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(54) **PINCH ROLL DEVICE**

VORRICHTUNG FÜR TREIBWALZEN

DISPOSITIF À ROULEAUX PINCEURS

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Description

Field of the invention

[0001] The present invention relates to a pinch roll device for rolled metallurgic products.

State of the art

[0002] In the technical field of line processes for semi-finished metallurgic products, e.g. wire rods, it is known to use pinch roll devices comprising systems for monitoring both the distance between the rolls and the pressure exerted by the rolls on the product when rolling.

[0003] Among the devices of the aforesaid type, the one described in Patent US 6920772 is known, for example, in which the rolls are connected to two cranks, respectively, connected to a single electric ratio motor. The controlled rotation of the ratio motor controls, by means of the two cranks, the reciprocal approach of the two rolls in one direction and the moving apart in the opposite direction. When a product being machined is present between the rolls, the ratio motor by means of the two cranks allows to adjust the thrust force of each roll against the other roll, thus also adjusting the pressure exerted by the rolls on the product being rolled.

[0004] The device described in US 6920772 has a series of drawbacks, caused by its constructional complexity and the inevitable presence of backlash in the transmission chain between the servo motor and the rolls, determined by the type and number of the mechanical members chosen to connect the servo motor to the rolls. Therefore, such a device does not allow to effectively control the distance between the rolls both during the waiting step, i.e. when the product to be rolled is not present between the rolls, and during the working step, when the product to be rolled is in contact with the rolls. During the working step, in devices as the one described in US 6920772, in which the distance between the rolls is adjusted only by means of a kinematic chain comprising electromechanical members, the dynamic stresses caused by the contact between product and rolls determine the juddering of the rolls, and the consequent intermittent loss of contact between rolls and rolled product. The impossibility of ensuring a constant pinching action implies the instability of the device which is also transmitted upstream of the rolling line.

[0005] Furthermore, the juddering of the pinch rolls causes a surface fault of the rolled product which reduces quality and increases material rejects.

[0006] Other pinch roll devices, as those described in US2003/034376 (on which the preamble of claim 1 is based) and in EP019298 are also known, which allow the distance between the rolls to be controlled by means of hydraulic actuators comprising one or more hydraulic cylinders controlled by servo valves. In this field, the use of hydraulic circuits comprising servo valves determines a plurality of drawbacks, the main drawbacks being:

- low operating speed of the servo valve (of the order of 40-50 Hz), with consequent low reactivity of the hydraulic circuit;
- open circuit operation with consequent need to provide external hydraulic attachments;
- high running and maintenance costs because the servo valves normally have low life cycles.

[0007] The devices described in US2003/034376 and in EP0192982 are also improvable with regards to roll positioning accuracy.

Summary

[0008] It is the object of the present invention to provide a new pinch roll device for rolled metallurgic products which allows to solve the mentioned drawbacks of the prior art, thus allowing to accurately control both the reciprocal distance of the pinch rolls and the pressure exerted by the rolls on the product when rolling, in order to ensure a continuous, even contact between rolls and rolled product.

[0009] Another object is to make available a new pinch roll device for rolled metallurgic products which is completely automatic and which does not require any manual intervention by the operator, e.g. for compensating roll wear.

[0010] A further object is to allow a high through speed, up to 150 m/s, of the product between the rolls to be achieved.

[0011] Another object of the present invention is to make available a pinch roll device controlled by a hydraulic circuit having size, in terms of length of the hydraulic line and amount of operating fluid, much smaller than the prior art.

[0012] A further object is to make available an operation method for the above-mentioned pinch roll device.

[0013] In accordance with the invention, the aforesaid technical problem is solved by means of a pinch roll device having the features set forth in independent claim 1, and by means of a method having the features set forth in independent claim 8.

[0014] Similarly as described above with regards to the first aspect, the present invention allows to obtain a method of operating a pinch roll device for metallurgic products with an optimized control comprising a step of checking the position, which allows to set the distance between the rolls before the passage of the product, and a step of checking the pressure, which allows to adjust the roll thrust when rolling. The two steps are carried out alternatively with respect to each other, allowing to optimize the control cycle which thus may be carried out rapidly, thus favoring an increase of the through speed of the product between rolls.

[0015] Other advantages of the present invention are achieved by means of a pinch roll device in accordance with the dependent claims, as explained in greater detail in the description that follows.

[0016] Including a first roll and a second roll reciprocally interconnected by means of a mechanical and/or hydraulic connection allows to reciprocally approach or space apart the two rolls in a symmetric manner with respect to the crossing axis, so as to accurately and effectively control the size of the passage gap. In particular, the hydraulic actuator being directly active on only one of the two rolls, while the other is controlled by a geared transmission between the two rolls allows to synchronize the movement due to the direct coupling of the first and second rolls, in a simpler manner than the other known solutions, e.g. the one in US 6920772, where a mechanical linkage transmission connects the operating member to both rolls. Alternatively, the use of two hydraulic actuators respectively acting on the two rolls and connected to each other by means of a compensation circuit allows to obtain the same operating accuracy and the same constructional simplicity.

[0017] Using a hydraulic control circuit further allows to obtain a stabilization of the system by damping the stresses between rolls and rolled product operated by the hydraulic fluid. Furthermore, the hydraulic circuit being closed and pressurized allows to have very small size with respect to the typical hydraulic circuits which include a hydraulic unit.

[0018] In the hydraulic circuit, using a reversible pump controlled by an electric motor, controlled in turn by a control unit connected to the position and pressure sensors, allows to implement a hydroelectric type control system in which the hydraulic part is used to control the reciprocal approach or spacing apart of the rolls, while the electric part allows to effectively obtain position and pressure feedback control. This allows to advantageously integrate the features of the hydraulic systems, in particular the possibility of exerting high pressures, with the features of the electric systems, in particular control speed and reliability.

[0019] Using the reversible pump controlled by the electric motor allows to omit the servo valve normally used in hydraulic circuits and to additionally decrease the amount of fluid needed by the hydraulic circuit and the overall length thereof.

Brief description of the figures

[0020] Further features and advantages of the present invention will become more apparent in the following detailed description of a preferred embodiment, provided by way of non-exclusive, indicative non-limiting example, with reference to the accompanying drawings, in which:

- figure 1 is a diagrammatic view of a pinch roll device for rolled metallurgical products in accordance with the present invention,
- figure 2 is a front view of some of the components of the device in figure 1;
- figure 3 is a side view of the components in figure 2,
- figure 4 is a diagrammatic view of a constructional

variant of the device in figure 1,

- figure 5 is a block diagram of a method for operating a pinch roll device for rolled metallurgical products in accordance with the present invention.

Detailed description of the invention

[0021] With reference to accompanying figures 1-3, a pinch roll device for a round-section, rolled metallurgical product is indicated by reference numeral 1 as a whole. In general, a pinch roll device provided in accordance with the present invention may be appropriately configured to hold any rolled metallurgical product, e.g. a flat-section rolled product.

[0022] Device 1 comprises a first pinch roll 2 and a second pinch roll 3 which is identical to the first roll 3, between which a substantially circular passage gap 5 for a wire rod 10 is defined. Gap 5 defines a crossing axis X, coaxial to gap 5, with which the wire rod 10 is aligned in operation when passing passage gap 5.

[0023] The first and second rolls 2, 3 can rotate about a first rotation axis Y1 and a second rotation axis Y2, respectively, to draw by friction the wire rod 10 through the passage gap 5. The rotation axes Y1, Y2 are parallel to each other and equally spaced apart from the crossing axis X, with respect to which they are arranged on the opposite side. The shape and size of gap 5 comply with those of the wire rod 10, and gap 5 is delimited by two annular grooves 5a, 5b provided on the cylindrical peripheral surface of the pinch rolls 2, 3, respectively. The first and second rolls 2, 3 are restrained to a first lever arm 7 and second lever arm 8, respectively, so as to rotate about respective rotation axes Y1, Y2. The rotation of the pinch rolls 2, 3 about the respective axes Y1, Y2, integral with the first and second arms 7, 8, respectively, is obtained by means of a conventional and known actuator comprising a drive motor (not shown) connected to the rolls by means of a transmission comprising a pair of driven toothed wheels 2a, 3a, coaxial with axes Y1, Y2, and a pair of drive toothed wheels 2b, 3b, meshing with each other so as to be counter-rotating. The driven toothed wheels 2a, 3a mesh with the toothed drive wheels 2b, 3b, respectively, from which they receive motion. The rotation motion is transmitted by the drive motor to the toothed drive wheel 3b, by means of a motion output shaft 3c. The motion is transmitted from the drive toothed wheel 3b to the other drive toothed wheel 2b and to the driven toothed wheel 3a. The motion is transmitted from the drive toothed wheel 2b to the other driven toothed wheel 2a. Due to the described coupling, the driven toothed wheels 2a, 3a, and therefore the respective rolls 2, 3, are counter-rotating.

