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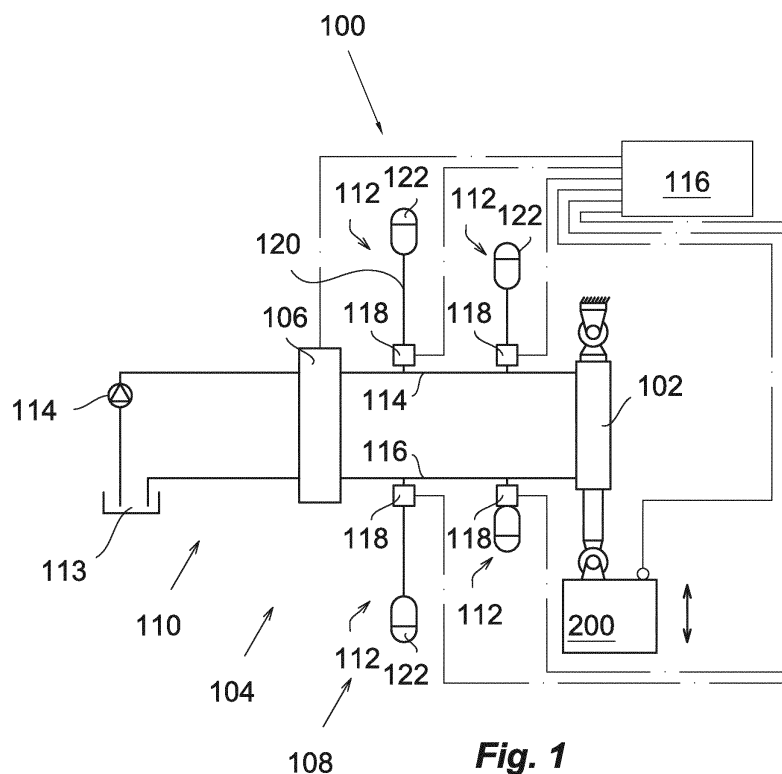
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(54) **A hydraulic force transmission system, fiber web machine and method of operating a hydraulic force transmission system**

(57) The present invention relates to a hydraulic force transmission system (100) the elements of which comprising at least one hydraulically operated fluid power device (102) and hydraulic working fluid circuit for supplying pressurized working fluid for the power device, and a control valve device for controlling the flow of the pres-

surized working fluid into and/or from the power device in the circuit. In the system the dynamical properties of at least one of the elements is arranged controllable such that the dynamic rigidity of the power device may be altered.



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Description

[0001] The present invention relates to a hydraulic force transmission system comprising at least one hydraulically operated fluid power device and hydraulic working fluid circuit for supplying pressurized working fluid for the power device, and a control valve device for controlling the flow of the pressurized working fluid into and/or from the power device in the circuit, which circuit is at its section between the valve device and the power device arranged alterable of its volume according to the preamble of claim 1.

[0002] Invention relates also to a fiber web machine, in which a machine element which participates in the process and which is totally or at least partly supported by a fluid power device.

[0003] Invention relates also to method of operating a hydraulic force transmission system comprising at least one hydraulically operated fluid power device and hydraulic working fluid circuit supplying pressurized working fluid for the power device and a control valve device.

[0004] Hydraulic or fluid power is commonly used for various industrial applications particularly requiring considerable amount of power and/or precise control of position of an object.

[0005] Particularly in machinery where hydraulic or fluid power is used to support a machine element participating in the process vibration characteristics comes to important role.

[0006] For example in fiber web machines there may be several such machine elements which participates in the process and which are totally or at least partly supported by a fluid power device such as a hydraulic cylinder.

[0007] As is known in prior art, in a slitter-winder the machine roll is un-wound and the wide web is slit with the slitting part of the slitter-winder into a number of narrower partial webs that are rewound with a partial web winder to form customer rolls. In a slitter-winder, particularly of two-drum type, there is a rider roll supporting the rotating set of rolls, the rider roll being controlled by means of hydraulic cylinders. In winding, e.g. when winding a paper web with a slitter-winder, large vibrations occur in certain paper types at same roll rotation frequency ranges regardless of the running speed of the slitter-winder. Usually there are about 1 to 3 vibration ranges, i.e. rotation speed ranges of the roll on which there is strong vibration, depending on the final diameter of the roll. This strong vibration causes winding reject, mechanical wear of the apparatuses, even loosening of the roll from the winding apparatus as well as decrease of winding capacity as the running speed has to be lowered during winding. Therefore it is a general aim to reduce the negative effects of such behavior.

[0008] FI101283 discloses a method in which the running speed of the winder is controlled based on the rotation frequency of the roll so that as the rotation frequency of the roll approaches the vicinity of the vibration range,

i.e. the roll rotation frequency range where there is a strong vibration, the running speed is quickly lowered so that the rotation speed of the roll decreases to below the lower frequency of the vibration range and subsequent to this the running speed is increased so that the rotation frequency of the roll remains constant until the original running speed of the winder is reached. Due to the change of the running speed this has an effect on the total capacity of the winder.

[0009] DE102006043628 discloses a winder in which a hydraulic cylinder of a rider roll is connected via lines having a servo valve to a reservoir for the hydraulic fluid. Further, the lines are provided with pressure accumulators which are connected to the lines via valves and with throttles. The accumulators serve for fast receive or deliver hydraulic fluid and the damping of vibration is accomplished by the throttles.

[0010] In WO2010106226 there is disclosed a hydraulic actuator arrangement comprising a hydraulic actuator and a control device to control the flow of hydraulic medium to and/or from the hydraulic actuator, as well as an energy accumulator unit connected to the hydraulic medium discharged from the hydraulic actuator between the control device and the actuator. The document does not specifically relate to vibration problems at all.

[0011] Thus it is known to provide several methods and arrangement for aiming to attenuate vibration of a hydraulic force transmission system. However, instead of aiming primarily attenuate vibration it is an object of the invention is to provide a hydraulic force transmission system by means of which the vibration is at least minimized in a straightforward manner by effecting on the dynamic rigidity of the hydraulic force transmission system.

[0012] The objects of the invention are mainly achieved with a hydraulic force transmission system according to claim 1.

[0013] Unless more particularly defined, in this context the following definitions are valid. The term hydraulics means fluid mechanics applying any suitable fluid and thus term hydraulic should not be interpreted to mean only liquid fluid. The term dynamical properties of an element mean one or more property by means of which it is possible to effect on dynamical behavior of the system. Dynamic rigidity is the static rigidity of the system complemented by the dynamic effects of mass and damping in the system.

