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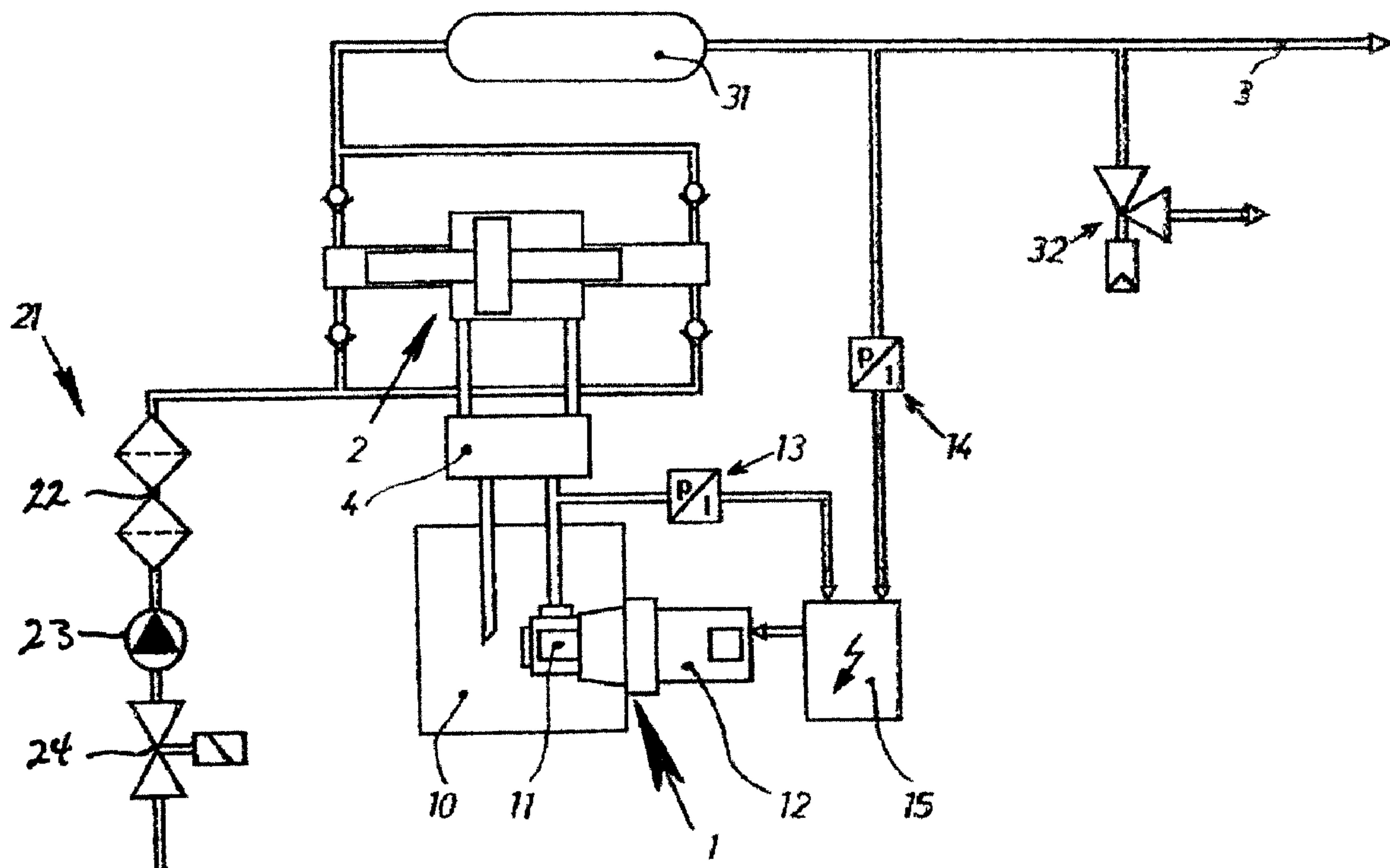
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(54) Title: HYDRAULIC DRIVE FOR A PRESSURE BOOSTER



(57) **Abrégé/Abstract:**

Hydraulic drive and method for driving a pressure booster of a high-pressure apparatus. The hydraulic drive includes a pressure medium pump having one of a constant displacement pump and a pump conveying a constant volume per revolution, a servo motor coupled to drive the pump, and a controller structured to at least one of electrically control, regulate and switch the servo motor, which is arranged on at least one of a low pressure side and a high pressure side of the pressure booster.