[0024] The first and second arms 7, 8 are equal to each other and rotationally supported with respect to a fixed reference system integral with the crossing axis X by means of a pair of respective hinges which define a third rotation axis Z1 and a fourth rotation axis Z2, respectively, which are parallel to each other and equally spaced apart

from crossing axis X, respect to which they are arranged on opposite side.

[0025] The first and second arms 7, 8 can rotate about Z1 and Z2, respectively, to reciprocally either approach or space apart the first and second rolls 2, 3, so as to reduce or increase the width of the passage gap 5, respectively. The third and fourth rotation axes Z1, Z2 are spaced apart along the respective arm 7, 8, from the first and the second rotation axes Y1, Y2, respectively, and parallel thereto. In practice, the four axes Y1, Y2, Z1 and Z2 form a parallel axis system in all operating conditions of device 1.

[0026] In order to control the rotation of the lever arms 7, 8 and therefore to reciprocally approach or space apart the first and the second rolls 2, 3, device 1 comprises a hydraulic circuit 20 in which a hydraulic fluid, e.g. oil, circulates and a mechanical gear transmission 11, by means of which the first and second rolls 2, 3 are interconnected.

[0027] The hydraulic circuit 20 is closed and pressurized, therefore no hydraulic control unit is required, and comprises a hydraulic actuator 21 connected to the first roll 2 to approach it to or space it apart from the second roll 3. The actuator 21 comprises a stem 31 hinged at a free end 31 a thereof to the first lever arm 7, close to the first roll 2. The translation of stem 31 determines a corresponding rotation of the lever arm 7 about the third rotation axis Z1. The same rotation is transmitted to the second arm 8 by means of transmission 11.

[0028] The transmission 11, which thus allows the hydraulic actuator 21 to be connected to the second roll 3, by means of the first roll 2, comprises the lever arms 7, 8 and a gear 12 between the first lever arm 7 and the second lever arm 8. Gear 12 comprises a first toothed sector 12a and a second toothed sector 12b integral with the first and second arms 7, 8, respectively, and meshing with each other so that each rotation imparted by the actuator 21 to the first arm 7 is transmitted to the second arm 8.

[0029] The first and second toothed sectors 12a,b are provided at the end of a third arm 32 and of a fourth arm 33, respectively, being integral with the first and second arms 7, 8, aligned with each other and orthogonal to crossing axis X. The arms 32, 33 are arranged on opposite sides with respect to the crossing axis X so that the first and second toothed sectors 12a, b mesh with each other at the same crossing axis X. The transmission ratio of the gear 12 is unitary so that each rotation of the first arm 7 corresponds to an equal, opposite rotation of the second arm 8. Gear 12 allows to obtain a synchronous, coordinated movement of the first and second lever arms 7, 8 and of the rolls 2, 3 restrained thereto. Therefore, the assembly consisting of the first arm 7 and the first roll 2 restrained thereto is equal and symmetric, with respect to axis X, to the assembly of the second arm 8 and the second roll 3 restrained thereto in all operating conditions.

[0030] According to another constructional variant of

the invention (not shown), the first and second rolls 2, 3 are interconnected to each other by means of another type of mechanical connection, free from gears, comprising a plurality of linkages for example.

[0031] The hydraulic actuator 21 is of the double-effect type, comprising a first chamber 21 a and a second chamber 21 b, with a piston 22 connected to stem 31 and to a secondary stem 31 b sliding therebetween and being also opposed to stem 31 and having an equal diameter. In order to control the movement of piston 22, the hydraulic circuit 20 comprises a reversible pump 9, connected to the first and second chambers 21 a, b of the actuator by means of a first branch 20a and a second branch 20b of the hydraulic circuit 20, respectively. The rotation of the reversible pump 9 in one direction or in the other allows to send oil directly to either one or the other of the chambers 21a, b of actuator 21, respectively, thus determining the movement of piston 22 and stem 31 in either one direction or in the opposite direction.

[0032] Pump 9 which controls the movement of piston 22 is operated by an electric motor 9a; the position of piston 22 inside the cylinder thus depends on the angular position of the motor 9a of pump 9, while the movement speed of the cylinder depends on the angular speed of pump 9.

[0033] As the hydraulic circuit 20 is closed and pressurized, i.e. free from hydraulic control unit, the same amount of fluid always circulates therein. The motor 9a of pump 9 determines each fluid movement in the hydraulic circuit 20: therefore, if motor 9a does not operate the pump 9, the fluid flow in each point of the hydraulic circuit 20 is substantially zero and the piston 22 does not move.

[0034] A connection branch is provided between the first branch 20a and the second branch 20b of the hydraulic circuit 20, being equipped with a maximum pressure valve 29 calibrated so as to protect the hydraulic circuit from pressure overloads resulting from excessive, even pulsing loads applied to the first roll 2 and transmitted to the actuator 2 through stem 31. The first and second branches 20a, b are connected upstream of the reversible pump 9 to a top-up source 27, which allows to top-up any leakage of fluid from the hydraulic circuit 20. A first check valve 28a and a second check valve 28b, oriented so as to prevent the flow from the pump 9 to the top-up source 27 and to allow the flow in the opposite direction, are provided between the top-up source 27 and the reversible pump 9 on the first and second branches 20a, b, respectively.

[0035] The amount of fluid needed for the operation of the hydraulic circuit 20, given by the sum of the circulating fluid and the fluid present in the top-up source 27, may advantageously range from 0.5 to 2 liters, preferably from 0.7 to 1.4 liters. As the hydraulic circuit 20 is closed, it is also possible to contain its size: the overall length of the hydraulic line in which the fluid circulates is advantageously from 0.5 to 1.5 meters, preferably from 0.7 to 1 meter.

[0036] The reversible pump 9 and thus the actuator 21 are actuated in a controlled manner. A feedback control circuit 30 is included, comprising the electric motor 9a connected to pump 9 by means of a connector 9b. The control circuit 30 further comprises a pressure sensor 25, located in the first branch 20a of the hydraulic circuit 20, between the actuator 21 and the maximum pressure valve 29, and a position sensor 24 in the actuator 21. The pressure sensor 25 allows to measure the pressure in the circuit, and in particular in the chamber 21a, and thus to determine the force F1 transmitted by the actuator 21 to the first roll 2 through the stem 31. Force F1 is transmitted from the first roll to the wire rod 10. In order to achieve the device balance, obtained through the connection between the arms 7, 8 by means of transmission 11, an equal opposite force F2 transmitted from the second roll 3 to the wire rod 10 corresponds to force F1. The rolling force and pressure can be controlled by controlling the pressure in the hydraulic circuit 20. The position sensor 24 allows to measure the movement of piston 22, and thus to determine the movement of the first roll 2. The position of the first roll 2 can be controlled by controlling the position of piston 22, therefore by means of the transmission 11, the position of the second roll 3 can also be controlled, thus adjusting the width of the passage gap 5. The control circuit 30 further comprises a control unit 26 by means of which the electric motor 9a is controlled. The control unit 26 is connected to the position sensor 24 and to the pressure sensor 25, so to obtain a feedback control. The control unit 26 receives pressure and position data measured by the sensors 25, 24 and processes them to determine the force F1 and width values of the passage gap 5. The control unit 26 then compares these values to respective reference values and therefore controls the electric motor 9a to either modify or keep the force F1 and the width of the passage gap 5, according to an operation method 100, the significant steps of which are described below.

