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(54) Cutting unit for cutting at least one continuous rod

(57) A cutting unit (1), for cutting at least one continuous rod (2), has a rotary cutting drum (5) with at least one radial blade (7); a cutting block device (8) having at least one blade-guide bush (9), which is advanced a given distance together with and enclosing the continuous rod (2), and has a transverse through slit (10) engaged by the blade (7) of the cutting drum (5) during the cutting operation; a first electric motor (14) for rotating the cutting drum (5) about a central axis of rotation (6); and an actuating system (11) for actuating and imparting to the blade-guide bush (9) a given cyclic law of motion synchronized with rotation of the cutting drum (5), and which has a second electric motor (15) mechanically independent of the first electric motor (14), and a control device (16) for controlling the second electric motor (15) to synchronize the second electric motor (15) with the first electric motor (14).

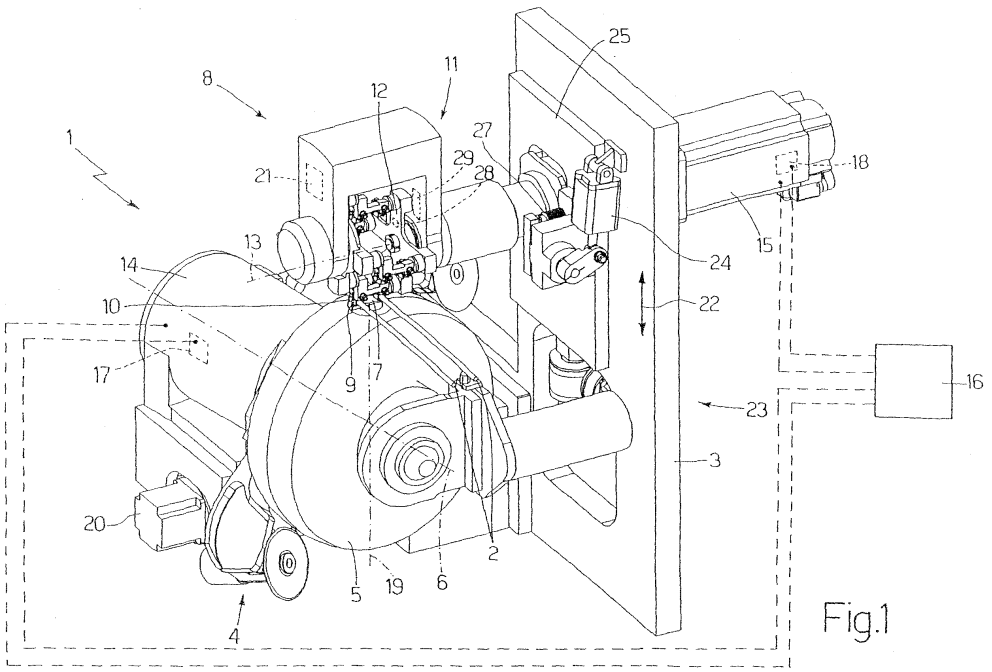

Fig.1

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Description

[0001] The present invention relates to a cutting unit for cutting at least one continuous rod.

[0002] The cutting unit according to the present invention may be used to advantage on a cigarette manufacturing machine, for cutting at least one continuous cigarette rod, or on a cigarette filter manufacturing machine, for cutting at least one continuous filter rod.

[0003] A cigarette or cigarette filter manufacturing machine produces and axially feeds at least one continuous cigarette or filter rod, which is cut transversely by a cutting unit into a succession of cigarette or filter segments for supply to a filter assembly machine.

[0004] Examples of cutting units of machines of the above type are described in Patent Applications WO2005048746A1, EP0780060A1 and GB2089187A.

[0005] The cutting unit of machines of the above type comprises a rotary cutting drum fitted with a number of radial blades; and a contrasting or cutting block device having at least one blade-guide bush which, fitted to a wheel, encloses, and is advanced a given distance together with, the rod, and has a through transverse slit engaged by a blade on the cutting drum during the cutting operation. The cutting block device has an actuating system, which imparts to the blade-guide bush a given cyclic law of motion synchronized with rotation of the cutting drum.

