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(54) ROLLING MACHINE FOR FORMING A THREADING ON A CYLINDRICAL BODY AND METHOD FOR MUTUALLY SYNCHRONISING FORMING ROLLERS OF A ROLLING MACHINE

(57) The rolling machine for forming a threading on a cylindrical body, comprising two or more forming rollers (6), each provided with a threading (8) having at least one thread extending around its rotation axis (Z), and adapted to plastically deform a cylindrical body available along a central working axis (A) of the machine (1). The machine therefore comprises two or more actuator means (15) each provided with a movable head on which a corresponding forming roller (6) is mounted to move it along a respective first transverse axis (R) perpendicular to the working axis (A), and two or more sensor means (30), each of which is fixedly mounted on the movable head to detect the distance of the thread profile of the corresponding forming roller (6) generating corresponding measurement signals. A logic control unit, in communication with the sensor means (30), receives measurement signals of the sensor means (30) and defines the relative position of the threads of the forming rollers (6).

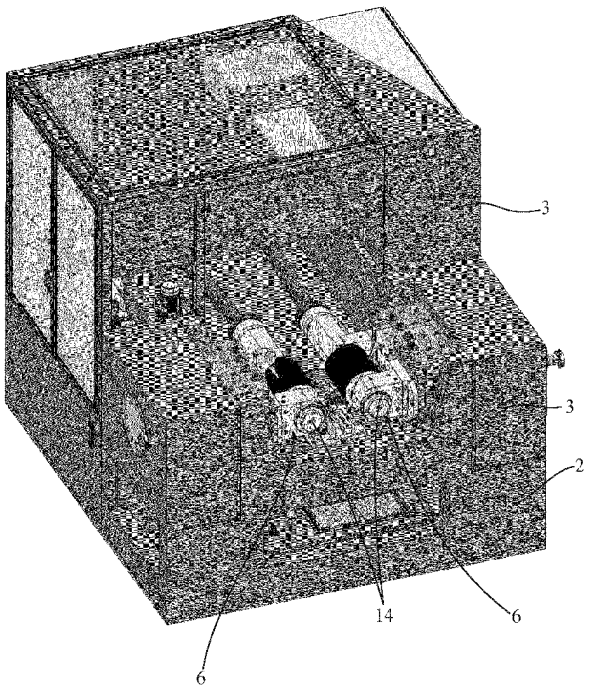

Fig. 1A

EP 3 505 268 A1

Description

[0001] The present invention regards a rolling machine for forming a threading on a cylindrical body and a method for mutually synchronising forming rollers of a rolling machine, according to the preamble of the respective independent claims.

[0002] The rolling machine and the method subject of the present invention regard the industrial field of precision mechanical machining aimed at providing - by means of cold plastic deformation - high mechanical performance machining in particular in terms of toughness and fatigue strength.

[0003] In particular, the machine and method in question are advantageously designated to be used for obtaining threadings of various types on metal cylindrical bodies, in particular made of steel, such as bars, shafts, rods etc.

[0004] Rolling machines comprising two or more forming rollers mounted on a support structure, each of which is provided with a threading, are currently available in the market. The cylindrical body to be machined is supported along a central work axis of the machine in a centred position with respect to the various forming rollers. The threadings of the latter are mutually synchronised and cooperated with each other to plastically deform the surface of the cylindrical body to be machined, so that the imprint left by the roller is synchronised with the imprint of the adjacent rollers to obtain a final imprint of the desired depth and shape, and obtained through the joint action of the single forming rollers. The forming by means of the rolling machine with cold plastic deformation allows producing cylindrical bodies provided with a particularly mechanically resistant threading. As a matter of fact, the metal fibres, for example made of steel, of the body to be machined with the deformation are not sheared, as it instead occurs in a conventional milling process, but deformed progressively up to obtaining the required imprint.

[0005] During the particular cold machining, the rolling machine confers - to the machined cylindrical body - forging properties that increase the fatigue strength of the metal that the cylindrical body to be machined is made of and also increase the static load at the base of the thread. It is known that the mechanical strength of a threading obtained by means of a rolling machine is in the order of 30% higher than that obtained using a normal shearing process.

[0006] More in detail, the rolling machines of the known type provide for that each forming roller be mounted on a tool holder shaft, which is driven to rotate by a corresponding motor.

[0007] Furthermore, the rolling machines of the known type provide for that each forming roller be controlled to move by a corresponding actuator along a transverse axis substantially perpendicular to the work axis, to impart, by compression, with a threading thereof, an imprint on the metal body to be formed.

[0008] The cylindrical body to be formed is supported at the centre of the work axis by a special support and it is cold-deformed by the threadings of the forming rollers that act thereon in compression rotating above it.

[0009] The threading imprint left by each forming roller on the metal body to be machined must reproduce - in an extremely precise manner - the imprint carried out by the threading of the previous forming roller to form the desired final threading on the metal body to be machined as a succession of threading operations.

[0010] The radial compression stresses and the axial shear stresses transmitted by the forming rollers on the cylindrical body are very high, and thus two or more forming rollers are generally used so as to distribute the stresses in a balanced fashion and avoid the risk of breaking.

[0011] According to the technique known in the industry, the rolling machines may provide for controlling the machining operations on the cylindrical body by means of a logic control unit preferably of the type numerical control controlled by an external computer (CNC).

[0012] The logic control unit receives the instructions from the operator through a work program that utilises an ISO standardised coding language.

[0013] The threads of the forming rollers of the rolling machines are spiral-wound in the axial extension direction of the roller so that when the forming roller is actuated to rotate carrying out an angular displacement, there correspondingly occurs the axial displacement of the threading on the outer surface of the forming roller. During the machining thereof, the cylindrical body advances axially and rotates at contact with the forming rollers, and thus there arises the need for the imprint impressed thereon by a forming roller, and that - as mentioned above - it first carries out an angular and axial displacement during passage to the subsequent forming roller, to be precisely reproduced by the imprint of the forming roller that follows. To this end, there arises the need that the forming rollers be perfectly mutually synchronised so that the imprints left on the cylindrical body are perfectly centred with respect to each other. Currently, machines and methods capable of detecting the precise position of the threading of the forming rollers, in particular that are not affected by mechanical clearances or excessive measuring tolerances, are not known. Furthermore, the axes of the single forming rollers are not entirely parallel to each other given that in order to advance the piece to be machined they must have a tilt angle with respect to each other. This angulation must be kept into account to obtain a precise synchronisation of the threadings of the single forming rollers.