[0037] With reference to figure 4, a constructional variant of a pinch roll device for a wire rod, indicated by reference numeral 40 as a whole, differs from device 1 in that it comprises a different hydraulic circuit 41, as described in greater detail below. Other components of device 40 are not described in detail because they are identical to the above-described respective components of device 1. The hydraulic circuit 41 differs from the hydraulic circuit 20 of device 1 in that it comprises a pair of single-effect, hydraulic actuators 42, 43 connected to the first roll 2 and to the second roll 3, respectively, instead of the double-effect, hydraulic actuator 21. Each of the hydraulic actuators 42, 43 comprises a piston 22 sliding between a respective upper first chamber 42a, 43a and a respective lower chamber 42b, 43b. The upper chambers 42a, 43a of the hydraulic actuators 42, 43 are connected to the first and second branches 20a, b of the hydraulic circuit 41, respectively. The lower chambers 42b, 43b of the hydraulic actuators 42, 43 are connected to each other by means of a hydraulic connection con-

sisting of a compensation circuit 44, by means of which the first and second rolls 2, 3 are interconnected so that when the first roll 2 is moved from and to said second roll 3, the latter is simultaneously moved from and to the first roll 2. As in the variant in figure 3, in the variant in figure 4, the first roll 2 and the second roll 3 are also either symmetrically spaced apart or approached with respect to the crossing axis X. When the reversible pump 9 sends oil directly to the upper chamber 42a of actuator 42 by means of the first branch 20a, the respective piston 22 moves towards the lower chamber 42b, while simultaneously pushing the oil through the compensation circuit 44, into the lower chamber 43b of actuator 43, the respective piston 22 of which moves towards the respective upper chamber 43a. Alternatively, when the reversible pump 9 sends oil directly to the upper chamber 43a of actuator 43 by means of the second branch 20b, the respective piston 22 moves towards the lower chamber 43b, while simultaneously pushing the oil through the compensation circuit 44, into the lower chamber 42b of actuator 42, in which the respective piston 22 moves towards the respective upper chamber 42a.

[0038] According to a further constructional variant of the invention (not shown), a pinch roll device according to the present invention comprises a hydraulic circuit similar to circuit 41 but not including the transmission 11.

[0039] With reference to the diagram in figure 5, the operation method 100 of device 1, which may be implemented in the control unit 26, comprises an initial step 50 in which the method checks whether the rolls 2, 3 are stationary with respect to the respective rotation axes Y1, Y2, or are rotating. If the rolls 2, 3 are stationary, the method 100 ends going to a next stopping step 51. If the rolls 2, 3 are rotating by means of the pair of toothed wheels 2a, 3a, the method 100 continues with a next step 52 in which it checks whether the control motor 9a of pump 9 is off or running. If the motor 9a is off, the method 100 ends and goes to the stopping step 51. If the motor 9a is running, the method 100 continues with a next step of setting the reference values 53, in which the type and features of the product being machined, e.g. the wire rod 10, are identified and a first reference value 61 of the position of piston 22 and a second reference value 71 of the pressure in the circuit 20 are set as a function of the identified product.

[0040] The method 100 continues with a next step 54 of checking the presence or absence of the metallurgic product to be machined, e.g. the wire rod 10, in the passage gap 5 between the rolls 2, 3. In order to carry out the checking step 54, the control unit 26 receives an external datum which identifies the presence or absence of the metallurgic product to be machined, obtained by means of one or more sensors (not shown), e.g. photocells, arranged upstream of the passage gap 5 and connected to the control unit 26.

[0041] When the absence of the metallurgic product to be machined in the passage gap 5 is identified during the checking step 54, the method 100 continues with a

step 110 of checking the position of piston 22 and thus of the first roll 2. Alternatively, when the presence of metallurgic product to be machined is identified in the passage gap 5 in the checking step 54, the method 100 continues with a pressure checking step 120, in which the pressure within actuator 21 is checked.

[0042] At the end of either the position checking step 110 and the pressure checking step 120, the method 100 includes the step 80 of checking the end of machining, in which it checks, by means of a signal supplied by the control unit 26, e.g. by means of a switch or other type of control actuatable by an operator, whether the machining process is underway or has ended. If the rolling process has ended, the method 100 ends with a final step 81 in which the first and second rolls 2, 3 are taken to the maximum reciprocal distance. Alternatively, if the rolling process has not ended, the method 100 continues by repeating step 53 of setting the reference values.

[0043] If the position checking step 110 comprises a first sub-step 60 of determining, by means of the measurement supplied by the position sensor 24, a measured value of the current position of piston 22, which can be associated with the position of the first roll 2 due to the connection by means of stem 31. A second position comparing sub-step 62 follows the first sub-step in order to compare the measured value of the position identified by the first sub-step 60 with the reference position value 61. The comparison is carried out by subtracting the measured value from the reference value. The position checking step 110 continues with a third checking sub-step 64, in which the method checks whether the subtraction carried out during the second sub-step 62 has a zero result or a result different from zero. If the result is zero, the position checking step 110 ends and the method 100 continues with the machining-end checking step 80, while if the result is other than zero, the position checking step 110 continues with a fourth sub-step 63, in which a movement is imposed by means of the motor 9a and the reversible pump 9 on the piston 22 to reach the position corresponding to the reference value 61. The movement imposed on the piston 22 is proportional to the difference between the measured position value and the reference position value 61. At the end of the fourth sub-step 63, the position checking step 110 ends and the method 100 continues with the machining-end checking step 80.

[0044] The pressure checking step 120 comprises a fifth fast approaching sub-step 59, in which the rolls 2, 3 are approached to the metallurgic product to be machined, which is followed by a sixth sub-step 70 of determining a measured value of the pressure in the first branch 20a of the hydraulic circuit 20, upstream of the reversible pump 9, by means of the measurement supplied by the pressure sensor 25, which pressure value can be associated with the pressure of the first chamber 21a of actuator 21 due to the proximity of the pressure sensor 25 to the actuator 21. A seventh pressure comparing sub-step 72 follows the sixth sub-step to compare the measured pressure value identified in the sixth sub-

step 70 with the reference position value 71. The comparison is carried out by subtracting the measured value from the reference value. The pressure checking step 120 continues with a eighth checking sub-step 75, in which the method checks whether the result of the subtraction carried out in the seventh sub-step 72 is zero or different from zero. If the result is zero, the pressure checking step 120 proceeds with a ninth sub-step 74 of refreshing the reference position, in which the first reference value 61 of the position of piston 22 is updated to the current value. At the end of the ninth sub-step 74, the pressure checking step 120 is carried out, and the method 100 continues with the machining-end checking step 80. If the result of the subtraction calculated in the eighth checking sub-step 75 is not zero, but other than zero, the pressure checking step 120 proceeds with a tenth sub-step 73, in which a movement is imposed by means of the motor 9a and the reversible pump 9 on the piston 22 to reach the pressure corresponding to the reference value 71. The movement imposed on the piston 22 is proportional to the difference between the measured pressure value and the reference pressure value 71. At the end of the tenth sub-step 73, the pressure checking step 120 ends and the method 100 continues with the machining-end checking step 80.

[0045] The above-described method, in which the force checking step 110 and the position checking step 120 are carried out alternatively to each other, may be carried out very rapidly, at a frequency typically of the order of 3000 Hz. This results in the possibility of reaching feeding speeds along the crossing axis X for the products to be machined of the order of 150 m/s.

[0046] The above-described method 100 may be also used in pinch roll devices other than device 1, provided that they comprise:

- a first pinch roll and a second pinch roll, a passage gap for a rolled metallurgic product being defined therebetween, which are rotatable about a first rotation axis Y1 and second rotation axis Y2, respectively, to draw by friction said metallurgic product through the passage gap,
- a hydraulic actuator connected to the rolls to approach them or space them apart in a controlled manner, so as to reduce or increase the width of the passage gap, respectively,
- a reversible pump connected to the hydraulic actuator to slidingly move the piston connected to the first and/or second pinch roll.

