connected to the inputs of feedback regulators 28. Solenoid-operated hydraulic valves 14 and 16 are switched on by means of device 27 so as to make the ends of the cylinders communicated with the servovalve. The program-controlled value of the

piston travel is preset by means of the microcomputer and the pistons are moved to the preset initial positions by varying the program-controlled value. To load or move a construction, the common rod is locked by the hydraulic clamp of cylinder 1 by making solenoid-operated hydraulic valve 8 switched on and solenoid-operated hydraulic valve 10 switched off. In the case of force control, the output of load gauge is connected to the input of feedback regulator 28 of that cylinder. The program-controlled signals are applied by means of microcomputer 25 via device 26 to the respective input of regulator 28 of cylinder 1 in whose end the pressure required for executing the loading program is built up. When the travel of the piston of cylinder 1 is over, which is determined by the readings of pickup 12, the hydraulic clamp of cylinder 2 becomes activated (solenoid-operated hydraulic valve 10 of that cylinder is switched off and solenoid-operated hydraulic valve 8 is switched on). In the case of force control, with the force being measured by load gauge 21, the feedback is changed over at the same time the hydraulic clamp of cylinder 2 is activated; in response to the instruction coming from the microcomputer, the input of regulator 28 of cylinder 2 is connected via devices 23 and 29 to the output of load gauge 21. The program-controlled force signals are applied from microcomputer 25 via device 26 to the program-controlled input of regulator 28 of cylinder 2.

At the same time, the feedback of regulator 28 of cylinder 1 is changed over to the difference of the pressures in the working ends of the cylinder, the difference being measured by means of pickups 17 and the normalizing transducer in unit 23. The program-controlled signal applied to the input of regulator 28 of cylinder 1 reduces the preset time down to zero. When the difference of the pressures in the ends of cylinder 1 drops down to zero, solenoid-operated hydraulic valve 10 is switched on and solenoid-operated hydraulic valve 8 is switched off. As a result, the hydraulic clamp of that cylinder becomes released. The cylinder 1 regulator feedback is changed over to movement pickup 12. The piston of cylinder 1 is moved to the initial position by the instructions coming from microcomputer 25 to regulator 28 of cylinder 1.

If the movement control of the process and cylinder 1 was first used, all the above operations are performed after the travel of the piston of cylinder 1 is over, except for the following two operations: the movement pickup of cylinder 2 remains connected to the feedback input of regulator 28 of that cylinder and the construction movement program signals computed with due regard for the preceding stage of movement are applied from microcomputer 25 to the program-controlled input

of the above regulator.

The construction loading or movement is controlled through the use of cylinder 2 until the travel of the piston of that cylinder is over, after which the process described above is to be repeated by changing over the numbers of the cylinders. The device can have more than two cylinders as well. In this case, some cylinders can be combined in groups both on the hydraulic principle and by the control channels. If the number of cylinders is increased, the device operating principle remains basically unchanged. It is only necessary to take into account that a group of cylinders will be used instead of one cylinder and several cylinders will be activated one after another. For example, after the first cylinder has operated, the second cylinder is activated, then the third one, and so on and the piston of each preceding cylinder is moved to the initial position in the manner described above.

In the case of a multirange loading, the method offered is realized in the device shown in Fig.7. Fig.3 shows the diagram of the testing machine in which there are several hydraulic cylinders (1,2, ..., N) that are permanently fixed to frame 34 and provided with a common rod. Each hydraulic cylinder is equipped with hydraulic clamp 32 and load gauge 33 that are mounted on the flanges of rod 31. Each hydraulic cylinder is controlled via its own servovale 20. The control diagram is identical with the one given in Fig.2. The component of construction 22 or a material sample to be loaded is connected to the common rod via adapters 35 and clamps 36.

The testing machine made according to the diagram given in Fig.3 makes it possible to carry out the precision loading of a construction component or a material sample in several ranges of load variation and with greater deformations of the sample. Each load variation range corresponds to the value of the force built up by one of the hydraulic cylinders and measured by its load gauge. Use can be also made of two or several hydraulic cylinders in joint operation for obtaining the required loading accuracy. For example, for reproducing small loading variables in the background of great quasistatic components.

Fig. 4 shows the diagram of the device employing the advanced method in the case of a noncircular-section common rod when the force of each hydraulic cylinder is measured separately.