ABSTRACT OF THE DISCLOSURE

Hydraulic drive and method for driving a pressure booster of a high-pressure apparatus. The hydraulic drive includes a pressure medium pump having one of a constant displacement pump and a pump conveying a constant volume per revolution, a servo motor coupled to drive the pump, and a controller structured to at least one of electrically control, regulate and switch the servo motor, which is arranged on at least one of a low pressure side and a high pressure side of the pressure booster.

P41488.S02

HYDRAULIC DRIVE FOR A PRESSURE BOOSTER

[0001]

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates to a hydraulic drive with a quantity control and/or pressure control for a pressure booster of a high-pressure apparatus, comprising essentially a motor drive with a pump for a pressure medium as well as a control.

2. Discussion of Background Information

[0003] Modern high-pressure apparatuses operate with pressures of up to 10,000 bar and more and make extremely high mechanical demands on the materials of the apparatus components, which often lie in the limit range of the high-strength alloys with respect to mechanical tensile strength and alternate strength. Although pressure relief valves are provided throughout therein for sudden interruptions of the flow of the fluid in the high-pressure line, an increase in pressure can cause material damage until the valve is triggered.

[0004] The pressure boosters as described above operate according to the principle of hydraulic pressure boosters, as is known to those practiced in the art.

[0005] A drive of a pressure booster usually takes place via a hydraulic part with a quantity control and/or pressure control of a hydraulic fluid, which part is essentially formed by a motor drive and a pump part.

P41488.S02

[0006] An efficient long-term pumping is essential for the hydraulic part of a high-pressure apparatus, a direct adjustability with shutdowns or blockages with an avoidance of overpressure peaks and a low pulsation in the high-pressure section of the apparatus.

[0007] According to the prior art, piston pumps are usually chosen as a hydraulic drive for a pressure booster, which have a high power density for high pressures with good volumetric efficiency and good hydraulic mechanical efficiency with the most accurate adjustability of the piston displacement. These pumps are piston pumps expertly formed throughout by several parallel units, which as axial piston machines can be embodied in bent axis design or as radial piston pumps and have special advantages.

[0008] Further, these are self-adjusting gaps with hydrostatic/hydrodynamic stresses of axial piston machines, while there is also the possibility of a direct quantity control of the fluid by axial angle adjustment drive/pump system.

SUMMARY OF THE INVENTION

[0009] In accordance with the demands on technical progress in the sector of high-pressure apparatuses, i.e., the safety of the plant control, the minimization of the pressure surges and thus the minimization of the material overloads of components in the high pressure section, the increase in the service life of the apparatus, the increase in energy efficiency, the reduction of power consumption in the case of pressure boosters at rest and the improved performance of the high-pressure apparatus, embodiments of the invention create a hydraulic unit for a high pressure booster of the type mentioned at the outset, the use of which overcomes the disadvantages of the prior art.

[0010] According to embodiments, a generic drive for a pressure booster of a high pressure apparatus includes a constant displacement pump, or a pump which conveys a constant volume per revolution, driven by a servomotor that together form a hydraulic drive. The servomotor can be electrically controlled, regulated and/or switched on the low-pressure side and/or on the high-pressure side.

More specifically the present invention provides a hydraulic drive for a pressure booster of a high-pressure apparatus, comprising:

- a pressure medium pump comprising one of a constant displacement pump and a pump conveying a constant volume per revolution;

- a servo motor coupled to drive the pump; and

- a controller structured to at least one of electrically control, regulate and switch the servo motor, which is arranged on at least one of a low pressure side and a high pressure side of the pressure booster.

The present invention also provides a method for driving a pressure booster of a high-pressure apparatus, comprising:

- controlling a servo motor based upon pressures on at least one of a low pressure side and a high pressure side of the pressure booster; and

- driving a pressure medium pump via the controlled servo motor to drive a hydraulic ram of the pressure booster.