[0006] In known cutting units, the actuating system of the cutting block device is driven directly by the cutting drum by means of a transmission comprising gears and pinions, to ensure the movement of the cutting block device is synchronized at all times with rotation of the cutting drum. The transmission provides for a given timing between the movement of the cutting block device and rotation of the cutting drum, which timing is determined at the cutting unit design stage to achieve optimum cutting. At the design stage, however, timing between the movement of the cutting block device and rotation of the cutting drum is determined theoretically and on the basis of static conditions, without taking into account inevitable slack of the transmission and minor alterations in the dynamic position of the blades caused by vibration and oscillation, so that the actual cutting unit rarely achieves the design level of efficiency. Moreover, because of the transmission, the actuating system of the cutting block device of known cutting units is extremely complicated and bulky, also because of the need for an oil lubricating system requiring fluidtight mechanics.

[0007] Brand changes often involve changes to the length of the cigarette or filter segments cut on the cutting unit, and therefore to the angle between the cutting drum rotation axis and the travelling direction of the continuous rod, which angle depends on the length of the segments being cut. In other words, as explained clearly in Patent Application GB1095970A, to adjust the length of the segments, the angle between the cutting drum rotation axis and the travelling direction of the continuous rod must be adjusted to ensure the line of interference between each blade and the continuous rod advances, during the cutting operation, at the same speed as the continuous rod, to achieve a straight cut perfectly perpendicular to the axis of the continuous rod at all times.

[0008] To make the above adjustment, the cutting drum is known to be mounted in a cutting head, which rotates about an adjustment axis with respect to the machine frame, and can be locked in any angular position about the adjustment axis.

[0009] At each brand change involving a change in the angle between the cutting drum rotation axis and the travelling direction of the continuous rod, the wheel to which the blade-guide bushes are fitted must also be changed.

[0010] Changing the wheel of the cutting block device, however, has various drawbacks : not being automatable, it calls for manual intervention on the part of an operator (and therefore relatively prolonged downtime and painstaking adjustments), and requires a large stock of wheels, each for a given segment length.

[0011] In an attempt to eliminate the above drawback, Patent Application WO2005089574A1 proposes a cutting block device comprising a number of blade-guide bushes fitted to a rotary drum by means of an epicyclic gear train; and the relative position of each blade-guide bush is adjustable to adjust the length of the bush trajectory and so adapt to segments of different brands (lengths). The cutting block device described in Patent Application WO2005089574A1, however, is highly complex mechanically, and therefore expensive to produce and complicated to set up. What is more, it has a relatively narrow adjustment range and so provides for only a small adjustment in segment length.

[0012] It is an object of the present invention to provide a cutting unit for cutting at least one continuous rod, designed to eliminate the aforementioned drawbacks, and which at the same time is cheap and easy to produce.

[0013] According to the present invention, there is provided a cutting unit for cutting at least one continuous rod, as claimed in the accompanying Claims.

[0014] A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view in perspective, with parts removed for clarity, of a cutting unit, in accordance with the present invention, for cutting two continuous rods;

Figure 2 shows a different view in perspective of the Figure 1 cutting unit;

Figure 3 shows a larger-scale view in perspective of a cutting block device of the Figure 1 cutting unit.

[0015] Number 1 in the accompanying drawings indicates as a whole a cutting unit for cutting filter (or cigarette) segments of given length off two parallel continuous filter (or cigarette) rods 2 produced on a known dual-rod manufacturing machine (not shown) supporting cut-

ting unit 1. Cutting unit 1 comprises a fixed frame 3 fitted rigidly to a frame (not shown) of the dual-rod manufacturing machine.

[0016] Frame 3 of cutting unit 1 supports a cutting head 4 comprising a cutting drum 5, which rotates about an axis of rotation 6 and has at least one radial blade 7 for cutting both continuous rods 2 in rapid succession.

[0017] Continuous rods 2 are fed simultaneously and at the same speed through a cutting block device 8, which forms part of cutting unit 1, is fitted to frame 3, and comprises a number of pairs of blade-guide bushes (or sleeves) 9. Each blade-guide bush 9 has a transverse through slit 10 (i.e. crosswise to the travelling direction of continuous rods 2) which is engaged by blade 7 of the cutting drum.

