(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 774 750 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.09.2014 Bulletin 2014/37

(51) Int Cl.:
B30B 1/14 *(2006.01)* ***B30B 1/26*** *(2006.01)*

(21) Application number: **14157139.8**

(22) Date of filing: **28.02.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **08.03.2013 IT VI20130060**

(71) Applicant: **Omera S.r.l.**
36015 Schio (VI) (IT)

(72) Inventors:
- **Filippi, Stefano**
  36036 Torrebelvicino (VI) (IT)
- **Crosara, Paolo**
  36030 Villaverla (VI) (IT)

(74) Representative: **Ziliotto, Tiziano**
Studio Ziliotto
Contrada Porta S. Lucia, 48
36100 Vicenza (IT)

(54) Press for machining components, in particular metal components

(57) The invention is a press (1; 101; 201; 301; 401; 501; 601) for processing a component (C), comprising a ram (2) suited to be subjected to a movement in a substantially longitudinal direction (X) against the component (C) in order to perform the processing cycle, the press (1; 101; 201; 301; 401; 501; 601) comprising a supply unit (20) suited to be connected to an electricity supply network (E) for the conversion of electrical energy into mechanical energy and a kinematic mechanism (5) associated with the ram (2) and suited to transmit the movement to the ram (2). Said press (1; 101; 201; 301; 401; 501; 601) comprises a hydraulic circuit (30; 230; 430) provided with a hydraulic motor (31) and supply means (32; 232; 432) suited to supply a hydraulic fluid for the hydraulic motor (31), said supply means (32; 232; 432) being operated by the supply unit (20) and the outlet (14) of the hydraulic motor (31) being connected to the kinematic mechanism (5).

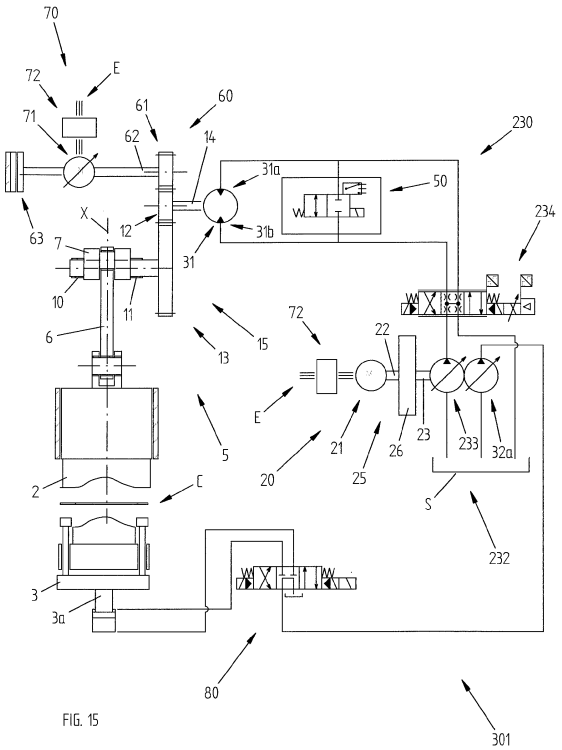


FIG. 15

EP 2 774 750 A1

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention concerns the processing of components, in particular metal components.

[0002] In particular, the present invention concerns a press used for pressing operations such as forming, punching, drawing, forging of metal parts.

DESCRIPTION OF THE STATE OF THE ART

[0003] Machines commonly known as presses are used in the industrial sector, and these machines are suited to process metal components, typically sheet elements, preformed elements or semi-finished components.

[0004] For example, forming, punching, drawing, forging, etc. are typical types of processing.

[0005] The presses of the known type are usually moved vertically and they substantially comprise a tool, called die, whose upper part is movable and integrally connected to the movable part of the press, commonly called ram, while the lower part of said die is usually fixed and connected to a counteracting element of the machine or fixed counteracting plane, usually called table.

[0006] Also the lower table can be movable and can be operated along a substantially vertical direction. In practice, the movable ram is lowered until the metal component to be processed (sheet) is pressed between the ram and the table. Depending on the component to be obtained, that is, depending on the material used and on the final shape to be obtained for the component itself, the laws of motion of the ram must be adapted from time to time in such a way as to meet the requirements of the necessary technological process, that is, a more or less deep forming process, a punching process rather than a forming process, etc.. The laws of motion of the ram, in terms of useful stroke and/or advance speed, must therefore be adapted to the type of processing required.

[0007] Between a processing cycle and another, therefore, it will be necessary to change the configuration of the press in order to adapt the laws of motion of the ram to the new processing cycle to be performed.

[0008] A first type of presses belonging to the known art is constituted by mechanical presses.

[0009] Mechanical presses are substantially constituted by an electric motor and a kinematic mechanism intended to transmit the rotary motion of the drive shaft to the ram.

[0010] Kinematic mechanisms of the known type comprise, for example, connecting rod-crank mechanisms or a toggle mechanisms capable of transforming the rotary motion of the drive shaft into a rectilinear, usually vertical, motion of the ram.

[0011] During some stages of the operation of these presses, for example during the actual pressing of the metal component against the table, a high power peak is usually required. In order to guarantee the above, the mechanical presses of the known type are provided with a flywheel with high inertia interposed between the drive shaft and the kinematic mechanism associated with the ram.

[0012] During the above mentioned pressing stages, the flywheel supplies the peak power that is necessary to perform the processing cycle.

[0013] A first drawback posed by these presses is represented by their low flexibility when the configuration of the press needs to be changed.

[0014] In fact, this change of configuration needs a mechanical operation and the replacement of elements of the kinematic mechanism. Thus, for example, it will be possible to intervene on the arm of the connecting rod that is associated with the ram in order to adapt it to the new stroke desired.

[0015] These operations are complicated and require a long time, with the consequent costs and extension of production times.

[0016] Furthermore, this mechanical change of stroke allows only the selection of discrete stroke values.

[0017] Another drawback posed by said presses is constituted by the fact that the optimal results of the advantageous and indispensable effect provided by the flywheel are necessarily guaranteed by its rotation at constant speed during the operation of the machine.

[0018] In a first case, therefore, the rotation speed of the motor, and therefore the advance speed of the ram, must be maintained at a constant value during a processing cycle, as variable speeds cannot be adopted.

[0019] Furthermore, if a new rotation speed, always constant but lower than the calculated speed of the flywheel, is set following a change of configuration for a new processing cycle, this will inevitably lead to a limitation of the kinetic energy that can be stored in the flywheel, as the latter is sized for a specific number of revolutions. As an alternative, it will be necessary to provide a system for changing the reduction ration through a mechanical change gear intended to maintain the variation of the flywheel's rotation speed within limited values. Consequently, in these mechanical presses the energy that can be transferred to the process depends on the adopted rotation speed and this affects negatively the energy that can be transferred to the die.

[0020] A second type of presses belonging to the known art that partially eliminates the drawbacks mentioned above is constituted by the so-called servo presses.

[0021] In servo presses action is taken on the rotation speed of the motor that is coupled with the ram through a kinematic mechanism, without the interposition of the flywheel. In these servo presses the kinematic parameters of the ram are modified by acting directly on the law of motion of the motor. In these machines the mechanisms are therefore simplified, while the desired flexibility is obtained by properly implementing the motor's speed curves according to the position. These machines allow

the stroke and the advance speed of the ram to be managed during processing and furthermore offer wide flexibility, allowing a rapid adaptation should it be necessary to change the configuration of the press for a new processing cycle.

[0022] Also the servo presses, however, pose some drawbacks.

[0023] A first drawback posed by servo presses is related to the size of the electric motors and the respective power supply devices.

[0024] Contrary to that which happens with mechanical presses, where the presence of the flywheel makes it possible to considerably reduce the size of the electric motors as the ratio between peak power and average power may vary from 10 to 20 times, in servo presses the electric motor alone is expected to guarantee the peak power required by the process. Consequently, the motors have big sizes and power cannot be provided directly by the electricity supply network, in fact it is necessary to introduce energy accumulation systems, typically through capacitor banks or kinematic systems with inertia connected to a motor/generator.

[0025] Given the size and therefore the inertia of the motor, also the acceleration and deceleration stages of the system require the use of high torques and powers that, inevitably, lead to a reduction in the energy efficiency of the machine.

[0026] This is due, in particular, to the continuous exchange of power among motor, driver and energy accumulation system.

[0027] The usable electric motors, for example of the synchronous type and with permanent magnets, have limitations in terms of torque availability. This means that the maximum deliverable torque is not available for the whole rotation range of the motor but only within a limit, generally called bend, beyond which the available torque progressively decreases as the number of revolutions increases. Therefore, unless the transmission and therefore motors, power supplies, etc. are oversized, it is not possible to have all the motor torque available for the entire rotation range of the motor. The servo press that uses said motors will therefore offer limited performance levels, as it will be possible to perform the required technological processing cycles only by reducing the rotation speed of the kinematic mechanisms and therefore increasing the final cycle time. Furthermore, the management of high instant electric powers by adopting accumulation systems like capacitor banks, as explained above, requires that they be positioned in air or liquid cooled electric panels, and also that large power cables be adopted. Furthermore, all the electrical parts must be properly insulated in order to avoid noxious electromagnetic emissions or disturbances from the outside.

[0028] Consequently, large spaces are needed, which goes to the detriment of the system size and of installation costs.

[0029] Additionally, said accumulation systems with capacitors, depending on the conditions of use, may have a short life or however deteriorate quickly and need replacing during the operating life of the press, which would periodically result in extraordinary maintenance costs.

[0030] Again, in order to comply with the safety regulations in force concerning safety of operators using the press, it is necessary to install safety brakes with negative control that must be oversized with respect to the torque of the motor, with consequently higher costs.

[0031] It is the object of the present invention to overcome the drawbacks mentioned above.

[0032] In particular, it is a first object of the invention to provide a press that makes it possible to maintain the high flexibility that is typical of servo presses while at the same time reducing the problems associated with electric motors and accumulation systems with capacitors.

[0033] It is another object of the invention to provide a press whose size is reduced compared to that of the servo presses of the known type.

[0034] It is a further object of the invention to provide a press that is capable of reducing production and installation costs compared to the presses of the known type.

[0035] It is another object of the invention to provide a press that is capable of reducing the problems related to noxious electromagnetic emissions or disturbances that are typical of the servo presses of the known type.

[0036] It is a further object of the invention to provide a press that is more reliable than the servo presses of the known type.

SUMMARY OF THE PRESENT INVENTION

[0037] According to a first aspect of the present invention, the same concerns, therefore, a press for processing a component, said press comprising a ram suited to be subjected to a movement in a substantially longitudinal direction against said component in order to carry out said processing cycle, said press comprising a supply unit suited to be connected to an electricity supply network for converting electrical energy into mechanical energy, and a kinematic mechanism associated with said ram and suited to transmit said movement to said ram, wherein said press comprises a hydraulic circuit provided with a hydraulic motor and with supply means suited to supply a hydraulic fluid for said hydraulic motor and operated by said supply unit, the outlet of said hydraulic motor being connected to said kinematic mechanism.

[0038] Preferably, said supply unit is electronically controlled.

[0039] Preferably, the supply unit comprises an electric motor fed by electronically controlled power supply systems, so that it is possible to control the performance of said electric motor and/or optimize the recovery of the energy of said press. Preferably, the electronically controlled power supply system can manage the driving or braking current in a different way and place the electric motor into "idle".

[0040] The electronically controlled power supply system preferably comprises a driver. Said driver preferably

comprises an inverter.

[0041] In a preferred embodiment of the invention, the hydraulic fluid supply means comprise a hydraulic pump.

[0042] The hydraulic pump is preferably a variable delivery pump. This serves to modify the rotation speed and the direction of rotation of the hydraulic motor.

[0043] In another preferred embodiment of the invention, the supply means comprise a hydraulic pump and a proportional valve that controls flow direction and flow rate.

[0044] Preferably, the press comprises an energy accumulation system suited to supply a power peak to the ram.

[0045] In a preferred embodiment of the invention, the energy accumulation system is arranged between the supply unit and the hydraulic circuit.

[0046] Preferably, the energy accumulation system is of the mechanical type. More preferably, it comprises a flywheel.

[0047] Alternatively, the energy accumulation system is of the hydraulic type and is arranged in the hydraulic circuit.

[0048] Preferably, the energy accumulation system of the hydraulic type comprises at least one container suited to accumulate the hydraulic fluid.

[0049] The energy accumulation system of the hydraulic type properly comprises also a control unit suited to control the hydraulic fluid flow from and towards said containers.

[0050] In a preferred embodiment of the invention, the hydraulic circuit is a hydraulic circuit in the closed circuit configuration.

[0051] In another preferred embodiment of the invention, the hydraulic circuit is a hydraulic circuit in the open circuit configuration.

[0052] Preferably, said hydraulic circuit comprises a bypass device suited to reduce the output torque delivered by the hydraulic motor to null or neglectable values. More preferably, said torque reduction is obtained by balancing pressure between the hydraulic motor's inlet mouths. In this way, the hydraulic motor is substantially in a "idle" condition.

[0053] Advantageously, the sizing of the braking unit typically expected and necessary to lock the press in particular conditions of use is performed based only on the inertia of the hydraulic motor and of the kinematic system, the hydraulic motor being in idle conditions.

[0054] In a preferred embodiment of the invention, the press that is the subject of the invention comprises an auxiliary moving system for the ram, associated with the kinematic mechanism.

[0055] Preferably, the auxiliary moving system is of the electrical type, even more preferably it comprises an electric motor.

[0056] In another preferred embodiment of the invention, the auxiliary moving system is of the hydraulic type.

[0057] Preferably, the auxiliary moving system of the hydraulic type comprises a bypass device suited to reduce the output torque delivered by the auxiliary hydraulic motor to null or neglectable values.

[0058] In a preferred embodiment of the invention, the kinematic mechanism comprises a connecting rod connected to the ram and a rotary crankshaft suited to move said connecting rod.

[0059] In another preferred embodiment of the invention, the kinematic mechanism comprises a connecting rod-crank system.

[0060] In further preferred embodiments of the invention, the kinematic mechanism may comprise a mechanism suited to convert the rotary motion transmitted by the hydraulic motor into a motion with a translational component.

[0061] Mechanisms of this type preferably comprise a toggle mechanism, or a modified toggle mechanism, or a link drive mechanism, or a screw-nut screw mechanism. Preferably, the kinematic mechanism also comprises a gear connected to the outlet of said hydraulic motor.

[0062] In a preferred embodiment of the invention, said gear comprises a pair of gear wheels suited to adjust the transmission ratio between the outlet of the hydraulic motor and the crankshaft.

[0063] In another preferred embodiment of the invention, the outlet of the hydraulic motor may be connected directly to the crankshaft.

[0064] The press properly comprises a safety braking system associated with the kinematic mechanism.

[0065] Preferably, the press comprises a movable counteracting table for the ram and also comprises an energy recovery system suited to recover energy during the displacement of the counteracting table caused by the movement of the ram. Preferably, the energy recovery system comprises a recovery pump associated with the hydraulic fluid supply means of said hydraulic circuit.

[0066] The press that is the subject of the invention advantageously comprises a control unit suited to control and manage the processing steps of the press itself. Preferably, the press of the invention is used for processing operations like forming, punching, drawing and forging.