The present invention also provides a hydraulic drive with a volume and/or pressure regulation for a pressure intensifier of a high pressure device, consisting substantially of a motor drive with a pump for a means of exerting pressure as well as a control, wherein:

- a constant delivery flow pump, or a pump which delivers a constant volume per rotation, is used as a hydraulic drive; and

- the hydraulic drive is driven by a servomotor, which servomotor is electrically controllable by low-pressure side means, by high-pressure side means, or by both low-pressure side means and high-pressure side means.

P41488.S02

[0011] There are multiple advantages of the hydraulic drive for a pressure booster according to the invention. One advantage is to be seen in that essentially no pulsation is produced during the insertion of a high-pressure medium into a filler, or no chipping off of brittle materials upon ejection with water jet cutting.

[0012] Pressure fluctuations when switching the cutting valve on and off are kept low by a use of the new hydraulic drive, whereby an overloading of the components is largely avoided.

[0013] A change in quantity during the removal of high pressure fluid does not require any direct plant adaptation.

[0014] A soft start of the high pressure plant takes place in a favorable manner with particularly low energy expenditures.

[0015] In a further development of the invention, a gerotor pump is used as a constant displacement pump. Due to an adapted tooth form, gerotor pumps have favorable tooth engagement ratios and thus low volume flow pulsation at high operating pressures of approx. 300 bar with good efficiency. Pumps of this type are also characterized by low sound pressure levels.

[0016] A servo drive can contain a direct-current motor, an asynchronous motor or a synchronous motor, that is, any type of electric motor. The distinction lies only in the triggering of the motor, which is carried out by a closed control loop to which according to the embodiments, signals can be fed by the pressure booster on the low pressure side and/or on the high pressure apparatus on the high pressure side.

[0017] In terms of installation engineering and process engineering, but also with respect to a minimization of energy consumption, it is advantageous if the servo motor is embodied or formed as a frequency-controlled drive motor.

[0018] Embodiments of the invention are directed to a hydraulic drive for a pressure booster of a high-pressure apparatus. The hydraulic drive includes a pressure medium pump having one of a constant displacement pump and a pump conveying a constant volume per revolution, a servo

P41488.S02

motor coupled to drive the pump, and a controller structured to at least one of electrically control, regulate and switch the servo motor, which is arranged on at least one of a low pressure side and a high pressure side of the pressure booster.

[0019] According to embodiments of the instant invention, the hydraulic drive can have at least one of a quantity control and a pressure control.

[0020] In accordance with other embodiments, when the pressure medium pump includes the constant displacement pump, the constant displacement pump can be a gerotor pump.

[0021] Further, in a closed control loop, the controller may be structured and arranged to receive signals from at least one of a signal generator on the low pressure side and a signal generator on the high pressure side in order to trigger operation of the servo motor. The signal generator on the low pressure side can include a low pressure pickup/converter, and the signal generator on the high pressure side can include a high pressure pickup/converter. Further, the low pressure pickup/converter and the high pressure pickup/converter may be structured to convert a sensed pressure to an electric signal.

[0022] According to other embodiments, wherein an operating pressure on the low pressure side can be within a range of 200 – 400 bar. Additionally or alternatively, an operating pressure on the high pressure side may be within a range up to 10,000 bar. Further, the operating pressure on the high pressure side can be within a range of 300 – 6000 bar.

[0023] In accordance with still other embodiments of the invention, the servo motor may include a frequency-controlled drive motor.

[0024] Embodiments of the present invention are directed to a method for driving a pressure booster of a high-pressure apparatus. The method includes controlling a servo motor based upon pressures on at least one of a low pressure side and a high pressure side of the pressure booster, and driving a pressure medium pump via the controlled servo motor to drive a hydraulic ram of the pressure booster.

P41488.S02

[0025] According to embodiments, the pressure booster can include two hydraulic rams driven by the pressure medium pump.

[0026] In accordance with other embodiments of the invention, the pressure medium pump can include at least one of a constant displacement pump and a pump conveying a constant volume per revolution.