[0018] Blade-guide bushes 9 are actuated by an actuating system 11, which imparts to blade-guide bushes 9 a given cyclic law of motion synchronized with rotation of cutting drum 5. More specifically, actuating system 11 advances the blade-guide bushes 9 in each pair a given distance together with continuous rods 2, so that each blade-guide bush 9 encloses, and moves synchronously together with, respective continuous rod 2.

[0019] In a preferred embodiment shown in the attached drawings, each blade-guide bush 9 has a U-shaped cross section, and actuating system 11 comprises a wheel 12, which rotates about a respective central axis of rotation 13, and supports blade-guide bushes 9 with the interposition of an epicyclic gear train (not shown) to keep blade-guide bushes 9 parallel to the travelling direction of continuous rod 2 at all times (as described, for example, in Patent Application WO2005089574A1 or Patent US3479913A1).

[0020] In a different embodiment not shown, cutting block device 8 comprises only one pair of tubular blade-guide bushes 9, inside each of which a respective continuous rod 2 runs; and actuating system 11 imparts to each blade-guide bush 9 a straight back-and-forth movement in the travelling direction of respective continuous rod 2 (as described, for example, in Patent Applications EP0780060A1 and GB2089187A).

[0021] Cutting head 4 has an electric motor 14 for rotating cutting drum 5 about central axis of rotation 6; and actuating system 11 has an electric motor 15 mechanically independent of electric motor 14, and a control device 16 for synchronizing electric motor 15 with electric motor 14.

[0022] Control device 16 synchronizes electric motor 15 with electric motor 14 using master-slave control logic, in which electric motor 14 is the master, and electric motor 15 the slave. For which purpose, control device 16 is connected to an angle encoder 17 on electric motor 14, and to an angle encoder 18 on electric motor 15, to determine the instantaneous angular position of the shafts (not shown) of both electric motors 14 and 15.

[0023] In one possible embodiment, each blade-guide bush 9 has a weak portion designed to break in controlled manner, in the event of severe mechanical stress of blade-guide bush 9 caused by a loss of synchronism of electric motors 14 and 15, and so prevent further damage to cutting block device 8. Loss of synchronism of electric motors 14 and 15 thus results in controlled breakage of blade-guide bushes 9, which are cheap and fairly easy to change.

[0024] In an alternative embodiment, each blade-guide bush 9 is designed to divert and cause controlled breakage of blade 7, in the event of a loss of synchronism of electric motors 14 and 15, and so prevent further damage to cutting block device 8. Loss of synchronism of electric motors 14 and 15 thus results in controlled breakage of blade 7, which is cheap and fairly easy to change.

[0025] In a preferred embodiment, cutting head 4 is fitted to frame 3 to rotate about an adjustment axis 19, and can be locked in any angular position about adjustment axis 19 to adjust the angle between axis of rotation 6 of cutting drum 5 and the travelling direction of continuous rod 2. Cutting head 4 preferably has an electric motor 20 for moving cutting head 4 about adjustment axis 19. A more detailed description of the cutting head 4 rotation mechanism is given in Patent Application WO2005048746A1, which is included herein by way of reference.

[0026] In one possible embodiment, cutting unit 1 comprises at least one accelerometer 21 for detecting vibration of cutting unit 1; and the signal from accelerometer 21 is transmitted to control device 16 which, in use, adjusts the timing of electric motors 14 and 15 as a function of the signal from accelerometer 21 to minimize vibration of cutting unit 1. Optimum timing of electric motors 14 and 15 can thus be determined and updated experimentally, also taking into account construction tolerances, wear-induced slack, and also vibration and oscillation resulting in minor alterations to the dynamic position of blade 7.

[0027] Accelerometer 21 may be fixed to frame 3, to cutting drum 5, or to wheel 12 of cutting block device 8.

[0028] In a preferred embodiment, cutting block device 8 is movable in an adjustment direction 22 perpendicular to the travelling direction of continuous rods 2; and an adjusting device 23 is provided to adjust the position of cutting block device 8 in adjustment direction 22.

[0029] Adjusting device 23 comprises a slide 25 supporting cutting block device 8 and fitted to frame 3 to slide in adjustment direction 22; and a linear actuator 26 (typically a pneumatic cylinder) fixed at one end to frame 3, and connected mechanically at the other end to slide 25 to adjust the position of cutting block device 8 in adjustment direction 22.

[0030] Slide 25 is locked in position by an actuator 24 operating in opposition to a spring 27.