[0047] The described technical solutions allow to fully solve the set task and objects with reference to the mentioned prior art, thus obtaining a plurality of further advantages, including:

- using a high-efficiency, closed hydraulic circuit in which only a minimum amount of fluid is moved, i.e. only that needed for moving the piston of the hydraulic

lic actuator. This allows to obtain a hydraulic circuit characterized by high reactivity. This is further encouraged by the use of a hydraulic pump controlled by an electric motor which allows to reach operating speeds (up to 200 - 300 Hz), which are significantly higher than those which can be achieved by means of servo valves;

- obtaining a device which is not affected by the inevitable wear of the pinch rolls, which may be compensated by the rotation of the lever arms which support the rolls;
- providing a self-damping system, in which the damping function is performed by the fluid in the hydraulic control circuit and which thus does not require the insertion of additional damping elements;
- using a hydraulic system free from servo valves thus allowing to significantly reduce running and maintenance costs.

Claims

1. A pinch roll device (1, 40) for rolled metallurgic products, comprising:

- a first pinch roll (2) and a second pinch roll (3), between which a passage gap (5) for a rolled metallurgic product (10) is defined, said first and second rolls (2, 3) being rotatable about first and second rotation axes (Y1, Y2), respectively, to draw by friction said metallurgic product (10) through said gap (5),

- a hydraulic circuit (20, 41) acting on said first and second rolls (2, 3) to reciprocally either approach or space apart said first and second rolls (2, 3) so as to either reduce or increase the width of said passage gap (5), respectively, said hydraulic circuit (20) comprising at least one hydraulic actuator (21, 42, 43) connected to said first roll (2) and/or to said second roll (3) to either reciprocally approach or space apart said first and second rolls (2, 3),

- a pressure sensor (25) in said hydraulic circuit (20, 41) to determine the force transmitted by said actuator (21, 42) to said first roll (2) and/or to said second roll (3),

- a position sensor (24) in said actuator (21, 42) to determine the movement of said first roll (2) and/or of said second roll (3),

characterized in that said hydraulic circuit (20, 41) is a closed and pressurized circuit and **in that** it further comprises:

- a reversible pump (9) in said hydraulic circuit (20, 41), said pump (9) being connected to a first chamber (21 a, 42a) and a second chamber (21 b, 43a) of said at least one hydraulic actuator (21, 42, 43) to slidably move a piston (22) of said at least one hydraulic actuator (21, 42, 43),

said piston being connected to said first roll (2) and/or to said second roll (3), the rotation of said reversible pump (9) in one direction or in the other allowing to send a fluid directly to either one or the other of said first and second chambers (21 a, 42a; 21 b, 43a), respectively and wherein said reversible pump (9) is operated by an electric motor (9a) which determines each fluid movement in said hydraulic circuit.

2. A pinch roll device (1) according to claim 1, wherein said first and second rolls (2, 3) are reciprocally interconnected by means of a mechanical and/or hydraulic connection (11, 44).

3. A pinch roll device (1) according to claim 2, wherein said hydraulic circuit (20, 41) comprises a hydraulic actuator (21, 42) connected to said first roll (2) and said connection (11, 44) comprises a geared transmission (11) between said first and second rolls (2, 3) to connect said hydraulic actuator (21, 42) to said second roll (3), by means of said first roll (2).

4. A pinch roll device (1) according to claim 2 or 3, wherein said hydraulic circuit (41) comprises a pair of hydraulic actuators (42, 43) connected to said first and second rolls (2, 3), respectively, to move said first roll (2) from and to said second roll (3) while moving said second roll (3) from and to said first roll (2), said connection (11, 44) comprising a compensation circuit (44) between said first and second rolls (2, 3).

5. A pinch roll device (1) according to claim 3 or 4, wherein said transmission (11) comprises first and second lever arm (7, 8), said first and second rolls (2, 3) being respectively restrained thereto, so as to rotate about respective rotation axes (Y1, Y2), said first and second arm (7, 8) being rotatable about a third rotation axis and a fourth rotation axis (Z1, Z2), respectively, to reciprocally either approach or space apart said first and second rolls (2, 3), said gear (12) comprising at least a first toothed sector (12a) and a second toothed sector (12b), integral with said first and second arms (7, 8), respectively, said first and second toothed sectors (12a, 12b) being meshed with each other to transmit the rotation between said first and second levers (7, 8).

6. A pinch roll device (1) according to claim 5, wherein said first, second, third and fourth rotation axes (Y1, Y2, Z1, Z2) are parallel to one another.

7. A pinch roll device (1) according to claim 1, wherein said pump (9) is controlled by an electric motor (9a) controlled means of a control unit (26) connected to said position sensor (24) and to said pressure sensor (25), the position of said piston (22) depending on

the angular position of said motor (9a), the speed of said piston (22) depending on the angular speed of said pump (9).

8. A method (100) of operating a pinch roll device (1) for rolled metallurgic products, said device comprising:

- a first pinch roll (2) and a second pinch roll (3), between which a passage gap (5) for a rolled metallurgic product (10) is defined, said first and second rolls (2, 3) being rotatable about first and second rotation axes (Y1, Y2), respectively, to draw by friction said metallurgic product (10) through said gap,
- a hydraulic closed and pressurized circuit (20, 41) comprising at least one hydraulic actuator (21, 42, 43) connected to said first roll and second roll (2, 3) to reciprocally either approach or space apart said rolls (2, 3) so as to either reduce or increase the width of said passage gap (5), respectively,
- a reversible pump (9) connected to a first chamber (21a, 42a) and a second chamber (21b, 43a) of said at least one hydraulic actuator (21, 42, 43) to slidingly move a piston (22) of said at least one hydraulic actuator (21, 42, 43), said piston being connected to said first roll (2) and/or to said second roll (3), and wherein said reversible pump (9) is operated by an electric motor (9a) which determines each fluid movement in said hydraulic circuit

said method (100) comprising:

- a step (54) of checking either the presence or absence of said metallurgic product (10) in said passage gap (5),
- a step (110) of checking the position of said first roll (2), implemented when the absence of said metallurgic product (10) in said passage gap (5) is identified in said checking step (54),
- a step (120) of checking the pressure of said hydraulic actuator (21), implemented when the presence of said metallurgic product (10) in said passage gap (5) is identified, said pressure checking step (120) comprising a sub-step (74) of refreshing said position reference value, said sub-step (74) of refreshing said position reference value is operated when said measured pressure value is identified as equal to said pressure reference value in said pressure comparing sub-step (72).

9. An operation method (100) according to claim 8, wherein said step (110) of checking the position of said first roll (2) comprises a position comparing sub-step (62) to compare a measured position value,

which may be associated with the position of said first roll (2), with a reference position value.

10. An operation method (100) according to claim 8 or 9, wherein said step (120) of checking the pressure in said hydraulic actuator (21) comprises a pressure comparing sub-step (72) to compare a measured pressure value, which may be associated with said hydraulic actuator (21), with a reference pressure value.