[0014] Thus, a problem observed in the rolling machines industry lies in defining - in an extremely precise manner - the relative position of the forming rollers (i.e. the relative position of their threadings) so that the imprint obtained by a forming roller on the cylindrical body is reproduced correctly in a precise manner by the one obtained by the subsequent forming roller.

[0015] Currently, forming rollers do not have reference

points that allow mounting - in a precise position - each forming roller on the tool holder shaft so that it can define the mutual position thereof a priori and accurately.

[0016] In particular, the seat of the key obtained in the forming roller for mounting on the tool holder shaft is manufactured without considering the relative threading position and thus once mounted on the shafts, the forming rollers must be mutually synchronised to define the mutual positions.

[0017] As known, the angular position of each tool holder shaft is controlled and known by the logic control unit of the machine in an extremely precise manner for example due to the use of brushless electric motors to actuate the tool holder shafts.

[0018] As a matter of fact, such motors allow to precisely know the position and angular speed of the drive shaft and thus of the tool holder shaft connected to the drive shaft connected to each other by means of a transmission, for example a universal joint.

[0019] In order to synchronize the forming rollers, the operator normally operates manually using special adjustment knobs provided for each of the forming rollers and susceptible to impart small angular displacements to the rollers. Furthermore, such method for synchronising the forming rollers provides for the use of specimen samples, generally made of plastic material or soft iron, on which machining cycles for receiving the imprints of the threadings of the single rollers are carried out and thus verify - upon examining the imprints - whether the rollers are mutually synchronised.

[0020] After each test machining cycle, the operator checks the imprint generated by the forming rollers on the sample specimens and carries out the appropriate corrections to the angular position of the single rollers.

[0021] Thus, according to the prior art, the position of the threading of each forming roller for the mutual synchronisation of the relative threadings is defined through imprint tests on the samples by means of subsequent approximations. This method for synchronising the forming rollers of a rolling machine of the known type, reveals numerous drawbacks. As a matter of fact, it requires a lot of time to define the precise position of each forming roller and the deployment of qualified personnel to carry out such initial synchronisation operation. Furthermore, such synchronisation procedure must be provided each time there arises the need to replace the forming rollers being used with different characteristics to change the type of machining or each time there arises the need to perform maintenance operations on the machine that requires the disassembly of the forming rollers.

[0022] Thus, a drawback stemming from the synchronisation method used by the rolling machines of the known type lies in the fact that the synchronisation precision excessively depends on the experience and ability of the operator and thus it does not allow a standardised quality. Furthermore, a further drawback lies in the costs for using numerous sample cylinders that have to be allocated to achieve the correct synchronisation of the forming rollers.

[0023] Thus, in this situation the problem on which the present invention is based is to overcome the drawbacks revealed by the solutions of the known type mentioned above, by providing a rolling machine to form a threading on a cylindrical body and a method for mutually synchronising the forming rollers of a rolling machine, which allow synchronising the forming rollers in an extremely precise manner.

[0024] A further object of the present invention is to provide a rolling machine for forming a threading on a cylindrical body and a method for mutually synchronising forming rollers of a rolling machine, that do not require the intervention of an operator.

[0025] A further object of the present invention is to provide a rolling machine for forming a threading on a cylindrical body and a method for mutually synchronising forming rollers of a rolling machine, which allow the precise synchronisation of the forming rollers arranged on axes not parallel to each other too.

[0026] These and other objects are attained by the machine and by the method according to the attached claims.

[0027] The technical characteristics of present invention, according to the aforementioned objects, are observable from the content of the claims outlined below and the advantages thereof will be more apparent from the detailed description that follows, provided with reference to the attached figures, which represent an embodiment thereof purely by way of exemplifying and nonlimiting purposes, wherein:

- figure 1A shows a front perspective view of the rolling machine subject of the present invention;
- figure IB shows a rear perspective view of the rolling machine subject of the present invention with some parts removed (in particular guard elements) so as to highlight others better;
- figure 2 shows a substantially front view of a detail of the rolling machine of figure 1 regarding sensor means mounted on the movable head of the actuator means;
- figure 3 shows a perspective view of a detail of the rolling machine of figure 1 regarding sensor means mounted on the movable head of the actuator means;
- figure 4 shows a perspective section of the detail of the rolling machine according to the invention of figure 3;
- figure 5 shows a detail of the forming roller of figure 3 in a longitudinal sectional view of the threading thereof.

[0028] With reference to the attached drawings, a rolling machine for forming threadings on cylindrical bodies according to the present invention is indicated in its entirety with 1.

[0029] The rolling machine in question is generally des-

ignated to be used for obtaining the aforementioned threadings on cylindrical bodies of mechanical members such as shafts, bars, rods etc. for a wide range of applications.

[0030] Thus, the piece or mechanical member on which the threading machining is to be carried out such as for example a shaft, a bar, a rod or any other cylindrical member, will hereinafter be referred to as "cylindrical body".

[0031] The threadings are obtained, in a per se known and conventional manner, by means of cold plastic deformation of the surface of the cylindrical body to be formed by placing the cylindrical body in compression between several forming rollers 6 arranged peripherally with respect to the cylindrical body that is thus centred with respect to the forming rollers.

[0032] More in detail, the rolling machine 1 is provided with a support structure 2 designated to be placed on the ground, mechanically associated to which are two or more forming rollers 6, which, as described in detail hereinafter, act with the threading thereof against the lateral surface of the cylindrical body to be formed being actuated to operate rotating, in first approximation around mutually parallel axes, in a common direction of rotation, and in compression on the lateral surface of the cylindrical body to be formed.

[0033] The support structure 2 is obtained by means of a metal framework between a front part, from which the supply of the cylindrical body to be formed occurs, and a rear part in which the drive means of the forming rollers are generally provided.

