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(54) FLUID-DYNAMIC PLANT FOR THE CONTROLLED DRIVE OF THE RAM OF A PRESS

(57) The fluid dynamic plant for the controlled drive of the ram of a press comprises: a pushing piston (20) housed sliding in a sliding seating (30) of a press and that divides it into a stem-side chamber (30A) and a thrust-side chamber (30B); a first pump (1) of a pressurized fluid which is driven and/or controlled by a first servomotor (11) functionally connected therewith; an accumulator group (6) of pressurized fluid which is fluid-dynamically connected alternatively to the first pump (1) or to the sliding seating (30); a distributor group (3) for alternate fluid-dynamic connection of the first pump (1) to said sliding seating (30) or of the first pump (1) to the accumulator group (6), a power generator group (34) being interposed between the latter and the sliding seating.

FIG. 2

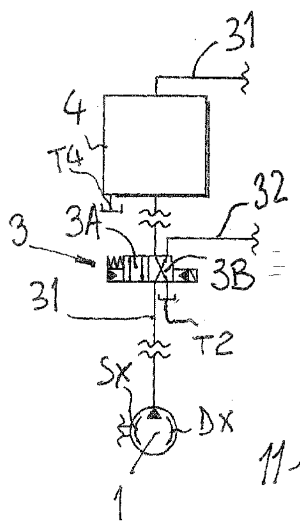
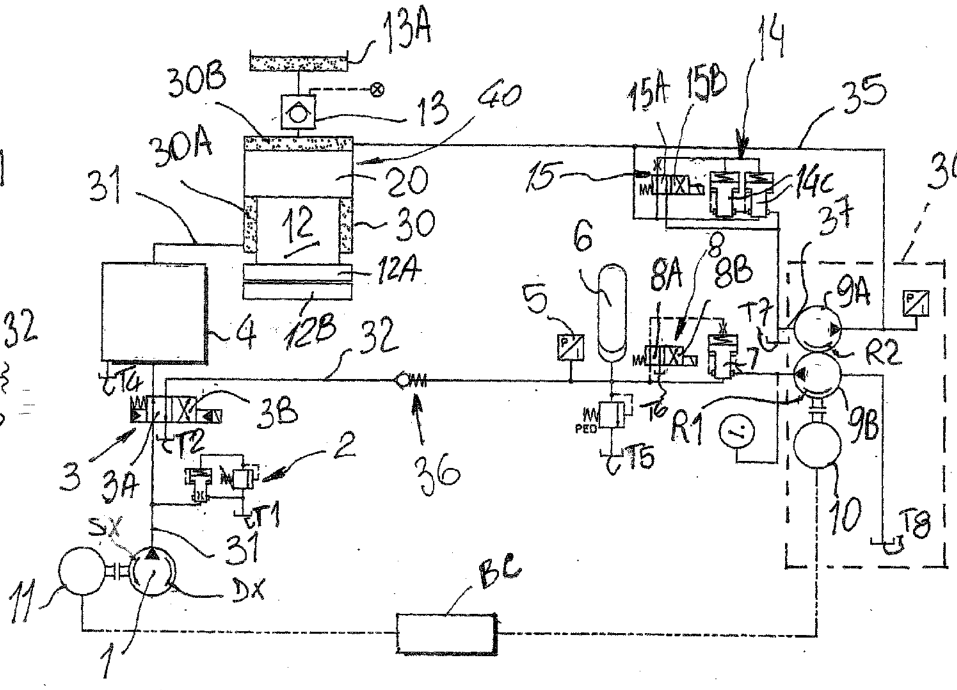


FIG. 1



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Description

Field of the invention

[0001] The invention concerns a fluid-dynamic plant for the controlled drive of the ram of a press, generally used to manage the functioning steps of the working piston and at the same time avoid waste of energy.

Background of the invention

[0002] Fluid-dynamic plants are known which are used to move the pushing piston of a press in the active work and return travels, in particular of a press typically used in the field of production of shaped metal sheets to produce household appliances.

[0003] Typically, a known fluid-dynamic plant comprises, very schematically, a fluid-dynamic pump with a variable flow rate that is driven by an asynchronous motor.

[0004] The pump, by means of a fluid-dynamic circuit in which oil flows, is connected to a control servo-valve, which functions as a multi-position distributor, and, through this, to a pressurized oil accumulator group or, alternatively according to the work positions of the servo-valve, to the chamber where the piston of the pushing cylinder slides.