Hydraulic cylinders 1 and 2 are fixed. Their pistons 4 are attached to movable rods 31 whose ends are used to mount casings 32 of hydraulic clamps 5. Common rod 3 is passed inside movable rods 31 and the hydraulic clamps and coupled via load gauge 21 with construction 22 being loaded or moved. In this case, use can be made of the device control diagram identical with the one given

in Fig.2. In addition, load gauge 33 are mounted on movable rods 31, which makes it possible to control the loading process more accurately. The outputs of load gauges 33 are connected via normalizing transducers unit 23 to the inputs of the analog signal input device provided in the micro-computer and to the inputs of the regulator feedback signal commutators provided for each hydraulic cylinder. In other respects, the hydraulic cylinder control circuit is identical with the one given in Fig.2.

Basically, there is no difference between the operation of this device and that of the device described above. However, load gauges 33 connected to the inputs of the regulator feedback signal commutators in place of the pressure pickups intended to measure the pressure in the working ends of the cylinders are used for separate control of the force built up by each hydraulic cylinder. The device shown in Fig.4 can have several cylinders to provide group and multirange loadings. In this case, the Loading in each range is carried out by means of a respective cylinder or a group of cylinders. The control process is identical with the one specified for the device shown in Fig.2. The device shown in Fig.4 features a greater loading accuracy owing to the use of individual drives and load gauges in each range of loading measurement. In the case of great movements of a construction when it is inadvisable to move the long and heavy common rod along with the construction, the method advanced is implemented in the device whose diagram is shown in Fig.5.

Power cylinders 1 and 2 are coupled via rods 31 and load gauges 33 with casings 33 of hydraulic clamps 5 and connected to each other by rigid frame 34 that is connected via load gauge 21 to construction 22 being moved or deformed. The common rods (guides) are permanently fixed. The device control diagram is identical with the one shown in Fig.2. The operating principle of the device is identical with that of the preceding device. Cylinders 1 and 2 operate alternately. They move frame 34 and construction 22 along with that frame.

Claims

1. Hydraulic movement method, for obtaining the movement of an object (rod 3) having at least one hydraulic clamp (5) for gripping the object (rod 3) and moving it in the longitudinal direction a certain length, and for then releasing the object (rod 3) and returning to an initial position, characterized by using another hydraulic clamp for gripping the object (rod 3) before the first hydraulic clamp has released the object (rod 3) and for moving it in the same manner as the first one, with the hydraulic clamps (5,5)

alternating in moving the object (rod 3) any distance, according to the "rope climbing" principle.

2. Method according to claim 1, characterized by expanding the functions of the machine, with the object (rod 3) of movement being fixedly mounted and a system consisting of pairs of hydraulic clamps (5,5), being moved over that object, thereby preferably adding the functions of a hoist and a jack.
3. Object moving hydraulic system, composed of a master cylinder (1) with a piston (14) and supplied from an oil plant, characterized by at least one additional hydraulic cylinder (2) introduced into the hydraulic system complete with a piston, that each of the pistons is equipped with a hydraulic module made in the form of preferably two hydraulic cylinders with pistons; with said hydraulic cylinders of that module preferably having a common casing of which the working ends (6) are independently connected to both a delivery line and a return line of the oil plant and the pistons of the module hydraulic cylinders being mounted so that they can move in the opposite direction with respect to each other; further characterized in that the master and additional hydraulic cylinders (5, 5) are permanently fixed one after the other so that their pistons can move coaxially, and that the hydraulic modules are connected to the oil plant also so that they can operate independently with respect to each other.
4. Hydraulic system according to claim 3, characterized in that there are two holes made in the module casing for mounting the object of movement on the module and that the additional hydraulic cylinder (5) is connected, in addition, to the oil plant but so that it can operate independently with respect to the master cylinder.
5. Hydraulic system according to claim 3 or 4, characterized by a combination of the casing of the hydraulic module of each piston (4) with the casing of that piston in order to decrease the overall dimensions without reducing the movement range.
6. Hydraulic system according to one of the claims 3 to 5, characterized in that the hydraulic module casings are attached to remote bars that are mounted on the pistons (4) of the master and additional hydraulic cylinders (5, 5) in the direction of piston travel when irregularly

shaped objects are to be moved.