Patentansprüche

1. Abziehrollenvorrichtung (1, 40) für gewalzte metallurgische Produkte, umfassend:

- eine erste Abziehrolle (2) und eine zweite Abziehrolle (3), zwischen denen ein Durchgangsspalt (5) für ein gewalztes metallurgisches Produkt (10) definiert ist, wobei die erste und zweite Rolle (2, 3) um eine erste bzw. zweite Rotationsachse (Y1, Y2) drehbar sind, um durch Reibung das metallurgische Produkt (10) durch den Spalt (5) zu ziehen,
- einen Hydraulikkreislauf (20, 41), der auf die erste und zweite Rolle (2, 3) wirkt, um die erste und zweite Rolle (2, 3) hin- und herbewegbar entweder anzunähern oder zu beabstanden, um so die Breite des Durchgangsspalts (5) entweder zu reduzieren oder zu erhöhen, wobei der Hydraulikkreislauf (20) zumindest einen Hydraulikaktor (21, 42, 43) umfasst, der mit der ersten Rolle (2) und/oder der zweiten Rolle (3) verbunden ist, um die erste und zweite Rolle (2, 3) hin- und herbewegbar entweder anzunähern oder zu beabstanden,
- einen Drucksensor (25) in dem Hydraulikkreislauf (20, 41), um die Kraft zu bestimmen, die von dem Aktor (21, 42) auf die erste Rolle (2) und/oder die zweite Rolle (3) übertragen wird,
- einen Positionssensor (24) in dem Aktor (21, 42), um die Bewegung der ersten Rolle (2) und/oder der zweiten Rolle (3) zu bestimmen,

dadurch gekennzeichnet, dass

- der Hydraulikkreislauf (20, 41) ein geschlossener und druckbeaufschlagter Kreislauf ist und dass er ferner umfasst:
- eine reversible Pumpe (9) in dem Hydraulikkreislauf (20, 41), wobei die Pumpe (9) mit einer ersten Kammer (21 a, 42a) und einer zweiten Kammer (21 b, 43a) des zumindest einen Hydraulikaktors (21, 42, 43) verbunden ist, um einen Kolben (22) des zumindest einen Hydraulikaktors (21, 42, 43) gleitend zu bewegen, wobei der Kolben mit der ersten Rolle (2) und/oder der

- zweiten Rolle (3) verbunden ist, wobei eine Rotation der reversiblen Pumpe (9) in einer Richtung oder in der anderen zulässt, dass ein Fluid direkt zu entweder einer oder der anderen der ersten und zweiten Kammern (21 a, 42a; 21 b, 43a) geliefert wird, und wobei die reversible Pumpe (9) durch einen Elektromotor (9a) betrieben wird, der jede Fluidbewegung in dem Hydraulikkreislauf bestimmt.
2. Abziehrollenvorrichtung (1) nach Anspruch 1, wobei die erste und zweite Rolle (2, 3) hin- und herbewegbar mittels einer mechanischen und/oder hydraulischen Verbindung (11, 44) verbunden sind.
 3. Abziehrollenvorrichtung (1) nach Anspruch 2, wobei der Hydraulikkreislauf (20, 41) einen Hydraulikaktor (21, 42) umfasst, der mit der ersten Rolle (2) verbunden ist, und die Verbindung (11, 44) ein Zahnradgetriebe (11) zwischen der ersten und zweiten Rolle (2, 3) umfasst, um den Hydraulikaktor (21, 42) mit der zweiten Rolle (3) mittels der ersten Rolle (2) zu verbinden.
 4. Abziehrollenvorrichtung (1) nach einem der Ansprüche 2 oder 3, wobei der Hydraulikkreislauf (41) ein Paar von Hydraulikaktoren (42, 43) umfasst, die mit der ersten bzw. zweiten Rolle (2, 3) verbunden sind, um die erste Rolle (2) zu und von der zweiten Rolle (3) zu bewegen, während die zweite Rolle (3) zu und von der ersten Rolle (2) bewegt wird, wobei die Verbindung (11, 44) einen Kompensationskreislauf (44) zwischen der ersten und zweiten Rolle (2, 3) umfasst.
 5. Abziehrollenvorrichtung (1) nach einem der Ansprüche 3 oder 4, wobei das Getriebe (11) einen ersten und zweiten Hebelarm (7, 8) umfasst, wobei die erste und zweite Rolle (2, 3) jeweils daran beschränkt sind, um so um jeweilige Rotationsachsen (Y1, Y2) zu drehen, wobei der erste und zweite Arm (7, 8) um eine dritte Rotationsachse bzw. eine vierte Rotationsachse (Z1, Z2) drehbar sind, um die erste und zweite Rolle (2, 3) hin- und herbewegbar entweder anzunähern oder zu beabstanden, wobei das Zahnrad (12) zumindest einen ersten gezahnten Sektor (12a) und einen zweiten gezahnten Sektor (12b) einteilig mit dem ersten bzw. zweiten Arm (7, 8) umfasst, wobei der erste und zweite gezahnte Sektor (12a, 12b) miteinander kämmen, um die Drehung zwischen dem ersten und zweiten Hebel (7, 8) zu übertragen.
 6. Abziehrollenvorrichtung (1) nach Anspruch 5, wobei die erste, zweite, dritte und vierte Rotationsachse (Y1, Y2, Z1, Z2) parallel zueinander sind.
 7. Abziehrollenvorrichtung (1) nach Anspruch 1, wobei die Pumpe (9) von einem Elektromotor (9a) gesteuert

ist, der mittels einer Steuereinheit (26) gesteuert ist, die mit dem Positionssensor (24) und dem Drucksensor (25) verbunden ist, wobei die Position des Kolbens (22) von der Winkelposition des Motors (9a) abhängt und die Geschwindigkeit des Kolbens (22) von der Winkelgeschwindigkeit der Pumpe (9) abhängt.

8. Verfahren (100) zum Betreiben einer Abziehrollenvorrichtung (1) für gewalzte metallurgische Produkte, wobei die Vorrichtung umfasst:

- eine erste Abziehrolle (2) und eine zweite Abziehrolle (3), zwischen denen ein Durchgangsspalt (5) für ein gewalztes metallurgisches Produkt (10) definiert ist, wobei die erste und zweite Rolle (2, 3) um eine erste bzw. zweite Rotationsachse (Y1, Y2) drehbar sind, um durch Reibung das metallurgische Produkt (10) durch den Spalt zu ziehen, einen geschlossenen und druckbeaufschlagten Hydraulikkreislauf (20, 41) der umfasst:
- zumindest einen Hydraulikaktor (21, 42, 43), der mit der ersten Rolle und der zweiten Rolle (2, 3) verbunden ist, um die Rollen (2, 3) hin- und herbewegbar entweder anzunähern oder zu beabstanden, um die Breite des Durchgangsspalts (5) jeweils entweder zu reduzieren oder zu erhöhen,
- eine reversible Pumpe (9), die mit einer ersten Kammer (21 a, 42a) und einer zweiten Kammer (21 b, 43a) des zumindest einen Hydraulikaktors (21, 42, 43) verbunden ist, um einen Kolben (22) des zumindest einen Hydraulikaktors (21, 42, 43) gleitend zu bewegen, wobei der Kolben mit der ersten Rolle (2) und/oder der zweiten Rolle (3) verbunden ist und wobei die reversible Pumpe (9) von einem Elektromotor (9a) betrieben ist, der jede Fluidbewegung in dem Hydraulikkreislauf bestimmt,

wobei das Verfahren (100) umfasst:

- einen Schritt (54) zum Prüfen entweder der Anwesenheit oder Abwesenheit des metallurgischen Produkts (10) in dem Durchgangsspalt (5),
- einen Schritt (110) zum Prüfen der Position der ersten Rolle (2), der implementiert ist, wenn die Abwesenheit des metallurgischen Produkts (10) in dem Durchgangsspalt (5) bei Prüfschritt (54) identifiziert ist,
- einen Schritt (120) zum Prüfen des Drucks des Hydraulikaktors (21), der implementiert ist, wenn die Anwesenheit des metallurgischen Produkts (10) in dem Durchgangsspalt (5) identifiziert ist, wobei der Druckprüfschritt (120) einen Teilschritt (74) zum Auffrischen des Positions-

referenzwertes umfasst, wobei der Teilschritt (74) zum Auffrischen des Positionsreferenzwertes betrieben wird, wenn der gemessene Druckwert als gleich dem Druckreferenzwert des Druck vergleichenden Teilschritts (72) identifiziert ist.

9. Betriebsverfahren (100) nach Anspruch 8, wobei der Schritt (110) zum Prüfen der Position der ersten Rolle (2) einen positionsvergleichenden Teilschritt (62) umfasst, um einen gemessenen Positionswert, der der Position der ersten Rolle (2) zugeordnet werden kann, mit einem Referenzpositionswert zu vergleichen.
10. Betriebsverfahren (100) nach einem der Ansprüche 8 oder 9, wobei der Schritt (120) zum Prüfen des Drucks in dem Hydraulikaktor (21) einen Druck vergleichenden Teilschritt (72) umfasst, um einen gemessenen Druckwert, der dem Hydraulikaktor (21) zugeordnet werden kann, mit einem Referenzdruckwert zu vergleichen.