[0005] The servo-valve, in this type of fluid-dynamic group, works in practice as an element to control the movements of the cylinder which, in the work step, occur in three consecutive travel segments and precisely a first segment of rapid approach to the piece of metal sheet to be worked positioned on a work plane of the press, a second segment in which work begins and a third segment in which the work to be performed is completed.

[0006] Indicatively, the first segment has a travel of about 400 millimeters, the second segment has a travel of about 60 millimeters, the third segment has a travel of about 15 millimeters.

[0007] In the first travel segment, the piston, starting from a resting position in which it is completely raised from the piece of metal sheet to be worked, that is, from the top dead center, rapidly descends by gravity toward it, controlled in the descent by the servo-valve, putting the stem-side seating of the piston in connection with a drain.

[0008] During the step of transferring the metal sheet, after completing a previous work cycle, the servo-valve switches its configuration and connects the fluid-dynamic pump with an accumulator group, closing the connection between the pump and the sliding seat of the piston.

[0009] In this configuration, the pump is put into function by the asynchronous motor which assumes an active function and which, since the connection with the sliding seat of the piston is intercepted by the servo-valve, supplies pressurized oil to the accumulator group, in the specific case in the form of a pair of accumulators, until oil is accumulated inside them at a predetermined pressure value, as a function of the force necessary to complete the second travel segment.

[0010] When the pressure inside the accumulator group has reached the predetermined value and detected by a pressure sensor provided for this purpose, the pump and the asynchronous motor stop and in this configuration, the lower end of the piston, which is typically equipped with a work tool, is in a position in which it rests on the piece of metal sheet to be worked, after having completed the first approach travel.

[0011] Subsequently, the servo-valve switches its position into the configuration in which it puts the accumulator group and the sliding seat of the piston in connection with each other, typically the thrust chamber side, that is, the side opposite the stem side, in which, after the first travel segment of the piston, the pressure is substantially zero.

[0012] Owing to this connection, a pressure difference is generated between the accumulator group and the thrust side chamber which is progressively reduced.

[0013] In the thrust side chamber of the piston, the oil pressure increases progressively, causing the piston to perform the second travel segment in which the tool starts its active action of working and pre-shaping the piece of metal sheet.

[0014] When the force of the piston is exhausted, to complete the deformation step, therefore make the piston perform the third travel segment, the servo-valve switches its position connecting the pump, typically with a variable flow rate, with the thrust side chamber of the sliding seat of the piston which, due to a further increase in the pressure inside it generated by the oil sent by the pump, performs the third and final travel segment, completing the working of the piece of metal sheet, using the maximum pressure of the oil, known as the specification power.

[0015] This state of the art has some disadvantages.

[0016] One disadvantage is that generally the control of the speed and of the position, and therefore of the overall functioning, of the ram that supports the piston of the press is obtained by means of servo-valves which have an energy dissipative functioning.

[0017] Another disadvantage is that the pump sends oil to an accumulator group until it reaches an excessive predetermined pressure therein, in particular at the beginning of the performance of the second segment, that is, when the mold is simply resting on the metal sheet and the beginning of the deformation occurs with a limited thrust.

[0018] Therefore, in these cases, the difference in oil pressure that is created between the maximum pressure that is stored inside the accumulator groups and the limited pressure actually necessary to perform some displacements of the piston, is completely lost, with the intervention of the servo-valve which, in order to maintain the speed of advance of the ram constant at a predetermined value, has to create a loss of load able to nullify the difference between the pressure available in the accumulator group and the real pressure necessary to perform the second segment of the travel.

[0019] A further disadvantage is that the servo-valve produces, during the steps of controlling the flows of pressurized oil, a high overheating which requires the adoption of suitable and expensive cooling devices, both air/oil and also water/oil.

[0020] Another disadvantage is that the asynchronous motor used for the functioning of the fluid-dynamic pump has to have a sufficiently high power to perform the third travel segment in the required time.

Objects of the invention

[0021] One object of the invention is to improve the state of the art.

[0022] Another object of the invention is to provide a fluid-dynamic plant for the controlled drive of the ram of a press that allows to generate energy when it is not required to drive the piston of the press, in particular during the rapid descent step, when the oil present in the stem-side chamber of the cylinder makes the servo-pump rotate, transforming the latter into a motor and the brushless motor into a generator.

[0023] A further object of the invention is to provide a fluid-dynamic plant for the controlled drive of the ram of a press that does not produce overheating.

[0024] Another object of the invention is to provide a fluid-dynamic plant for the controlled drive of the ram in the third travel segment, that is, when the maximum force is required to complete the third segment within the minimum time required.

[0025] According to one aspect of the invention, a fluid-dynamic plant is provided for the controlled drive of the ram of a press, in accordance with the characteristics of claim 1.