[0067] The components subjected to processing are preferably metal components, more preferably sheet components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0068] Further advantages, objects and characteristics, as well as further embodiments of the present invention are defined in the claims and are explained here below through the following description, in which reference is made to the attached tables; in the drawings, corresponding or equivalent characteristics and/or component parts of the present invention are identified by the same reference numbers. In particular, in the figures:

- Figure 1 shows a simplified diagram of a press according to a first embodiment of the present invention

in a first operating position;
- Figure 1A shows a partial side view of Figure 1;
- Figure 2 shows the press of Figure 1 in a second operating position;
- Figure 2A shows a partial side view of Figure 1;
- Figure 3 shows a simplified diagram of a press according to another embodiment of the present invention;
- Figure 3A shows a partial side view of Figure 1;
- Figure 4 shows a simplified diagram of a press according to a further embodiment of the present invention;
- Figure 4A shows a partial side view of Figure 1;
- Figure 5 shows a simplified diagram of a press according to another embodiment of the present invention;
- Figure 5A shows a partial side view of Figure 1;
- Figure 6 shows a simplified diagram of a press according to a further embodiment of the present invention;
- Figure 6A shows a partial side view of Figure 1;
- Figures from 7 to 9 show variant embodiments of a detail of the press represented in Figure 1A;
- Figures 10 and 11 show other variant embodiments of the press represented in Figure 1;
- Figure 12 shows a variant embodiment of the press of Figure 1;
- Figure 13 shows a variant embodiment of the press of Figure 3;
- Figure 14 shows a variant embodiment of the press of Figure 4;
- Figure 15 shows a variant embodiment of the press of Figure 5;
- Figure 16 shows a variant embodiment of the press of Figure 10;
- Figure 17 shows a variant embodiment of the press of Figure 11;
- Figure 18 shows another variant embodiment of the press of Figure 1.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0069] The present invention will be further illustrated through the following detailed description of its embodiments shown in the drawings. It should however be noted that the present invention is not limited to the specific embodiments described below and illustrated in the drawings; it should rather be noted that the embodiments described below and represented in the drawings clarify some aspects of the present invention, the scope of which is defined in the claims. The present invention should therefore be considered as including all those variations and/or modifications that will be clear to the expert in the art.

[0070] It should furthermore be considered that the present invention can be particularly advantageous when applied to the field of processing of metal components like metal sheets or similar elements, and thus to the field of presses for processing said metal components. It is for this reason, therefore, that here below we make reference to presses for processing metal components.

[0071] In the figures shown in the enclosed tables, identical or corresponding component parts, as well as identical or corresponding characteristics of the press according to the present invention are identified by the same reference numbers.

[0072] In Figure 1, the embodiment of the press according to the present invention represented therein is identified by reference number 1. This figure shows only the components of the press 1 that are significant for the purpose of describing the present invention.

[0073] The press 1 comprises a supporting structure (not represented in the figure) in which there are a movable top part 2, or movable ram 2, and a fixed counteracting plane 3, also called counteracting table 3. The movable ram 2 practically constitutes the processing tool suited to be moved towards and against a component C to be processed interposed between the processing tool 2 and the counteracting table 3, as shown in Figure 2, in which the press 1 is in its closed operating position.

[0074] The movable ram 2, or processing tool, can be constituted by a suitable element according to the type of processing for which the press 1 is used. For example, said ram may comprise a forming die if the press is used for forming operations, it may comprise a punch if the press is used for punching operations, etc. Typical processing procedures may comprise forming, punching, drawing and forging of metal parts.

[0075] The counteracting table 3 is made, in fact, as a reacting or counteracting element. The top ram 2 can be moved along a substantially longitudinal direction X, preferably vertical, towards the counteracting table 3.

[0076] The counteracting table 3 can be fixed or, in variant embodiments, can also be moved along a substantially longitudinal direction X.

[0077] The component to be processed C, typically a metal component, will then be processed (formed, punched, drawn, forged) by means of the movable ram 2 and of the counteracting action exerted by the counteracting table 3 and by other movable elements, such as pads or extractors suited to carry out special technological processing cycles. In particular, during processing of the component C, the movable ram 2 is lowered so that the same component C is pressed between the movable ram 2 and the counteracting table 3.

[0078] The movable elements such as pads or extractors can exert a counteracting action against the downward lowering movement of the movable ram 2 and if necessary will accompany the movable ram 2 in its downward movement in such a way as to grade its speed and the distance it covers during its downward movement 2. It will also be possible to move the counteracting table 3 upwards.

[0079] The operation of the movable slide 2 is obtained through a kinematic mechanism 5 comprising compo-

nents dedicated to the movement of the movable ram 2 along said longitudinal direction X.

[0080] In the preferred embodiment of the invention illustrated herein, the kinematic mechanism 5 comprises a connecting rod 6 connected to the ram 2 and a crankshaft 7 suited to move, during its rotation, the connecting rod 6 and the ram 2 along said longitudinal direction X.

[0081] The crankshaft 7 is preferably supported by suitable supporting means 10, 11, preferably constituted by rolling or sliding means like ball bearings or bushings. In variant embodiments of the invention it will be possible to use different systems suited, in any case, to convert the rotary motion into a motion with a translational component.

[0082] Mechanisms of this type are schematically shown in Figures 7, 8 and 9 and preferably comprise: a toggle mechanism 5' (Figure 7), a modified toggle mechanism 5" (Figure 8), a link drive mechanism 5"' (Figure 9).

[0083] In each one of said mechanisms, the rotation of a respective shaft 7', 7", 7"' moves the ram 2 along said longitudinal direction X.

[0084] In the preferred embodiment of the invention illustrated herein, the kinematic mechanism 5 also comprises a gear 15 constituted by a pair of gear wheels 12, 13 meshing with each other and suited to transmit the motion of a driving shaft 14 to the crankshaft 7.

[0085] More particularly, the first gear wheel 12 during rotation is integral with the driving shaft 14 and the second gear wheel 13 during rotation is integral with the crankshaft 7.

[0086] The gear 15 makes it possible to adjust in the best possible way the transmission ratio between the driving shaft 14 and the crankshaft 7.

[0087] In variant embodiments of the invention, different systems may be used, for example several gears in cascade, for the purpose of increasing the reduction ratio, or again the driving shaft 14 can be directly connected to the crankshaft 7. The press 1 comprises also a supply unit 20 suited to be connected to an external electricity supply network E and to convert electrical energy into mechanical energy.

[0088] The supply unit 20 preferably comprises an electric motor 21 suited to be connected to the electricity supply network E and provided with an output shaft 22. More preferably, the electric motor 21 is constituted by a motor of the asynchronous type, or synchronous with permanent magnets fed by the network E and/or by electronically controlled power supply systems (like, for example, inverters or similar devices, rectifiers, etc.).

[0089] In variant embodiments of the invention, drivers may be used between the electric motor 21 and the network E, in such a way as to be able, if necessary, to control the performance of the motor 21.

[0090] An energy accumulation system 25 is associated with the outlet of the supply unit 20, in particular with the output shaft 22 of the electric motor 21.

[0091] In the preferred embodiment of the invention illustrated herein, the energy accumulation system 25 is of the mechanical type and comprises a flywheel 26 mounted in and during rotation integral with a portion of the output shaft 22 of the electric motor 21.

[0092] In variant embodiments of the invention, the flywheel 26 may not be mounted directly on the output shaft 22 of the electric motor 21 but be connected to it through a transmission mechanism, like for example a gear reduction unit or a belt.

[0093] According to the present invention, a hydraulic circuit 30 is interposed between the supply unit 20 and the kinematic mechanism 5 that moves the ram 2.

[0094] The hydraulic circuit 30 comprises a hydraulic motor 31 and supply means 32 suited to supply a hydraulic fluid, typically oil, suited to feed the hydraulic motor 31. The output shaft 14 of the hydraulic motor 31 coincides with the driving shaft 14 for the kinematic mechanism 5 that moves the ram 2, as already explained above. The fluid supply means 32 are operated by the supply unit 20. The fluid supply means 32 are operated by the output shaft 23 of the flywheel 26. In variant embodiments of the invention, the fluid supply means 32 may not be mounted directly on the output shaft 23 of the flywheel 26 but connected to it through a transmission mechanism, like for example a gear reduction unit.

[0095] The hydraulic fluid supply means 32 convey the hydraulic fluid to the hydraulic motor 31, thus determining the desired rotation of the driving shaft 14.

[0096] The rotation speed of the driving shaft 14 will depend on the flow of the hydraulic fluid.

[0097] At the moment when a force is generated in the die due to the component C, a torque is transmitted to the driving shaft 14 by the kinematic mechanism 5. Consequently, a higher pressure is required by the hydraulic motor 31 to maintain its rotation speed. Said pressure is transferred by the supply means 32, in the form of the required torque, to the output shaft 23 of the flywheel 26. Said torque will then be guaranteed by the assembly made up of the supply unit 20 and the flywheel 26.

[0098] Preferably, the hydraulic motor 31 and the hydraulic fluid supply means 32 are connected with a closed circuit configuration, in which the hydraulic fluid flows thanks to the thrust exerted by the supply means 32.

[0099] More particularly, the hydraulic motor 31 is preferably constituted by a radial piston hydraulic motor with fixed delivery. In variant embodiments of the invention, however, it is possible to use a hydraulic motor of a different type, like for example one or more axial piston hydraulic motors with fixed or variable delivery.

[0100] The supply means 32 preferably comprise a hydraulic pump. Variant embodiments of the invention may be provided with a plurality of hydraulic pumps, that is, a so-called pump unit. More preferably, said pump is an axial piston pump with variable delivery and with electronically controlled displacement.

[0101] The hydraulic pump 32 is operated by the output shaft 22 of the electric motor 21 and determines the desired flow and flow rate of the hydraulic fluid inside the hydraulic circuit 30.

[0102] The flow rate of the hydraulic fluid can be preferably adjusted by acting on a small plate that controls the delivery of the pump 32, preferably through an electronic control device of a control unit, not illustrated herein, of the press 1. More preferably, the variation of the hydraulic fluid flow rate is achieved maintaining in any case a constant rotation speed of the output shaft 22 of the electric motor 21 that operates the pump 32.

[0103] Varying the delivery of the hydraulic pump 32, consequently, means varying the flow and pressure of the hydraulic fluid and therefore the rotation speed of the driving shaft 14, as explained above.

[0104] Preferably, the hydraulic pump 32 may even reverse the flow direction of the hydraulic fluid inside the hydraulic circuit 30, reversing in this way the direction of rotation of the hydraulic motor 31 and thus of the driving shaft 14.

[0105] By appropriately controlling the direction of conveyance of the hydraulic fluid and its flow rate through the hydraulic pump 32, it is thus possible to control the direction and speed of rotation of the driving shaft 14 and, in conclusion, the direction and advance speed of the ram 2 along the longitudinal direction X.

[0106] In practice, the processing cycle (for example, the forming cycle) of the component C with the hydraulic press 1 schematically shown in Figure 1 can substantially include the following operations.

[0107] The electric motor 21 is fed by the electricity supply network E and rotated at a constant speed. The electric motor 21 operates the hydraulic pump 32. The hydraulic motor 31 is operated and the driving shaft 14 is rotated at a desired rotation speed by controlling the hydraulic pump 32 as described above. The rotation of the driving shaft 14 is converted, by means of the kinematic mechanism 5, into a movement of the ram 2 along the longitudinal direction X towards the table 3 and against the component C to be processed, shifting from an operating position in which the press is open, as shown in Figure 1, to an operating position in which the press is closed, as shown in Figure 2.

[0108] The advance speed of the ram 2, as well as the extension of the movement of the same ram 2, will therefore depend on the speed of the driving shaft 14 and on how much it is rotated and therefore, to conclude, on the way the hydraulic pump 32 is controlled.

[0109] At the moment when the ram 2 comes into contact with the component C and pushes it against the table 3, a power peak suited to guarantee the deformation of the component C is required. Said power peak is delivered and transmitted to the ram 2 along the hydraulic circuit 30 by the energy accumulation system 25 constituted by the flywheel 26.

[0110] Advantageously, the electric motor 21 that operates the hydraulic pump 32 is rotated continuously and at a constant speed, independently of the advance speed and the distance by which the ram 2 is moved. Advantageously, also the flywheel 26 is thus rotated at a constant speed and therefore there are no limitations to the quantity of kinetic energy stored in the flywheel 26 that is then transferred to the ram 2 to supply said energy peak.

[0111] Still advantageously, also the flywheel 26 is then rotated at a constant speed that is independent of the instant speed of the kinematic mechanism 5. Therefore, the desired rotation speed of the flywheel 26 can be fixed to the maximum value compatible with the reliability of the flywheel unit, making the accumulation of kinetic energy stored in the flywheel 26 optimal and independent of the rotation speed of the kinematic mechanism 5.

[0112] Therefore, the fact that the motion of the ram 2 can be controlled by controlling the variable delivery pump 32 and that the motion of said ram 2 is independent of the rotation speed of the flywheel 26, which instead is advantageously kept constant, makes it possible to obtain the advantages that are typical of servo presses as far as control of the stroke of the ram 2 is concerned. In the meantime, the kinetic energy supplied by the energy accumulation system 25, in this specific case constituted by the flywheel 26, is exploited in the best possible way. At the end of this stage, meaning with the component C subjected to the required processing cycle, the ram 2 is moved along the longitudinal direction X away from the table 3, that is, upwards, until reaching the initial condition in which the press is open. This away movement is preferably and advantageously obtained by maintaining the same direction of operation of the hydraulic pump 32 so that the hydraulic motor 31 and the driving shaft 14 rotate always in the same direction and preferably at the same rotation speed.

[0113] Analogously and advantageously, even in the case of use of kinematic mechanisms of a different type, for example those mentioned with reference to Figures 7, 8 and 9, the upward movement of the ram 2 away from the table 3 is obtained without reversing the direction of operation of the hydraulic pump 32 and of the hydraulic motor 31, which will advantageously continue to work with the same operation direction.

[0114] In any case, each kinematic mechanism features a stroke in direction X of the top part of the ram 2 determined by the length of the connecting rods and corresponding to a complete rotation of the crankshaft 7. This stroke can advantageously be limited by avoiding a complete rotation of the crankshaft 7. Given the same rotation speed, reducing the rotation angle of the crankshaft 7 means advantageously reducing also the time necessary to perform the stroke of the ram 2 compared to the case in which a complete rotation is performed.

[0115] In a variant embodiment of the invention, the step of moving the ram 2 away from the table 3 can be obtained by reversing the operation direction of the hydraulic pump 32, so that the hydraulic motor 31 works in the opposite direction and the driving shaft 14 is rotated in the opposite direction at a desired rotation speed. The rotation of the driving shaft 14 in the opposite direction is converted, by means of the kinematic mechanism 5, in the desired displacement of the ram 2 along the lon-

gitudinal direction X away from the table 3. Advantageously, any variation that may be required for the processing of the component C, like for example the variation of the closing speed of the press 1 and/or of the distance by which the ram 2 actually moves towards the table 3, may be comfortably managed by controlling the delivery of the hydraulic pump 32, with no need to act on the mechanical components of the press 1 itself. Analogously, if the configuration of the press 1 needs to be changed in order to prepare it for a new type of processing, for example if the tool, meaning the ram 2, must be changed in order to pass from a forming to a punching operation, it will not be necessary to change any mechanical parts, like for example the connecting rod 6, to adapt them to the new strokes and speeds required. Even in this case, the new motion of the ram 2 can be comfortably managed by acting on the control of the delivery of the hydraulic pump 32.

[0116] Advantageously, the press 1 according to the invention makes it possible to maintain the high flexibility of servo presses but at the same time does not need energy accumulation systems with capacitors or other types of accumulation of the electrical type.

[0117] Therefore, the press according to the invention will not pose all the drawbacks described above and deriving from the fact that capacitors are used as an energy accumulation system.

[0118] Advantageously, the press according to the invention may have a reduced size compared to the servo presses of the known type.