[0031] The following is a description of the way in which cutting unit 1 performs a brand change involving a change in the length of the segments cut on cutting unit 1.

[0032] Changing the length of the segments cut by cutting unit 1 calls for changing the angle between the axis of rotation 6 of cutting drum 5 and the travelling direction

of continuous rods 2, to ensure the line of interference between blade 7 and continuous rods 2 travels, during the cutting operation, at the same speed as continuous rods 2, to obtain straight cuts perfectly perpendicular to continuous rods 2 (as explained clearly in Patent Application GB1095970A). The first operation, when making a brand change, is therefore to adjust the angular position of cutting head 4 (i.e. of cutting drum 5) about adjustment axis 19 by means of electric motor 20 (the details of this operation are described in Patent Application W02005048746A1).

[0033] Once the angular position of cutting head 4 (i.e. of cutting drum 5) about adjustment axis 19 is set, the position of slit 10 of each blade-guide bush 9 must be adjusted to the new angular position of cutting head 4, which is done by setting control device 16 as a function of the desired segment length. More specifically, control device 16 of electric motor 15 provides for adjusting the timing of electric motors 14 and 15 as a function of the desired segment length.

[0034] In the event of a significant change in segment length, however, it may be necessary to change wheel 12, so a sufficient number of interchangeable wheels 12 are provided, each for cutting segments of a length within a given range.

[0035] Changing from one wheel 12 to another of different diameter obviously calls for subsequently adjusting the height of slide 25 so the wheel is again tangent to rods 2.

[0036] In one possible embodiment, each wheel 12 comprises a transponder 28 in which an identification code of wheel 12 is memorized; and cutting block device 8 comprises a transponder reader 29 for reading the transponder and identification code of wheel 12. In this way, it is possible to automatically determine whether or not cutting block device 8 is fitted with the right wheel 12, and to operate actuator 26 accordingly.

[0037] In a different embodiment not shown, cutting unit 1 described above may also be used to cut one continuous rod 2 or more than two (normally, no more than three or four) continuous rods 2, by simply changing the number of blade-guide bushes 9 and, obviously, adapting the laws of motion of the various component parts.

[0038] Cutting unit 1 as described has numerous advantages by being cheap and easy to produce and compact, through not requiring an external transmission between cutting drum 5 and blade-guide bushes 9.

[0039] Moreover, in cutting unit 1 as described, timing between the movement of blade-guide bushes 9 and rotation of cutting drum 5 can be adjusted continuously to compensate for manufacturing tolerances, wear-induced slack, and even vibration and oscillation resulting in minor changes to the dynamic position of blade 7, thus enabling cutting unit 1 to achieve and maintain the design level of efficiency.

[0040] Moreover, the longitudinal speed of bushes 9 can be adjusted throughout the interference period to achieve optimum tracking and engagement between bushes 9 and the blades of cutting drum 5.

[0041] Finally, cutting unit 1 as described provides for adjusting segment length by adjusting the angle between the axis of rotation 6 of cutting drum 5 and the travelling direction of continuous rods 2, and by appropriately correcting timing between the movement of blade-guide bushes 9 and rotation of cutting drum 5. In other words, each blade-guide bush 9 of cutting unit 1 as described is capable of covering a respective range of segment lengths, thus reducing the number of wheels 12 required.

[0042] As a result, brand changes involving only minor changes in segment length are performed much faster, and spare part cost and storage are reduced by no longer requiring a wheel 12 for each segment length.

Claims

1. A cutting unit (1) for cutting at least one continuous rod (2) transversely into a succession of segments, the cutting unit (1) comprising:

a rotary cutting drum (5) with at least one radial blade (7);

a cutting block device (8) having at least one blade-guide bush (9), which is advanced a given distance together with and enclosing the continuous rod (2), and has a transverse through slit (10) engaged by the blade (7) of the cutting drum (5) during the cutting operation;

a first electric motor (14) for rotating the cutting drum (5) about a central axis of rotation (6); and an actuating system (11) for actuating and imparting to the blade-guide bush (9) a given cyclic law of motion synchronized with rotation of the cutting drum (5);

the cutting unit (1) being **characterized in that** the actuating system (11) comprises a second electric motor (15) mechanically independent of the first electric motor (14); and a control device (16) for controlling the second electric motor (15) to synchronize the second electric motor (15) with the first electric motor (14).