[0026] Further characteristics of the invention are indicated in the dependent claims. The invention allows to obtain the following advantages:

- recover energy during the rapid descent step of the ram, exploiting its own weight to drive the pump as a fluid-dynamic motor and the brushless motor as a generator;
- maintain oil temperatures and general functioning temperatures lower than those of the state of the art;
- use, for equal performances, servo-motors of reduced power, and therefore more economical than those of the state of the art.

Brief description of the drawings

[0027] Further characteristics and advantages of the invention will become increasingly apparent from the following detailed description of preferred, but not exclusive, embodiments of a fluid-dynamic plant for the controlled drive of the ram of a press, given as a not-limiting example with reference to the attached drawings wherein:

FIG. 1 is a schematic view of a fluid-dynamic plant for the controlled drive of the ram of a press, according to the invention, in a first embodiment;

FIG. 2 is a partial view of a second possible functioning condition of the fluid-dynamic plant according to the invention, in the version of fig. 1;

FIG. 3 is a schematic view of a fluid-dynamic plant for the controlled drive of the ram of a press, according to the invention, in a second embodiment;

FIG. 4 is a partial view of a second possible functioning condition of the fluid-dynamic plant according to the invention, in the version of fig. 3.

Detailed description of a preferred embodiment

[0028] With reference to all the drawings as above, references from T1 to T8 generally indicate fluid-dynamic drains provided in the plant for the controlled drive of the ram of a press, according to the invention, and BC generally indicates a battery of capacitors.

[0029] Reference 40 indicates a conventional cylinder of a press, which comprises a piston 20 which is received sliding in a sliding seating 30.

[0030] The piston 20 has a stem 12 and divides the sliding seating 30 into two parts, namely a stem-side chamber 30A and a thrust-side chamber 30B.

[0031] The latter is connected to a suction valve 13 which allows to supply oil to the thrust chamber 30B under certain conditions described below, oil that is contained in a tank 13A.

[0032] The stem-side chamber 30A is connected by means of a line 31 to a first pump 1 able to rotate alternately in two directions of rotation, indicated respectively with SX and DX, and which is mechanically connected to a first servo-motor 11 of the brushless type, hereafter first servo-motor 11 for short.

[0033] A distributor 3 is positioned along the line 31, which has two functioning positions, indicated with 3A and 3B respectively.

[0034] A safety unit 4 is interposed between the distributor 3 and the stem-side chamber 30A, which has the task of preventing the accidental fall of the piston 20 and which comprises a safety valve (not shown) which can be activated or deactivated on command.

[0035] Still on the line 31, between the first pump 1 and the distributor 3, a maximum pressure valve 2 is provided which can be pre-calibrated and which serves to maintain the first pump 1 in safe conditions, that is, to drain oil to an outlet T1 in case of excessive increase of the pressure.

[0036] The distributor 3 is connected to an accumulator group 6, comprising in practice one or more accumulators associated with one another in a battery, by means of a second line 32 and a pressure transducer 5 is disposed upstream thereof, which is pre-calibrated to interrupt the functioning of the first pump 1 when a predetermined pressure value is reached inside the accumulator group 6.

[0037] An interception cartridge 7 is disposed immediately downstream of the accumulator group 6, which has the function of intercepting the oil that comes from the accumulator group 6 under certain functioning conditions of the fluid-dynamic group according to the invention.

[0038] The interception cartridge 7 is controlled by a second distributor, or pilot 8, which has two work positions, namely a position 8A, in which the interception cartridge 7 is maintained in a closed position, and a position 8B in which the interception cartridge 7 is free to open the connection of the second line 32 toward an power generating group.

[0039] The latter, in figs. 1 and 3, is visible inside the dashed box 34 and, as seen in fig. 1, is connected by means of the fluid-dynamic line 32 to the distributor 3 and to the thrust-side chamber 30B of the cylinder 40, by means of a further fluid-dynamic line 35.

[0040] A unidirectional valve 36 is located on the second line that allows the passage of a flow of oil only from the distributor 3 toward the accumulator group 6.

[0041] In a first embodiment, the power generating group comprises a second pumping group consisting of two pumps, namely a second 9A and a third 9B pump, both of the type with two quadrants, which have respective directions of rotation R1 and R2 and which are mechanically connected to each other.

[0042] The third pump 9B is mechanically connected to a second servo-motor 10 of the brushless type, hereafter second servo-motor 10 for short, while the second pump 9A is connected to the thrust-side chamber 30B by means of the third line 35 and to a drain T7 by means of a fourth line 36.