Revendications

1. Dispositif à rouleaux pinceurs (1, 40) pour produits métallurgiques roulés, comprenant :
 - un premier rouleau pinceur (2) et un second rouleau pinceur (3), entre lesquels est définie une fente de passage (5) pour un produit métallurgique roulé (10), lesdits premier et second rouleaux (2, 3) étant capables de tourner respectivement autour de premier et second axes de rotation (Y1, Y2), pour tirer par friction ledit produit métallurgique (10) à travers ladite fente (5),
 - un circuit hydraulique (20, 41) agissant sur lesdits premier et second rouleaux (2, 3) pour rapprocher ou bien éloigner réciproquement lesdits premier et second rouleaux (2, 3) de sorte à réduire ou bien augmenter respectivement la largeur de ladite fente de passage (5), ledit circuit hydraulique (20) comprenant au moins un actionneur hydraulique (21, 42, 43) relié audit premier rouleau (2) et/ou audit second rouleau (3) pour rapprocher ou bien éloigner réciproquement lesdits premier et second rouleaux (2, 3),
 - un capteur de pression (25) dans ledit circuit hydraulique (20, 41) pour déterminer la force transmise par ledit actionneur (21, 42) audit premier rouleau (2) et/ou audit second rouleau (3),
 - un capteur de position (24) dans ledit actionneur (21, 42) pour déterminer le mouvement dudit premier rouleau (2) et/ou dudit second rouleau (3), **caractérisé en ce que** ledit circuit hydraulique (20, 41) est un circuit fermé et sous

pression et **en ce qu'il** comprend en outre :

- une pompe réversible (9) dans ledit circuit hydraulique (20, 41), ladite pompe (9) étant reliée à une première chambre (21a, 42a) et une seconde chambre (21b, 43a) dudit au moins un actionneur hydraulique (21, 42, 43) pour déplacer de manière coulissante un piston (22) dudit au moins un actionneur hydraulique (21, 42, 43), ledit piston étant relié audit premier rouleau (2) et/ou audit second rouleau (3), la rotation de ladite pompe réversible (9) dans une direction ou dans l'autre permettant d'envoyer un fluide directement vers l'une ou l'autre desdites première et seconde chambres (21a, 42a ; 21b, 43a), respectivement, et dans lequel ladite pompe réversible (9) est actionnée par un moteur électrique (9a) qui détermine chaque mouvement de fluide dans ledit circuit hydraulique.

2. Dispositif à rouleaux pinceurs (1) selon la revendication 1, dans lequel lesdits premier et second rouleaux (2, 3) sont réciproquement interconnectés à l'aide d'un raccord mécanique et/ou hydraulique (11, 44).
3. Dispositif à rouleaux pinceurs (1) selon la revendication 2, dans lequel ledit circuit hydraulique (20, 41) comprend un actionneur hydraulique (21, 42) relié audit premier rouleau (2) et ledit raccord (11, 44) comprend une transmission à engrenage (11) entre lesdits premier et second rouleaux (2, 3) pour relier ledit actionneur hydraulique (21, 42) audit second rouleau (3), au moyen dudit premier rouleau (2).
4. Dispositif à rouleaux pinceurs (1) selon la revendication 2 ou 3, dans lequel ledit circuit hydraulique (41) comprend une paire d'actionneurs hydrauliques (42, 43) reliés respectivement auxdits premier et second rouleaux (2, 3), pour déplacer ledit premier rouleau (2) depuis et vers ledit second rouleau (3) tout en déplaçant ledit second rouleau (3) depuis et vers ledit premier rouleau (2), ledit raccord (11, 44) comprenant un circuit de compensation (44) entre lesdits premier et second rouleaux (2, 3).
5. Dispositif à rouleaux pinceurs (1) selon la revendication 3 ou 4, dans lequel ladite transmission (11) comprend des premier et deuxième bras de levier (7, 8), lesdits premier et second rouleaux (2, 3) étant respectivement limités à ceux-ci, de sorte à tourner autour d'axes de rotation respectifs (Y1, Y2), lesdits premier et second bras (7, 8) étant capables de tourner respectivement autour d'un troisième axe de rotation et d'un quatrième axe de rotation (Z1, Z2), pour rapprocher ou bien éloigner réciproquement lesdits premier et second rouleaux (2, 3), ledit engrenage (12) comprenant au moins un premier secteur denté (12a) et un second secteur denté (12b),

solidaires respectivement desdits premier et second bras (7, 8), lesdits premier et second secteurs dentés (12a, 12b) étant engrenés l'un avec l'autre pour transmettre la rotation entre lesdits premier et second leviers (7, 8).

6. Dispositif à rouleaux pinceurs (1) selon la revendication 5, dans lequel lesdits premier, deuxième, troisième et quatrième axes de rotation (Y1, Y2, Z1, Z2) sont parallèles l'un à l'autre.

7. Dispositif à rouleaux pinceurs (1) selon la revendication 1, dans lequel ladite pompe (9) est commandée par des moyens commandés par un moteur électrique (9a) d'une unité de commande (26) connectée audit capteur de position (24) et audit capteur de pression (25), la position dudit piston (22) dépendant de la position angulaire dudit moteur (9a), la vitesse dudit piston (22) dépendant de la vitesse angulaire de ladite pompe (9).

8. Procédé (100) de fonctionnement d'un dispositif à rouleaux pinceurs (1) pour produits métallurgiques roulés, ledit dispositif comprenant :

- un premier rouleau pinceur (2) et un second rouleau pinceur (3), entre lesquels est définie une fente de passage (5) pour un produit métallurgique roulé (10), lesdits premier et second rouleaux (2, 3) étant capables de tourner respectivement autour des premier et second axes de rotation (Y1, Y2), pour tirer par friction ledit produit métallurgique (10) à travers ladite fente,
- un circuit hydraulique fermé et sous pression (20, 41) comprenant au moins un actionneur hydraulique (21, 42, 43) relié audit premier rouleau et second rouleau (2, 3) pour rapprocher ou bien éloigner réciproquement lesdits rouleaux (2, 3) de sorte à réduire ou bien augmenter respectivement la largeur de ladite fente de passage (5),
- une pompe réversible (9) reliée à une première chambre (21a, 42a) et une seconde chambre (21b, 43a) dudit au moins un actionneur hydraulique (21, 42, 43) pour déplacer de manière coulissante un piston (22) dudit au moins un actionneur hydraulique (21, 42, 43), ledit piston étant relié audit premier rouleau (2) et/ou audit second rouleau (3), et dans lequel ladite pompe réversible (9) est commandée par un moteur électrique (9a) qui détermine chaque mouvement de fluide dans ledit circuit hydraulique

ledit procédé (100) comprenant :