2. A cutting unit (1) as claimed in Claim 1, wherein the control device (16) of the second electric motor (15) employs master-slave control logic to synchronize the second electric motor (15) with the first electric motor (14).

3. A cutting unit (1) as claimed in Claim 1, wherein the control device (16) of the second electric motor (15) is connected to a first angle encoder (17) fitted to the first electric motor (14), and is connected to a second angle encoder (18) fitted to the second electric motor (15).

4. A cutting unit (1) as claimed in Claim 1, 2 or 3, where-

in, when making a brand change, the control device (16) of the second electric motor (15) adjusts the timing between the first electric motor (14) and the second electric motor (15) as a function of the desired length of the segments.

5. A cutting unit (1) as claimed in one of Claims 1 to 4, wherein the cutting block device (8) comprises a single tubular blade-guide bush (9), in which the continuous rod (2) runs; and the actuating system (11) imparts to the blade-guide bush (9) a linear back-and-forth movement in the travelling direction of the continuous rod (2).

6. A cutting unit (1) as claimed in one of Claims 1 to 4, wherein the cutting block device (8) comprises a number of blade-guide bushes (9), each having a U-shaped cross section; and a wheel (12) which rotates about a respective central axis of rotation (13), and supports the blade-guide bushes (9) with the interposition of an epicyclic gear train to keep the blade-guide bushes (9) parallel at all times to the travelling direction of the continuous rod (2).

7. A cutting unit (1) as claimed in Claim 6 and comprising a number of interchangeable wheels (12) having respective blade-guide bushes (9); each wheel (12) being designed to cut segments of a length within a given range.

8. A cutting unit (1) as claimed in Claim 7, wherein, to adapt a given wheel (12) to cut segments of a different length within the respective range of the wheel (12), the control device (16) of the second electric motor (15) adjusts the timing between the first electric motor (14) and the second electric motor (15) as a function of the desired length of the segments.

9. A cutting unit (1) as claimed in Claim 8, wherein each wheel (12) comprises a transponder (28), in which an identification code of the wheel (12) is memorized; and the cutting block device (8) comprises a transponder reader (29) for reading the transponder and the identification code of the wheel (12).

10. A cutting unit (1) as claimed in one of Claims 6 to 9, wherein the cutting block device (8) is movable in an adjustment direction (22) perpendicular to the travelling direction of the continuous rod (2); and an adjusting device (23) is provided to adjust the position of the cutting block device (8) in the adjustment direction (22).

11. A cutting unit (1) as claimed in one of Claims 1 to 10, wherein each blade-guide bush (9) has a weak portion designed to break in controlled manner, in the event of severe mechanical stress on the blade-guide bush (9) caused by a loss of synchronism between the two electric motors (14, 15), and so prevent further damage to the cutting block device (8).

12. A cutting unit (1) as claimed in one of Claims 1 to 10, wherein each blade-guide bush (9) is designed to divert the blade (7) and so produce controlled breakage of the blade (7) in the event of a loss of synchronism between the two electric motors (14, 15), so as to prevent damage to the cutting block device (8).

13. A cutting unit (1) as claimed in one of Claims 1 to 12, wherein the cutting drum (5) is fitted to a cutting head (4) which rotates, with respect to a fixed frame (3) of the cutting unit (1), about an adjustment axis (19), and can be locked in any angular position about the adjustment axis (19) to adjust the angle between the axis of rotation (6) of the cutting drum (5) and the travelling direction of the continuous rod (2).

14. A cutting unit (1) as claimed in one of Claims 1 to 13, and comprising at least one accelerometer (21) for detecting vibration of the cutting unit (1).

15. A cutting unit (1) as claimed in Claim 14, wherein the control device (16) of the second electric motor (15) adjusts, in use, the timing between the first electric motor (14) and the second electric motor (15) as a function of the signal from the accelerometer (21).

16. A cutting unit (1) as claimed in one of Claims 1 to 15, and for simultaneously cutting at least two continuous rods (2); the cutting block device (8) having at least one blade-guide bush (9) for each continuous rod (2).