[0043] As shown in fig. 1, a quick decompression group, indicated as a whole with 14, is interposed between the thrust-side chamber 30B and the second pump 9A, which serves to quickly decompress the thrust-side chamber 30B after the step in which the piston 20 works a piece to be worked has been completed, and to allow the piston 20 to return to the top dead center of the sliding seating 30.

[0044] Referring to Fig. 3, a second possible embodiment of the fluid-dynamic plant for the controlled drive of the ram of a press, according to the invention, is shown.

[0045] In fig. 3, identical numerical references have been maintained for the elements in common with the first version of fig. 1, to make understanding more immediate for a reader.

[0046] The difference with respect to the first version of fig. 1 is that the second pump 9A and the third pump 9B of the second pumping group have been replaced with a single pump 9C of the type with four quadrants and double direction of rotation, as indicated with the arrows SX and DX.

[0047] Furthermore, the suction of the pump 9C is connected to the draint T7 which also uses the quick decompression group 14.

[0048] The latter comprises a pair of interception cartridges 14C which are located in parallel and which are commanded by a third distributor, or pilot 15, which has two work positions 15A and 15B.

[0049] Both the interception cartridges 14C are maintained in the normally closed position in order to intercept the flow of oil, in which the pilot 15 is in the work position 15A and only in a certain condition described below do they switch their position from normally closed to open.

[0050] The operation of the invention is as follows: in order to perform work on a piece positioned in a known manner between a mold 12A and a counter-mold 12B of a press, the piston 20 has to perform a first travel segment of rapid approach, indicatively of about 400 millimeters, a second segment to deform the piece, of about a further 60 millimeters, and finally a third segment of about 15 millimeters to complete the work of the piece.

[0051] Once the step of working the piece, normally a metal or plastic sheet, is completed, the piston 20 rises upward, until it reaches a top dead center (TDC) of the sliding seating 30, ready for a subsequent work cycle of another piece.

[0052] In the starting configuration of each work cycle, the piston 20 is therefore in a position raised to the TDC and this position is maintained by the anti-fall safety unit 4 in which the safety valve is in a closed configuration, while the distributor 3 is in the work position 3B and the first pump 1, driven by the first servo-motor 11, recharges the accumulator group 6, in which pressurized oil is already present, a residue of a previous work cycle.

[0053] The interception cartridge 7 is in a closed configuration since the pilot 8 is in the work position 8A connecting it to the outlet T6.

[0054] To perform the first travel segment that brings the mold 12A into contact with the piece to be worked, the configuration of the fluid-dynamic group for presses according to the invention is as follows: the safety unit 4 is deactivated by switching the safety valve to the open position.

[0055] The first pump 1 is driven in rotation in the direction SX by the pressurized oil which comes from the stem-side chamber 30A through the fluid dynamic line 31, thrust by the displacement caused by the weight of the piston 20, integral with the ram: the first pump 1 therefore is in a passive functioning step in which it drives the first servo-motor 11 which controls its speed of rotation.

[0056] The first servo-motor 11, therefore, in this step has the dual function both of generator of power, which can be sent to the battery of capacitors BC, or released directly to a utility electric network, and also of device to control the speed of rotation of the first pump 1 and, consequently, the speed of descent of the piston 20.

[0057] When the piston 20 has reached the position in which the mold 12A is in contact with the piece to be worked, the distributor 3 switches its work position from 3A to 3B (fig. 2), connecting the first pump 1 with the accumulator group 6.

[0058] In this step, on the second line 32 the interception cartridge 7, advantageously calibrated to a predetermined threshold value, is maintained in the closed position by the work position 8A of the pilot 8, the one-way valve 36 prevents oil return refluxes toward the first pump 1 and the accumulator group 6 is charged up to a maximum pressure, determined by the maximum value to which the pressure transducer 5 is calibrated.

[0059] To activate the second segment of deformation of the piece to be worked, the pilot 8 is switched to the work position 8B in which the interception cartridge 7 moves from the closed position to the open position, so that the oil coming from the accumulator group 6 reaches the third pump 9B making it rotate.

[0060] The third pump 9B drives both the second servo-motor 10 and also the second pump 9A to which it is mechanically connected and the latter sends oil toward the thrust-side chamber 30B of the sliding seating 30, removing it from the tank T7.

[0061] The pressure inside the thrust-side chamber 30B increases progressively, causing the piston 20 to perform the second travel segment, typically intended to deform the piece between the mold 12A and the counter-mold 12B.

[0062] The oil that occupies the stem-side chamber 30A is progressively drained toward the outlet T2, allowing the piston 20 to descend and to perform the second travel segment of deformation.