[0119] The production and installation costs will also be reduced compared to those of the servo presses of the known type.

[0120] Again, the problems related to noxious electromagnetic emissions or disturbances deriving from the use of capacitors can be eliminated.

[0121] This leads, furthermore, to a higher reliability of the press and eliminates the drawbacks deriving from the need to replace the capacitors.

[0122] On the other hand, the mechanical flywheel used in the present invention is characterized by low cost, high reliability and constant performance over time. Furthermore, the hydraulic circuit 30 of the invention described above is preferably associated with a bypass device 50. The bypass device 50, properly operated, serves as a device that reduces or zeroes the torque delivered by the hydraulic motor 31 in particular conditions.

[0123] The bypass device 50, in fact, can intervene to reduce or zero the torque delivered by the hydraulic motor 31 while the hydraulic pump 32 continues to work.

[0124] The bypass device 50 can be constituted, in fact, by a portion of circuit that is opened in order to deviate the flow of hydraulic fluid into a closed circuit comprising the hydraulic pump 32, as indicated by the arrow F of Figure 1.

[0125] The bypass device 50 is represented in a symbolic form as a single monitored on-off hydraulic valve but it can advantageously be made in such a way as to meet the redundancy and monitoring principles that are referred to in the international standards concerning the safety of machinery.

[0126] With the bypass device 50 activated, the pressure of the hydraulic fluid at the inlets 31a, 31b of the hydraulic motor 31 is substantially the same and therefore the torque delivered by the motor 31 itself is substantially null or has a negligible minimum value due to its inertia. The hydraulic motor 31 substantially works in idle conditions.

[0127] Deactivating the bypass device 50, instead, restores normal operating conditions, with the hydraulic fluid that flows in the hydraulic motor 31.

[0128] The bypass device 50 can advantageously be operated in emergency situations, in order to interrupt the transmission of power to the ram 2.

[0129] Another possible use of the bypass device 50 is illustrated further on with reference to the embodiment of Figure 3.

[0130] In variant embodiments of the invention, however, there may also be no bypass device. According to the invention, in this case there would advantageously be a braking system intended to guarantee that the hydraulic motor is locked even if it delivers an output torque.

[0131] Furthermore, a safety braking system 60 is preferably associated with the press 1 of the invention described above.

[0132] The braking system 60, when properly operated, serves as a locking device for the hydraulic motor 31 in special conditions.

[0133] The braking system 60 is advantageously connected to the frame of the press 1 and comprises a gear wheel 61 meshing with the first gear wheel 12 and a rotation pin 62 integral with the gear wheel 61 and connected to a safety brake 63, preferably a safety brake with negative control.

[0134] In a variant embodiment of the invention, the safety brake 63 can be connected directly to the first gear wheel 12.

[0135] It should be noted that further elements of the press, known per se, are neither illustrated nor described herein, like for example any auxiliary circuits for overfeeding, washing, filtering and cooling the hydraulic circuit, ram balancing cylinders or cylinders with other technological functions, safety cylinders against overload.

[0136] Figure 3 shows another embodiment of the press 101 according to the present invention; in Figure 3, the component parts and/or characteristics of the press according to the present invention described above with reference to Figure 1 are identified by the same reference numbers.

[0137] The embodiment represented in Figure 3 differs from the embodiment previously described in that it uses a mixed electric and hydraulic system employing a further electric motor for the idle movements of the ram 2 that are characterized by low power, and the hydraulic motor 31 substantially only for the actual stage of processing of the component C.

[0138] In particular, the press 1 comprises an auxiliary moving system 70 of the electrical type associated with the kinematic mechanism 5.

[0139] The auxiliary moving system 70 comprises an auxiliary electric motor 71, preferably of the synchronous type with permanent magnets, powered by a driver 72 connected to the external electricity supply network E. The driver 72 is preferably of the regenerative type, for example in the case of synchronous or asynchronous motors it comprises a driver that regenerates part of the excess energy in the network and/or in energy accumulators (capacitors and/or accumulators). The same applies in the case of use of cc motors.

[0140] Even more preferably, the auxiliary moving system 70 may comprise an energy accumulation system, not represented herein, for example of the type with capacitors.

[0141] In the embodiment of the invention illustrated herein, the output shaft 62 of the auxiliary electric motor 71 coincides with the rotation pin 62 of the braking system 60.

[0142] Therefore, the rotation of the auxiliary electric motor 71 and of its output shaft 62 is transformed into a displacement of the ram 2 through the gear wheel 61 that meshes with the kinematic mechanism 5 that moves the ram 2.

[0143] In variant embodiments of the invention, however, the auxiliary moving system may be separated from the braking system and associated with the kinematic mechanism 5 in an autonomous way, for example through a system that acts on the second gear wheel 13.

[0144] From the operational point of view, the auxiliary electric motor 71 is operated for the idle movements of the ram 2, that is, the movements characterized by the use of low power, while the hydraulic motor 31 is used only during the actual processing stage, that is, during the actual pressing stage.

[0145] Therefore, for example, in the steps during which the ram 2 is moved near the table 3 and in the steps during which the ram 2 is moved away from the table 3 after the pressing operation, the ram 2 itself is advantageously moved through the operation of the auxiliary electric motor 71. During the stages of operation of the auxiliary electric motor 71, the hydraulic circuit 30 is properly disconnected in order to avoid interfering with the transmission of motion from the auxiliary electric motor 71 to the ram 2 through the gear wheels 12, 13 and 61.

[0146] In a preferred embodiment of the invention, the disconnection of the hydraulic circuit 30 takes place through the activation of the bypass device 50.

[0147] With the activation of the bypass device 50, in fact, the hydraulic fluid feeds both sides of the hydraulic motor 31, which therefore is balanced on both sides thus zeroing the delivered torque. The hydraulic motor 31 and therefore also the driven shaft 14 continue to rotate integrally with the kinematic mechanism but do not interfere with the motion transmitted by the auxiliary electric motor 71. When the power necessary for processing is needed, the hydraulic circuit 30 is activated again by deactivating the bypass device 50, which restores the normal operating conditions of the hydraulic motor 31, while the operation of the auxiliary electric motor 71 is interrupted.

[0148] Advantageously, in addition to the advantages illustrated above with reference to the first embodiment of the invention, this embodiment, depending on the required performance, makes it possible to reduce the size of the used pumps. In fact, in some cases, for the purposes of the forming process and of the die duration, it is advantageous to reduce the translation speed of the ram during operation.

[0149] The use of the auxiliary moving system 70 makes it possible to speed up the approaching and away movements, while the supply unit 20 guarantees only a reduced operating speed.

[0150] In fact, in some cases, since for the purposes of the forming process and of the die duration it is advantageous to reduce the translation speed of the ram 2, it is sufficient that the supply unit 20 guarantees said slow speed while fast speeds are guaranteed by the auxiliary electric motor 71.

[0151] The embodiment illustrated in Figure 3 thus allows a reduced size of the supply unit 20 compared to the cases illustrated in Figures 1 and 2.

[0152] Figure 4 shows a further embodiment of the press 201 according to the present invention; in Figure 4, the component parts and/or characteristics of the press according to the present invention described above with reference to Figure 1 are identified by the same reference numbers.

[0153] The embodiment illustrated in Figure 4 differs from the first embodiment of the invention due to the different configuration of the hydraulic circuit 230, more particularly due to the different configuration of the supply means 232 of the hydraulic motor 31.

[0154] The hydraulic fluid supply means 232 comprise, in fact, a hydraulic pump 233 operated by the output shaft 22 of the electric motor 21 and a proportional valve 234 controlling direction and flow rate.

[0155] The direction of the hydraulic fluid within the hydraulic circuit 230 and therefore the rotation direction of the hydraulic motor 31 are controlled through said proportional valve 234 controlling direction and flow rate.

[0156] The components of the hydraulic circuit 230, meaning the hydraulic motor 31, the hydraulic pump 233 and the valve 234, are connected in an open circuit configuration, wherein a tank S is provided for drawing and discharging the hydraulic fluid.

[0157] The flow rate of the hydraulic fluid in the hydraulic circuit 230 is also preferably controlled through the proportional valve 234 controlling direction and flow rate. In this way, the rotation speed of the hydraulic motor 31 is therefore controlled. This system advantageously makes it possible to control more promptly the variations in the speed of the hydraulic motor 31, as the proportional valves 234 controlling direction and flow rate are typically capable of getting positioned more quickly than the hy-

draulic pumps 233.

[0158] In this embodiment, the hydraulic pump 233 can be of the type with fixed delivery, meaning a type of pump that is less expensive and does not need special checks.

[0159] In other cases, preferably, the hydraulic pump 233 can be of the type with variable delivery with displacement control. In this case, the laminated delivery on the proportional valve 234 controlling direction and flow rate is reduced to a minimum.

[0160] In variant embodiments of the invention, the flow rate of the hydraulic fluid in the hydraulic circuit 230 can be controlled both through the proportional valve 234 controlling direction and flow rate and through the hydraulic pump 233, in the case where the latter is of the type with variable and controllable delivery. In this way, a synergic control effect is obtained by means of the valve 234 and the pump 233.

[0161] Figure 5 shows another embodiment of the press 301 according to the invention; in Figure 5, the component parts and/or characteristics of the press according to the present invention described above with reference to Figure 4 are identified by the same reference numbers.

[0162] The embodiment shown in Figure 5 differs from the embodiment described with reference to Figure 4 due to the fact that it uses a mixed electrical and hydraulic system employing a further electric motor 71 for the idle movements of the ram 2 characterized by the use of low power, and the hydraulic motor 31 only during the actual operating stage.

[0163] For this purpose, analogously to that which has been described above with reference to the embodiment with mixed system shown in Figure 3, the press 301 of Figure 5 comprises an auxiliary moving system 70 of the electrical type associated with the kinematic mechanism 5.

[0164] Therefore, the description provided above with reference to the embodiment illustrated in Figure 3 applies also to this embodiment, with the advantageous effects ensured by the auxiliary moving system 70.

[0165] Figure 6 shows another embodiment of the press 401 according to the invention; in Figure 6, the component parts and/or characteristics of the press according to the present invention described above with reference to Figure 5 are identified by the same reference numbers.

[0166] The embodiment shown in Figure 6 differs from the embodiment described above with reference to Figure 5 due to the fact that it uses a different energy accumulation system 425 inside the hydraulic circuit 430.

[0167] The energy accumulation system 425 is of the hydraulic rather than of the mechanical type.

[0168] It is evident that such an energy accumulation system 425 of the hydraulic type can be applied to each one of the possible configurations of the present invention, in particular to the embodiment previously illustrated in Figure 4.

[0169] The energy accumulation system 425 is arranged along the hydraulic circuit 430, preferably between the hydraulic pump 233 and the proportional valve 234 controlling direction and flow rate.

[0170] The energy accumulation system 425 preferably comprises one or more accumulators 427 suited to accumulate hydraulic fluid, in the number of three in the embodiment illustrated herein, and a control unit 428. The control unit 428 makes it possible to distribute the flow rate of the hydraulic fluid from the hydraulic pump 233 towards the accumulators 427 and from the containers 427 to the valve 234.

[0171] The accumulation of energy in the accumulators 427 guarantees the availability of a power peak when this is needed on the ram 2 to ensure the deformation of the component C, analogously to that which is described above with reference to the mechanical flywheel.

[0172] The embodiment described herein thus includes a system of the mixed type in which the auxiliary moving system 70 makes it possible to perform the idle movements of the ram 2 characterized by the use of low power, while the hydraulic motor 31 is used and the energy peak provided by the accumulators 427 is exploited during the actual operating stage, that is, during the actual pressing operation.

[0173] The displacement of the ram 2 during the operating stage is therefore performed by the hydraulic motor 31, controlling the hydraulic pump 233 and the proportional valve 234 that controls direction and flow rate.

[0174] Advantageously, the accumulators 427 are recharged by the hydraulic pump 233 operated by the electric motor 21, preferably during the transition steps and/or during the steps in which the auxiliary moving system 70 is activated.

[0175] The control unit 428 is preferably provided, furthermore, with protection valves for safe discharge of the hydraulic circuit 430.

[0176] Advantageously, the use of an energy accumulation system 425 of the hydraulic type makes it possible to reduce the cost of some components of the system, in particular less expensive pumps with lower delivery and accumulators with larger volumes are used.

[0177] It is evident that in all the embodiments described above the press according to the invention is provided with a control and management unit that is suited to operate the various components of the press and manage the various processing stages.

[0178] Figure 10 shows another embodiment of the press 501 according to the invention; in Figure 10, the component parts and/or characteristics of the press according to the present invention described above with reference to Figure 1 are identified by the same reference numbers.

[0179] The press 1 of the invention comprises an auxiliary moving system 530 for the ram 2 associated with the kinematic mechanism 5. Preferably, the auxiliary moving system 530 is of the hydraulic type with a second pump 532 in closed circuit that controls a second motor 531 also provided with a safe bypass system 550. In this

embodiment of the invention the second motor 531 and the second pump 532 serve for the quick loadless movements towards and away from the table 3 and therefore will have a reduced size compared to the motor 31 and the pump unit 32. In this case, the torque peaks due to the acceleration and deceleration of the kinematic mechanisms are still provided by the flywheel 26.

[0180] Figure 11 shows another embodiment of the press 601 according to the invention; in Figure 11, the component parts and/or characteristics of the press according to the present invention described above with reference to Figure 1 are identified by the same reference numbers.

[0181] The press 601 of the invention comprises an auxiliary moving system 630 for the ram 2 associated with the kinematic mechanism 5. Preferably, the auxiliary moving system 630 is of the hydraulic type with a second pump 632 in open circuit that controls a second motor 531 also provided with a safe bypass system 550. In this embodiment of the invention the second motor 531 and the second pump 632 serve for the quick loadless movements towards and away from the table 3 and therefore will a have reduced size compared to the motor 31 and the pump unit 32. In this case, the torque peaks due to the acceleration and deceleration of the kinematic mechanisms are still provided by the flywheel 26. The auxiliary hydraulic system 530, 630 of Figures 10 and 11 is substantially a replacement for the auxiliary moving system 70 of the electrical type of Figure 3, but can be advantageously used also to replace the auxiliary electrical system shown in Figure 5.

[0182] It is known that in the case of forming and punching of metal parts, depending on the type of process, it may be necessary to use the sheet pressing function, which is usually obtained with the aid of hydraulic cylinders that during the forming stage apply a force contrary to the direction of motion of the ram 2. A hydraulic cylinder of this type is indicated by reference number 3a in Figures from 12 to 17.

[0183] A further application of the present invention, illustrated in fact in Figures from 12 to 17, is given by the connection between the hydraulic cylinder/cylinders 3a and a recovery pump/recovery pumps 32a with variable displacement and electronic pressure control, preferably operating in an open circuit and mechanically connected to the main pump/pumps 32.

[0184] During the forming stage, the hydraulic cylinder 3a is pushed downwards by the ram 2 and the pressure controlled by the recovery pump 32a generates a driving torque towards the main pump 32. In this way, the energy required by the sheet pressing function is recovered by the recovery pump 32a and re-transmitted to the main pump 32, thus reducing the energy consumed by the process.

[0185] Once the operating stage has been completed, the recovery pump 32a brings the hydraulic cylinder 3a back to its position by switching the solenoid valve 80.

[0186] Figures 12, 13, 14 and 15 show the application of said recovery system to the embodiments shown in the corresponding to Figures 1, 3, 4 and 5.

[0187] Figure 16 shows a further embodiment of the recovery system applied to the embodiment shown in Figure 10, in which the recovery pump in open circuit 32a is connected to the axis 23 of the main pump 32 and of the second pump 532.