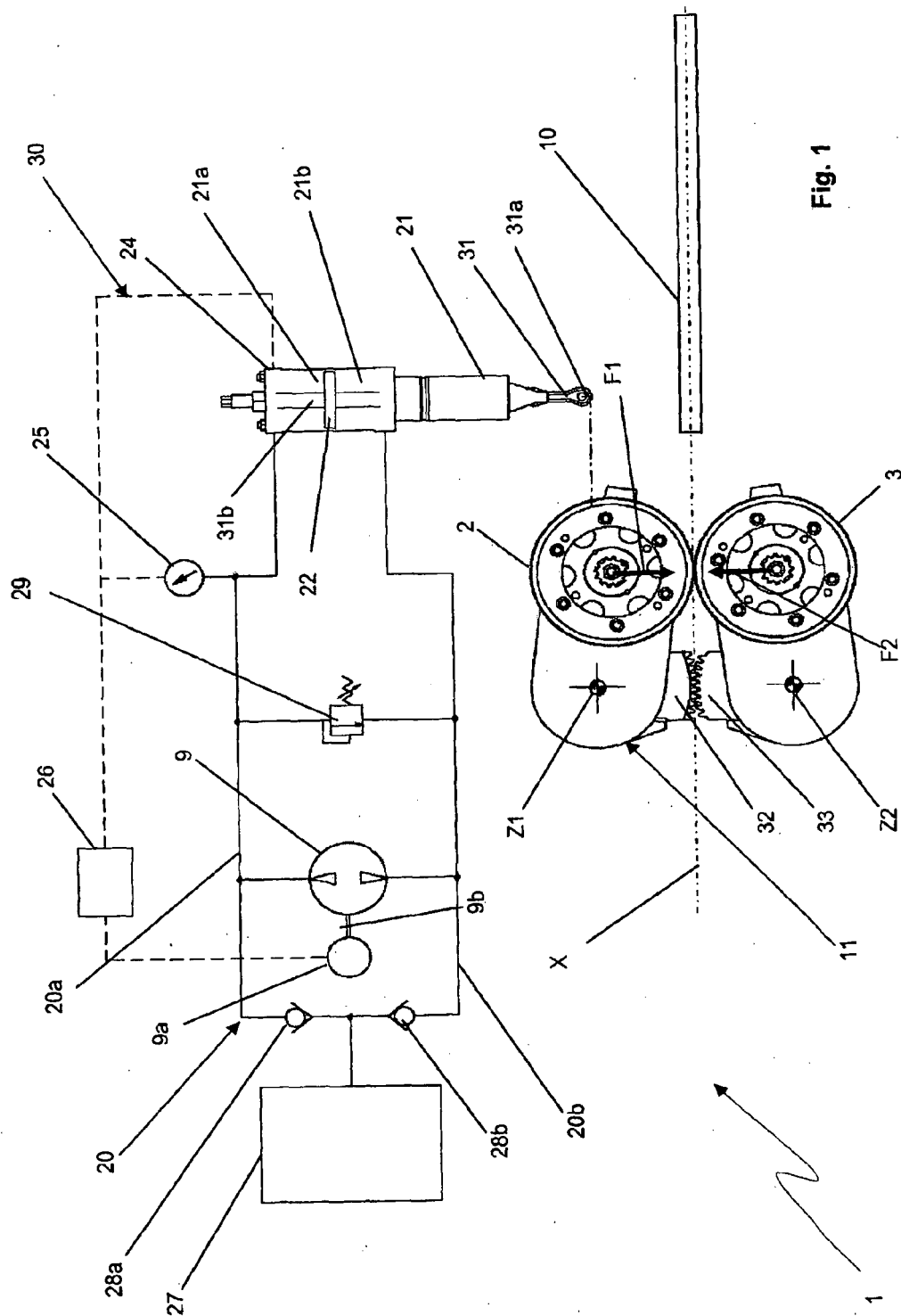
- une étape (54) de vérification de la présence ou bien de l'absence dudit produit métallurgique (10) dans ladite fente de passage (5),
- une étape (110) de vérification de la position

dudit premier rouleau (2), mise en oeuvre lorsque l'absence dudit produit métallurgique (10) dans ladite fente de passage (5) est identifiée dans ladite étape de vérification (54),

- une étape (120) de vérification de la pression dudit actionneur hydraulique (21), mise en oeuvre lorsque la présence dudit produit métallurgique (10) dans ladite fente de passage (5) est identifiée, ladite étape de vérification de la pression (120) comprenant une sous-étape (74) de rafraîchissement de ladite valeur de référence de position, ladite sous-étape (74) de rafraîchissement de ladite valeur de référence de position est mise en oeuvre lorsque ladite valeur de pression mesurée est identifiée comme égale à ladite valeur de référence de pression dans ladite sous-étape de comparaison de pression (72).

9. Procédé de fonctionnement (100) selon la revendication 8, dans lequel ladite étape (110) de vérification de la position dudit premier rouleau (2) comprend une sous-étape de comparaison de position (62) pour comparer une valeur de position mesurée, qui peut être associée à la position dudit premier rouleau (2), à une valeur de position de référence.

10. Procédé de fonctionnement (100) selon la revendication 8 ou 9, dans lequel ladite étape (120) de vérification de la pression dans ledit actionneur hydraulique (21) comprend une sous-étape de comparaison de pression (72) pour comparer une valeur de pression mesurée, qui peut être associée audit actionneur hydraulique (21), à une valeur de pression de référence.