[0063] The second servo-motor 10, in this step, acts as a generator of power which is sent to the first servo-motor 11 which is simultaneously rotating the first pump 1 in order to send oil to the accumulator group 6.

[0064] Simultaneously, the same accumulator group 6 feeds the second pump 9A and the third pump 9B and of these, the third pump 9B rotates the second servo-motor 10, which therefore acts as a generator.

[0065] When the maximum specification pressure of the press is required, that is, when the piston 20 has to perform the last travel segment to complete the work of a piece, for example a punching, the first servo-motor 11 is stopped while the second servo-motor 10 is active which, by driving the second pump 9A and the third pump 9B, sends oil coming from the accumulator group 6 to the thrust-side chamber 30B.

[0066] After completing the work cycle of the piece, piston 20 has be returned to the TDC of the sliding seating 30 to then begin a subsequent work cycle.

[0067] For this, the quick decompression group 14 is activated which puts, through the fluid-dynamic line 35, the thrust-side chamber 30B in communication with the drain T7, quickly and progressively reducing the pressure inside the thrust-side chamber 30B.

[0068] In this configuration, the pilot 15 is switched to the work position 15B.

[0069] The distributor 3 switches its work position from 3B to 3A restoring the connection between the first pump 1 and the stem-side chamber 30A.

[0070] The first servo-motor 11 is activated and drives the first pump 1 into rotation in the direction DX, which sends oil toward the stem-side chamber 30A, passing through the safety unit 4, still in an inactive configuration.

[0071] This configuration of the fluid-dynamic plant allows to progressively fill the stem-side chamber 30A with pressurized oil by raising the piston 20 until it reaches the TDC position.

[0072] When this position is reached, the safety unit 4 is reactivated, the safety valve thereof closes and the plant is ready to perform a subsequent work cycle as described.

[0073] In this condition, that is, when the piston 20 is at the TDC, the first pump 1, driven by the first servo-motor 11, once again sends oil to the accumulator group 6 in order to top up the oil used in the previous work cycle.

[0074] At the same time, the "transfer" of the press, i. e. the device typically provided to grip and translate the pieces to be worked onto the work surface, repositions the piece to be worked between the mold 12A and the counter-mold 12B.

[0075] The transmission of oil to the accumulator group 6 is interrupted when the pressure transducer 5 signals that the predetermined pressure at which it is calibrated has been reached.

[0076] In the alternative version of the plant to control the ram of the piston 20 of a press shown in figs. 2 and 3, the functioning is similar with the sole difference that the four-quadrant pump 9C alone replaces the two pumps 9A and 9B both of the type with two quadrants of the version described above.

[0077] In summary, after the ram has completed the second travel segment, the second servo-motor 10 which commands the second pump 9A and the third pump 9B, or, in the alternative version, the four-quadrant pump 9C, no longer operates as a generator, but as a servo-motor which sends oil to the thrust-side chamber 30B of the piston 20 which commands the advance of the ram having a high pressure present in the accumulator group 6.

[0078] The second pump 9A and the third pump 9B, or the four-quadrant pump 9C, could also have a cubic capacity three times greater than that of the first pump 1, since they have a second servo-motor 10 which has the same or similar sizes to those of the first servo-motor 11, because the difference in pressure between the one present in the accumulator group 6 and the pressure necessary to make the ram advance is substantially equal to one third of the pressure available on the first pump 1.

[0079] To limit the power required to make the plant function, in the third travel segment the pump 1 remains deactivated while only the second servo-motor 10 functions, which commands the second pump 9A and the third pump 9B, or the four-quadrant pump 9C.

[0080] In order to briefly provide, by way of example, some indicative numerical data relating to the functioning of the fluid-dynamic plant 1 according to the invention, in the condition in which the piston 20 is at the TDC and the "transfer" is in action, the first pump 1 commanded by the first servo-motor 11, loads the accumulator group 6.

[0081] The sizes of the first servo-motor 11 are contained, because the first pump 1, which, in the example in question, typically has a flow rate of 150 Lt/min, is in turn sized in order to make the ram, and therefore the piston 20, rise toward the TDC at a desired speed, as well as to load the accumulator group 6 when the press is stopped.

[0082] As we said, the step of rapid descent of the ram is controlled by the first servo-motor 11 which functions as a generator and the energy produced can be fed into a supply network or it can load the battery of capacitors BC.

[0083] When the mold 12A rests on the material to be worked, the opening of the interception cartridge 7 connects the accumulator group 6 with the two pumps 9A and 9B: the difference in pressure that exists between the accumulator group 6 and the pressure necessary to make the piston 20 perform the second travel segment produces energy by means of the second servo-motor 10 which in this condition functions as a generator.