[0188] Figure 17 shows a further embodiment of the recovery system applied to the embodiment of Figure 11, in which the recovery pump in open circuit 32a is connected to the axis of the main pump 32. In this case the recovery pump 32a is connected to both the auxiliary moving system 630 and the hydraulic cylinder 3a.

[0189] During the approach step the recovery pump 32a is connected to the auxiliary hydraulic motor 531. When the operating stage starts, the auxiliary hydraulic moving system 630 is bypassed and the recovery pump 32a is connected to the hydraulic cylinder 3a in order to obtain the sheet pressing force. At the end of the operating stage, the recovery pump 32a is connected again to the auxiliary hydraulic moving system 630 in order to perform the away movement, while the hydraulic cylinder 3a is repositioned through an auxiliary hydraulic system 90.

[0190] Advantageously, as previously explained, the electric motor 21 can be fed by electronically controlled power supply systems 72 (like, for example, inverters or similar devices, rectifiers, etc.), as clearly shown, for example, in Figure 15. It is evident that the same configuration can be used in the various embodiments described and illustrated above (Figures from 1 to 17).

[0191] In this case, the electric motor 21 is preferably fed by a driver 72 with speed control in a closed ring. In this way, advantageously, it is possible to allow the flywheel 26 to absorb the torque peaks, while the driver 72 can manage the driving or braking current in a different manner in order to improve the energy efficiency of the press. In fact, by limiting observation to the forming operation only, the main cause of variation of the moment of the quantity of motion or of the kinetic energy level of the flywheel is given by the negative energy (meaning energy that opposes the motion of the hydraulic motor 31) which is absorbed by the die and transferred to the piece in order to cause it to be deformed. This energy must be delivered by the flywheel 26, by lowering the value of the moment of the quantity of motion or of the kinetic energy level, and then restored by the electric motor 21 during its rotation.

[0192] In the operation of the presses according to the present invention, the motion of the ram 2 and of the electric motor 21 can be changed in order to modify the stroke and the speed profile of the ram 2 and consequently be subjected to continuous accelerations and decelerations. In the case of acceleration, the electric motor 21 must deliver power in order to accelerate the masses, therefore the energy related to said process is negative (meaning that the action of the inertias generates a moment whose direction is contrary to the direction of motion

of the hydraulic motor 31).

[0193] In the case of deceleration, the electric motor 21 must act as a brake, meaning that it must absorb power to decelerate the masses, therefore the energy related to said process is positive (meaning that the action of the inertias generates a moment whose direction is the same as the direction of motion of the hydraulic motor 31).

[0194] Furthermore, in the press that is the subject of the present invention the contribution of the energies due to the accelerations and decelerations of the system is considerably reduced by the fact that hydraulic motors have a much lower inertia than electric motors with permanent magnets. In fact, generally, the ratio of inertias between hydraulic motors and electric motors with permanent magnets is equal to approximately 1/15-1/20.

[0195] Consequently, the proposed solution makes it possible to obtain a system with a total inertia, including the mass of the machine, that is approximately 40% lower compared to the analogous systems of the known type.

[0196] In the present invention, advantageously, the driver 72 can manage the driving or braking current in a different manner and set the electric motor 21 to idle if the speed of the flywheel exceeds the desired speed, avoiding to brake the flywheel when the latter accelerates and exceeds the desired speed due to the generation of a positive energy.

[0197] In this manner, the instant excess energy due to the occurrence of any process that generates positive energy is stored in the flywheel and made available successively, when any process generating negative energy takes place.

[0198] In other words, with this solution energy fluctuations are not exchanged between the electric motor 21, the driver 72 and the electricity supply network E or a possible capacitor bank or any electric energy accumulation system, but energy is stored in the flywheel 26.

[0199] Since any power supply unit transforming mechanical energy into electrical energy, even in the presence of high-efficiency systems like permanent magnet motors, drivers, high-efficiency regenerative drivers and current accumulation systems with capacitor banks or other solutions, is characterized by a yield, it is clear that eliminating energy fluctuations and therefore the exchange of energy within the supply unit itself makes it possible to improve to overall energy balance of the press and of the process.

[0200] Figure 18 shows a variant embodiment of the press 701 according to the present invention.

[0201] In the embodiment 701 of Figure 18 the parts or components described above with reference to the other figures are identified by the same reference numbers.

[0202] This embodiment of the press 701 differs first of all from the embodiments shown in Figures from 12 to 17 due to the fact that the hydraulic cylinder 3a used for the sheet pressing function of the counteracting table 3, the energy recovery circuit 80 and the recovery pump/pumps 32a are replaced by a hydraulic, pneumatic or gas cylinder 3A and one or more accumulation tanks 3B.

[0203] In the operation of the dies, in fact, the sheet pressing function is often required and this can be preferably obtained by means of said pneumatic or gas cylinders 3A complete with the corresponding tank 3B.

[0204] When the ram 2 closes the die against the table 3, the pressure inside the piston 3A and the tank 3B generates a force that counteracts the movement of the ram 2, generating a negative energy (meaning energy that opposes the motion of the hydraulic motor 31). When the ram 2 moves back upwards, reversing the direction of motion, the force generated by the pressure inside the cylinder 3A and the tank 3B acts in the same direction as that of the movement and generates a positive energy (meaning energy that acts in the same direction as that of the motion of the hydraulic motor 31).

[0205] It should be noted that said sheet pressing function, and in particular the use of pneumatic or gas cylinders 3A complete with a corresponding tank 3B, can be used in any of the embodiments described above.

[0206] Furthermore, said press 701 comprises a system constituted by pneumatic or hydraulic cylinders 400P, commonly called balancing cylinders, if necessary connected to a gas hydraulic accumulator or an air tank 400S for the purpose of avoiding impacts in the kinematic mechanisms during the steps of change of direction of the linear acceleration of the ram 2. When the ram lowers down and compresses the cylinders 400P, the pressure inside the cylinders 400P and the tank 400S generates a force that counteracts the movement of the ram 2, generating a negative energy (meaning energy that opposes the motion of the hydraulic motor 31). When the ram 2 moves back upwards, reversing the direction of motion, the force generated by the pressure inside the cylinders 400P and the tanks 400S acts in the same direction as that of the movement, generating a positive energy towards the electric motor 21 (meaning energy that acts in the same direction as that of the motion of the hydraulic motor 31).

[0207] It should be noted that this solution comprising cylinders 400P and tanks 400S can be used in any of the embodiments described above.

[0208] Advantageously, also for this embodiment, that is, for the system constituted by the cylinders and tanks 3A and 3B and/or the piston unit 400P and the tanks 400S, the driver 72 makes it possible to manage in an optimal manner the excess energy stored in the flywheel 26, obtaining the same results and the advantages described above and deriving from the control of the electric motor 21.

[0209] The description provided above thus shows that the press according to the present invention for processing metal components, like sheet components and/or similar elements, allows the set objects to be achieved. In particular, the press according to the present invention makes it possible to overcome the drawbacks posed by the servo presses known in the art. In fact, the press

according to the present invention makes it possible to avoid the use of electric capacitors for energy accumulation, and therefore the press according to the present invention can be produced with reduced size and costs and higher reliability compared to the servo presses of the known type.

[0210] Even though the present invention has been illustrated above by means of the detailed description of some of its embodiments represented in the drawings, the present invention is not limited to the embodiments described above and shown in the drawings; on the contrary, further variants of the embodiments described herein fall within the scope of the present invention, which is defined in the claims.

Claims

1. Press (1; 101; 201; 301; 401; 501; 601) for processing a component (C), said press (1; 101; 201; 301; 401; 501; 601) comprising a ram (2) suited to be subjected to a movement in a substantially longitudinal direction (X) against said component (C) in order to carry out said processing operation, said press (1; 101; 201; 301; 401; 501; 601) comprising a supply unit (20) suited to be connected to an electricity supply network (E) for converting electrical energy into mechanical energy and a kinematic mechanism (5) associated with said ram (2) and suited to transmit said movement to said ram (2), **characterized in that** said press (1; 101; 201; 301; 401; 501; 601) comprises a hydraulic circuit (30; 230; 430) provided with a hydraulic motor (31) and with supply means (32; 232; 432) suited to supply a hydraulic fluid for said hydraulic motor (31) and operated by said supply unit (20), the outlet (14) of said hydraulic motor (31) being connected to said kinematic mechanism (5).

2. Press (1; 101; 201; 301; 401; 501; 601) according to claim 1, **characterized in that** said hydraulic fluid supply means (32; 232; 432) comprise a hydraulic pump (32; 233).

3. Press (1; 101; 201; 301; 401; 501; 601) according to claim 2, **characterized in that** said hydraulic pump (32; 233) is a variable delivery pump.

4. Press (201; 301; 401) according to claim 1, **characterized in that** said supply means (32; 232; 432) comprise a hydraulic pump (232; 432) and a proportional valve that controls flow direction and flow rate (234).

5. Press (1; 101; 201; 301; 401; 501; 601) according to any of the preceding claims, **characterized in that** it comprises an energy accumulation system (25; 425) suited to supply a power peak to said ram (2).

6. Press (1; 101; 201; 301; 501; 601) according to claim 5, **characterized in that** said energy accumulation system (25) is arranged between said supply unit (20) and said hydraulic circuit (30; 230).

7. Press (1; 101; 201; 301; 501; 601) according to claim 5 or 6, **characterized in that** said energy accumulation system (25) is of the mechanical type.

8. Press (1; 101; 201; 301; 501; 601) according to claim 7, **characterized in that** said energy accumulation system (25) of the mechanical type comprises a flywheel (26).

9. Press (401) according to claim 5, **characterized in that** said energy accumulation system (425) is of the hydraulic type and is arranged in said hydraulic circuit (430).

10. Press (401) according to claim 9, **characterized in that** said energy accumulation system (425) of the hydraulic type comprises one or more accumulators (427) of said hydraulic fluid.

11. Press (1; 101; 501; 601) according to any of the preceding claims, **characterized in that** said hydraulic circuit (30) is a hydraulic circuit (30) in the closed circuit configuration.

12. Press (201; 301; 401) according to any of the claims from 1 to 10, **characterized in that** said hydraulic circuit (230; 430) is a hydraulic circuit (230; 430) in the open circuit configuration.

13. Press (1; 101; 201; 301; 401; 501; 601) according to any of the preceding claims, **characterized in that** said hydraulic circuit (30; 230; 430) comprises a bypass device (50) suited to reduce and/or cancel the output torque of said hydraulic motor (31).

14. Press (101; 301; 401; 501; 601) according to any of the preceding claims, **characterized in that** it comprises an auxiliary moving system (70; 530; 630) for said ram (2) that is associated with said kinematic mechanism (5).

15. Press (1; 101; 201; 301; 501; 601) according to any of the preceding claims, **characterized in that** it comprises a counteracting movable table (3) for said ram (2) and **in that** it comprises an energy recovery system suited to recover energy during the displacement of said counteracting table (3) caused by the movement of said ram (2).

16. Press (1; 101; 201; 301; 501; 601) according to any of the preceding claims, **characterized in that** said supply unit (20) comprises an electric motor (21) fed by electronically controlled power supply systems

(72) in such a way that it is possible to control the performance of said electric motor (21) and/or to optimize the recovery of the energy of said press.

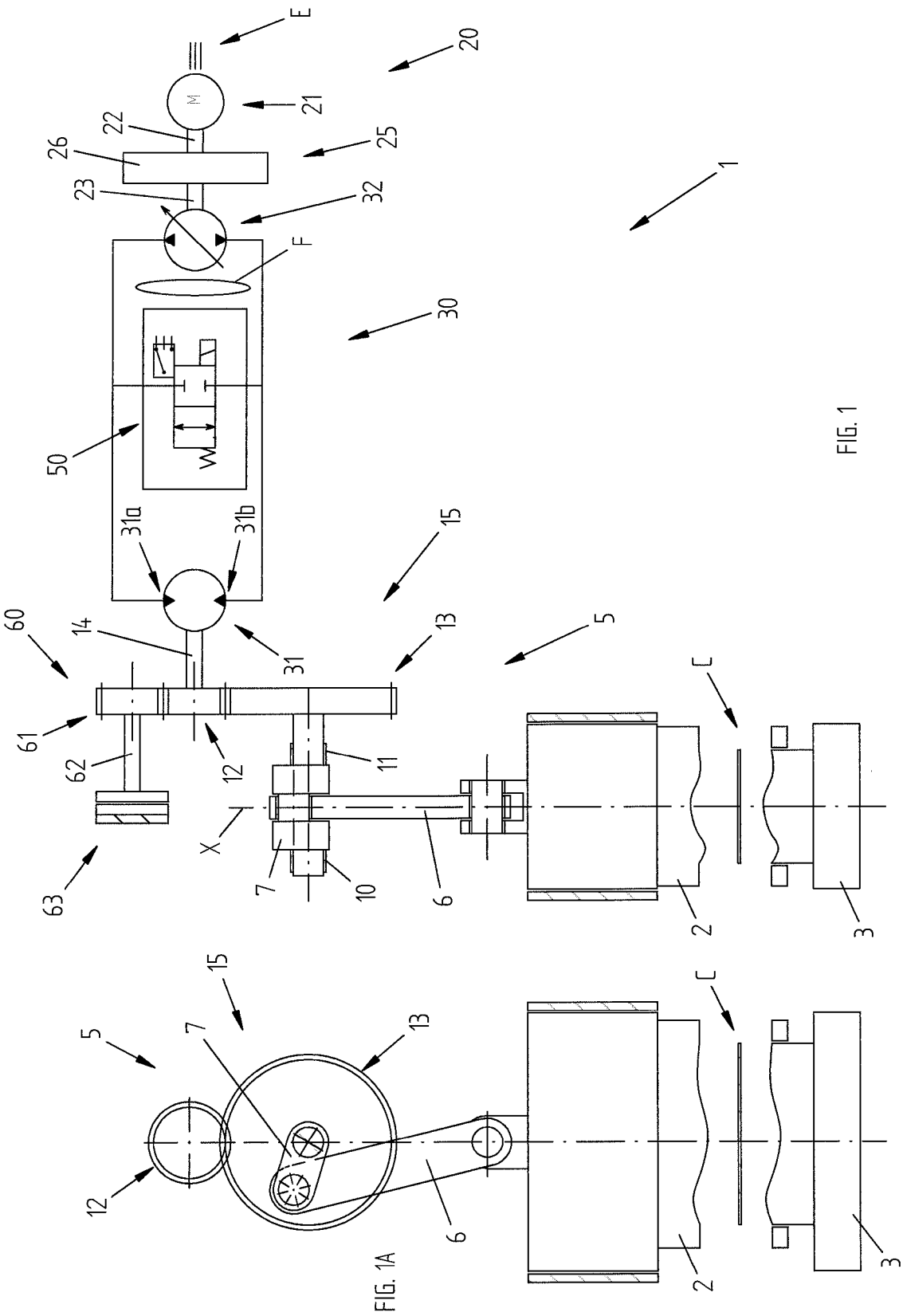

E
20
21
22
25
26
23
32
1
F
30
50
31a
31b
15
60
14
31
13
5
61
62
12
11
C
X
7
10
6
2
3
63