[0014] The other additional characteristic features of the invention will become apparent from the appended claims and the following description of the embodiments of figures.

[0015] A hydraulic force transmission system according to the invention, the elements of which system comprise at least one hydraulically operated fluid power device and hydraulic working fluid circuit for supplying pressurized working fluid for the power device, and a control valve device for controlling the flow of the pressurized working fluid into and/or from the power device in the circuit. In the system the dynamical properties of at least

one of the elements are arranged controllable such that the dynamic rigidity of the system and therefore also the dynamic rigidity of the power device may be altered.

[0016] In the hydraulic system according to the invention the dynamical properties or features of the hydraulic elements are controlled in order to controllably alter the dynamic rigidity of the system. In practice the dynamical rigidity of the system is seen as dynamical rigidity of the power device. Thus the state of the force transmission system effects on the dynamical rigidity of the power device and therefore the dynamical rigidity of the force transmission system is realized into practice behavior of via the power device. With the term dynamic rigidity it is specifically referred to vibrational rigidity rather than static rigidity.

[0017] Hydraulic elements may have several dynamical properties or features such as compressibility of a fluid in a volume belonging to the system, which may be called also as hydraulic capacitance, and inertia of a fluid in a narrow cross sectional flow channel or pipe, as well as hydraulic capacitance in connection with a pressure accumulator ruled by preset counter pressure in the accumulator.

[0018] According to an embodiment of the invention in the system the dynamical properties of at least one of the elements are arranged controllable such that peak rigidity frequency of the power device locates within the vibration frequency range subjected to the power device when the system is in use.

[0019] According to another embodiment of the invention in the system the dynamical properties of at least one of the elements are arranged controllable into at least two different settings, of which in the first setting the dynamical properties are arranged to effect on dynamic rigidity of the power device at a first vibration frequency range subjected to the power device and, in the second setting the dynamical properties are arranged to effect on dynamic rigidity of the power device at a second vibration frequency range subjected to the power device. By the vibration subjected to the power device it is meant an external vibration or excitation.

[0020] Since one of the dynamical properties or features in hydraulic elements is hydraulic capacitance the dynamical properties are, according to an embodiment of the invention, arranged controllable by controllably connecting or disconnecting additional volume or volumes to at least one of the elements.

[0021] Advantageously one of the elements of the system is an elongated element having a volume, first end and a second end and a section of constant cross sectional area or the volume between the first and the second ends. This way the inertia of a fluid in a narrow cross sectional flow channel, such as a pipe, may be used in increasing the dynamic rigidity of the system. Advantageously the system comprises a pressure accumulator in connection with the pipe.

[0022] Such an additional volume additional volume or volumes may be arranged at a section between the valve

device and the power device in the circuit, which volumes have been tuned to increase dynamical hydraulic rigidity of the power device.

[0023] The circuit may comprise a first and a second main fluid channel via which the working fluid is delivered to and removed from the power device and that the additional volume is arranged connectably to the first and/or the second main fluid channel.

[0024] According to an embodiment of the invention the hydraulically operated fluid power device has a first fluid volume and the section in the circuit between the valve device and the power device has a second volume, and the dynamical properties of at least one of the elements are arranged controllable by setting total volume of the first and the second volumes, wherein the second volume is controllable into at least two different settings of which in the first setting the combination of the first and the second volumes is arranged to effect on dynamic rigidity of the system at a first vibration frequency range subjected to the power device and, in the second setting the combination of the first and the second volumes is arranged to effect on dynamic rigidity of the system at a second vibration frequency range subjected to the power device.

[0025] This may be further developed so that the system comprises a third volume in connection with the second volume arranged selectively connectable to the second volume and that the combination of the first, the second and the third volume is arranged to increase dynamic rigidity of the system at a predetermined vibration frequency range experienced by the power device. The third volume act also as an additional volume.

[0026] According to an embodiment of the invention the third volume comprises an accumulator having a volume capable of receiving fluid from and returning fluid back to the system without substantial restriction.

[0027] According to an embodiment of the invention the third volume comprises an elongated element having a volume, a first end and a second end and a section of constant cross sectional area of the volume between the first and the second ends. This way the inertia of a fluid in a narrow cross sectional flow channel may be used in increasing the dynamic rigidity of the system.

[0028] According to an embodiment of the invention the accumulator has controllable counter pressure which is arranged controllable dynamical property of the accumulator by means of which the dynamic rigidity of the system may be altered.

[0029] According to an embodiment of the invention the accumulator is connectable to the second volume or generally to one of the elements of the hydraulic system via an elongated element having a first end and a second end and a section of cross sectional area between the first and the second ends. This way the inertia of a fluid in a narrow cross sectional flow channel may be used in increasing the dynamic rigidity of the system.

[0030] According to an embodiment of the invention the system comprises a control system which is arranged

change the dynamical properties of at least one of the element based on a predetermined operation map. In such a case the progression or course of the process where the power device is connected to is known and the made available or stored in the control system. The control system is this way arranged to control the dynamical properties based on the information of the course of the process.

[0031] According to another embodiment of the invention the system comprises a control system which is arranged change the dynamical properties of at least one of the element based on on-line vibration related frequency information made available to the control system. The control system is this way arranged to control the dynamical properties based on the feedback information obtained from the process. The control system may be arranged to have access to vibration status information of the power device mechanical output and/or the hydraulic working fluid so that the control system is arranged to control the dynamical properties based on the vibration status information.

[0032] According to an embodiment of the invention the system volume has been arranged alterable in tuned manner such that the volume of the fluid circuit being active is selected by a control system in response of determined vibration and/or based on vibration related information made available to the control system.

[0033] This provides an effect of increasing the dynamic rigidity of the power device at particularly at a predetermined frequency or frequency range when the power device is subjected to vibration.

[0034] According to an embodiment of the invention the system comprises more than one additional volumes selectively connectable to the circuit by means of a valve in each of the additional volume.

[0035] According to an embodiment of the invention the system comprises a control system which is arranged to control the state of the valves in on-off manner.

[0036] According to an embodiment of the invention that each of the additional volumes in the system has inner space of different size.

[0037] According to another embodiment of the invention that each of the additional volumes in the system has inner space of equal size.

[0038] According to an embodiment of the invention the elongated element having a first end and a second end and a section of constant cross sectional area between the first and the second ends is a pipe which has been arranged coiled configuration. This way the pipe is in a compact form.