[0034] Between such front and rear parts there can thus be identified a central work axis A at which the cylindrical body to be formed can be arranged coaxially. According to an embodiment of the attached figures, the support structure 2 extends longitudinally between a front wall 3 and a rear wall 4, each advantageously provided with a central opening 5 for the passage of the cylindrical body to be machined.

[0035] Each forming roller 6 consists, in a per se conventional manner, of a cylindrical body, preferably made of steel, provided with a central symmetry axis corresponding to the rotation axis Z thereof, and it is provided with a threading 8 formed by at least one thread.

[0036] Hereinafter, the expression thread is used to indicate a single spiral-shaped relief rib arranged on the outer surface of each forming roller 6. The threading 8 of each forming roller 6 may consist of a single thread or several threads arranged adjacent and parallel. The expression threading 8 is thus used to indicate a thread, whether single or an assembly of several threads, extending on the outer lateral surface of the forming rollers 6. Solely for the sake of descriptive clarity, hereinafter the threading 8 shall be deemed to consist of a single thread so that such terminals coincide same case applying to the reference point "8", but the threading may obviously consist of several threads without departing from the scope of protection of the present invention.

[0037] Each thread 8 continuously extends with a spiral shape extending being wound on the outer surface of the forming roller 6 advancing along the extension and rotation longitudinal axis Z thereof.

[0038] Each thread 8 appears formed, in a reading longitudinal direction parallel to the axis Z thereof, by a succession of sections 12 which are obviously continuously circumferentially connected to each other to form a single spiral-wound thread. The thread 8 has a cross-section with respect to the spiral extension thereof for example approximately triangular or trapezoidal-shaped with outer crests 9 tapered with respect to a widened base. At the crests 9, the radius of the forming roller 6 is maximum, while at the bottoms 10 which are alternating with respect to the crests 9, the radius of the forming rollers 6 is minimum.

[0039] The crests 9 and the bottoms 10 are connected by tilted sides 11. The pitch P of the threading 8 is defined by the axial distance between two crests 9 in succession while the radial distance between the crests 9 and the bottoms 10 defines the depth L of the threading 9.

[0040] Thus, the thread 8 extends on the outer peripheral surface of the roller 6 and around the rotation axis Z with a helical extension and with shape and pitch characteristics that change depending on the application needs of the cylindrical body to be formed.

[0041] According to the example illustrated in the attached figures, the machine 1 provides for two forming rollers 6, arranged at 180 degrees from each other, which are suitable for the cold plastic deformation of the cylindrical body to be formed positioned along the central work axis A of the machine and supported in such position, by a special support structure (not illustrated) for example consisting of a plate with a V-shaped concavity facing upwards and fixed to the support structure of the machine 1.

[0042] The machine may obviously provide for a different number of forming rollers 6, in particular three forming rollers 6 arranged at 120 degrees with respect to each other, without departing from the scope of protection of the present invention. The machine 1 further comprises two or more actuator means 15 mounted on the support structure 2, each mechanically connected to a corresponding forming roller 6 to displace it along a respective first transverse axis R substantially perpendicular to the work axis A.

[0043] The actuator means 15 actuate the forming rollers 6 to translate along the first transverse axes R approaching and moving away with respect to the central work axis A and thus with respect to the cylindrical body to be formed.

[0044] To this end, the forming rollers 6 are positioned around the central work axis A with the extension axes Z thereof in first approximation substantially parallel to the central work axis A and at a radial distance adjustable due to the actuation of the actuator means 15. More precisely, the axes of the forming rollers are slightly tilted with respect to each other to determine the advancement

of the cylindrical body to be machined.

[0045] More in detail, each of such actuator means 15 is provided with a movable head 21, mounted on which is a corresponding forming roller 6 to displace it along a respective first transverse axis R perpendicular to the work axis A.

[0046] More in detail, according to the embodiment illustrated in the attached figures, the actuator means 15 are obtained with hydraulic actuators of the linear type directed with the displacement axis aligned with the first transverse axis R for displacing the corresponding forming roller 6 and passing through the work axis A.

[0047] Each actuator 15 is provided with a hollow cylindrical body fixed to the front wall 3 of the support structure 2 of the machine 1 advantageously in a conventional manner by means of a support carcass, not illustrated.

[0048] Slidably mounted along the first transverse axis R in the hollow cylindrical body is a piston 20 provided with the movable head 21, which mechanically supports a corresponding forming roller 6.

[0049] The actuator 15 is connected to a pressurised oil hydraulic system capable of displacing the piston 20 and the roller supported thereby along such first transverse axis R as well as placing the forming roller 6 under pressure with an adjustable force against the outer surface of the cylindrical body to be formed. Advantageously, the mechanical connection between the forming rollers 6 and the actuator means 15 occurs by means of brackets 27, which are mechanically fixed to the movable heads 21 of the pistons 20 by means of bolts and comprise two drilled lateral fins 28 in which bearings for supporting the forming rollers 6 are housed.

[0050] Further provided for are drive means 16 arranged on the support structure 2, mechanically connected to the forming rollers 6 to drive them in rotation resting against the cylindrical body to be formed so as to impress a cold plastic deformation on the outer surface thereof.

[0051] To this end, the forming rollers 6 have a seat, for example a through hole provided along the longitudinal extension axis Z thereof, in which a tool holder shaft 14, connected by means of a transmission to the drive means 16, is inserted in a coupling fashion.

[0052] The latter are for example obtained with electric motors in particular of the brushless type, each associated to a corresponding forming roller 6, and provided with a drive shaft connected to the tool holder shaft by means of a universal joint transmission.

[0053] The drive means 16, and in particular brushless motors, are capable of precisely controlling the rotation speed of the shafts thereof and the angular position thereof (and thus of the forming roller that they drive in rotation) with respect to angular reference position.

[0054] The cardans interposed between the drive shafts and the tool holder shafts 14 allow the transmission of the rotation without necessarily requiring the alignment of the drive shafts with the axes of the forming rollers 6, which can thus rotate at different distances from the central work axis A and they can have a different tilt with respect to the rotational axes of the drive shafts.

[0055] The combination of the transverse compression action due to the actuator means 15 which lead to the compression of the forming rollers 6 on the cylindrical body to be formed, and the rotation motion of the forming rollers 6 around the rotation axis Z thereof due to the drive means 16 allows to plastically deform the cylindrical body arranged along the central work axis A, obtained on the outer peripheral surface of the progressive imprints up to obtaining the desired threading.