[0084] The first pump 1, commanded by the first servo-motor 11, loads the accumulator group 6, receiving energy from the second servo-motor 10 which, as stated, in this step functions as a generator.

[0085] When the second travel segment is completed, the first pump 1 stops so as to not generate a simultaneous functioning of the two servo-motors 10 and 11.

[0086] The two pumps 9A and 9B are driven by the second servo-motor 10 which has the characteristic of having sizes similar to those of the first servo-motor 11, because, despite having a high cubic capacity so as to quickly complete the third travel segment, it has the advantage of removing oil from the accumulator group 6 in which a residual pressure of about 190 bar remains, after having completed the third travel segment.

[0087] The two pumps 9A and 9B supply pressurized oil to the thrust-side chamber 30B of the sliding seating 30 at the desired pressure of 280 bar, removing oil from the accumulator group 6 loaded at a pressure of about 210 bar.

[0088] Compared to the first pump 1, which in this specific case has a flow rate of 150 Lt/min operating at 240 bar (load value of the battery of accumulators) absorbing 64 kW, the two pumps 9A and 9B have a total flow rate of 400 Lt/min to feed the thrust-side chamber 30B of the cylinder at 280 bar and work with a pressure of 90 bar, absorbing equally 64 kW.

[0089] In practice it has been found that the invention achieves the intended purposes.

[0090] The invention as conceived is susceptible to modifications and variants, all of which come within the scope of the inventive concept.

[0091] Furthermore, all the details can be replaced with other technically equivalent ones.

[0092] In practice, any materials, shaped and sizes can be used, according to requirements, without departing from the field of protection of the following claims.

Claims

1. A fluid dynamic plant for the controlled drive of a ram of a press that comprises:

    - A pushing piston (20) slidingly received in a sliding seating (30) of a press that is divided by the ram into a stem-side chamber (30A) and a push-side chamber (30B);
    - A first pump (1) of a pressurized fluid which is driven and/or controlled by a first servo-motor (11) that is functionally connected with it;
    - An accumulator group (6) of said pressurized fluid which is fluid-dynamically connected to said first pump (1) or to said sliding seating (30) alternatively;
    - A distributor group (3) for alternate fluid-dynamic connection of said first pump (1) to said sliding seating (30) or of said first pump (1) to said accumulator group (6);

    characterized in that a power generator group (34) is interposed between said accumulator group (6) and said push-side chamber (30B).

2. Plant as in claim 1, wherein said power generator group (34) comprises a second drive pumping group (9A,9B;9C) fluid-dynamically connected to said push-side chamber (30B) and to said accumulator was group (6).

3. Plant as in claim 2, wherein said second pumping group (9A,9B;9C) is connected with a second servo-motor (10) which is driven by said second pumping group and is independent from said first servo-motor (11).

4. Plant as in any claim hereinbefore, wherein said second pumping group comprises:

    - A second two-quadrant pump (9A); and
    - A third two-quadrant pump (9B) connected with said second two-quadrant pump (9A).

5. Plant as in any claim hereinbefore, wherein said second pumping group (9A,9B;9C) comprises a four-quadrant pump (9C).

6. Plant as in claim 1, wherein a quick decompression group (14) is interposed between said push-side chamber (30B) and said power generator group (34).

7. Plant as in claim 1, wherein a one-way valve (36) is interposed between said first pump (1) and said accumulator group (6).

8. Plant as in claim 1, wherein a second distributor or pilot (8) to command a cartridge (7) for the intercep-

tion of said pressurized fluid is interposed between said accumulator group (6) and said power generator group (34).

9. Plant as in claim 7, wherein at least one pressure transducer (5) is interposed between said one-way valve (36) and said accumulator group (6).

10. Plant as in claim 1, wherein said push-side chamber (30B) is connected to a tank (13A) to contain said pressurized fluid with the interposition of a one-way valve (13).