[0039] According to an embodiment of the invention the at least one selectively connectable additional volume is fluidly separated from the circuit and is filled with a second fluid different to the one in the circuit and that the additional volume is separated from the circuit in a manner of allow pressure pulsation transmission back and forth between the fluid in the circuit and the second fluid.

[0040] Objects of the invention are also met by method of operating a hydraulic force transmission system comprising at least one hydraulically operated fluid power device and hydraulic working fluid circuit supplying pressurized working fluid for the power device, and a control valve device, in which method the flow of the pressurized working fluid into and/or from the power device in the circuit and the position of and force exerted by the fluid power device is controlled by the control valve device. It is characteristic to the invention that the dynamical properties of at least one of the elements of the system are controlled such that the dynamic rigidity of the power device is altered.

[0041] According to an embodiment of the invention in the system the dynamical properties of at least one of the elements are controlled such that the peak rigidity frequency of the power device is arranged to locate within the vibration frequency range subjected to the power device when in use.

[0042] According to a further embodiment of the invention the dynamical properties of at least one of the elements are selected between at least two different settings of which in the first setting the dynamical properties effect on dynamic rigidity of the system at a first vibration frequency range subjected to the power device and, in the second setting the dynamical properties effect on dynamic rigidity of the power device at a second vibration frequency range subjected to the power device.

[0043] Objects of the invention are also met by a fiber web machine, in which a machine element which participates in the process and which is totally or at least partly supported by a fluid power device, and the fluid power device is provided with a hydraulic force transmission system according to anyone of the claims 1-12.

[0044] In the following the invention and its operation are described with reference to the appended schematic drawings, in which

figure 1 illustrates a hydraulic force transmission system according to an embodiment of the invention, figure 2 illustrates a hydraulic force transmission system according to another embodiment of the invention, figure 3 illustrates another embodiment of the invention, figure 4 illustrates a still another embodiment of the invention, figure 5 illustrates a volume unit according to an embodiment of the invention, figure 6 illustrates a volume unit according to another embodiment of the invention, and figure 7 illustrates a fiber web machine provided with a hydraulic force transmission system according to an embodiment of the invention.

[0045] Fig. 1 shows a hydraulic force transmission system 100 according to an embodiment of the invention. The force transmission system comprises at least

one hydraulically operated fluid power device 102, such as a hydraulic cylinder, and a hydraulic fluid circuit 104. In this context the fluid power device is advantageously a hydraulic cylinder. The fluid circuit is arranged for supplying working medium, typically oil, for the operation of the power device 102. The system comprises further a control valve device 106, which is arranged to guide the flow of the hydraulic working fluid into and out of the power device to obtain desired operation of the power device 102. The circuit comprises two sections, the first section 108 comprising the ducting and possible appliances between the valve device and power device and a second section 110 comprising the ducting and possible appliances between the valve device 106 and a tank 113 or alike functioning as a power fluid storage for the circuit 104. The second section is also provided with a pump unit 114 or alike in order to pressurize the power fluid to appropriate level.

[0046] The power device 102 is connected to a machine element 200, which participates in a process. The machine element 200 is totally or at least partly supported by the fluid power device 102 so that power device exerts force to the machine element. That nature of force may be dynamic or static. The machine element participates in a process which is prone to excite vibration and which transmits the vibration to the fluid power device 102. Now, according to the embodiment of the invention the dynamical properties of at least one of the elements of the hydraulic working fluid circuit of force transmission system 100 is arranged controllable such that the dynamic rigidity of the system therefore also the dynamic rigidity of the power device 102 may be altered. In this embodiment the section 108 between the valve device 106 and the power device 102 is arranged alterable of its inner volume in tuned manner. According to the embodiment of the invention the active volume is used to control the dynamical properties and it is selected by required frequency or frequency range at which rigidity of the system is desired to be increased during the course of the process. The actual manner of changing actual volume may be selected in various manners during the operation of the system e.g. by selecting predefined suitable volume unit 112 arranged to or in connection with the system.

[0047] The active volume of the circuit which is in connection with the power device in such a manner that there are no practically effective constrictions dividing the volume which is open to the power device.

[0048] The inner volume has been arranged alterable in tuned manner such that the volume of the fluid circuit being active is selected by a control system 116 in response of determined frequency of vibration and/or based on information made available to the control system. Effective active volume is tuned to effect on a predetermined vibration frequency or vibration frequency range.

[0049] Generally an active volume may be arranged controllable or changeable in several ways as will become apparent in the following.

[0050] In figure 1 the section 108 between the valve device 106 and the power device 102 is provided with four separate volume units 112 as the additional volumes, attached to the main fluid channel, comprising a first and a second main fluid channel, 114 and 116 respectively. The working fluid is delivered to and removed from the power device 102 via the main fluid channels. The main fluid channels are typically pipes.

[0051] The volume units 112 are each independently connectable to the main fluid channel 114, 116 by a valve means 118. The valve means is according to an embodiment of the invention an on/off valve by means of which the each volume unit 112 may be independently connected to or disconnected from the main fluid channel 114, 116. The state of the connection is controlled by the control system 116.

[0052] The volume unit i.e. the additional volume, as is shown in figure 1, may comprise an elongated element 120 having a first end and a second end and section of constant cross sectional area between the first and the second ends, which may particularly be a pipe. Such a pipe acts mainly as inertia of the fluid in a narrow cross sectional flow channel of the pipe. In other words it brings desired inertia effect to the system. The pipe is connectable to the circuit at its first end by the valve means 118. There is a pressure accumulator 122 arranged at the end of the second end of the pipe 120. The pressure accumulator has been coupled to the pipe so, that there is no substantial constriction in the couple i.e. so that the fluid may flow back and forth into the accumulator without substantial pressure drop. The elongated elements 120 may be of different cross sectional area and length since they are tuned and selected to operate at specific process situation defined by the control system 116. Additionally the pressure accumulators may have different volumes for the same reasons.

[0053] Each of the volume units 112 has been specifically tuned to increase the dynamic rigidity of the power device at a specific frequency or frequency range. In order to have the system tuned for increasing dynamic rigidity at different frequencies or frequency ranges it is possible to e.g. alter the length of the main fluid channel pipe, have different volume units with different pipe length, have different volume units with different pipe diameter, have different volume units with different pressure accumulator volumes, and have a pressure accumulator arranged connectable to the pipe at different locations.