FIG. 1

15
5
7
13
C
12
6
2
3

FIG. 1A

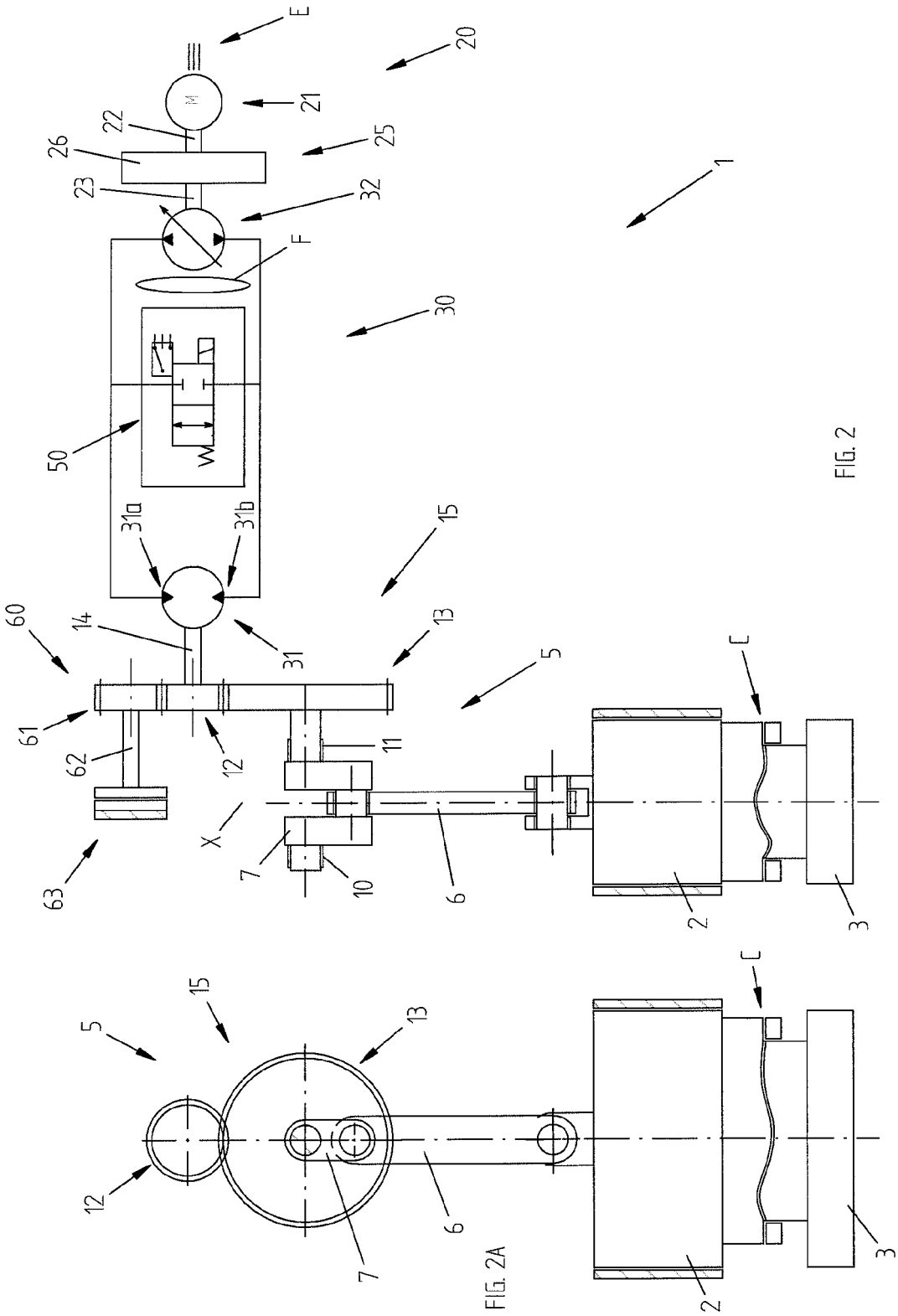

E
20
21
22
26
25
23
32
1
F
30
50
31a
31b
15
60
14
31
13
5
61
62
12
11
C
X
7
10
6
63
2
3

FIG. 2

5
15
13
C
12
7
6
2
3

FIG. 2A

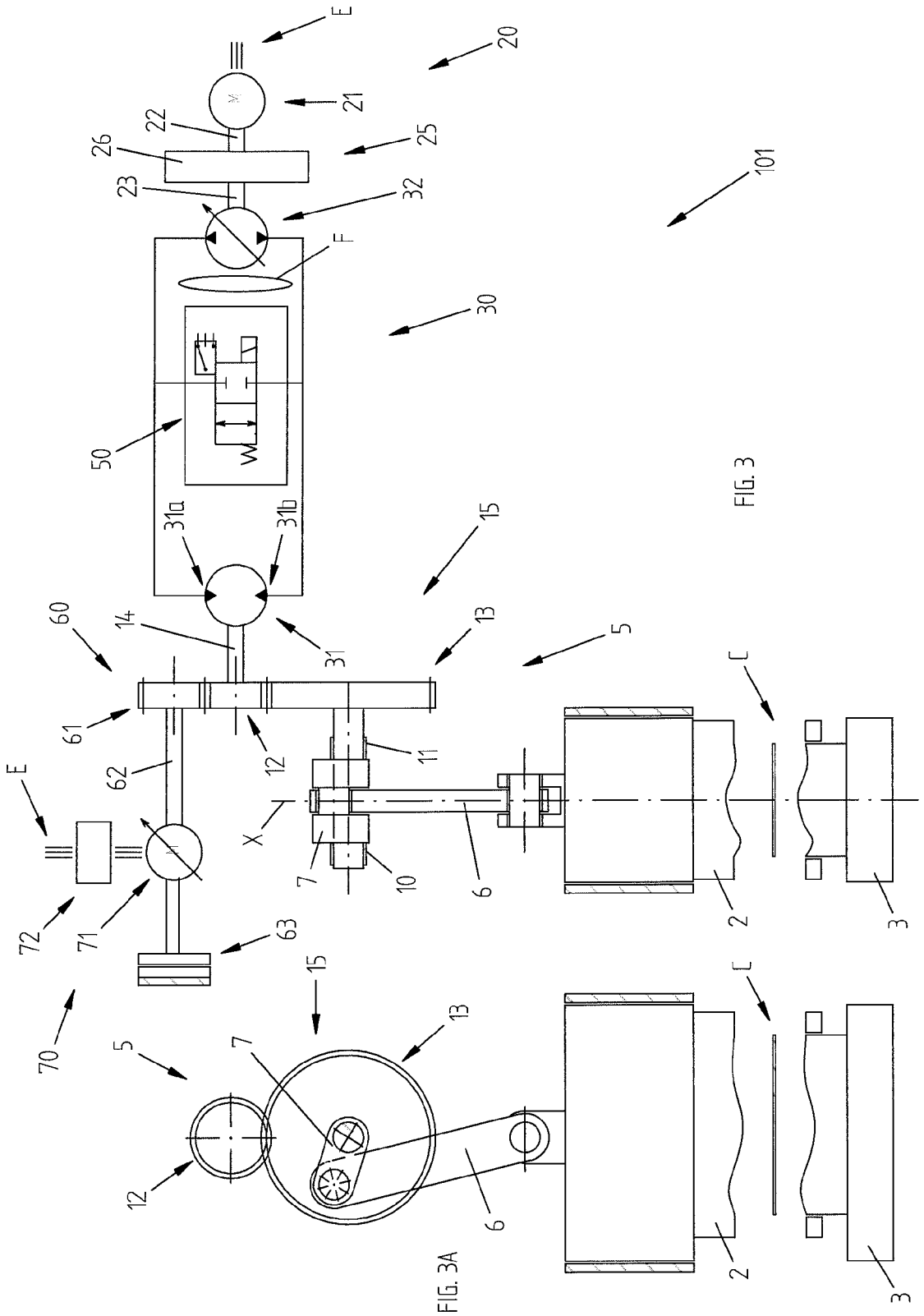
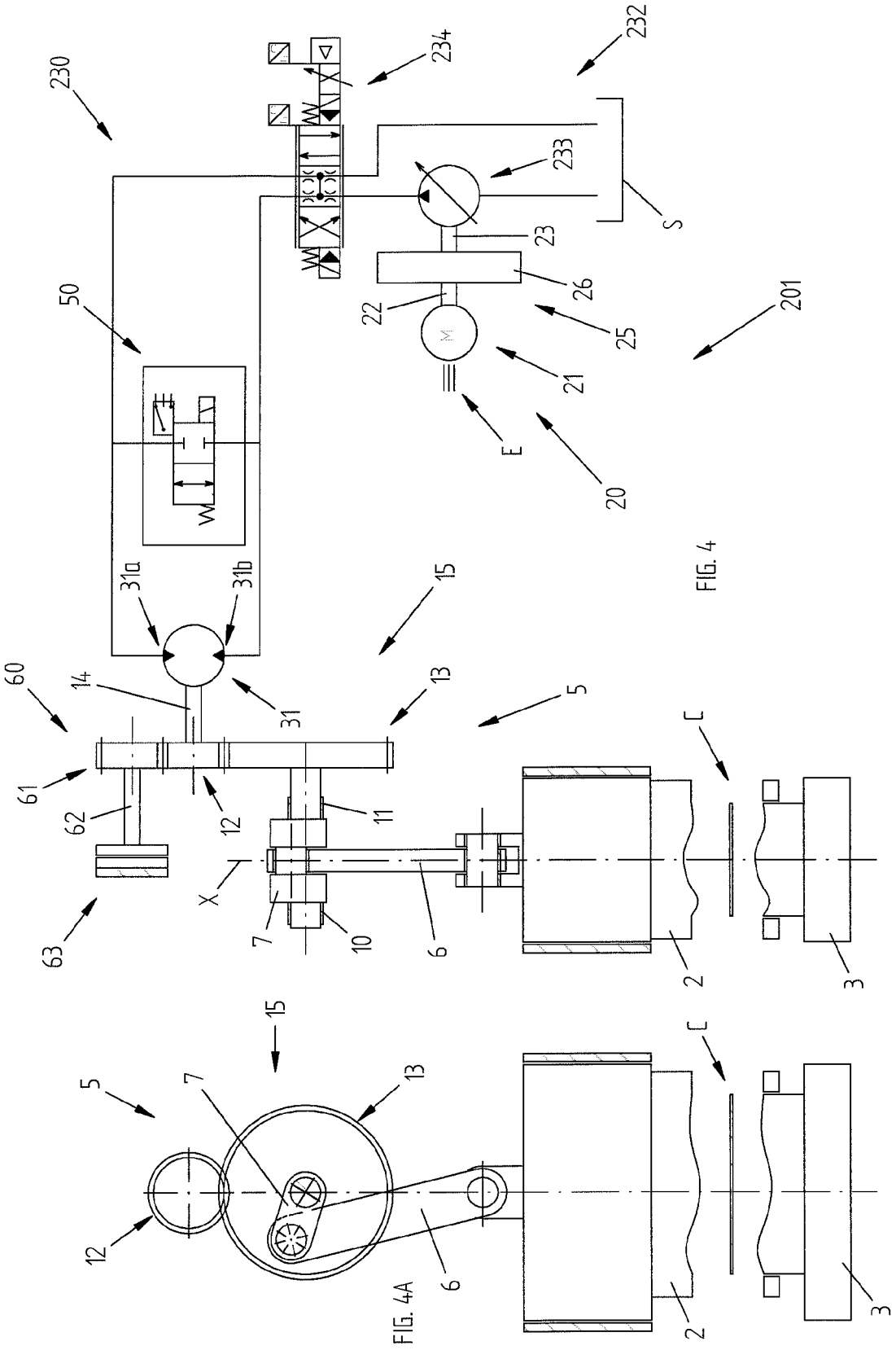

E
20
21
22
25
26
23
32
101
F
30
50
31a
31b
15
60
14
31
13
5
61
62
12
11
E
X
7
10
6
2
3
72
71
63
70
15
13
5
7
12
6
2
3

FIG. 3

FIG. 3A


230
234
232
233
23
S
50
22
26
25
201
21
E
20
31a
31b
15
60
14
31
13
5
61
62
12
11
X
7
10
6
63
C
2
3
FIG. 4
15
5
7
13
12
6
C
2
3
FIG. 4A

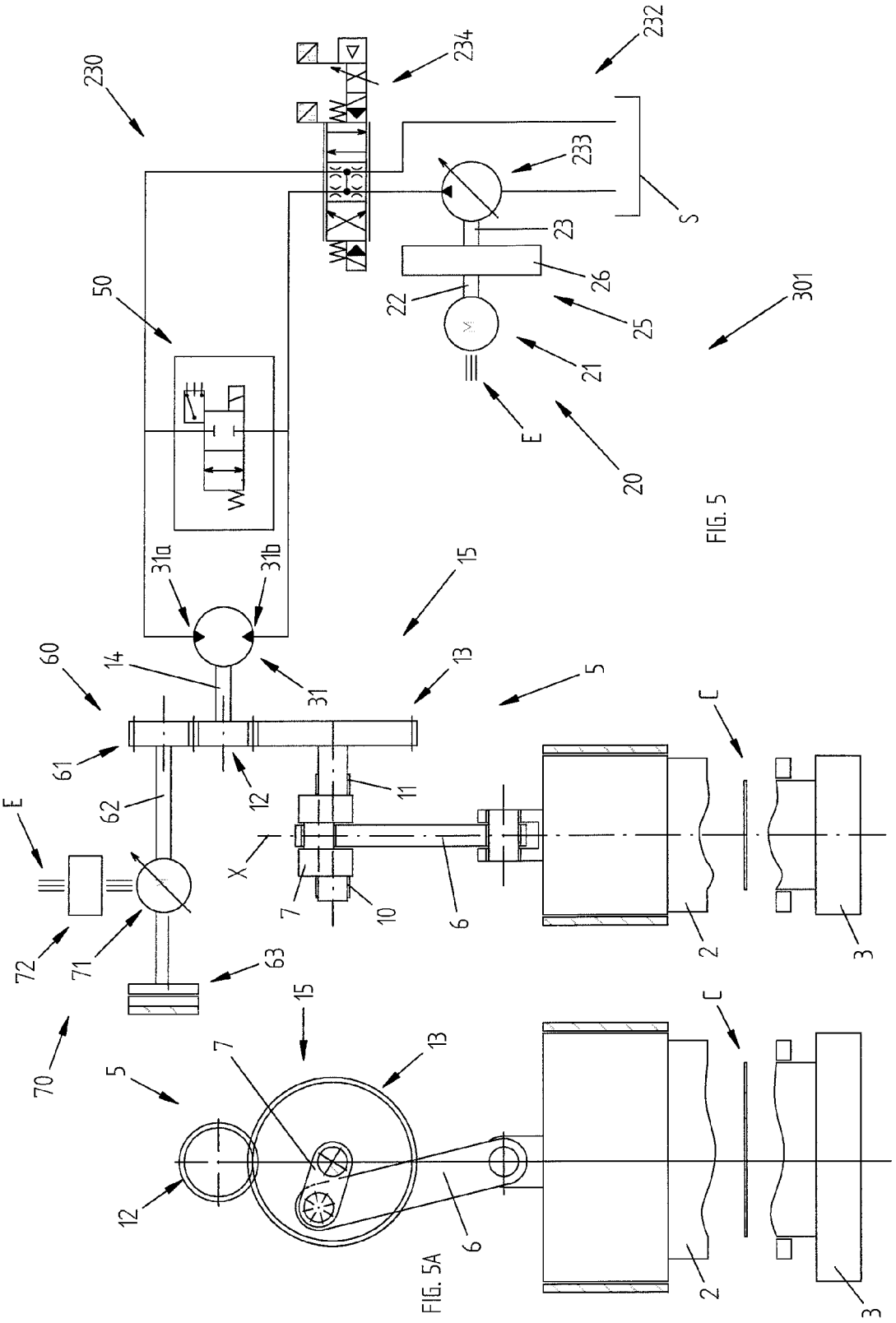

230
234
232
233
23
S
26
22
25
301
21
50
E
20
31a
31b
15
60
14
31
13
5
61
62
12
11
E
X
7
10
6
C
2
3
72
71
63
70
15
13
7
5
12
6
C
2
3