[0056] Advantageously, according to the embodiment of the machine 1 illustrated in the attached figures, provided for are two forming rollers 6 arranged at 180° from each other with respect to the work axis A so as to equally distribute the stresses on the cylindrical body to be formed.

[0057] According to the idea on which the present invention is based, the machine 1 further comprises two or more sensor means 30, each one of which is mounted fixed on the movable head 21 associated to a corresponding forming roller 6, and it detects the distance D of the thread section, or at least one reference point on the thread section, of the corresponding forming roller 6 generating corresponding measurement signals.

[0058] The machine 1 according to the invention comprises a logic control unit, which is in communication with the sensor means 30 to receive the measurement signals therefrom and thus define the relative position of the threads on the forming rollers 6.

[0059] Due to the present invention, it is possible to precisely detect the relative position of a thread of the threading of a forming roller with respect to the thread of the threading of the other forming rollers so as to be able to synchronise the relative threadings and thus impress - on the cylindrical body - the imprints of the threads of the forming rollers 6 perfectly superimposed. Being integrally joined and fixed with respect to the movable head 21 of the piston 20, the sensor means follow all the movements of the forming roller 6 and they are thus capable of correctly reading the position of the threading even should the axis of the forming roller be different with respect to that of the other forming rollers 6, for example due to the change of dimensions of the cylindrical body to be formed and provided for is a different axial sliding of the cylindrical body so as to make the threads of the different forming rollers coincide.

[0060] As a matter of fact, as known, the rotation axes of the forming rollers 6 are susceptible to be adjusted, in a known manner, in the mutual tilt thereof in particular to vary the axial sliding of the cylindrical body. To this end, the machine comprises adjustment means (not illustrated in the drawings in that of the type per se known to a man skilled in the art) to vary the tilt of the movable head. The invention shows that being mounted on the movable head 21 of the piston 20 on which the forming roller is mounted, the sensor means are not affected, to their extent, by the variation of such tilt which always remains - with respect to the forming roller 6 - with the same spatial

reference, i.e. it does not change with respect to the variation of the tilt of the forming roller 6.

[0061] More in detail, the logic control unit is programmed to continuously detect the measurement signals of the sensor means 30 during the rotation of the forming rollers 6 acquiring - for each forming roller 6 - the position of a reference point M associated to the sections of the threads. Thus, the logic control unit is programmed for calculating the angular offset between the forming rollers 6 based on the relative angular position of the reference points P associated to the sections of the threads of the forming rollers 6.

[0062] For example, the reduction of the distance detected by the sensor means 30 and received by the logic control unit is associated to an increasing section of the thread in the juxtaposed position with respect to the sensor means, while an increase of the distance detected by the sensor means 30 and received by the logic control unit is associated to a decreasing section of the thread. Thus, when the distance starts to increase, the logic control unit can recognise the presence of a reference point on the thread relative to the crest. Advantageously, in order to define the exact position of the thread, many crests 9 or many bottoms 10 can be detected and then proceed to obtain the mean values.

[0063] The reference point associated to the section of the threads of the forming rollers 6 and detected by the logic control unit through the sensor means 30 may for example regard the crest of the threads as mentioned above, or the bottoms 10 otherwise.

[0064] The logic control unit is electrically connected to the sensor means 30 and to the drive means 16 to synchronize the threadings 8 of the forming rollers 6. Obviously, the logic control unit is electrically connected to the actuator means 15 too, to control the cylindrical bodies forming operations.

[0065] Preferably, the sensor means 30 consist of an optical sensor in particular a triangulation laser optical sensor which allows to carry out remote measurements i.e. contactless and wearless measurements. The laser optical sensor 30 emits a laser beam schematically indicated with 31 in form of a triangle in the attached figures.

[0066] The measurement method by means of laser triangulation provides for that a laser diode emits a beam which hits the thread of the forming roller, emitted from which is a reflected light beam which - through a lens - reaches a CCD/CMOS matrix or a PSD analogue sensor. The distance is established with extreme precision by applying simple trigonometric calculations, and the resolution obtained with this method is smaller than the fractions of micrometres.

[0067] Advantageously, the laser optical sensor is focused for detecting distances comprised within an interval of 50-250 mm starting from a distance from the sensor of 45-70 mm. In this manner, the sensor provides precise measurement indications, even considerably changing the dimensions of the forming roller 6.

[0068] A method for synchronising forming rollers 6 of a rolling machine 1, in particular of the type described above, regarding which the same reference numbers will be maintained for the sake of descriptive clarity, is an object of the present invention.

[0069] The method according to the present invention provides for that the logic control unit continuously detects the measurement signals of the sensor means during a forming rollers rotation step. Such rotation step may advantageously be provided in an initial machine setting step.

[0070] At this point, the angular offset between the threadings of the forming rollers is calculated based on the acquisition - for each forming roller 6 - of the angular position of a reference point associated with the section of said threads, in particular relative to the crest of the threads, and detected by means of said measurement signals. In other words, a reference point on the threads, for example the crest, is recognised for each forming roller using the measurement signals. Such reference point is identified with reference to an angular position of the forming roller detected directly for example through the brushless motor of the drive means 16 which controls the rotation of the forming rollers 6.

[0071] At this point, the logic control unit can synchronise the forming rollers 6, should they not be synchronised with each other, controlling the rotation of at least one of the forming rollers 6 by actuating the drive means 16 so as to make the angular position for detecting the reference signal coincide on the sections on the threads of the forming rollers 6 so that they leave imprints that can be superimposed in succession on the cylindrical bodies to be formed. Advantageously, the reference point of the section of the threads is selected in the crest of the threads, and the acquisition - for each forming roller 6 - of the angular position of the crest of the threads is calculated by detecting, by means of the sensor means 30, the passage between decreasing distance measurement values and increasing distance measurement values. Such detection can be further repeated for many threads, in particular it can simultaneously provide for detecting the bottom of the threads or even mathematical calculations to refine the detection of a precise reference point on the threads.