[0054] As is depicted in the figure the additional volume i.e. the accumulator 122 may be connected also directly to the main fluid channel 114, 116 or pipe.

[0055] In figure 2 there is shown an embodiment which differs from that shown in figure 1 by the feature that the volume of the circuit 104 at its section 108 between the valve device 106, 106', 106'' and the power device 102 has been arranged alterable in tuned manner such that the circuit is provided with at least two separate valve devices. Here three valve devices 106, 106', 106'' are arranged at different distances in the circuit from the power

device. The effective volume of the circuit may be set by selecting one of the valve devices to be active and setting any valve devices between the active one and the power device in a state where both the main fluid channel 114, 116 are unrestricted. This way by selecting proper valve device 106, 106', 106'' to be the active one the volume of the fluid circuit 110 may be selected by a control system 116 in response of determined vibration and/or based on vibration related information made available to the control system.

[0056] In figure 3 there is shown still another embodiment of the invention. This is basically similar to that shown in figure 1 with an exception that the elongated element 120 of the volume unit 112 is divided into two separate parts 120', 120''. They are separated by a second valve means 118' in the volume unit 112. As is depicted by figure 4 each of the volume unit may have the elongated element 120 divided at different locations. This way the lengths of the separate parts 120', 120'' may be different. Even if not shown here the total lengths of the elongated element 120 of the volume elements may be different from each other.

[0057] In figure 4 there is shown still another embodiment of the invention. This is also similar to that shown in figure 1 with an exception that the elongated element 120 of the volume unit 112 is different. Here is illustrated how the elongated element 120 may comprise a separate fluid compartment 121 between the valve means 118 and the accumulator unit 122. The compartment has been filled with a second fluid different from the working fluid in the circuit 110. The compartment is provided with a diaphragm at its both ends where it communicates with the valve means 118 and the accumulator unit 122. The diaphragm transmits the pressure vibration through in a desired extent by preventing mixing of the second fluid and the working fluid. The second fluid is according to a preferred embodiment selected to have greater density and/or lower viscosity than the working fluid. Instead or additionally to have the separate fluid compartment, the volume unit 112 may be provided with a controllable heater to effect controllably on the properties of the fluid in the volume unit 112 (not shown).

[0058] In figure 4 there is also shown an embodiment where the elongated element 120 may comprise a separate fluid compartment 121 after the valve means 118 so that the separate fluid compartment 121' comprises a pipe portion and an accumulator unit 122 filled with a second fluid different from the working fluid in the circuit 110. Here the compartment is provided with a diaphragm only at its first end where it communicates with the valve means 118. This way the fluid in the section behind the diaphragm is separated from the working fluid. The diaphragm transmits the pressure vibration through in a desired extent by preventing mixing of the second fluid and the working fluid. The second fluid is according to a preferred embodiment selected to have greater density and/or lower viscosity than the working fluid.

[0059] Figure 5 shows a volume unit 112 according to

an embodiment of the invention. The volume unit serves as the additional volume. Also in the embodiment the volume unit 112 comprises an elongated element 120 having a first end and a second end and section of constant cross sectional area between the first and the second ends. In this embodiment the elongated element is a pipe which has been coiled into spiral form. The volume unit 112 is provided with a valve means 118 at its first end by means of which the pipe coil is connectable to the circuit at its first end by the valve means 118. There is a pressure accumulator 122 arranged at the second end of the pipe coil 120. The accumulator may be connected to the coil by a second valve means 123. This valve may be used to isolate the accumulator from the system. Isolation of the accumulator has a strong decreasing effect on the dynamic rigidity. All the valve means 118, 123 are arranged under control of the control system. The coil is assembled into the system advantageously so that the center axis of the coil is substantially vertical or so that the pipe is always sloping upwards. This allows efficient gas removal from the fluid in the volume.

[0060] In figure 5 there is also shown an accumulator 122 in which instead of or in addition to a preset counter pressure, as may be considered to be the case in other accumulator in the figures, the accumulator is provided with mechanical spring 124. The accumulator may be connected to an external pressure fluid source by means of which the counter pressure may be actively controlled by the control system, when applied e.g. in connection with the embodiment shown in figure 1, in order to control the dynamical properties of the system.

[0061] In figure 6 there is shown another embodiment of the volume unit similar to that shown in figure 5 except that there is an additional accumulator 125 connected to the pipe between its first end and the second end. The accumulator 125 is coupled to the pipe by an additional valve means 127.

[0062] As a particular embodiment of the invention the system is arranged in connection with fiber web machine, particularly a rider roll of a partial web winder 10 as depicted in figure 7. There is a partial view of a two-drum winder which comprises a front winding drum and a rear winding drum as support rolls (not shown). The winding drums support from below a set of web rolls 25 being wound of partial webs W in the winder in a manner known as such. To support the roll 25 from the above there is also arranged a rider roll 30. The rider roll 30 is supported on a beam 35. The rider roll may be a single roll extending from the first (front) side of the winder to the second (back) side thereof or it may be constructed of several interconnected roll segments. The interconnection means that the roll segments are rotatably connected with each other. The position of the rider roll and the force applied by the rider roll to the set of web roll is at least partly controlled by the hydraulic cylinder 102 at both ends of the beam 35. The hydraulic force transmission system is used in connection with the cylinders 102. Here only one

of the main fluid channels 114 is shown for clarity reasons. The valve device 106 comprises a combination of on/off valve 106.1 and a controllable throttle 106.2. While the winding process advances the on-off valve is closed and the throttle separates dynamically the cylinder 102 and the volume unit 112 from the other system still allowing a required fluid flow rate through it. This way the dynamic rigidity may be maintained in the cylinder 102. In winder, and generally in fiber web machine (reel-up, calender, coater, press section, head box etc.) the harmful vibrations are considerably low, example 5 - 50 Hz. It is apparent that any corresponding application is other part of a fiber web machine may be provided with the system according to the invention.

[0063] In an embodiment where the power device is arranged to operate with a process in which vibration will emerged at various frequencies during course of the operation, the system comprises at least one volume unit tuned for increasing the dynamic rigidity of the power device at each frequency and the control system 116, when the process operating at one of such frequency range, is arranged to open the valve means 118 of respective volume unit 112.

[0064] During the operation the control system is arranged to acquire the current frequency or frequency of the vibration and according to a predetermined mapping open a valve means 118 to corresponding to acquired frequency.