17. A method of making a brand change on a cutting unit (1) for cutting at least one continuous rod (2) transversely into a succession of segments, the cutting unit (1) comprising:

a rotary cutting drum (5) with at least one radial blade (7);
a cutting block device (8) having at least one blade-guide bush (9), which is advanced a given distance together with and enclosing the continuous rod (2), and has a transverse through slit (10) engaged by the blade (7) of the cutting drum (5) during the cutting operation;
a first electric motor (14) for rotating the cutting drum (5) about a central axis of rotation (6); a second electric motor (15), mechanically independent of the first electric motor (14), for actuating and imparting to the blade-guide bush (9) a given cyclic law of motion synchronized with rotation of the cutting drum (5); and
a control device (16) for controlling the second electric motor (15) to synchronize the second

electric motor (15) with the first electric motor (14);
the method comprising the steps of:

rotating the cutting drum (5) about an adjustment axis (19) to adjust the angle between the axis of rotation (6) of the cutting drum (5) and the travelling direction of the continuous rod (2) as a function of the desired length of the segments; and
adjusting the timing between the first electric motor (14) and the second electric motor (15) by acting on the control device (16) as a function of the desired length of the segments.

18. A method as claimed in Claim 17, and comprising the further step of moving the cutting block device (8) in an adjustment direction (22) perpendicular to the travelling direction of the continuous rod (2).