FIG. 5

FIG. 5A

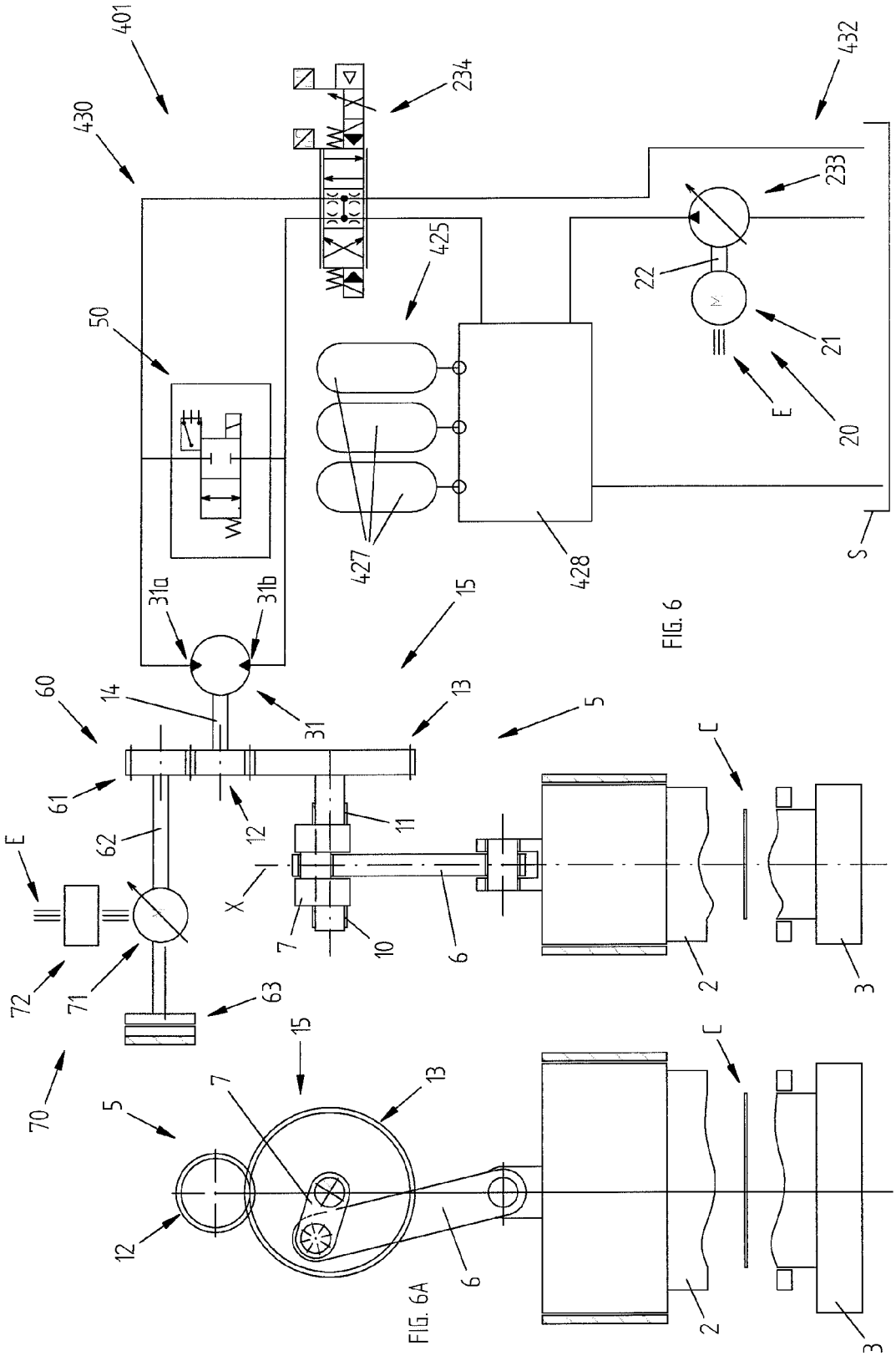

401
430
234
432
233
425
22
50
21
E
20
427
428
S
31a
31b
15
60
14
31
13
5
61
12
11
62
E
X
7
10
6
C
2
3
72
71
63
15
70
5
7
13
12
6
C
2
3

FIG. 6

FIG. 6A

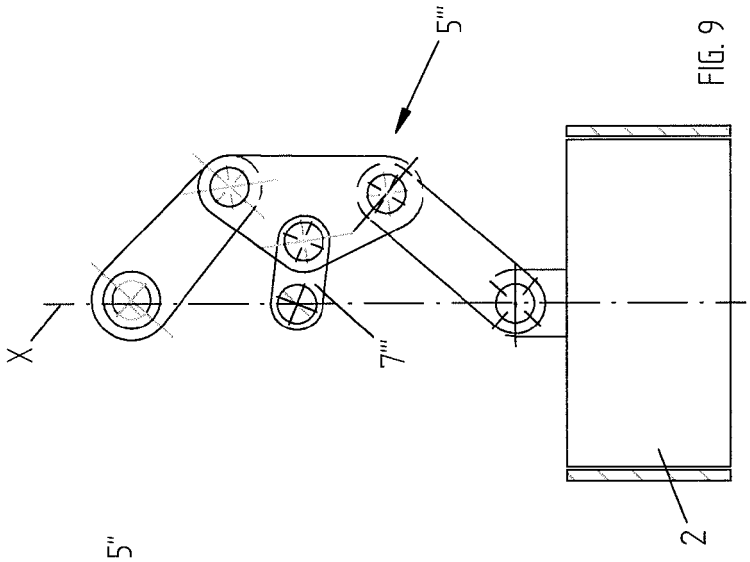


FIG. 9

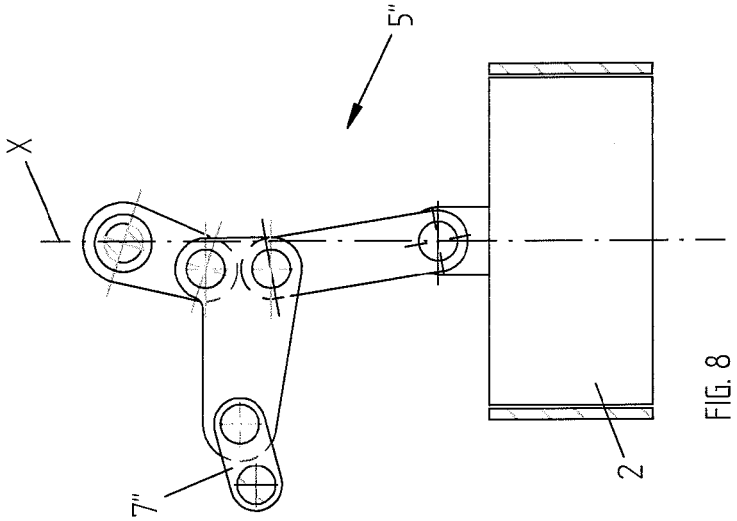


FIG. 8

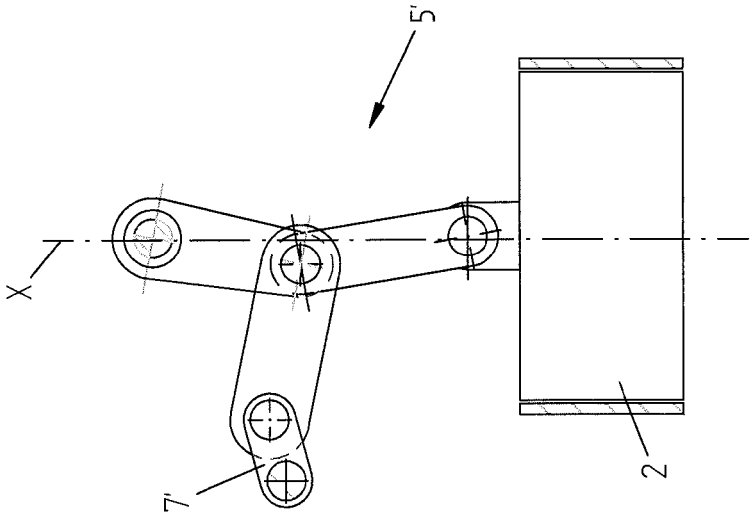


FIG. 7

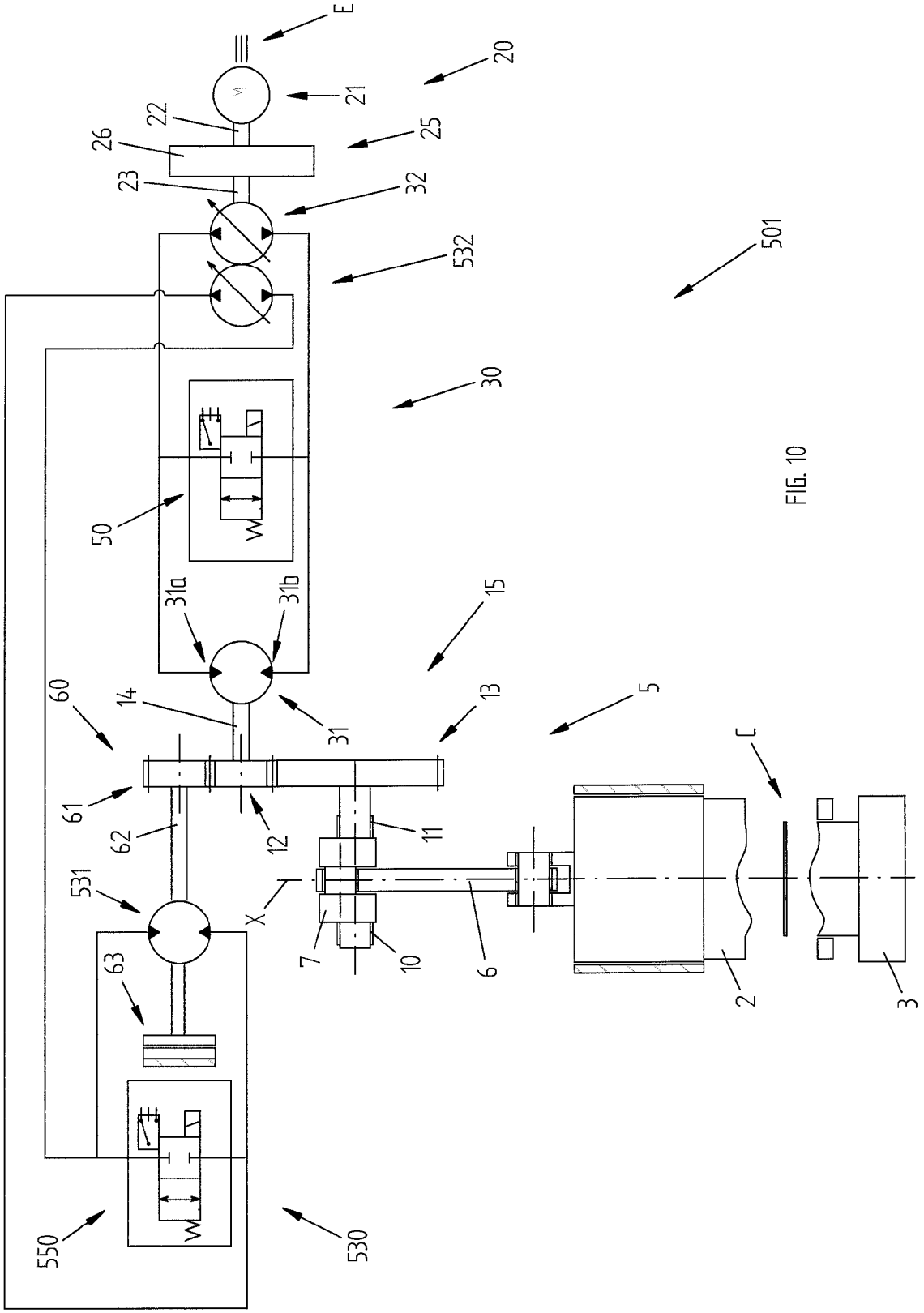

E
20
21
22
25
26
23
32
532
501
30
50
31a
31b
15
60
14
31
13
5
61
62
12
11
C
531
X
7
10
6
2
3
63
550
530

FIG. 10

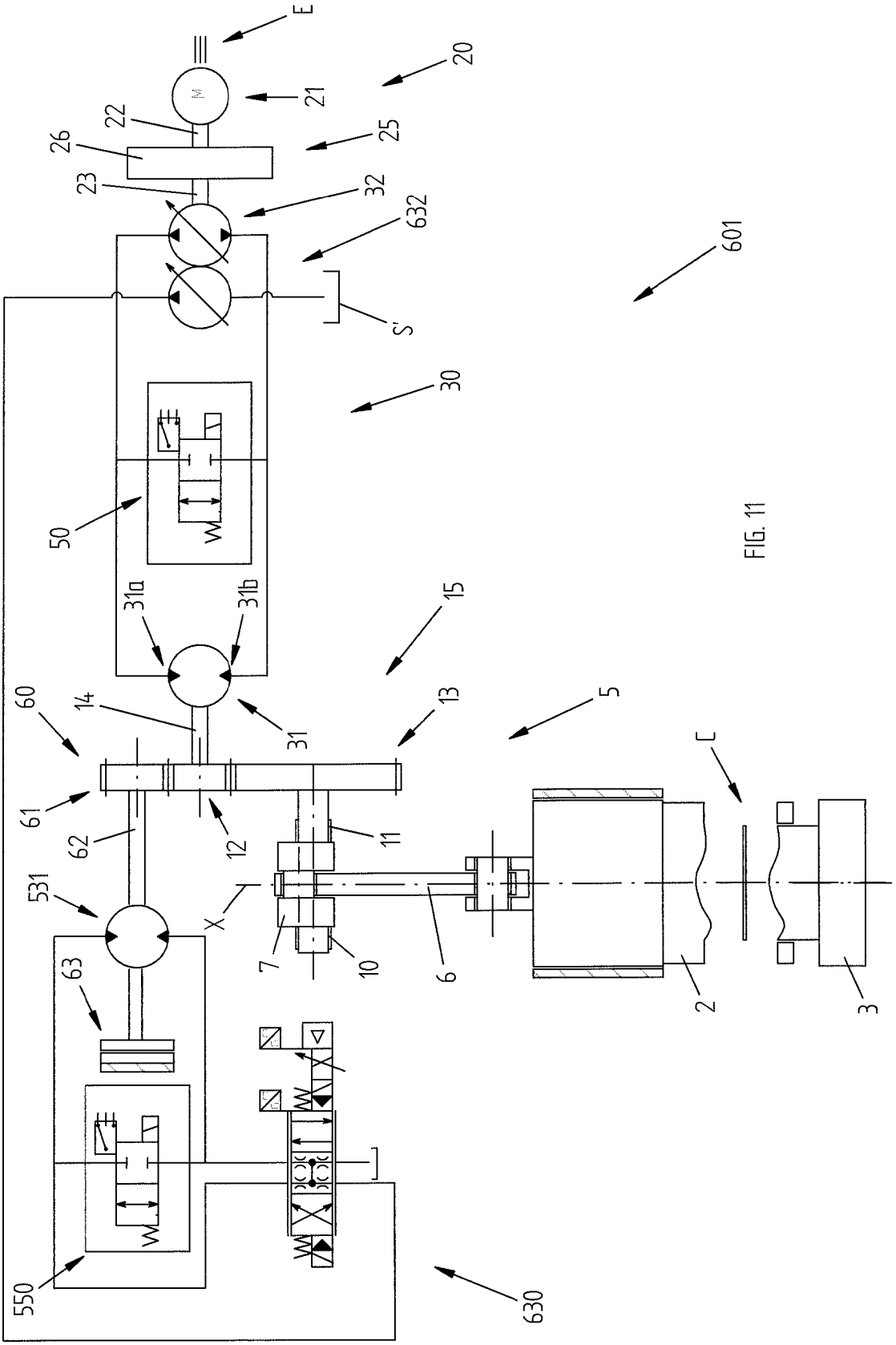

E
20
21
22
25
26
23
32
632
601
S'
30
50
31a
31b
15
60
14
31
13
5
61
62
12
11
C
531
X
7
10
6
2
3
63
550
630