[0027] In accordance with still yet other embodiments of the present invention, the method can also include controlling, in a closed control loop, a triggering operation of the servo motor based upon signals received from signal generators located on the low pressure side and on the high pressure side. Still further, a low pressure pickup/converter can be arranged in the closed control loop as the signal generator on the low pressure side, and a high pressure pickup/converter may be arranged in the closed control loop as the signal generator on the high pressure side. The low pressure pickup/converter and the high pressure pickup/converter can convert a sensed pressure to an electric signal.

[0028] Other exemplary embodiments and advantages of the present invention may be ascertained by reviewing the present disclosure and the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The present invention is further described in the detailed description which follows, in reference to the noted plurality of drawings by way of non-limiting examples of exemplary embodiments of the present invention, in which like reference numerals represent similar parts throughout the several views of the drawings, and wherein:

[0030] Fig. 1 schematically illustrates a high pressure apparatus in accordance with embodiments of the invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0031] The particulars shown herein are by way of example and for purposes of illustrative discussion of the embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the

P41488.S02

principles and conceptual aspects of the present invention. In this regard, no attempt is made to show structural details of the present invention in more detail than is necessary for the fundamental understanding of the present invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the present invention may be embodied in practice.

[0032] Fig. 1 diagrammatically shows a high pressure apparatus with a conveyor line 3, a pulsation damper 31 and a pressure relief valve 32 on the outlet side.

[0033] A pressure booster 2 can be supplied with high-pressure fluid via series units 21, such as, for example, low pressure filters 22, booster pump 23, and shut-off valve 24.

[0034] A pressure booster 2, which can, e.g., have two hydraulic rams, may be moveable by a pressure medium 10 via a hydraulic unit 1 formed by, e.g., a pump 11, e.g., a constant flow rate pump and/or a pump conveying a constant volume per revolution, and a motor 12, e.g., a servo motor, through cluster gears 4. An electronic control 15 of motor 12 can be arranged to receive electrical feedback signals, e.g., by way of a closed control loop, from a high pressure pickup/converter 14 and/or from a low pressure pickup/converter 13 in order to electrically control, regulate or switch motor 12. High and low pressure pickup/converters 14 and 13 convert a sensed pressure into an electrical signal, such as a current signal, having a magnitude related to the magnitude of the pressure. By way of non-limiting example, the operating pressure on the low pressure side can be in a range of, e.g., 200 – 400 bar, while the operating pressure on the high pressure side can be in a range of, e.g., 3000 – 6000 bar, and up to 10,000 bar in, e.g., test systems.

[0035] A feed of pressure booster 2 can be carried out in a known manner, e.g., by bent axis displacement pumps with hydraulic mechanical quantity controllers with parallel acting cylinders, the conveyor flows of which are added together.

[0036] In the case of direct axial alignment, an immediate reduction of the pump performance of pressure medium to zero can be achieved despite a motor rotation.

[0037] A high pressure apparatus such as, for example, a water jet cutting plant usually has longer lasting work phases, so that a drive of a pressure booster via a servo motor and a pump with constant quantity pumping must appear far removed from a conventional technically advantageous solution to one with skill in the art.

[0038] Surprisingly, it has been shown that a use of a constant displacement pump 11 driven by a servo motor 12 has advantages when used as part of a hydraulic drive 1 in accordance with embodiments of the invention for a pressure booster 2 of a high pressure apparatus.

[0039] Among other things, this arrangement results in extremely low pulsations of a high-pressure water jet, which does not cause any chipping in the case of brittle materials even when cutting a through hole. Moreover, this may advantageously be achieved through the use of a gerotor pump 11 for a hydraulic drive 1 of a pressure booster 2.

[0040] According to embodiments, hydraulic drive 1 can be utilized in accordance with the invention to cause low pulsations and in particular slight high-pressure fluctuations in the case of a stop/go operation of a system. In this way, the service life of the high pressure components is increased.

[0041] In an advantageous manner with closed high-pressure nozzles, no movement of the servo motor and no power consumption of the same take place. In this manner, the start power consumption can be reduced with a soft start of the hydraulic drive 1.