[0072] Such synchronisation method requires a few minutes for completion and guarantees high precision in terms of the mutual positioning of the forming rollers 6; so, the invention thus conceived achieves the pre-set objects. Obviously, in its practical embodiment, it may take shapes and configurations even different from the ones illustrated above without departing from the present scope of protection.

Claims

1. Rolling machine for forming a threading on a cylindrical body, comprising:

- a support structure (2);
- two or more forming rollers (6), each of which is drivable to rotate around its rotation axis (Z) and provided with a threading (8) having at least one thread extending around said rotation axis (Z), said forming rollers (6) being susceptible of plastically deforming a cylindrical body available along a central work axis (A) of said machine (1);
- two or more actuator means (15), mechanically associated with said support structure (2) and each provided with a movable head on which a corresponding said forming roller (6) is mounted, in order to move such roller along a respective first transverse axis (R) perpendicular to said work axis (A);

characterised in that it further comprises:

- two or more sensor means (30), each of which is mounted fixed on the movable head associated with a corresponding forming roller, and detects the distance of the section of said thread of the corresponding forming roller (6), generating corresponding measurement signals,
- a logic control unit, which is in communication with said sensor means (30) in order to receive the measurement signals of said sensor means (30) and define the relative position of the threads of said forming rollers (6).

2. Machine according to claim 1, **characterized in that** said logic control unit is programmed for continuously detecting the measurement signals of said sensor means during the rotation of said forming rollers, acquiring for each forming roller the position of a reference point associated with the section of said threads; said logic control unit being programmed for calculating the angular offset between said forming rollers on the basis of the relative angular position of the reference points associated with the sections of said threads of said forming rollers.

3. Machine according to claim 2, **characterized in that** said reference point associated with the section of said threads and detected by said logic control unit through said sensor means relates to the crest of said threads.

4. Machine according to claim 1, **characterized in that** it comprises drive means (16) arranged on said support structure (2), mechanically connected to said forming rollers (6) and suitable to drive said forming rollers (6) in rotation on said cylindrical body in order to plastically deform it; said one logic control unit being electrically connected to said sensor means (30) and to said drive means (16) in order to synchronize the threadings (8) of said forming rollers (6).

5. Rolling machine according to one or more of the preceding claims, **characterized in that** said sensor means (30) comprise an optical sensor, in particular laser.

6. Machine according to claim 5, **characterized in that** said laser optical sensor is focused for detecting distances comprised within an interval of 50-250 mm starting from a distance from the sensor of 45-70 mm.

7. Rolling machine according to one or more of the preceding claims, **characterized in that** said actuator means (15), comprise a cylindrical body (18) fixed to said support structure (2) and a piston (20) slidably movable within said cylindrical body (18) provided with said movable head (21), which mechanically supports a corresponding said forming roller (6).

8. Rolling machine according to one or more of the preceding claims, **characterized in that** it comprises means for adjusting the tilt of the movable head of said actuator means in order to vary the tilt of the rotation axes of said forming rollers; said sensor means being mounted on said movable head, not varying the relative spatial position with respect to said forming roller.

9. Process for synchronizing the forming rollers of a rolling machine according to claim 1, **characterized in that** said logic control unit:

- continuously detects the measurement signals of said sensor means during a step of rotation of said forming rollers;
- calculates the angular offset between the threadings of said forming rollers on the basis of the acquisition, for each forming roller, of the angular position of a reference point associated with the section of said threads, in particular relative to the crest of said threads, and detected by means of said measurement signals;
- commands the rotation of at least one of said forming rollers (6) by means of the actuation of said drive means for synchronizing said forming rollers, making the angular position of the detection of said reference signal coincide on the sections of the threads of said forming rollers.

10. Method for synchronizing the forming rollers according to claim 9, **characterized in that** said reference point of the section of the threads is selected in the crest of said threads, and said acquisition for each forming roller of the angular position of the crest of said threads is calculated by detecting, by means of said sensor means, the passage between decreasing distance measurement values and increasing distance measurement values.