FIG. 11

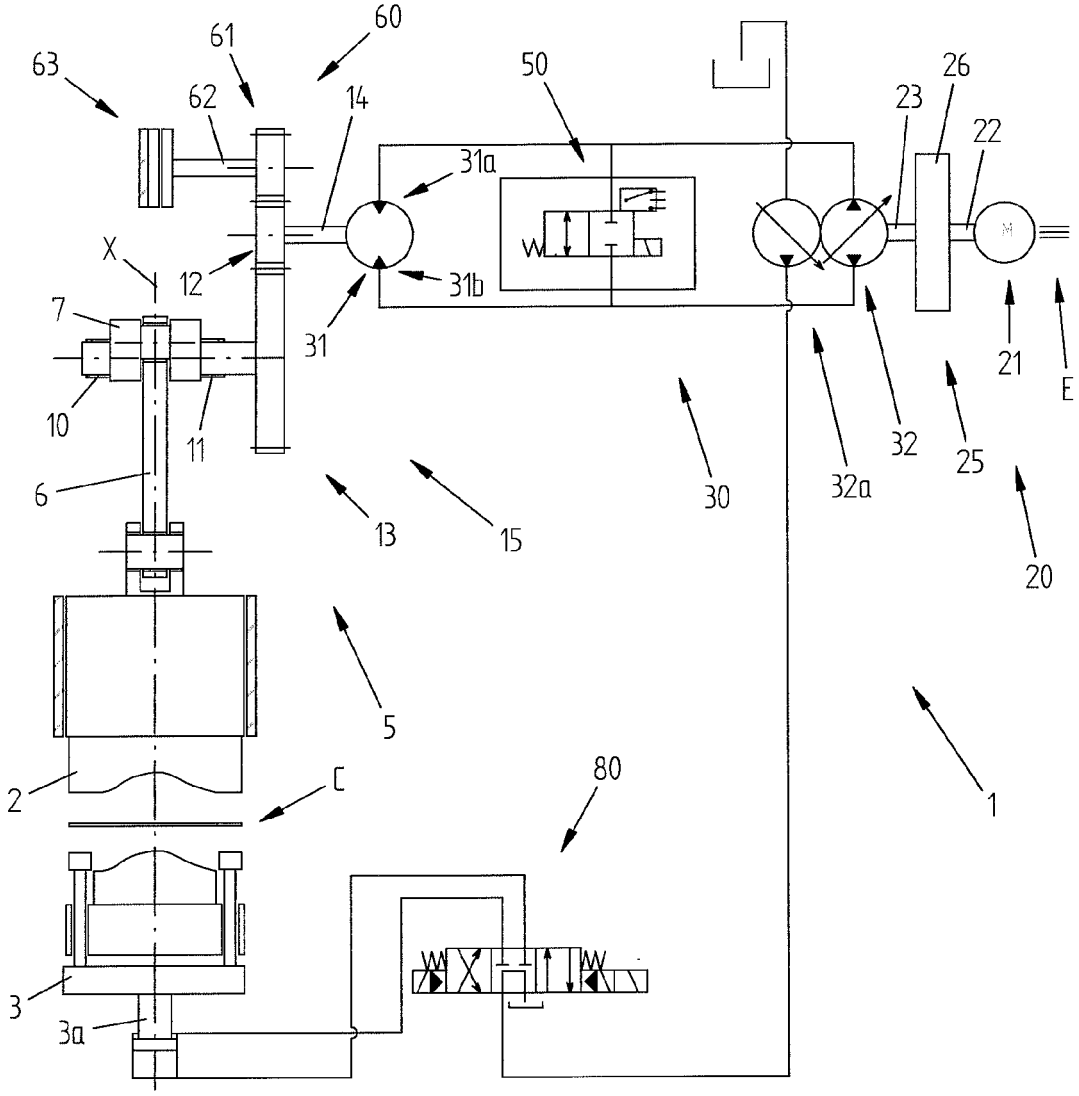

63
61
60
62
14
50
26
23
22
31a
X
12
31b
7
31
21
E
10
11
32
25
6
13
15
30
32a
20
5
1
2
C
80
3
3a

FIG. 12

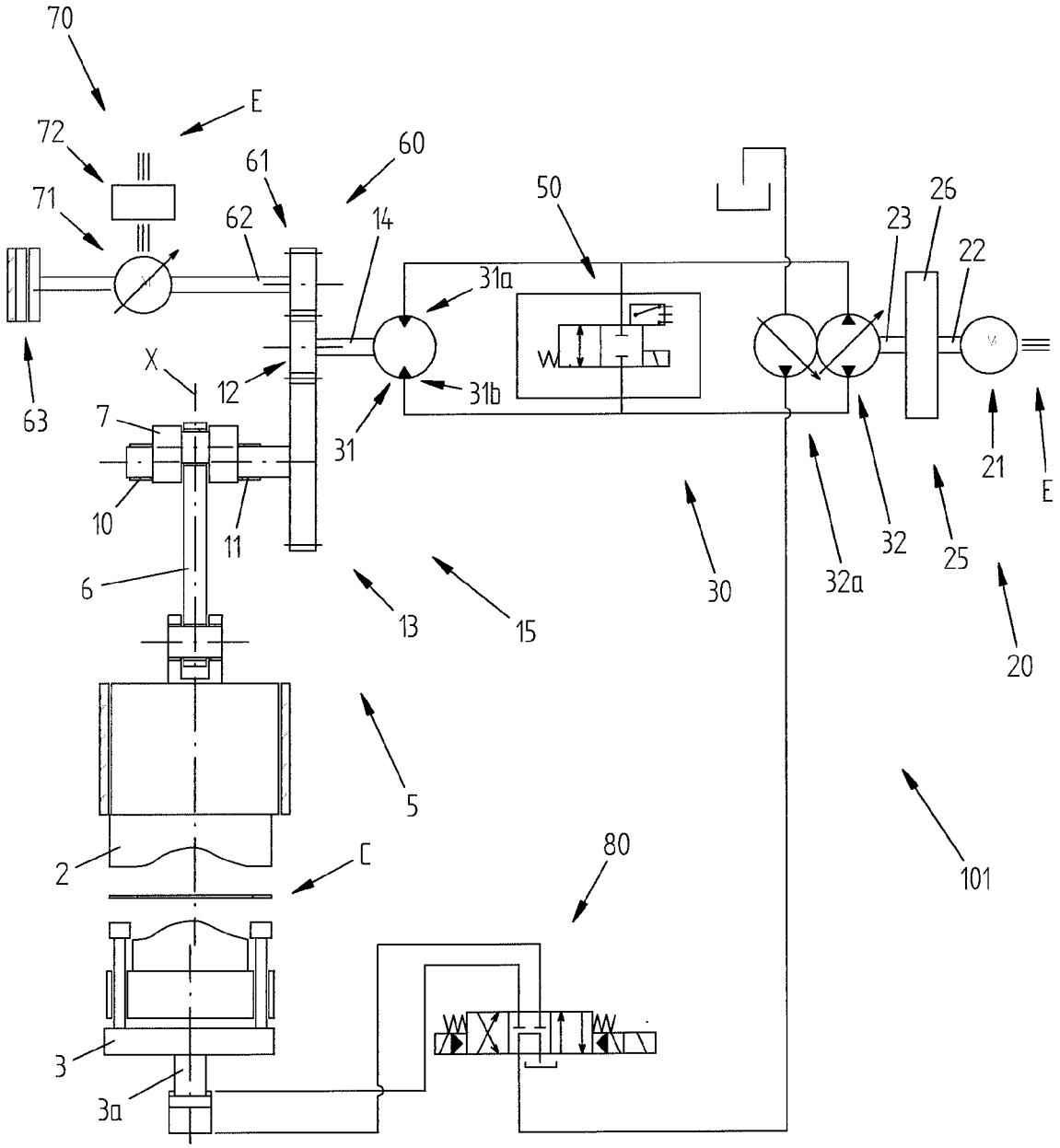

70
E
72
71
61
60
62
14
50
26
23
22
31a
63
X
12
31b
7
31
21
E
10
11
32
25
6
13
15
30
32a
20
5
101
2
C
80
3
3a

FIG. 13

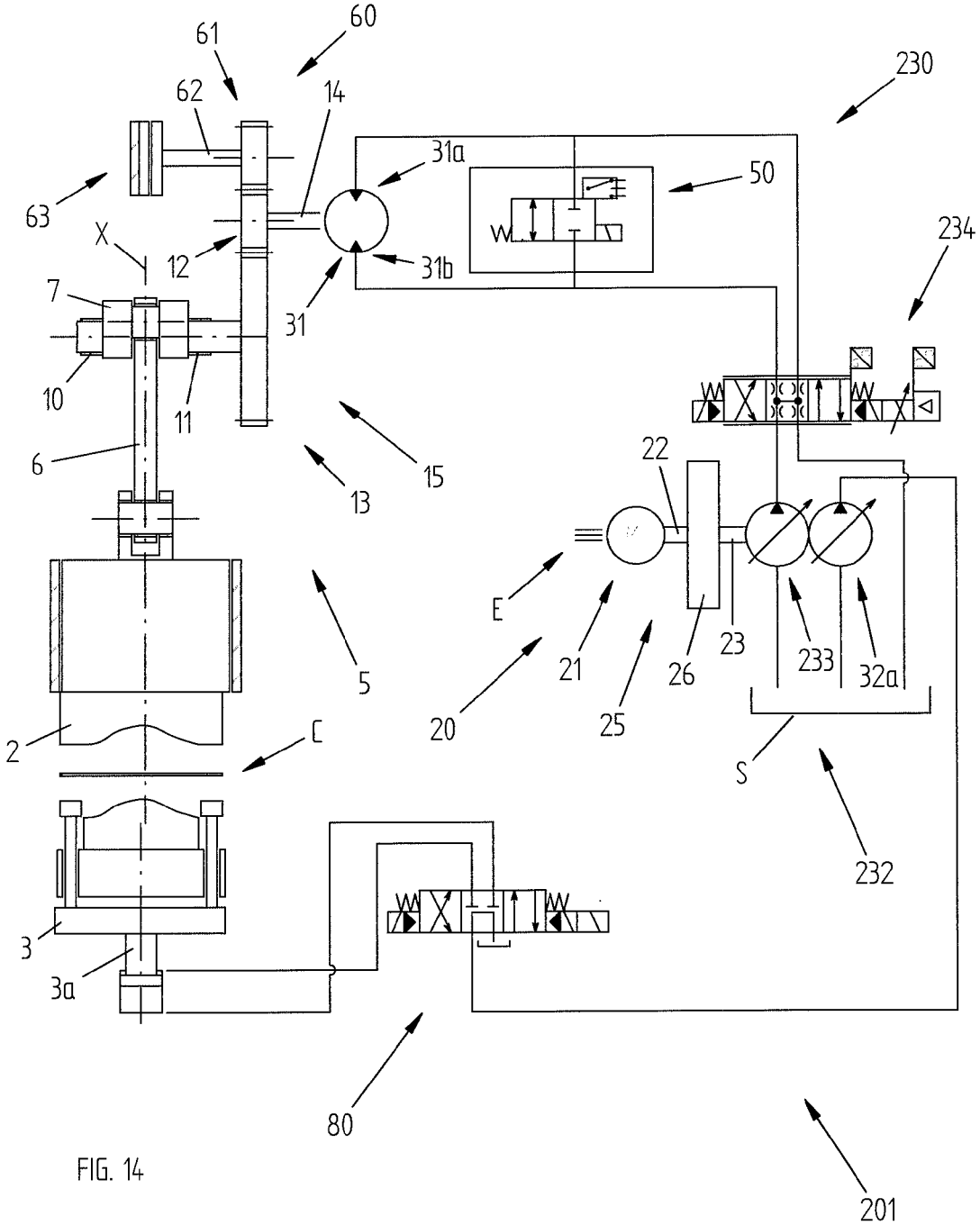

61
60
62
14
230
31a
50
63
X
12
31b
234
7
31
10
11
6
15
13
22
E
5
21
26
23
233
32a
20
25
2
C
S
232
3
3a
80
201

FIG. 14

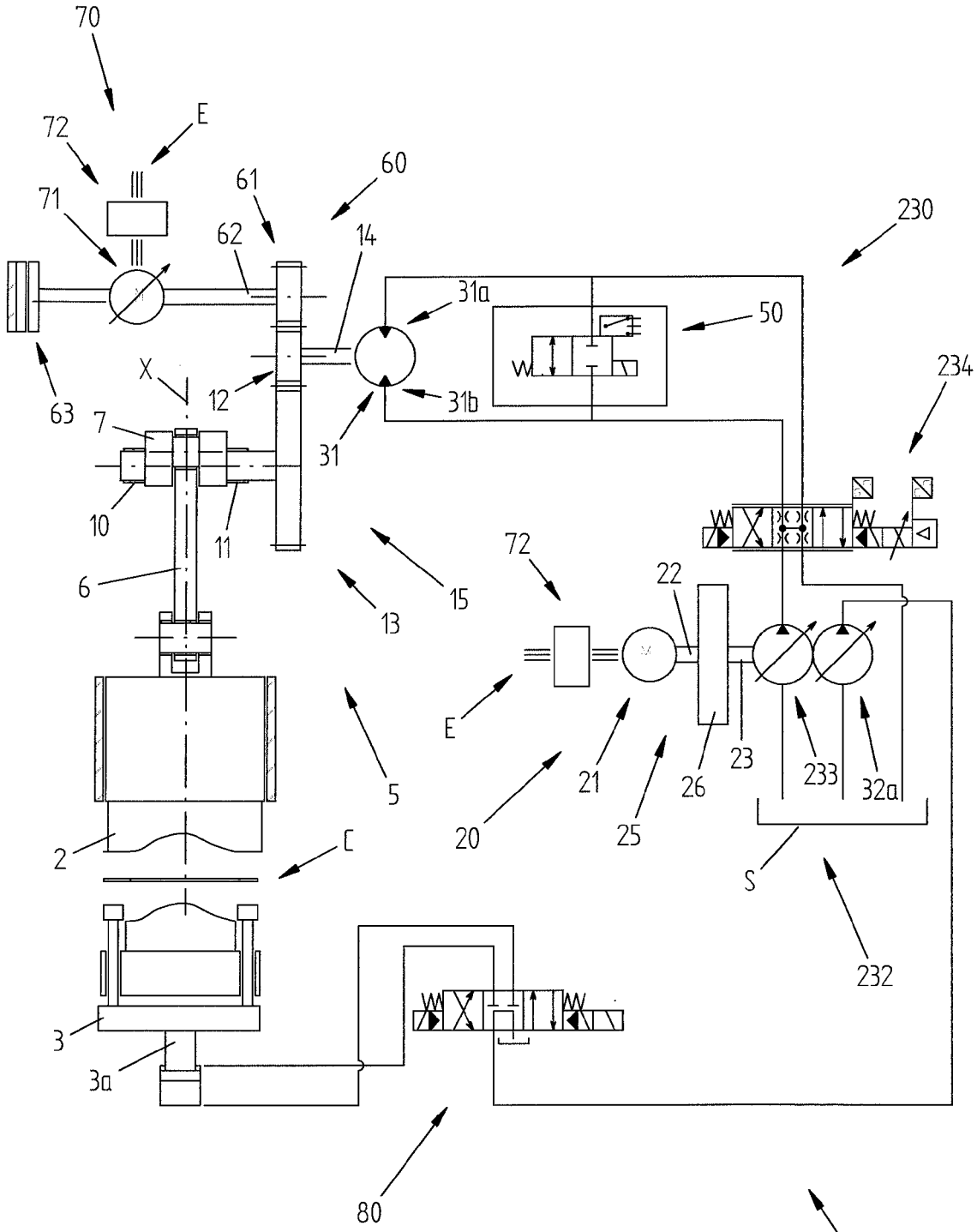

70
72
E
71
61
60
62
14
230
31a
50
63
X
12
31b
234
7
31
10
11
72
22
6
15
13
E
5
21
26
23
233
32a
20
25
2
C
S
232
3
3a
80
301