[0065] It should be noted that only a few of the most preferable embodiments are disclosed above. Thus, it is evident that the invention is not limited to the above-mentioned embodiments but it can be applied in many ways within the scope defined by the appended claims. The power device may also be in certain applications a compact hydraulic linear actuator or hydrostatic bearing. The features disclosed in connection with various embodiments can also be used in connection with other embodiments within the inventive scope and/or different embodiments can be combined from the disclosed features, should it be desired and should it be technically feasible.

Claims

1. A hydraulic force transmission system (100) the elements of which comprising at least one hydraulically operated fluid power device (102) and hydraulic working fluid circuit (104) for supplying pressurized working fluid for the power device, and a control valve device (106) for controlling the flow of the pressurized working fluid into and/or from the power device in the circuit, **characterized in that** in the system the dynamical properties of at least one of the elements is arranged controllable such that the dynamic rigidity of the power device (102) may be altered.
2. A hydraulic force transmission system according to claim 1, **characterized in that** in the system the dy-

namical properties of at least one of the elements are arranged controllable such that the peak rigidity frequency of the power device (102) locates within the vibration frequency range subjected to the power device when in use.

3. A hydraulic force transmission system according to claim 1, **characterized in that** in the system the dynamical properties of at least one of the elements are arranged controllable into at least two different settings of which in the first setting the dynamical properties are arranged to effect on dynamic rigidity of the power device (102) at a first vibration frequency range subjected to the power device and, in the second setting the dynamical properties are arranged to effect on dynamic rigidity of the power device at a second vibration frequency range subjected to the power device.
4. A hydraulic force transmission system according to claim 1, 2 or 3, **characterized in that** the dynamical properties are arranged controllable by controllably connecting or disconnecting additional volume (112) or volumes to at least one of the elements so that the combination of the connected volumes is arranged to increase dynamic rigidity of the power device (102) at a predetermined vibration frequency range experienced by the power device (102).
5. A hydraulic force transmission system according to claim 4, **characterized in that** the volume comprises an accumulator (122) capable of receiving fluid from and returning fluid back to the system without substantial restriction.
6. A hydraulic force transmission system according to claim 5, **characterized in that** the accumulator is connectable to the second volume via an elongated element (120) having a first end and a second end and a section of constant cross sectional area between the first and the second ends.
7. A hydraulic force transmission system according to claim 4, **characterized in that** the volume comprises an elongated element (120) having a first end and a second end and a section of constant cross sectional area between the first and the second ends.
8. A hydraulic force transmission system according to claim 4, **characterized in that** that additional volume or volumes comprises an accumulator (122) connectable to the second volume via a pipe selectively connectable to the circuit at its first end and at having a pressure accumulator at the second end of the pipe.
9. A hydraulic force transmission system according to anyone of the preceding claims, **characterized in**

that the system comprises a control system (116) which is arranged change the dynamical properties of at least one of the element based on a predetermined operation map and/or on-line vibration related frequency information made available to the control system.

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of the power device at a second vibration frequency range subjected to the power device.

10. A hydraulic force transmission system according to claim 8, **characterized in that** the pipe is in coiled configuration.

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11. A hydraulic force transmission system according to claim 4, **characterized in that** the at least one selectively connectable additional volume (112) is fluidly separated (121) from the circuit (108) and is filled with a second fluid different to the one in the circuit and that the additional volume is separated from the circuit in a manner of allow pressure pulsation transmission back and forth between the fluid in the circuit and the second fluid.

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12. Fiber web machine, in which a machine element (200) which participates in the process and which is totally or at least partly supported by a fluid power device (102), **characterized in that** the fluid power device is provided with a hydraulic force transmission system according to anyone of the preceding claims.

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13. Method of operating a hydraulic force transmission system (100) comprising at least one hydraulically operated fluid power device (102) and hydraulic working fluid circuit (104) supplying pressurized working fluid for the power device, and a control valve device (106), in which method the flow of the pressurized working fluid into and/or from the power device in the circuit and the position of and force exerted by the fluid power device (102) is controlled by the control valve device (106), **characterized in** the dynamical properties of at least one of the elements of the system are controlled such that the dynamic rigidity of the power device (106) is altered.

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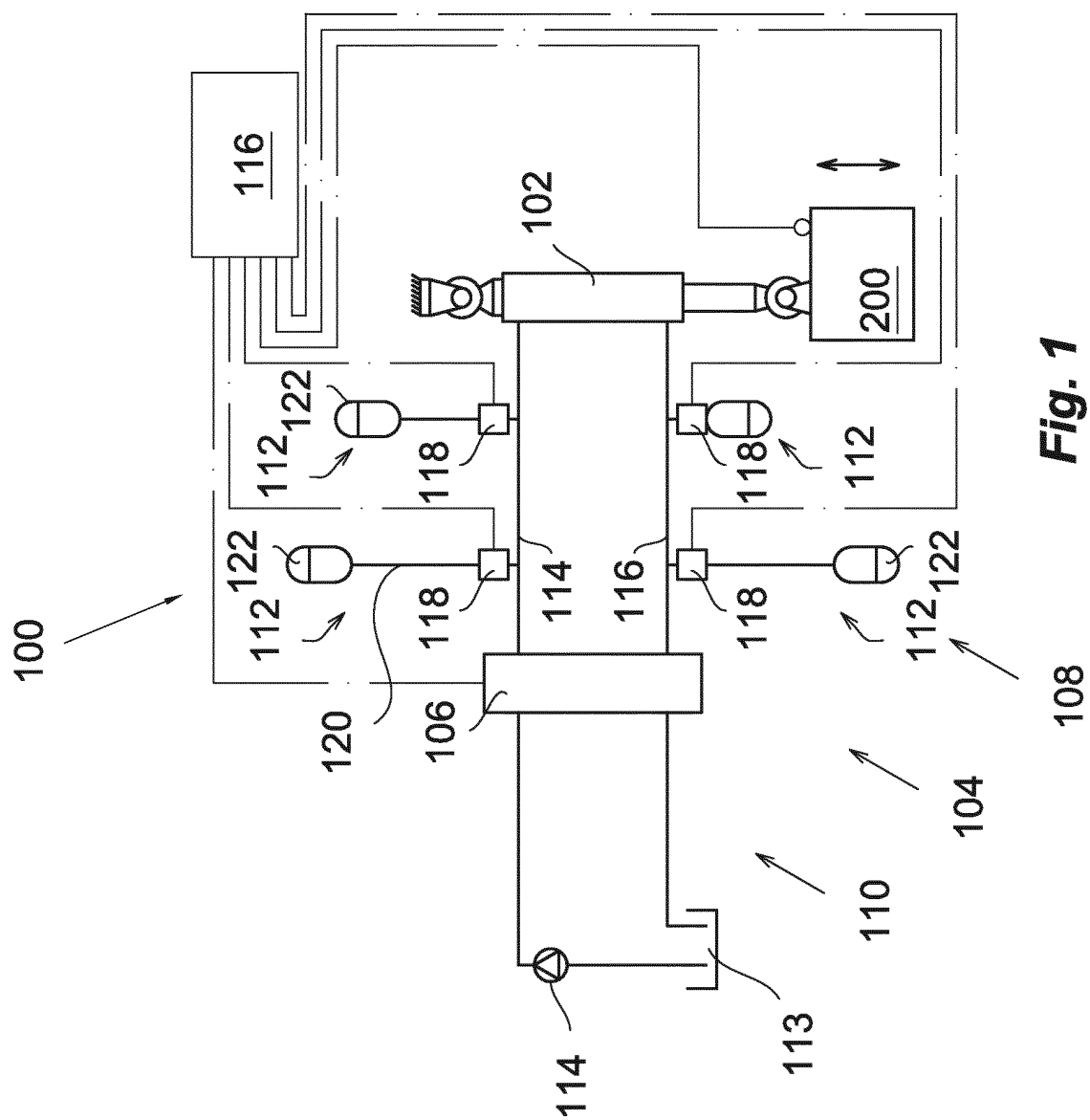
14. Method according to claim 13, **characterized in that** the dynamical properties of at least one of the elements are controlled such that the peak rigidity frequency of the power device (102) is arranged to locate within the vibration frequency range subjected to the power device.