7. Hydraulic system according to one of the claims 3 to 6, characterized in that a cross-piece is mounted on the pistons (4) of the master and additional hydraulic cylinders (5, 5) as a remote component intended for expanding the functions of the hydraulic system with the hydraulic modules attached to the ends of that cross-piece so that they can move over the rods (3) that are fixedly mounted and parallel to the cross-piece movement.
8. Hydraulic system according to one of the claims 3 to 7, characterized by several master and additional hydraulic cylinders (5, 5) of various power ranges which are mounted on the same frame one after the other and have a common rod for loading in order to expand the hydraulic system functions with the load dosing accuracy being increased.

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Fig. 1

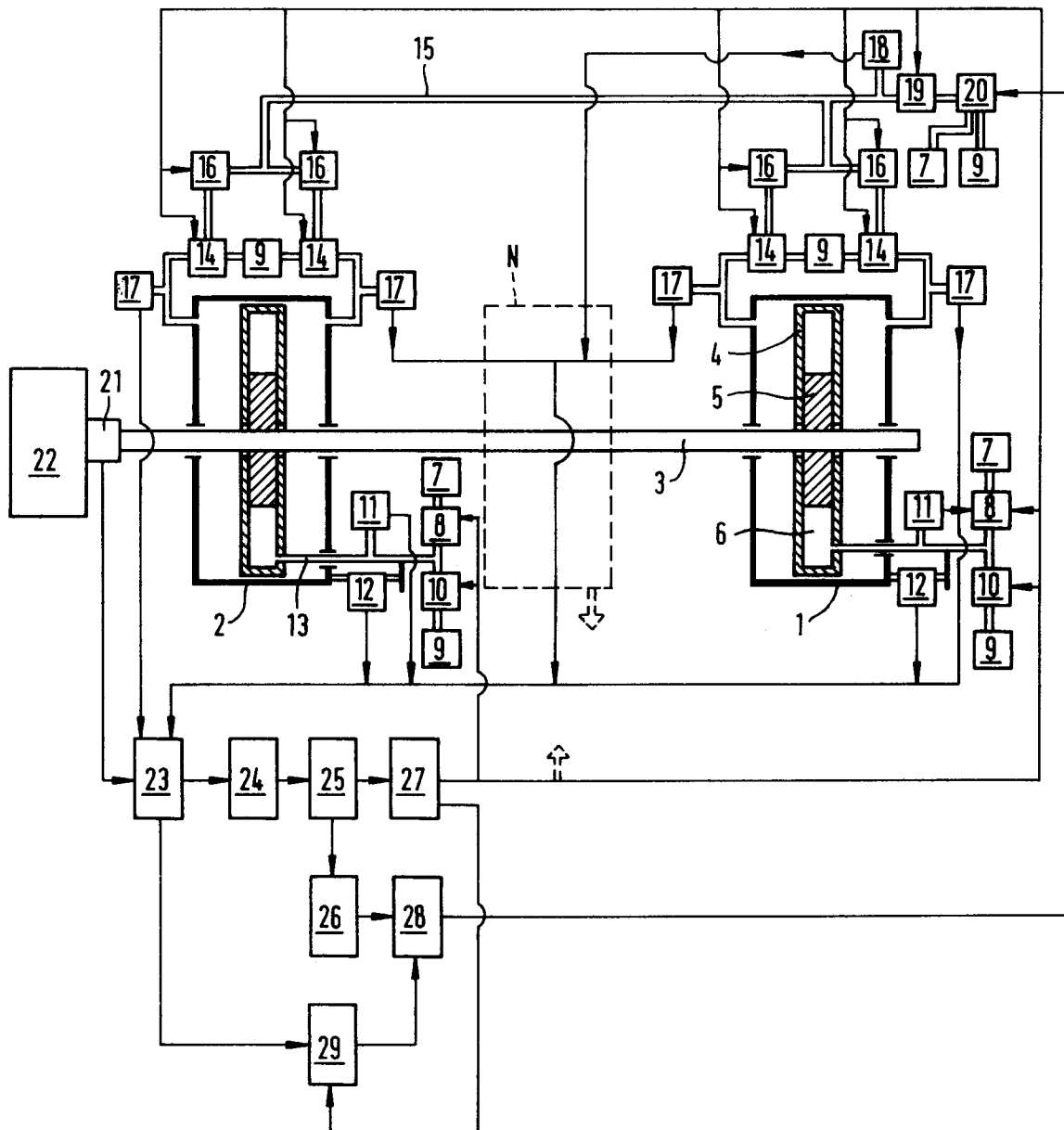


Fig. 2

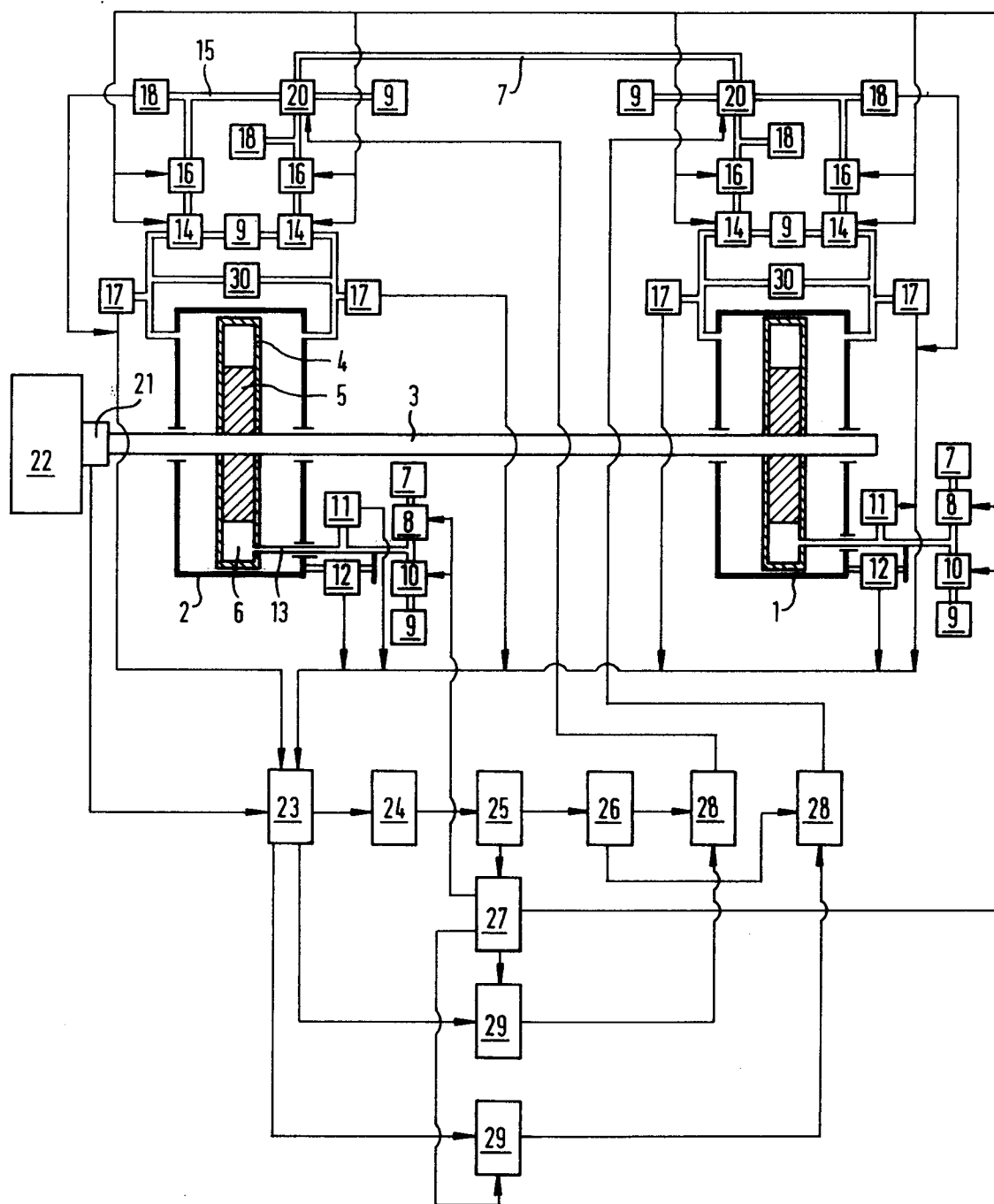


Fig. 3

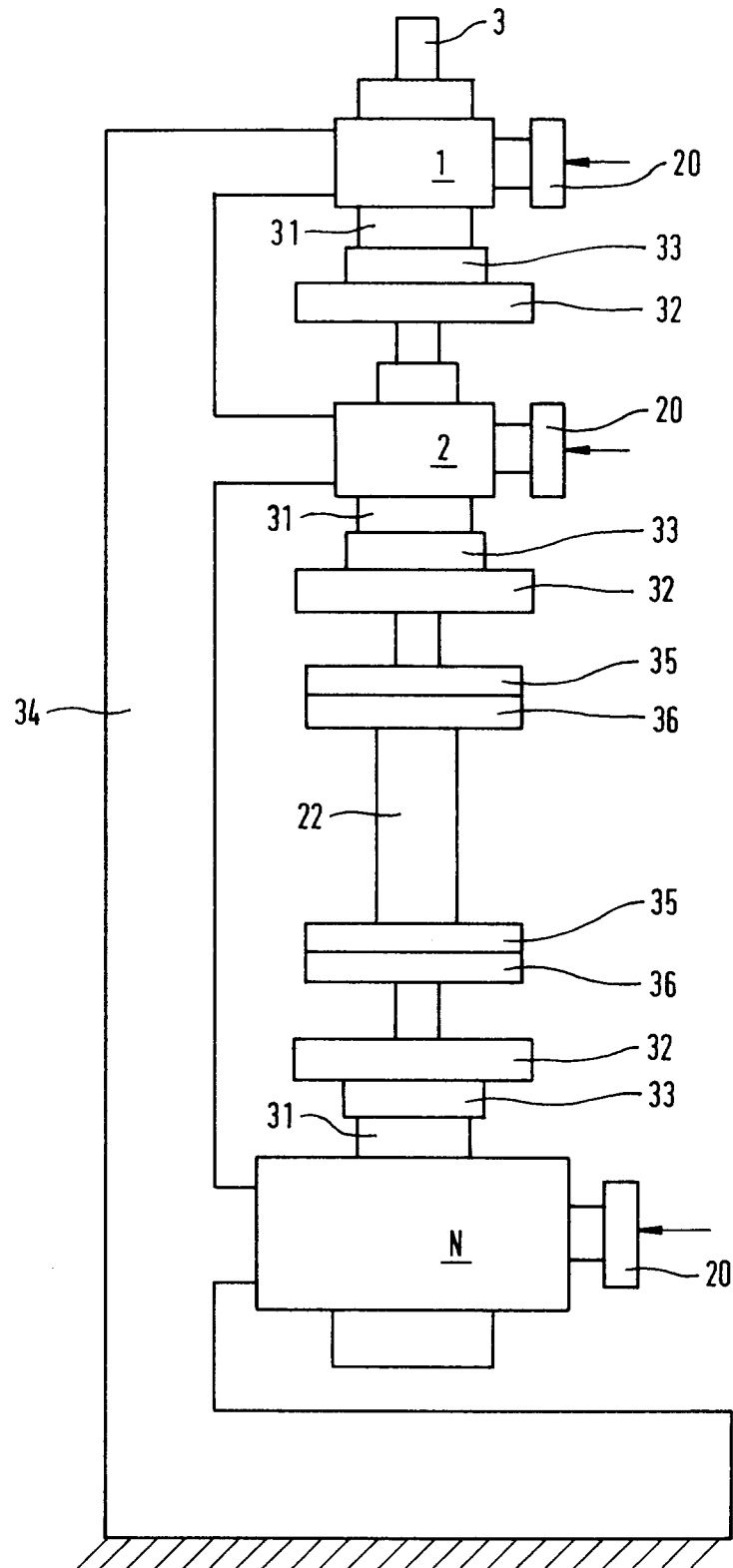