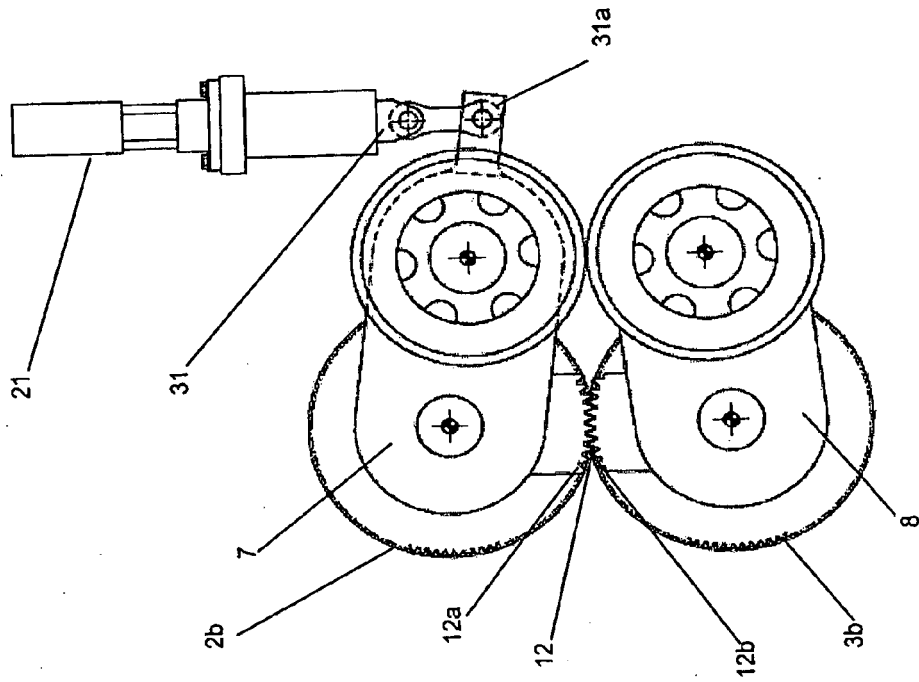


Fig. 3

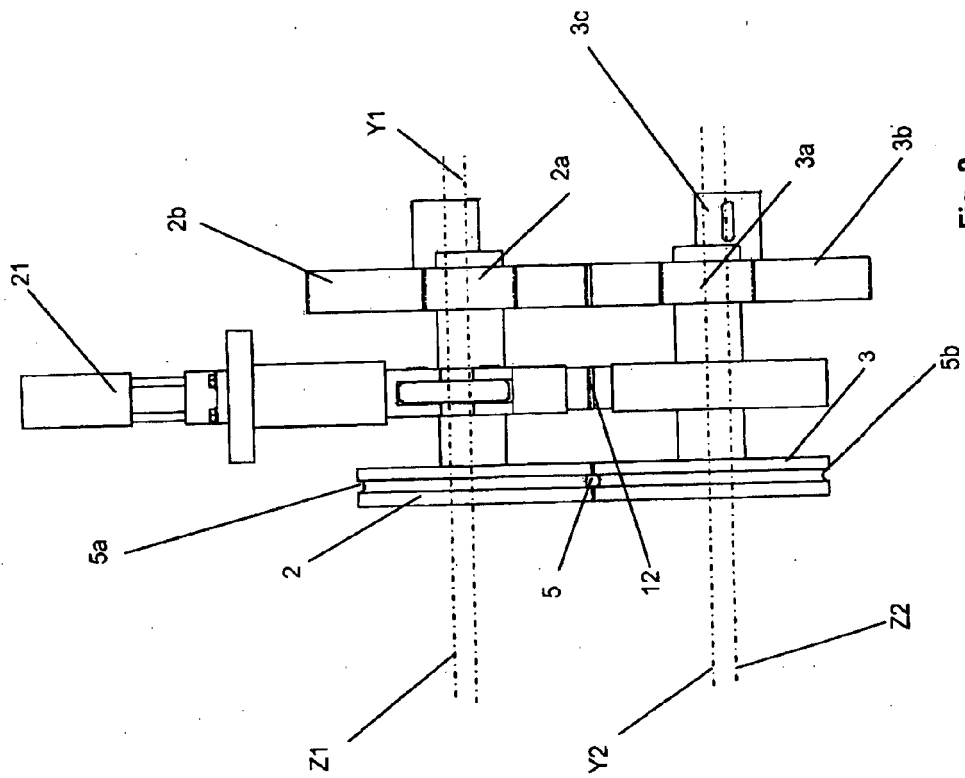


Fig. 2

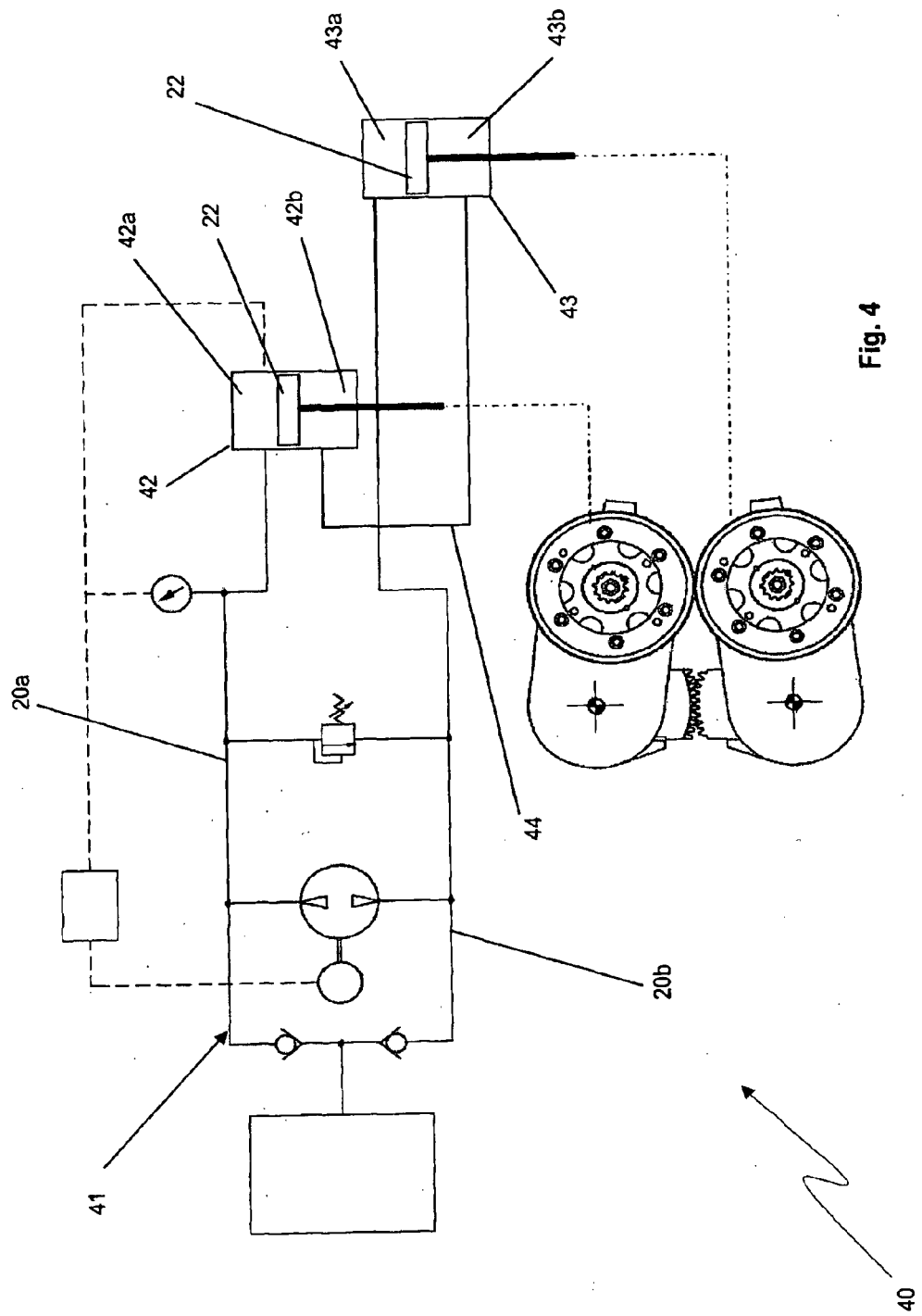


Fig. 4

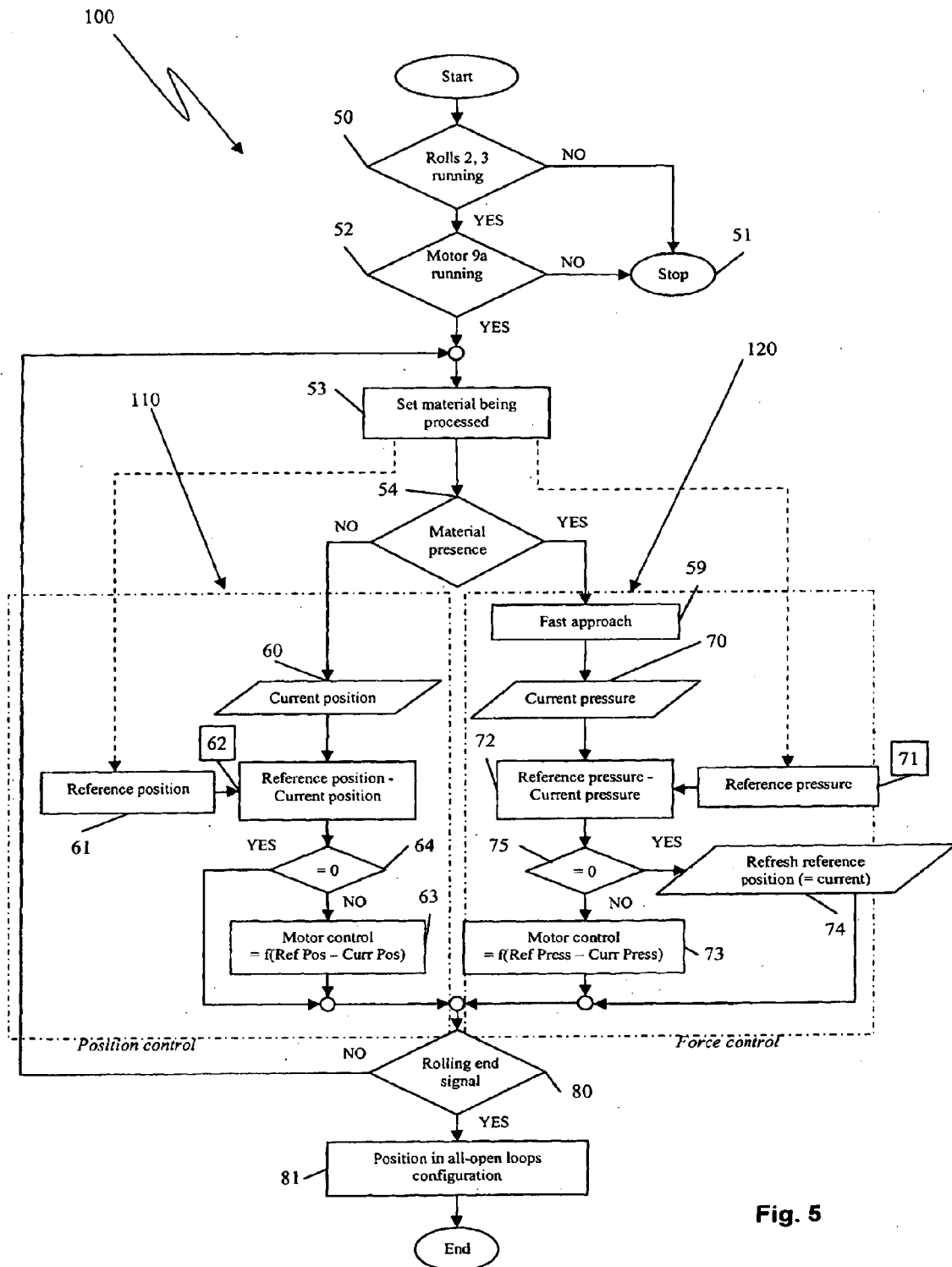


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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