FIG. 1

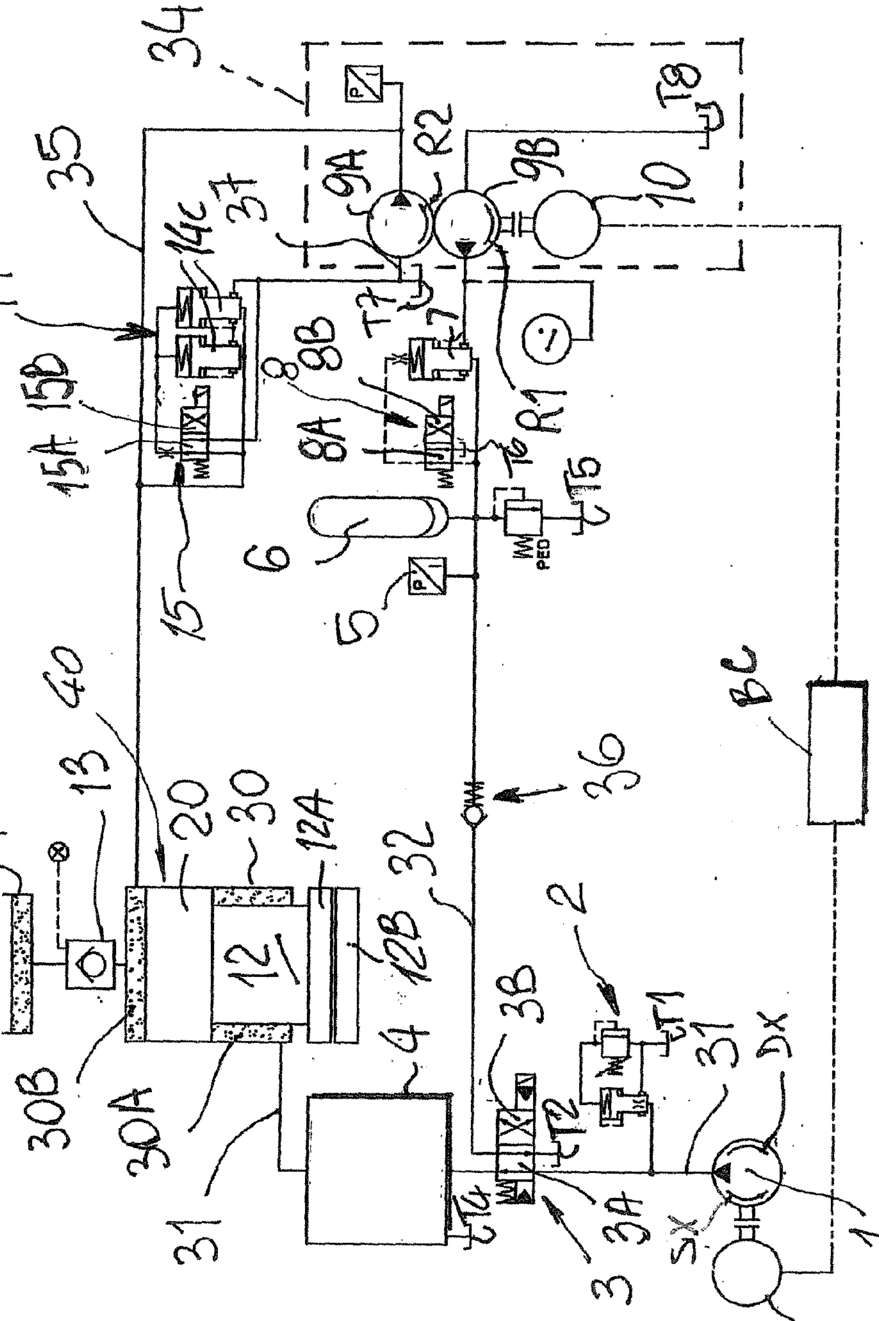
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FIG. 2

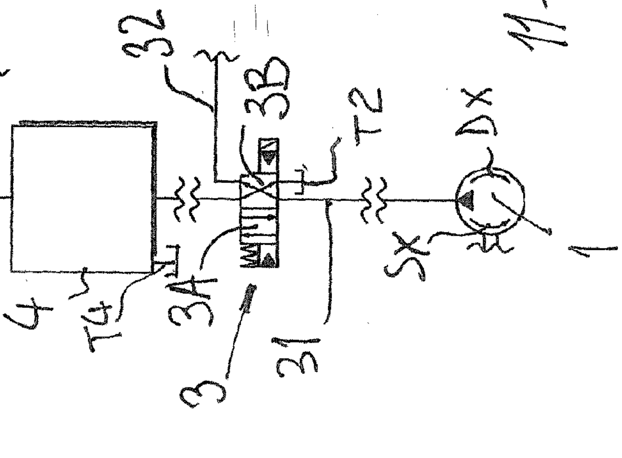
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FIG. 3