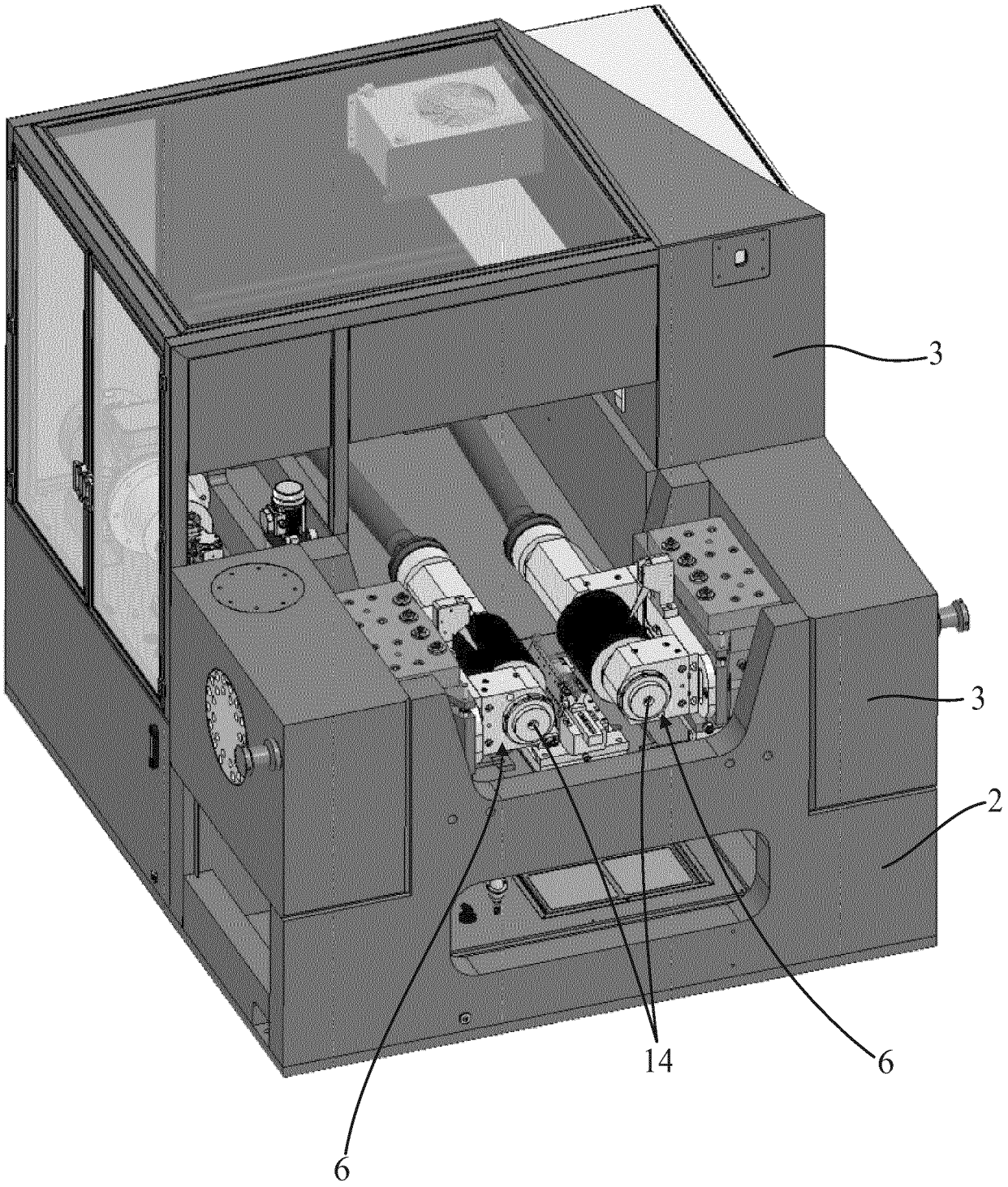

Fig. 1A

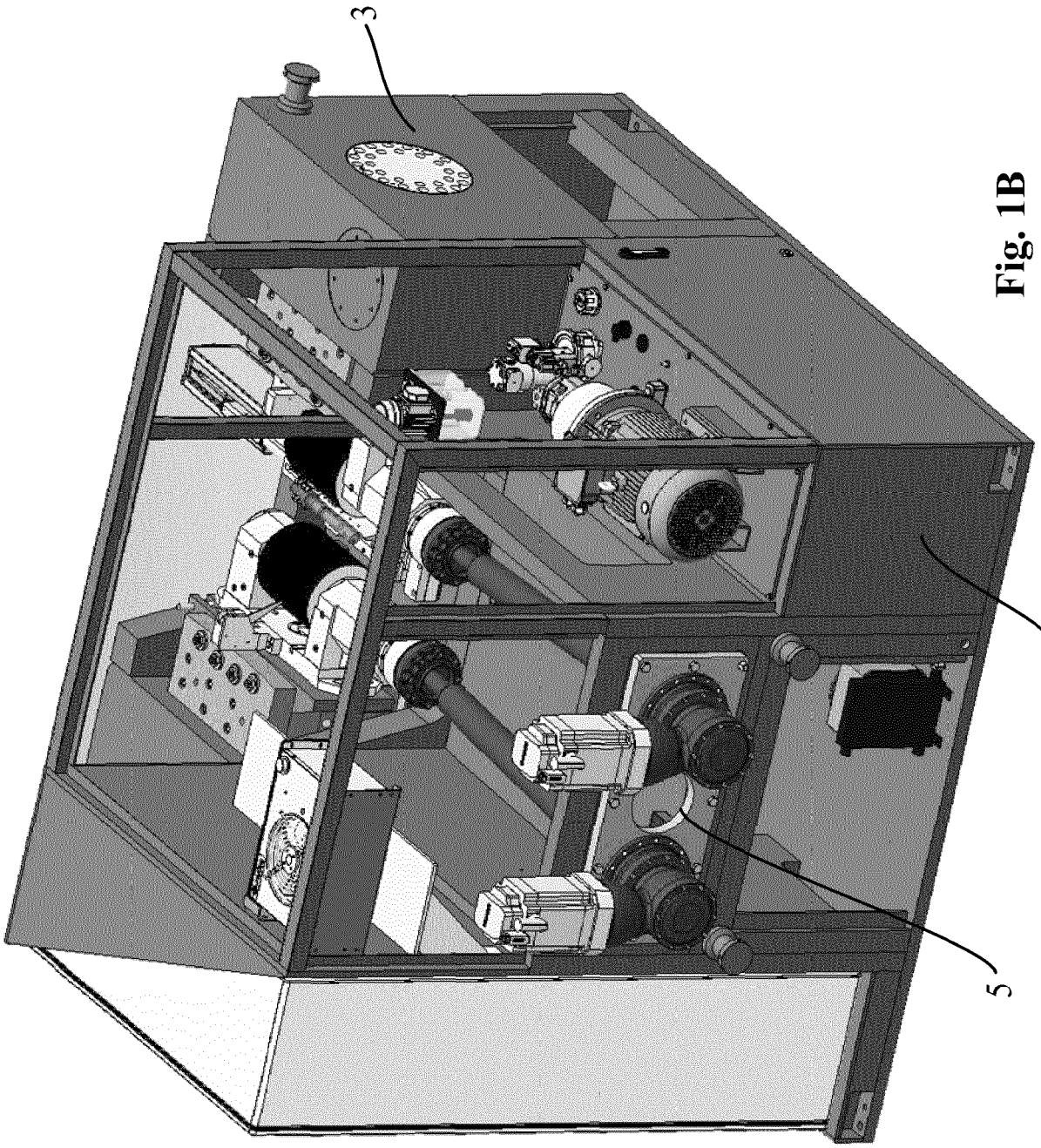

Fig. 1B

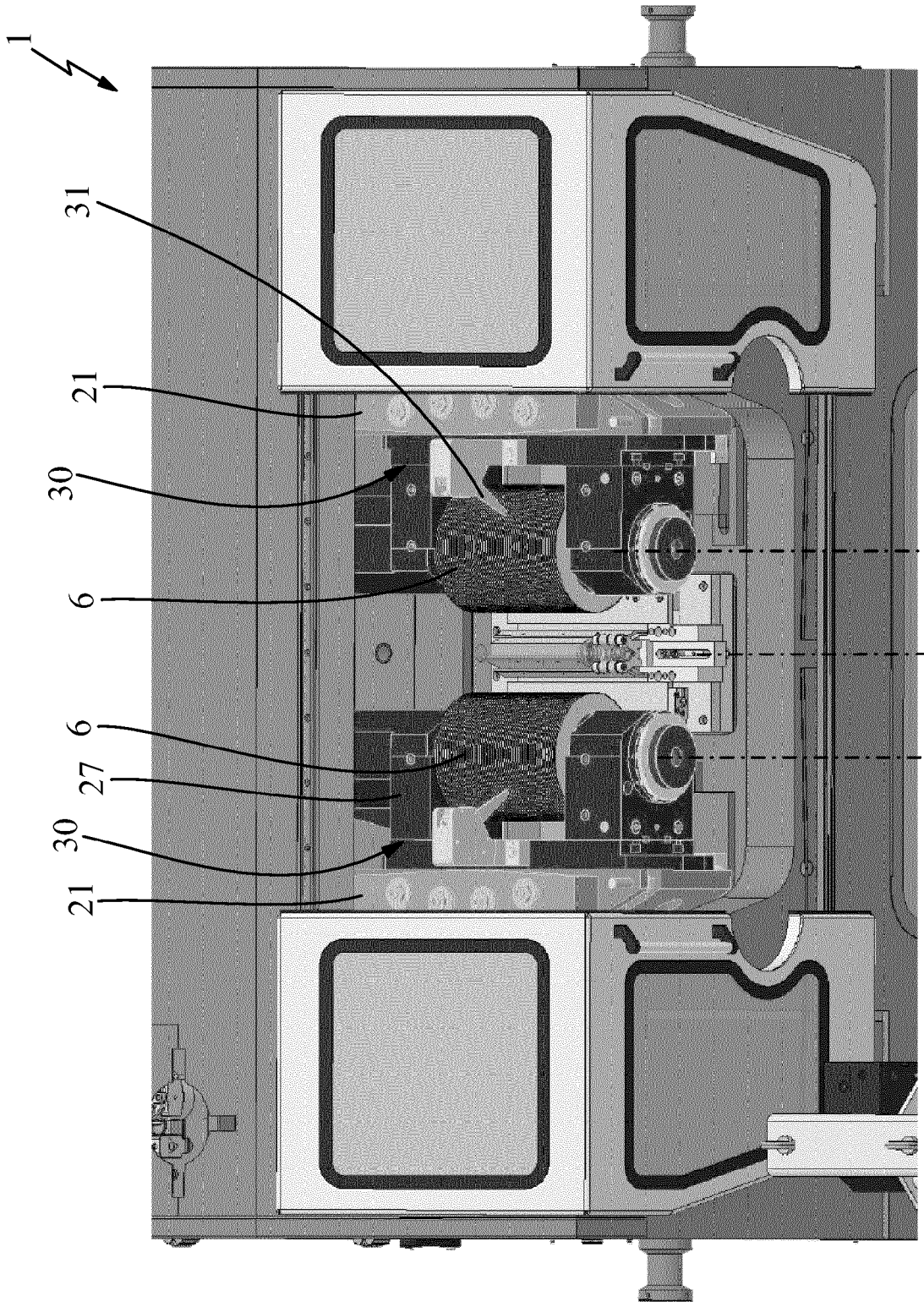

Fig. 2

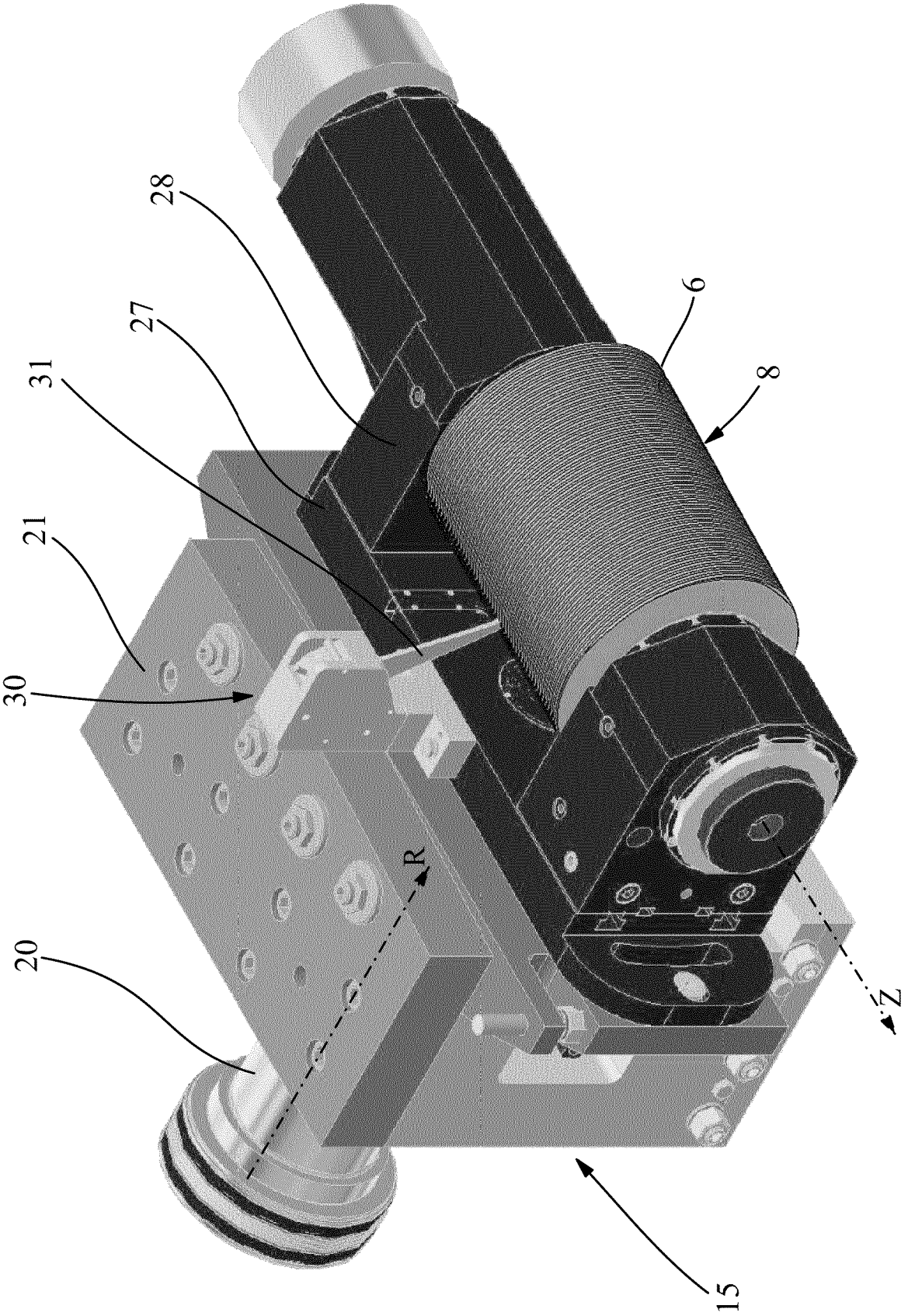

Fig. 3