[0042] It is noted that the foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention. While the present invention has been described with reference to an exemplary embodiment, it is understood that the words which have been used herein are words of description and illustration, rather than words of limitation. Changes may be made, within the purview of the appended claims, as presently stated and as amended, without departing from the scope of the present invention in its aspects. Although the present invention has been described herein with reference to particular means, materials and embodiments, the present invention is not intended to be limited to the particulars disclosed herein; rather, the present invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A hydraulic drive for a pressure booster of a high-pressure apparatus, comprising:
 - a pressure medium pump comprising one of a constant displacement pump and a pump conveying a constant volume per revolution;
 - a servo motor coupled to drive the pump; and
 - a controller structured to at least one of electrically control, regulate and switch the servo motor, which is arranged on at least one of a low pressure side and a high pressure side of the pressure booster.
2. The hydraulic drive according to claim 1 having at least one of a quantity control and a pressure control.
3. The hydraulic drive according to claim 1 or 2, wherein, when the pressure medium pump comprises the constant displacement pump, the constant displacement pump is a gerotor pump.
4. The hydraulic drive according to claim 1, 2 or 3, wherein, in a closed control loop, the controller is structured and arranged to receive signals from at least one of a signal generator on the low pressure side and a signal generator on the high pressure side in order to trigger operation of the servo motor.
5. The hydraulic drive according to claim 4, the signal generator on the low pressure side comprises a low pressure pickup/converter, and the signal generator on the high pressure side comprises a high pressure pickup/converter.
6. The hydraulic drive according to claim 5, wherein the low pressure pickup/converter and the high pressure pickup/converter are structured to convert a sensed pressure to an electric signal.

7. The hydraulic drive according to any one of claims 1 to 6, wherein an operating pressure on the low pressure side is within a range of 200 — 400 bar.

8. The hydraulic drive according to any one of claims 1 to 6, wherein an operating pressure on the high pressure side is within a range up to 10,000 bar.

9. The hydraulic drive according to claim 8, wherein the operating pressure on the high pressure side is within a range of 300 — 6000 bar.

10. The hydraulic drive according to any one of claims 1 to 9, wherein the servo motor comprises a frequency-controlled drive motor.

11. A method for driving a pressure booster of a high-pressure apparatus, comprising:

controlling a servo motor based upon pressures on at least one of a low pressure side and a high pressure side of the pressure booster; and

driving a pressure medium pump via the controlled servo motor to drive a hydraulic ram of the pressure booster.

12. The method according to claim 11, wherein the pressure booster comprises two hydraulic rams driven by the pressure medium pump.

13. The method according to claim 11 or 12, wherein the pressure medium pump comprises at least one of a constant displacement pump and a pump conveying a constant volume per revolution.

14. The method according to claim 11, 12 or 13, further comprising controlling, in a closed control loop, a triggering operation of the servo motor based upon signals received from signal generators located on the low pressure side and on the high pressure side.

15. The method according to claim 14, wherein a low pressure pickup/converter is arranged in the closed control loop as the signal generator on the low pressure side, and a high pressure pickup/converter is arranged in the closed control loop as the signal generator on the high pressure side.

16. The method according to claim 15, wherein the low pressure pickup/converter and the high pressure pickup/converter convert a sensed pressure to an electric signal.

17. The method according to any one of claims 11 to 16, wherein an operating pressure on the low pressure side is within a range of 200 — 400 bar.

18. The method according to any one of claims 11 to 16, wherein an operating pressure on the high pressure side is within a range up to 10,000 bar.

19. The method according to claim 18, wherein the operating pressure on the high pressure side is within a range of 300 — 6000 bar.

20. The method according to any one of claims 11 to 19, wherein the servo motor comprises a frequency-controlled drive motor.

21. A hydraulic drive with a volume and/or pressure regulation for a pressure intensifier of a high pressure device, consisting substantially of a motor drive with a pump for a means of exerting pressure as well as a control, wherein:

a constant delivery flow pump, or a pump which delivers a constant volume per rotation, is used as a hydraulic drive; and

the hydraulic drive is driven by a servomotor, which servomotor is electrically controllable by low-pressure side means, by high-pressure side means, or by both low-pressure side means and high-pressure side means.

22. A hydraulic drive according to claim 21, wherein an internal gear pump is used as a constant delivery flow pump.

23. A hydraulic drive according to claim 21 or 22, wherein activation of the motor in servo operation occurs through a closed control loop, to which signals are supplied by low-pressure side means in the hydraulic circuit and/or by high-pressure side means of the electrical control of the high pressure device.