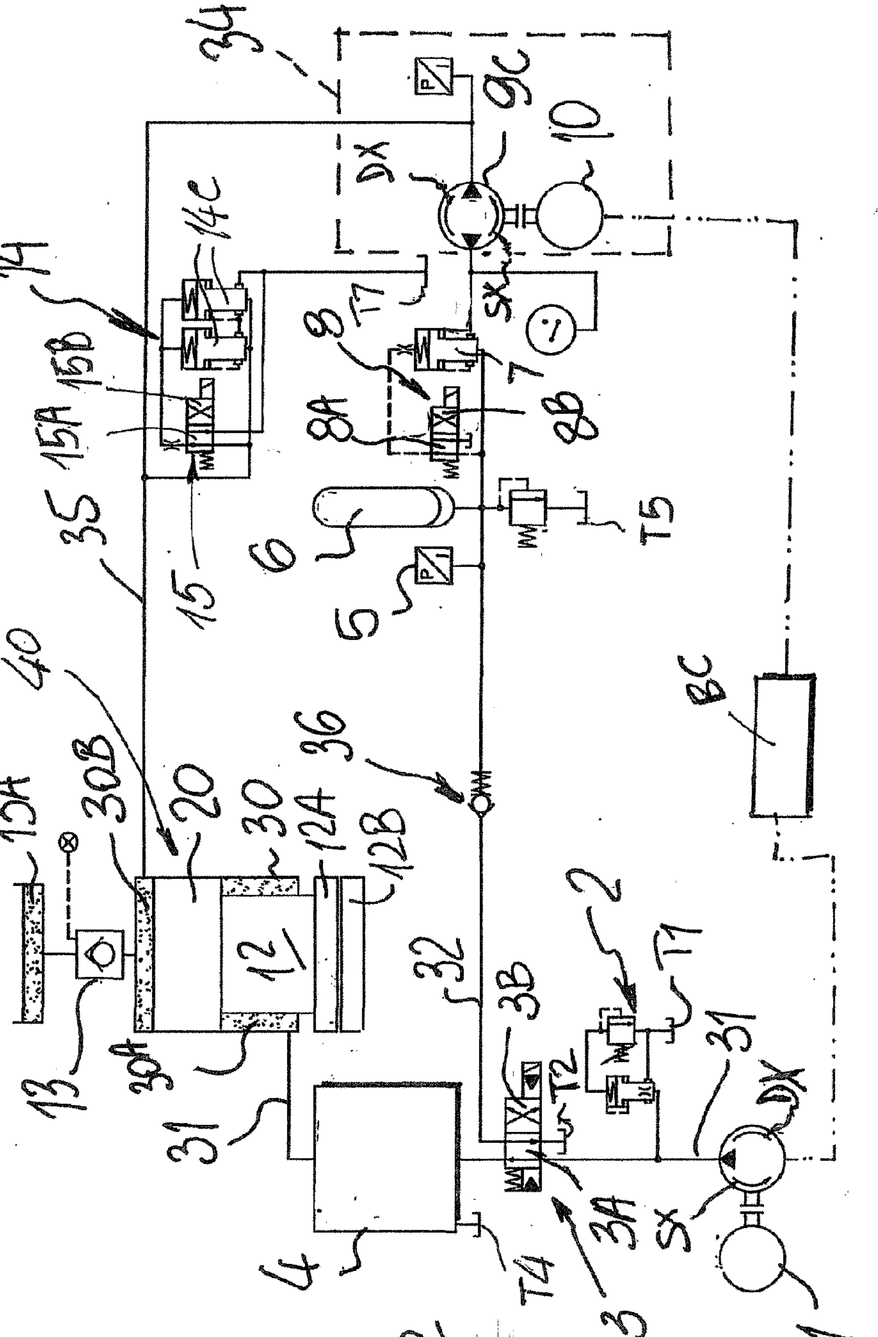
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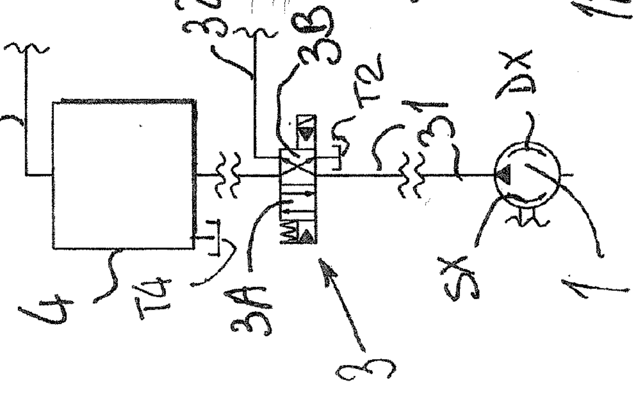
FIG. 4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EUROPEAN SEARCH REPORT

Application Number
EP 19 02 0422

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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