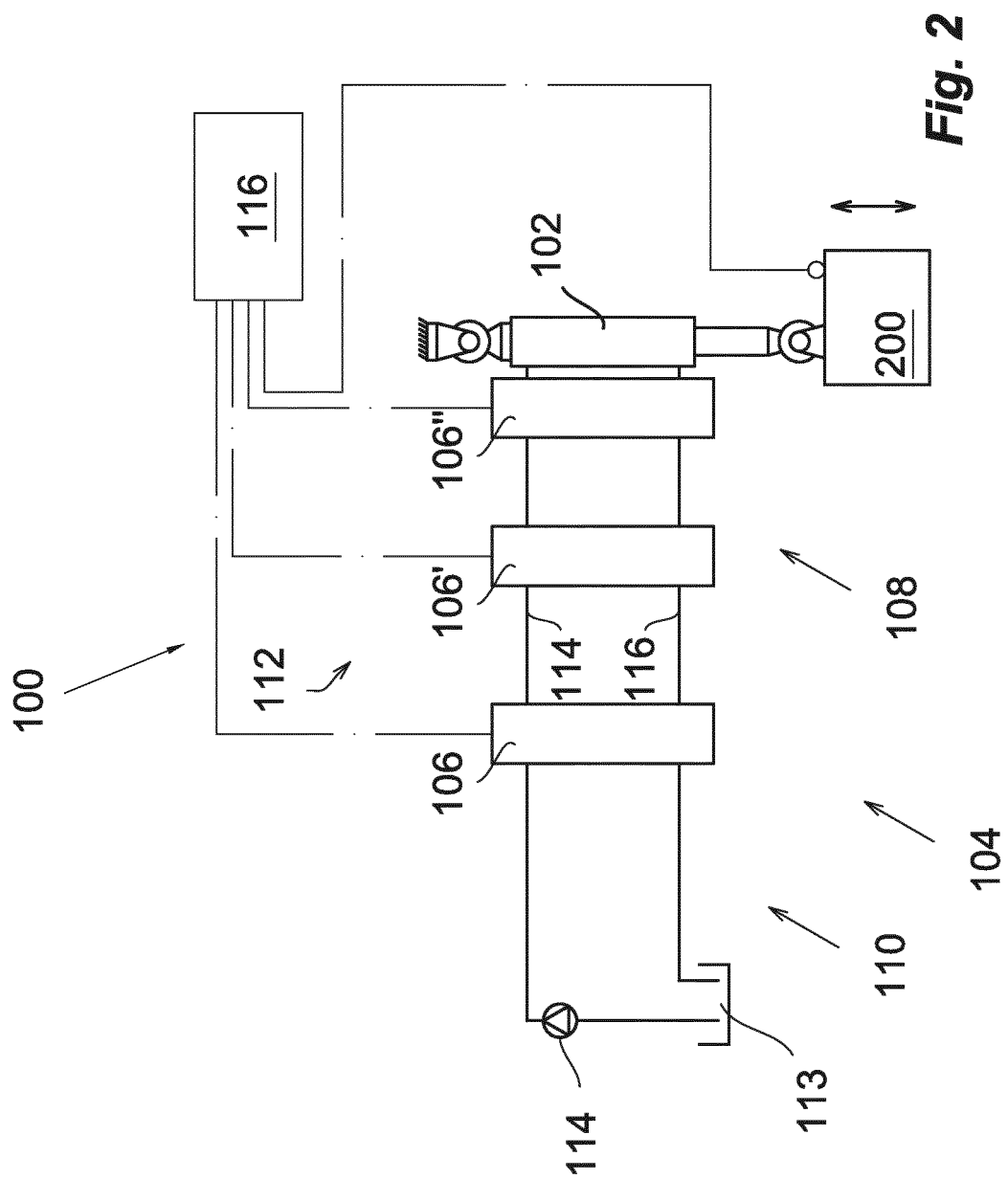
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15. Method according to claim 14, **characterized in that** the dynamical properties of at least one of the elements are selected between at least two different settings of which in the first setting the dynamical properties effect on dynamic rigidity of the power device (102) at a first vibration frequency range subjected to the power device and, in the second setting the dynamical properties effect on dynamic rigidity