24. A hydraulic drive according to any one of claims 21 to 23, wherein the servomotor is designed as a frequency-controlled drive motor.

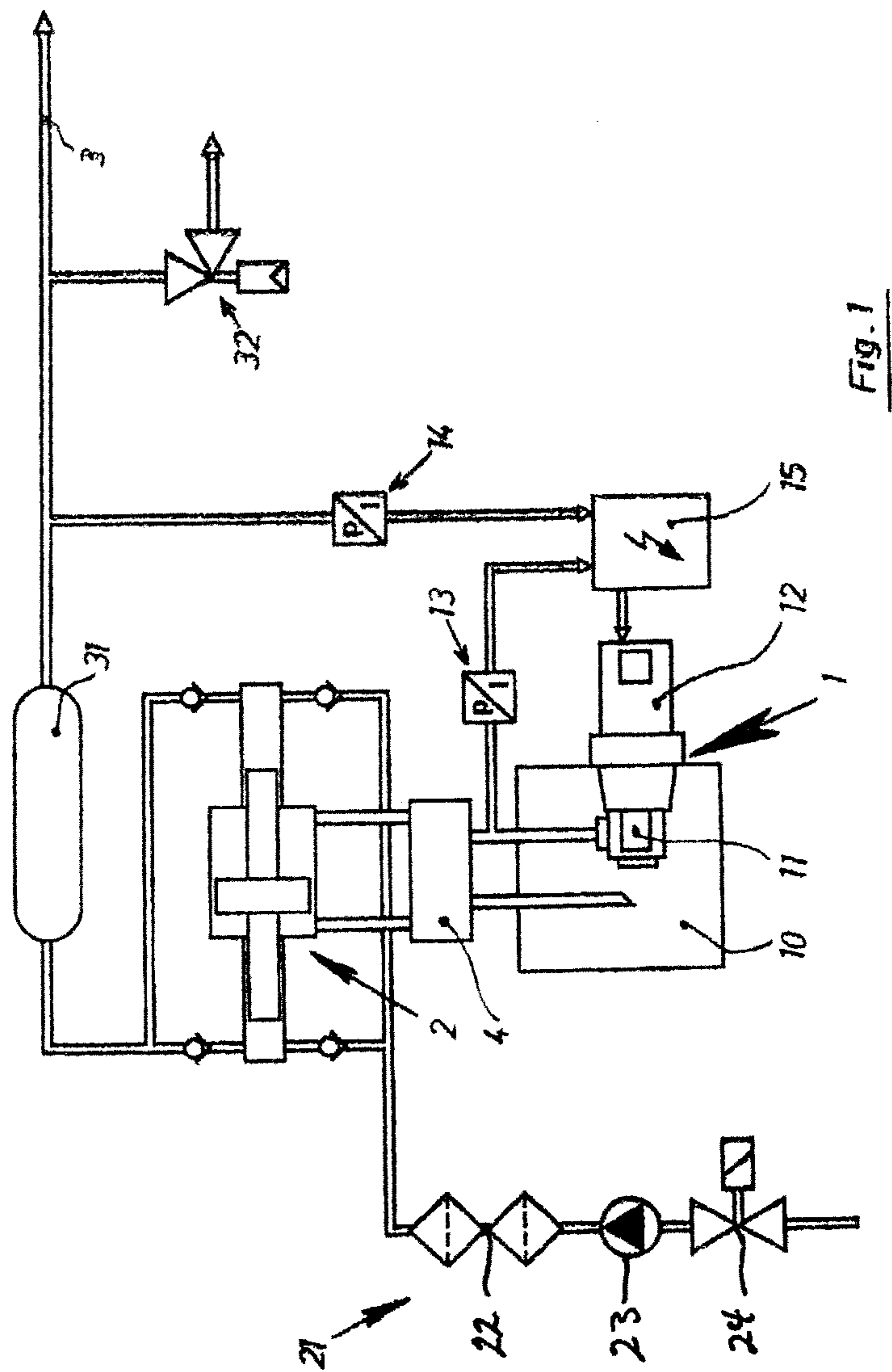


Fig. 1