FIG. 15

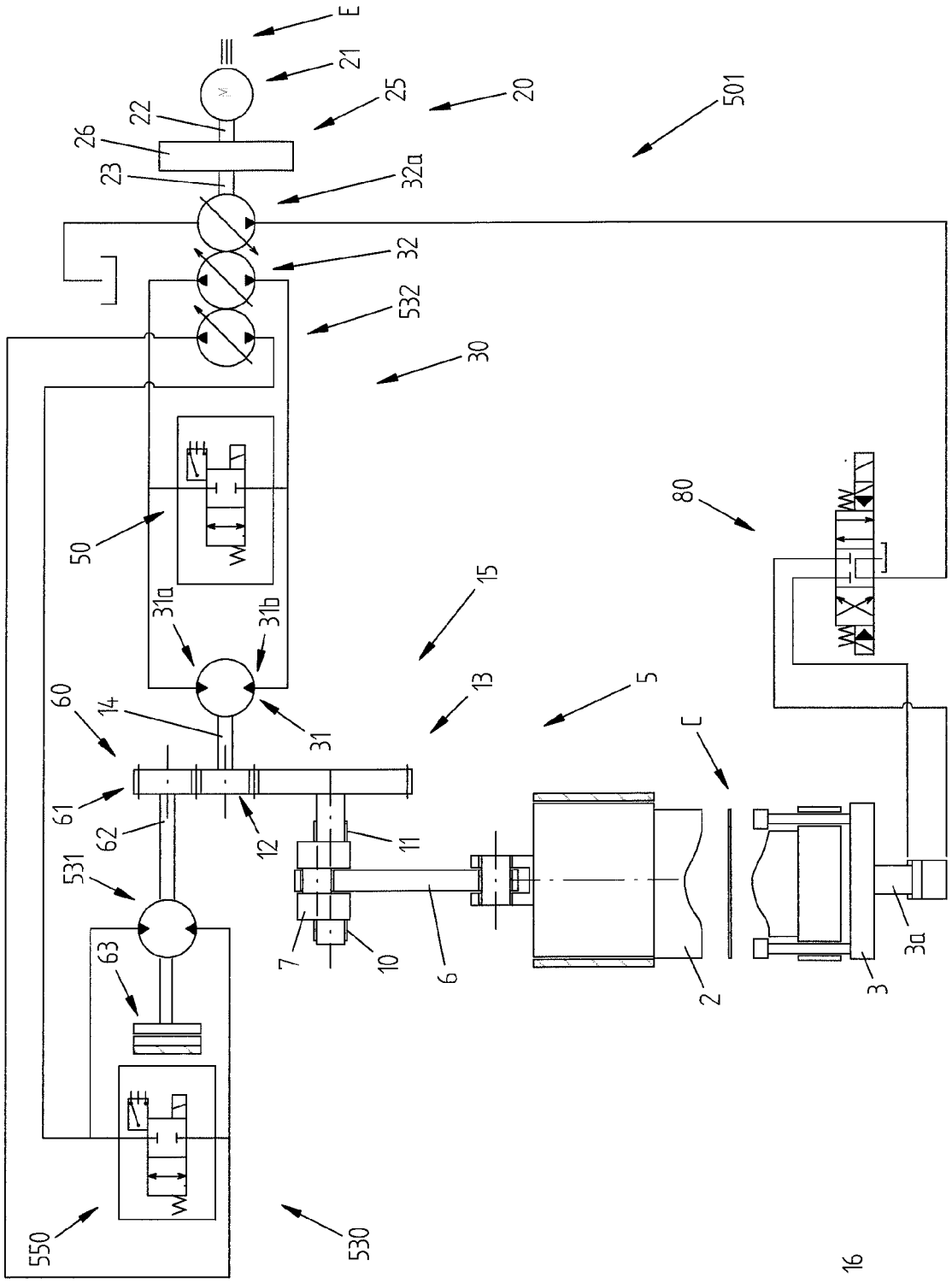

E
21
25
20
501
22
26
23
32a
32
532
30
50
80
31a
31b
15
60
14
31
13
5
61
62
12
11
531
63
7
10
6
2
3
3a
550
530

FIG. 16

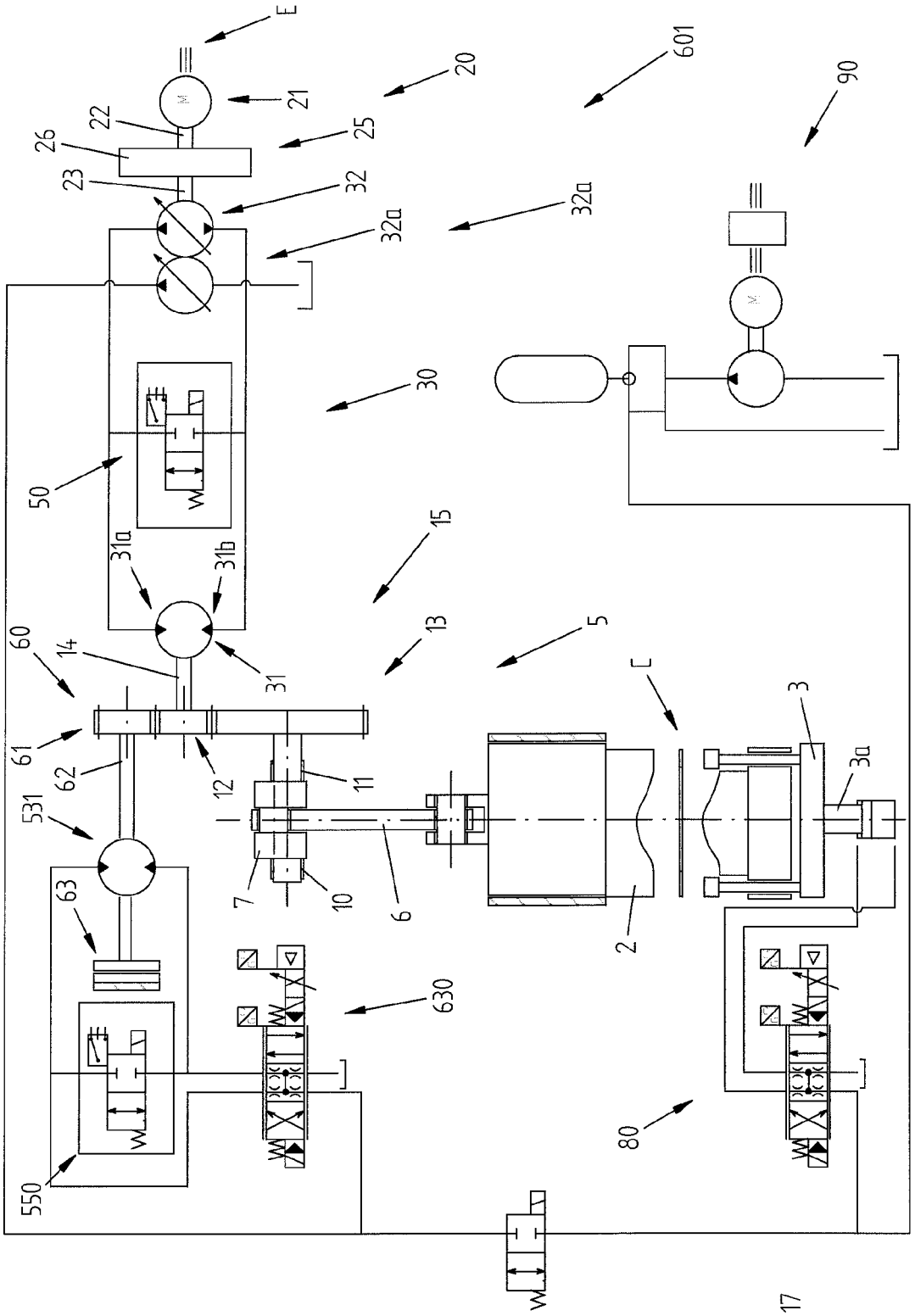

E
20
601
90
21
22
25
26
23
32
32a
32a
30
50
31a
31b
15
60
14
31
13
5
61
62
12
11
531
63
7
10
6
2
3
3a
630
80
550

FIG. 17

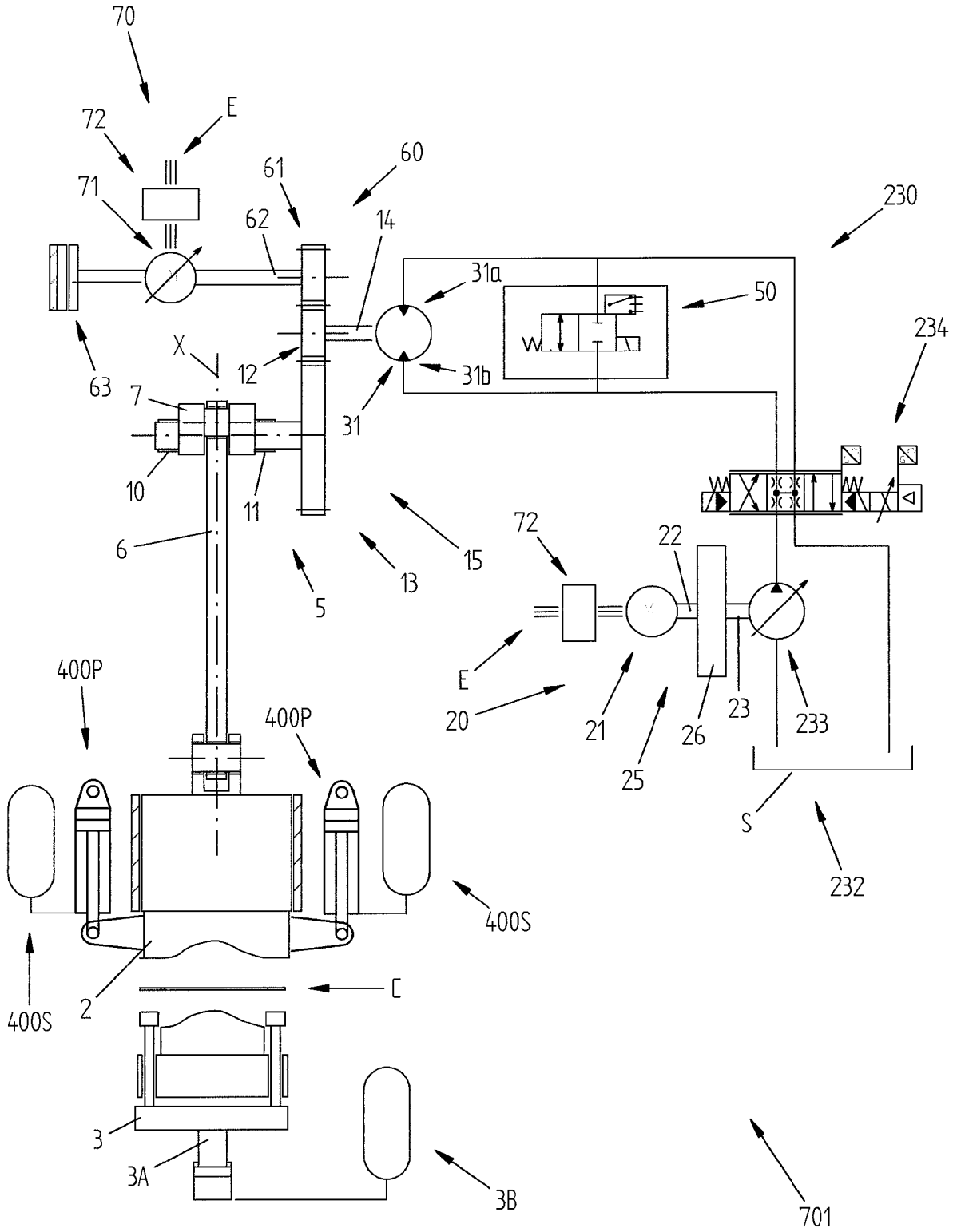

70
72
E
71
61
60
62
14
230
31a
50
234
X
12
31b
63
7
31
10
11
6
15
72
22
5
13
E
20
21
26
23
233
25
S
232
400P
400P
400S
400S
2
C
3
3A
3B
701

FIG. 18

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 14 15 7139

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 350 091 A (MYLES J EDGAR) 21 September 1982 (1982-09-21) * columns 2-6; figures *	1-5, 9-11,13	INV. B30B1/14 B30B1/26
X	US 3 324 653 A (NELSON PAUL C) 13 June 1967 (1967-06-13) * the whole document *	1,2,4, 12,13	
X	DE 102 19 581 A1 (MUELLER WEINGARTEN MASCHF [DE]) 13 November 2003 (2003-11-13) * the whole document *	1-3,5-8, 11	
X	JP H09 174289 A (AIDA ENG LTD) 8 July 1997 (1997-07-08) * abstract; figures *	1-3,5,9, 10,12	
X	EP 0 947 259 A2 (SUMITOMO HEAVY INDUSTRIES [JP]) 6 October 1999 (1999-10-06) * paragraphs [0005] - [0007]; figures *	1,2, 12-14	
X	US 5 499 525 A (KORDAK ROLF [DE] ET AL) 19 March 1996 (1996-03-19) * paragraphs [0006] - [0009], [0015] - [0016]; figures 1-4,10 *	1-3,12, 15,16	TECHNICAL FIELDS SEARCHED (IPC) B30B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 May 2014	Labre, Arnaud

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 15 7139

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

16-05-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4350091 A	21-09-1982	NONE	
US 3324653 A	13-06-1967	BE 686296 A	15-02-1967
		GB 1097048 A	29-12-1967
		US 3324653 A	13-06-1967
DE 10219581 A1	13-11-2003	NONE	
JP H09174289 A	08-07-1997	JP 3288569 B2	04-06-2002
		JP H09174289 A	08-07-1997
EP 0947259 A2	06-10-1999	EP 0947259 A2	06-10-1999
		JP 3437758 B2	18-08-2003
		JP H11285897 A	19-10-1999
		US 6178803 B1	30-01-2001
US 5499525 A	19-03-1996	CZ 9302262 A3	12-06-1996
		DE 4309641 A1	30-09-1993
		DE 59308158 D1	26-03-1998
		EP 0586669 A1	16-03-1994
		ES 2114044 T3	16-05-1998
		JP H06510949 A	08-12-1994
		US 5499525 A	19-03-1996
		WO 9319866 A1	14-10-1993

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82