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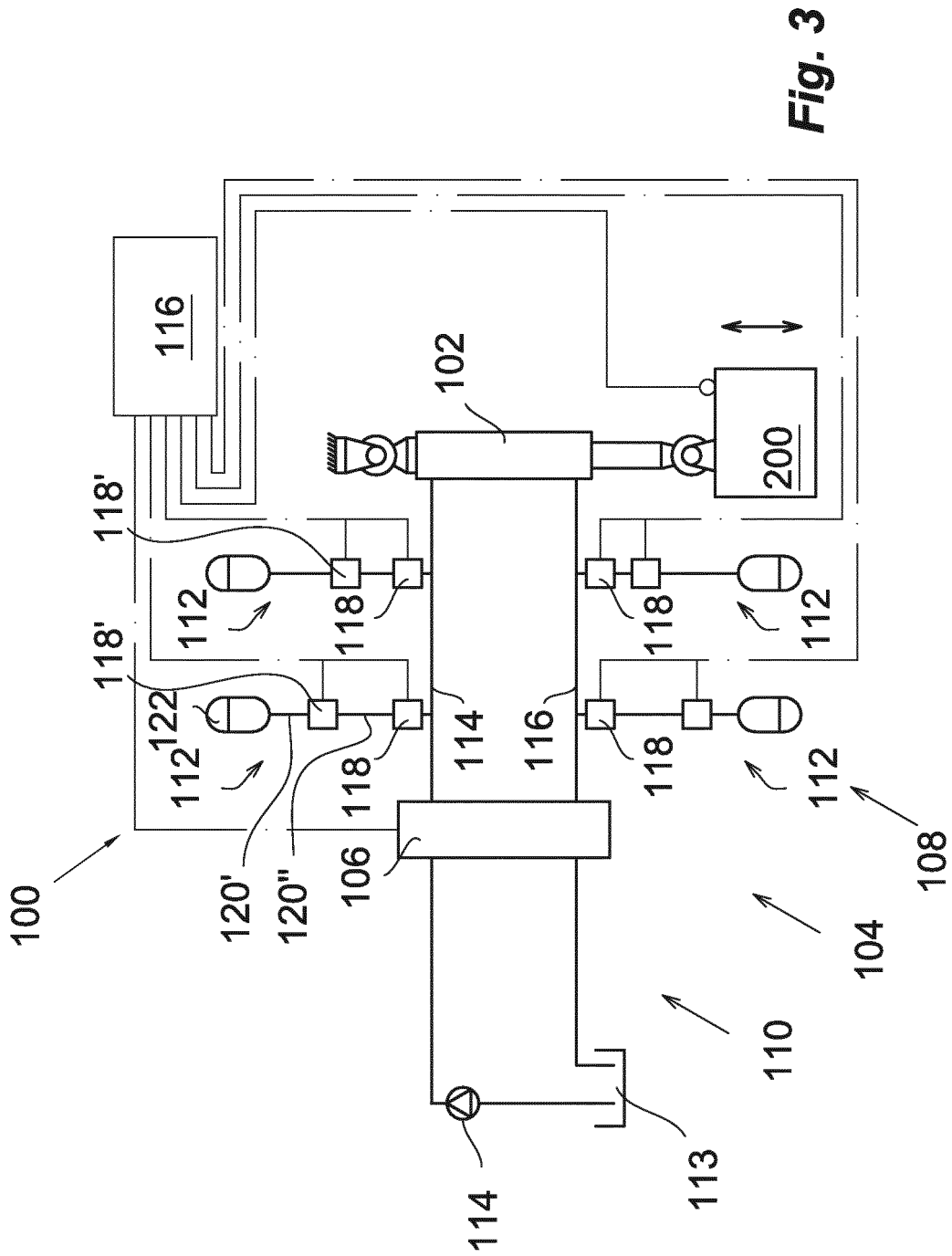