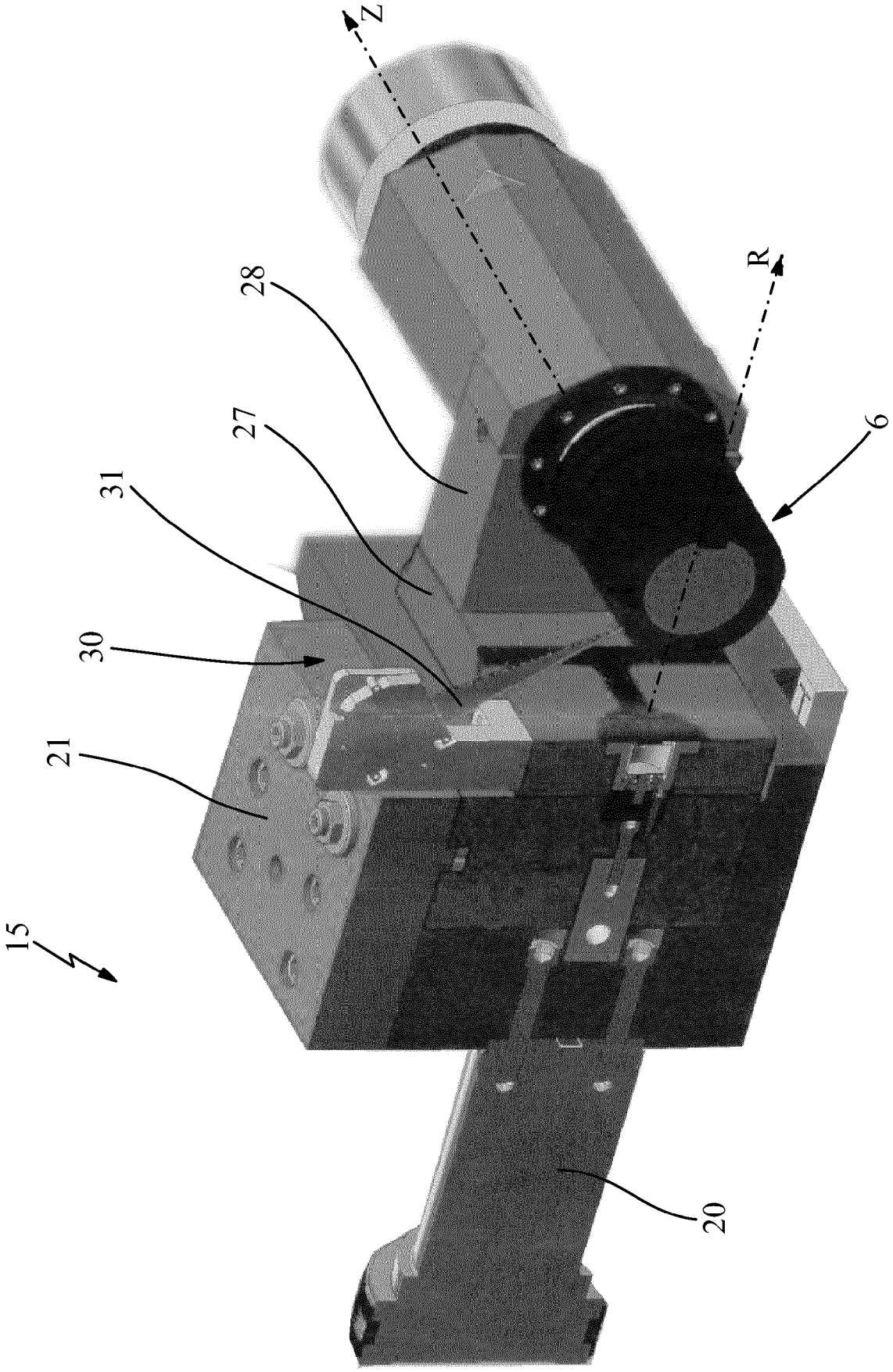

Fig. 4

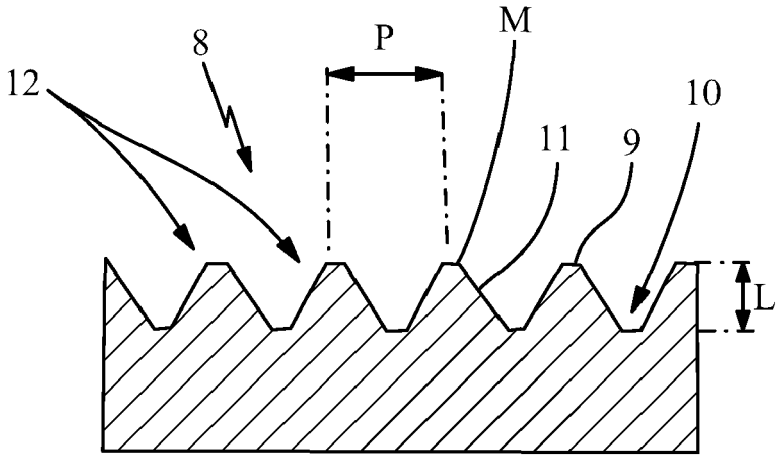

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 18 21 2692

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B21H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 April 2019	Charvet, Pierre

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26-04-2019

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