Fig. 4

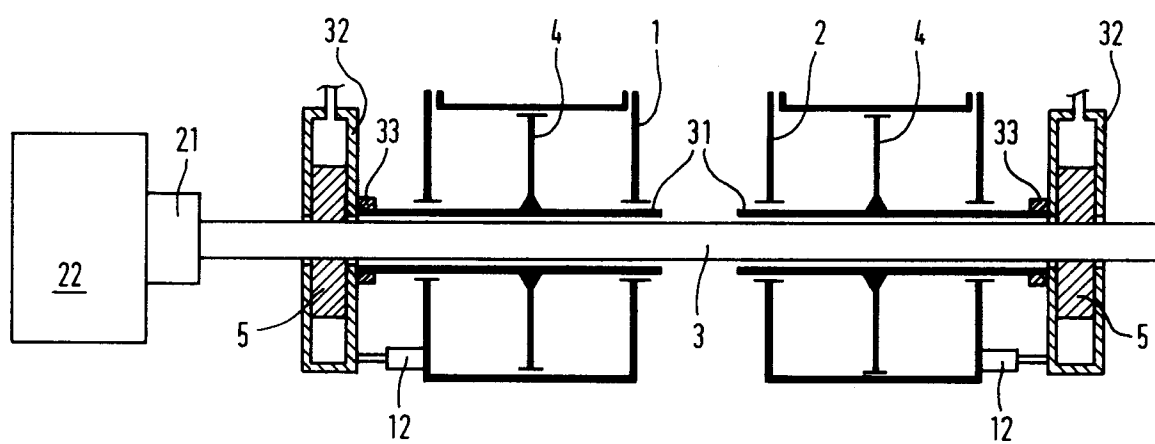


Fig. 5

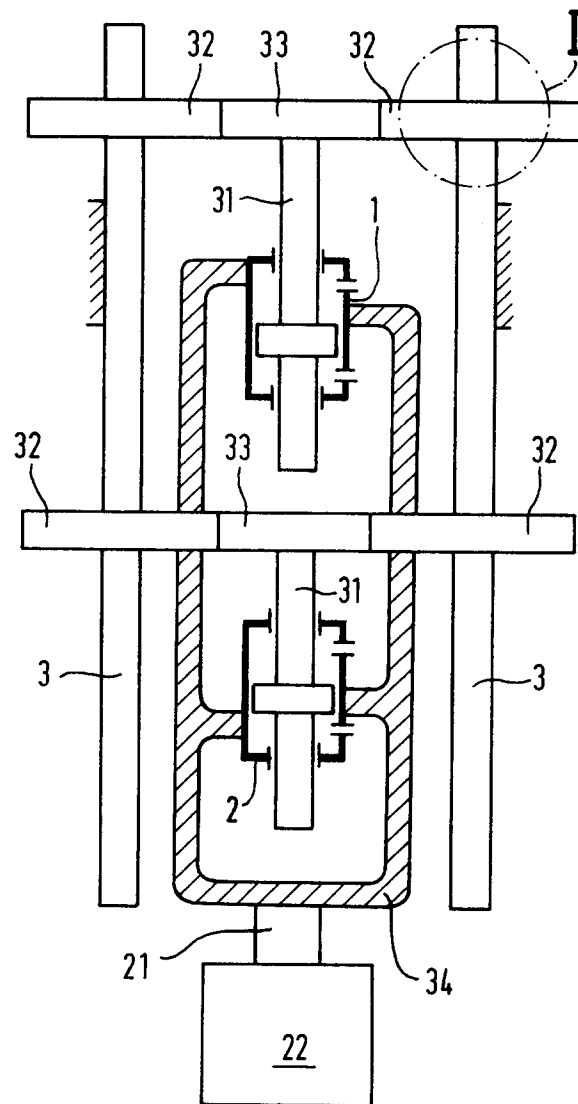
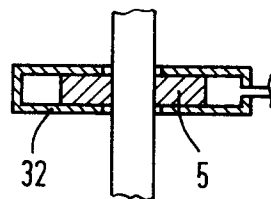


Fig. 6 (I)





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EUROPEAN SEARCH REPORT

Application Number

EP 92 10 8168

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-B-1 133 526 (GUTEHOFFNUNGSHÜTTE STERKRADE)	1,2	B66F1/02 B66C23/32
A	* column 3, line 9 - column 4, line 16; figures 1-3 *	3,4	
Y	DE-B-1 219 199 (VEB PKM HYDRAULIK KARL-MARX-STADT) * claims 1,2; figure 1 *	1	
Y	DD-A-71 849 (WERNER RÖHR ET AL.) * column 4, line 52 - column 5, line 21; figures 1-3 *	1	
A	DE-A-2 746 216 (ISHIKAWAJIMA-HARIMA) * claim 1; figure 5 *	1	
A	US-A-3 936 032 (WALTER WASCHULZIK ET AL.) * column 4, line 32 - line 64; figures 1-3 *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B66F B66C F15B
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 10 DECEMBER 1992	Examiner THOMAS C.
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	