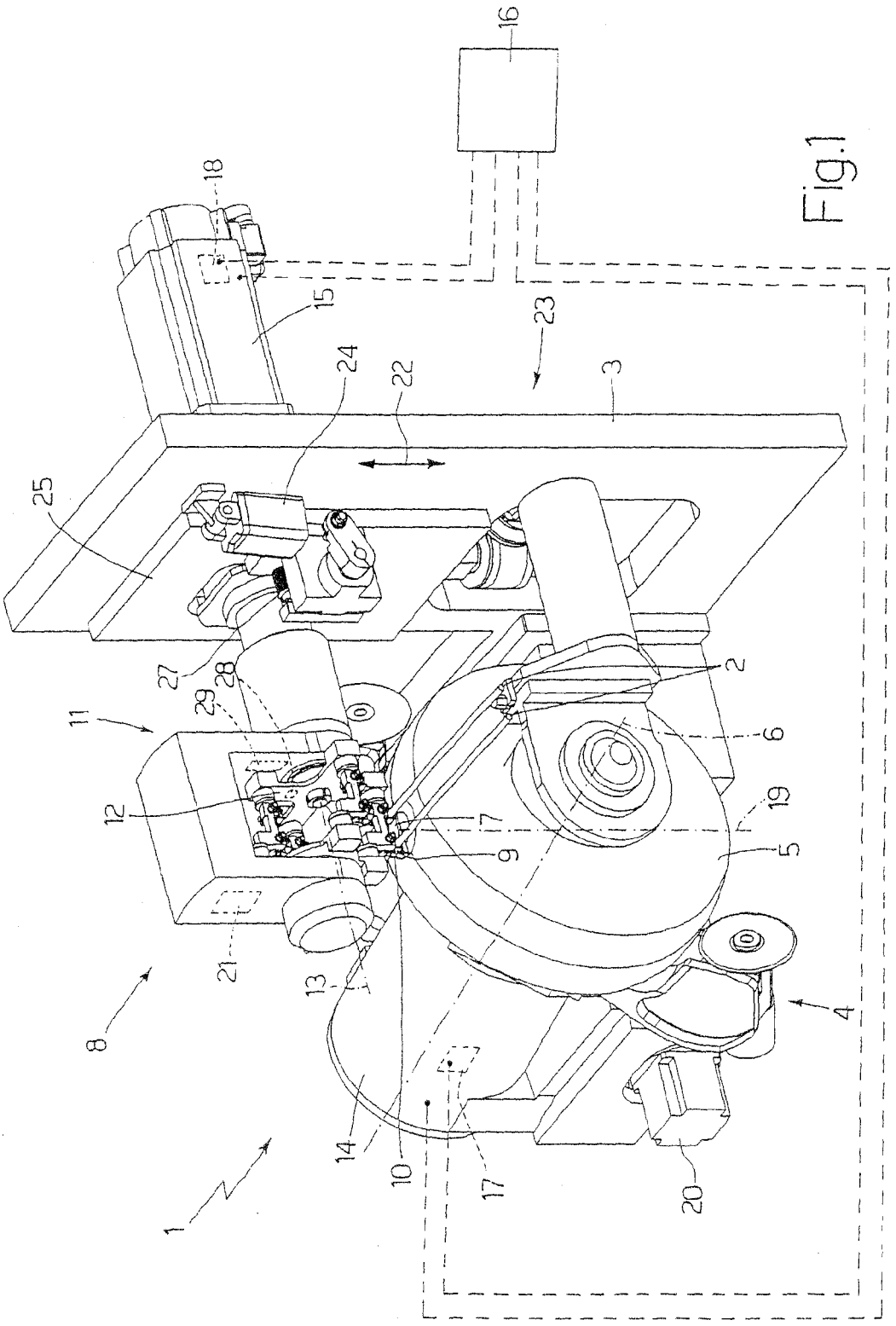

Fig.1

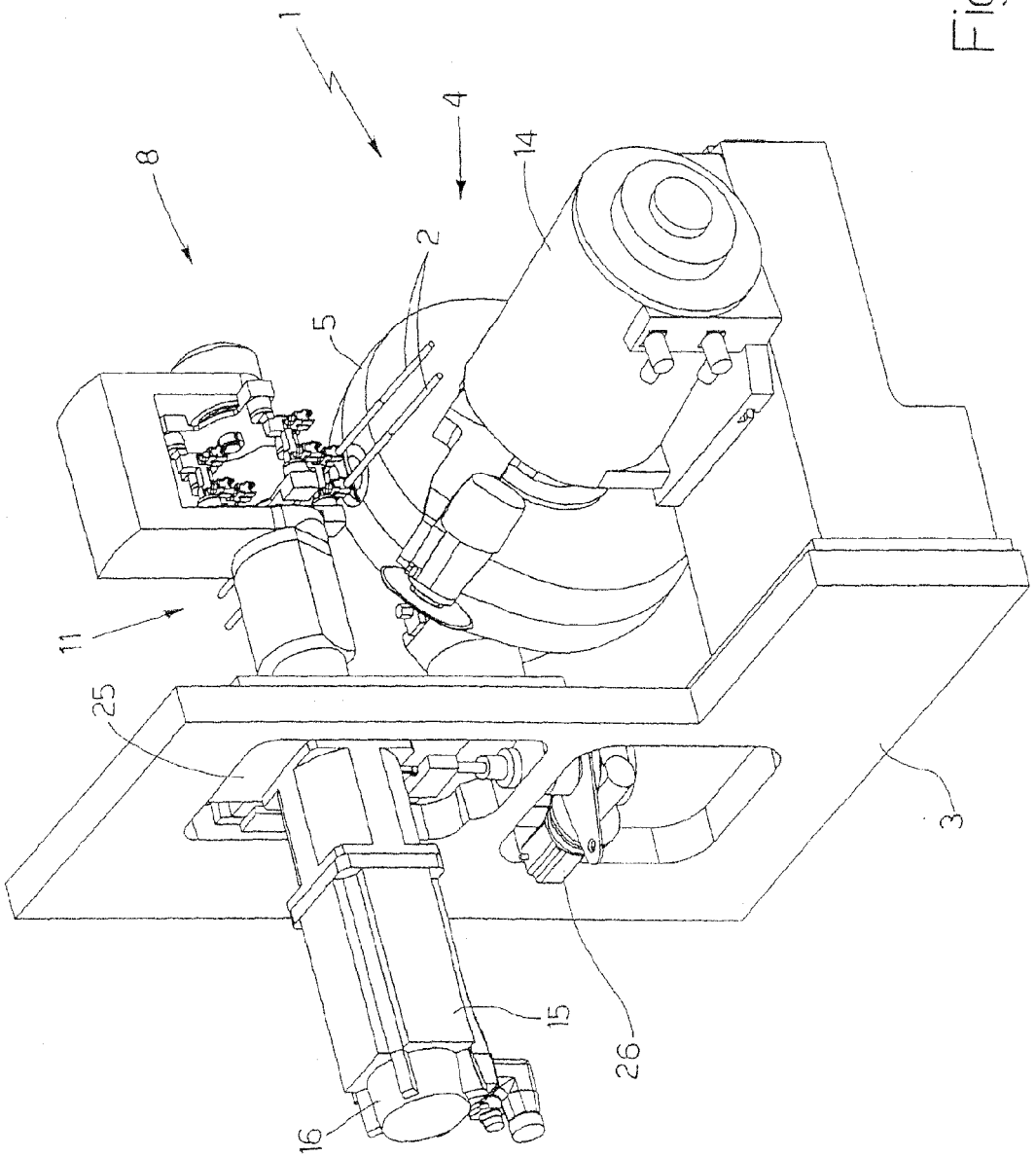

Fig.2