Fig. 3

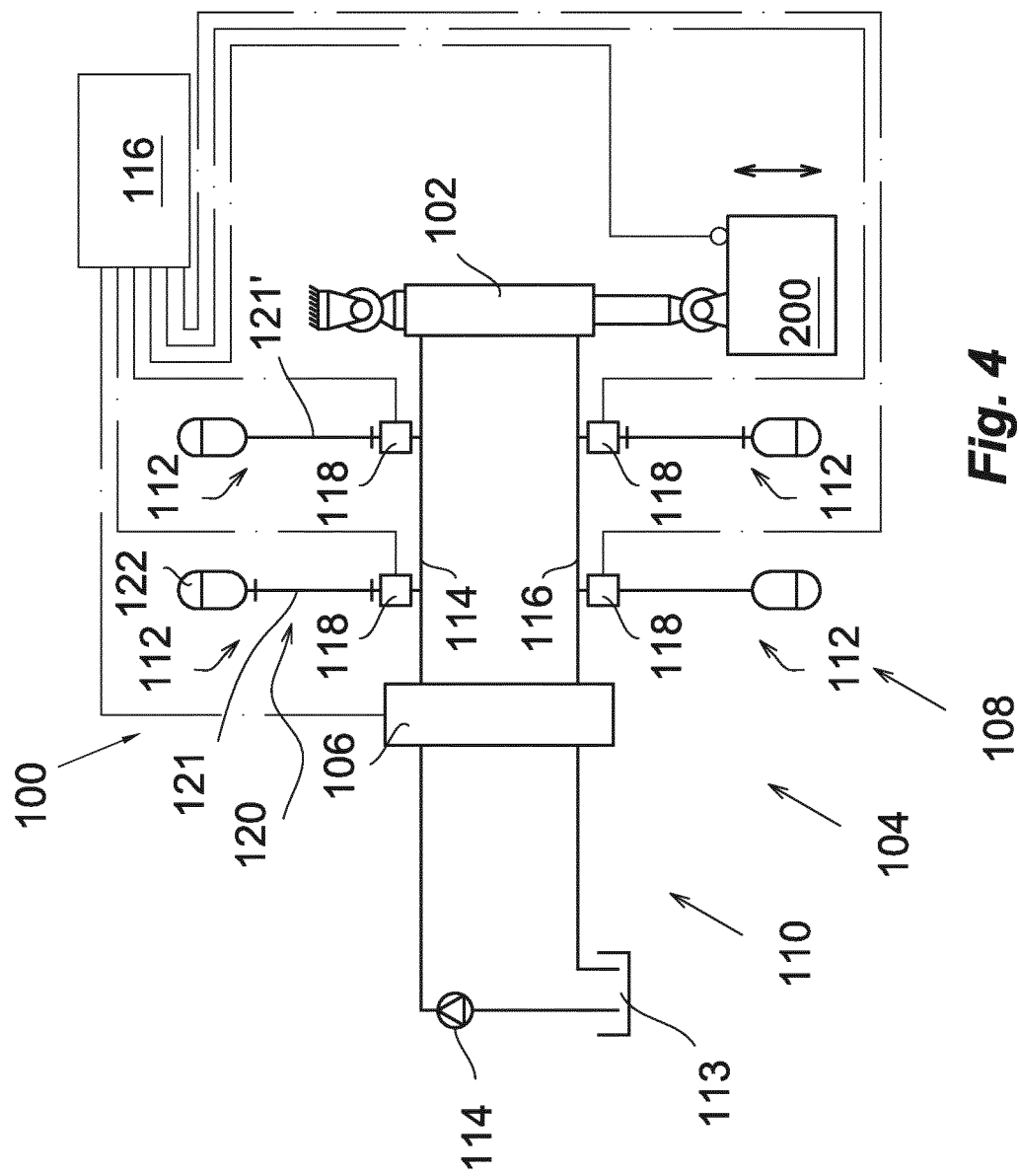


Fig. 4

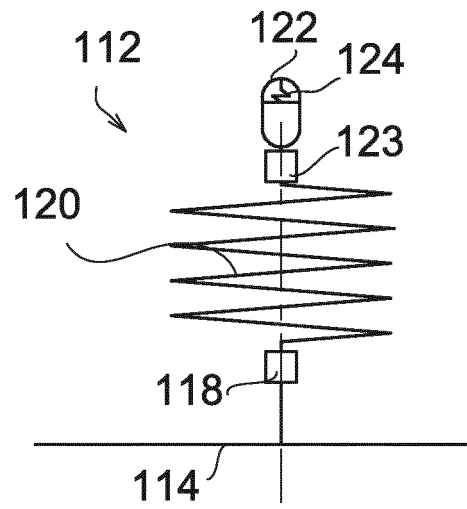


Fig. 5

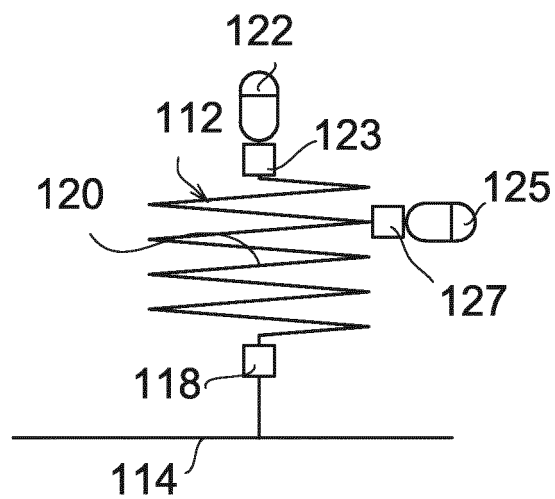
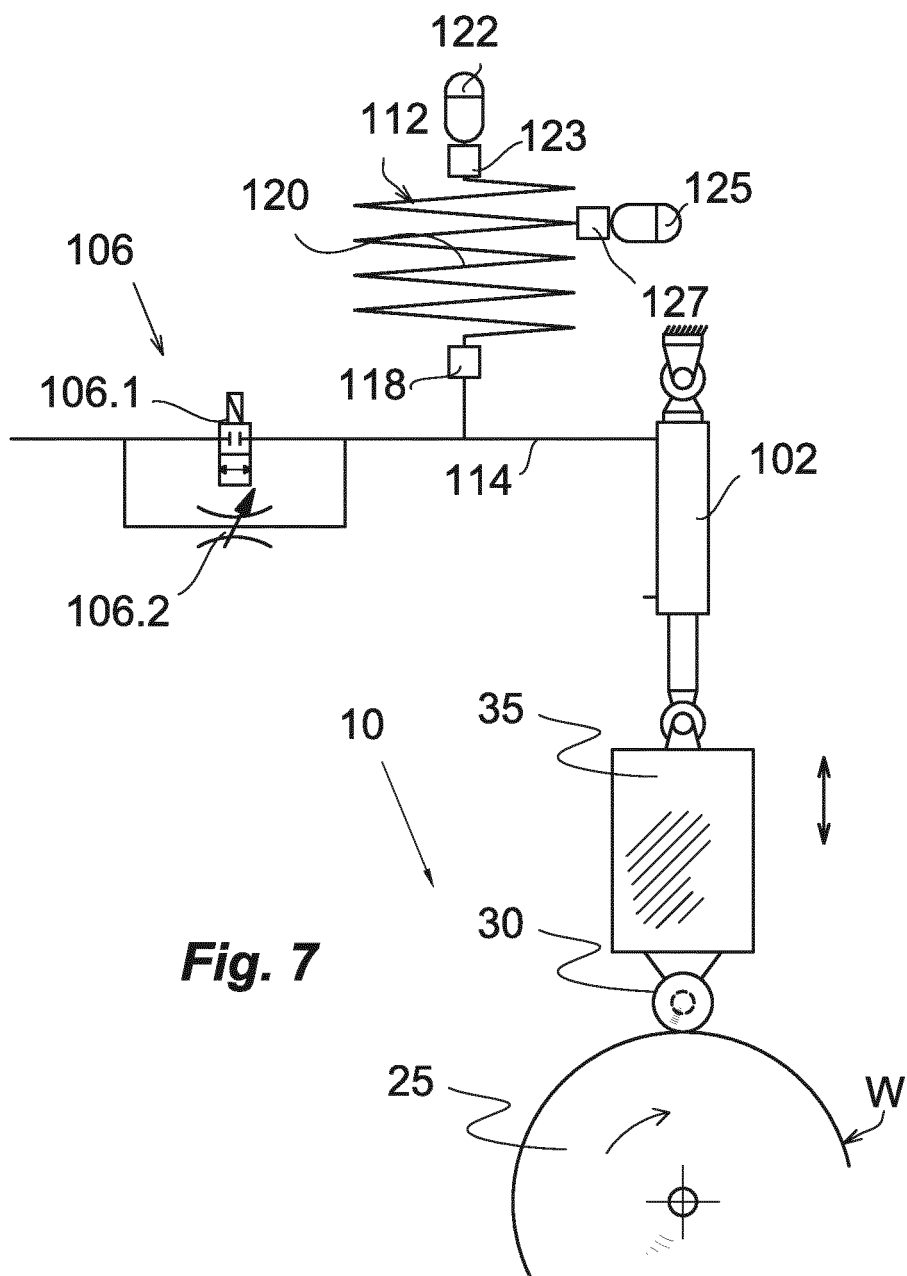


Fig. 6





EUROPEAN SEARCH REPORT

Application Number
EP 13 17 4187

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 4 February 2014	Examiner Raffaelli, Leonardo
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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