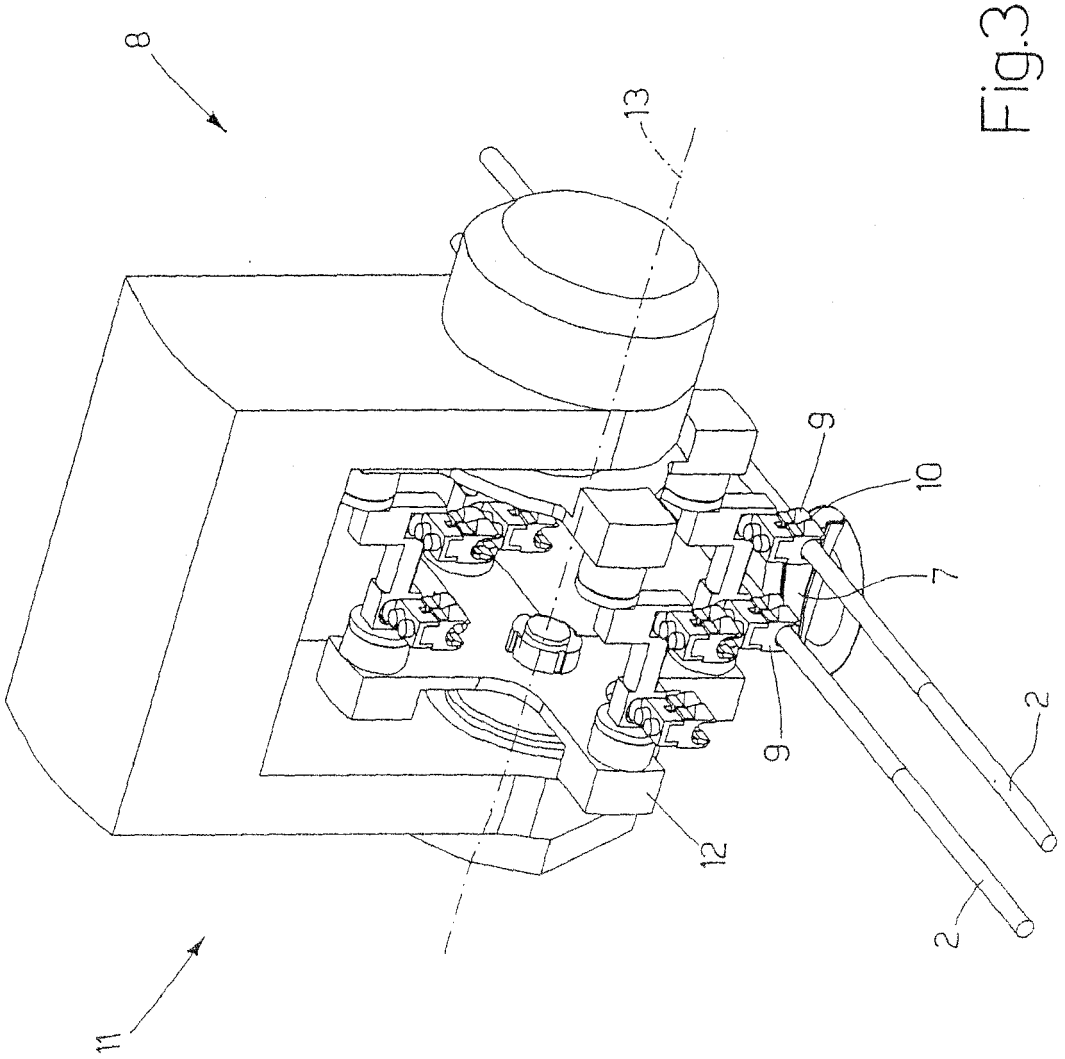

Fig.3

REFERENCES CITED IN THE DESCRIPTION

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