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

(11) EP 2 965 638 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.01.2016 Bulletin 2016/02

(21) Application number: **15174766.4**

(22) Date of filing: **01.07.2015**

(51) Int Cl.:
A24B 7/12 *(2006.01)* ***B26D 1/36*** *(2006.01)*
B26D 5/00 *(2006.01)* ***B26D 7/12*** *(2006.01)*
B26D 7/26 *(2006.01)*

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

(30) Priority: **08.07.2014 GB 201412126**

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(54) KNIFE POSITIONING APPARATUS

(57) A knife positioning apparatus arranged in a rotatable drum assembly comprising a substantially cylindrical drum with an axis of rotation. The knife positioning apparatus comprises one or more knife modules each with a cutting edge and a positioning device. The positioning device is arranged to move the cutting edge of a knife module in a direction substantially perpendicular to the axis of rotation of the drum and substantially tangential to the circumference of the drum. The knife positioning apparatus further comprises a position sensor arranged to sense the position of the cutting edge of an individual knife module and communicate said position to the positioning device.

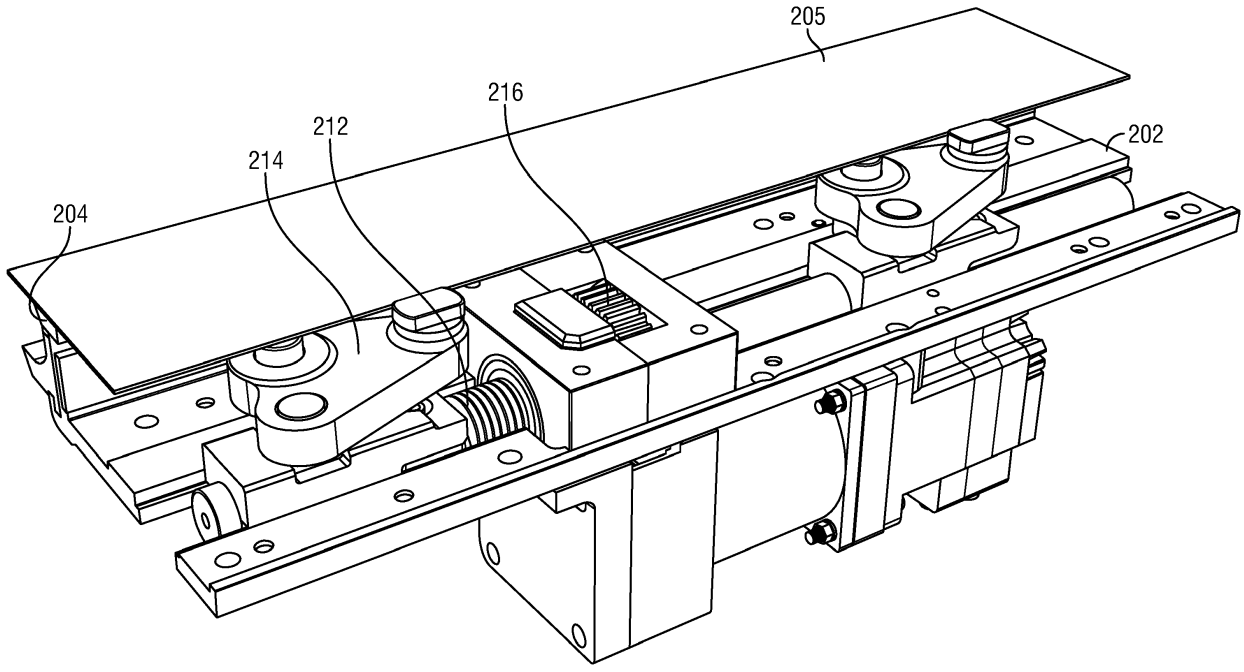

FIG. 3

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Description

[0001] The present invention relates to a knife positioning apparatus and to a method of positioning the cutting edge of a knife module in a rotatable drum assembly. Embodiments of the present invention relate to a knife positioning apparatus arranged in a rotatable drum assembly on a tobacco cutting machine.

Background

[0002] Cutting machines are known to be used in a number of different industries for processing a range of products such as paper, fabric, tobacco. The product material to be cut can be laminar, fibrous or granular.

[0003] In the tobacco industry, tobacco leaves are processed for cigarette manufacture in a primary tobacco process. The laminar portions of the tobacco leaves are first compressed and then cut in a cutting machine to create tobacco particles suitable for use and processing by cigarette manufacturers.

[0004] Cutting machines for cutting tobacco leaves or stems are known in the art, for example, as described in GB2010/051607. Cutting machines for tobacco leaves generally comprise a rotatable drum assembly comprising a plurality of knives arranged on a rotatable drum. The cutting edges of the knives project from the rotatable drum such that they are orientated approximately tangential to the circumference of the drum.

[0005] As the drum rotates, the knives cut through compressed tobacco material which is extruded towards the rotatable drum from the mouth of the cutting machine. The tobacco material is cut into shreds for subsequent use as smoking material. The cutting edges of the knives are blunted by the tobacco which is being cut and must be sharpened. It is common to use a grinding wheel to compensate for the blunting of the knives. The grinding wheel traverses in a direction parallel to the axis of rotation of the drum. The projecting edges of the knives contact the surface of the grinding wheel as they pass the grinding wheel and are continually abraded. The knives may be adjusted to compensate for the sharpening action of the grinding wheel.

[0006] The grinding wheel is periodically dressed by passing it over a diamond that is commonly located near the end of its traverse motion near the edge of the rotating drum. The diamond removes a thin layer from the grinding wheel (said layer commonly comprising bonding material and abrasive grit).

[0007] We have now devised an improved knife positioning apparatus that provides additional benefits to a cutting machine compared to existing systems.

Summary of the invention

[0008] According to the present invention, as seen from a first aspect, there is provided a knife positioning apparatus arranged in a rotatable drum assembly comprising a substantially cylindrical drum with an axis of rotation;
the knife positioning apparatus comprising one or more knife modules each comprising a positioning device and a knife with a cutting edge and, wherein the positioning device is arranged to move said cutting edge in a direction substantially perpendicular to the axis of rotation of the drum;
the knife positioning apparatus further comprising a position sensor arranged to sense the position of the cutting edge of an individual knife module and communicate said position to the positioning device.

[0009] Preferably, the one or more knife modules are arranged on the cylindrical drum such that the knife cutting edge or edges project from the drum. The present invention provides an automated system in which the knife cutting edge of each knife module may be moved independently or together with other cutting edges such that the cutting edges are rapidly arranged at the optimum geometrical position for sharpening in preparation for the cutting operation of the rotatable drum assembly.

[0010] Preferably, the position sensor is arranged to provide a laser beam orientated substantially parallel to the axis of rotation of the drum. Preferably, the position sensor is further arranged to communicate the intersection of the knife cutting edge with said laser beam to the positioning device. Advantageously, the laser position sensor ensures that the cutting edges are positioned in a reasonably accurate manner, preferably within 100 microns or better, so that sharpening of the knives can take place with the minimum of delay. If the knives are not initially extended far enough, the initial sharpening of the knives will be time consuming due to the small increments by which the knives are fed outwards. During this time, the machine will not be available for production. If the knives are initially extended too far from the drum there is a risk that damage to the grindstone or other parts of the machine will occur.

[0011] Preferably, the position sensor communicates with the positioning device via wireless communication.

[0012] Preferably, the positioning device comprises a stepper motor. In alternative embodiments, the positioning device may comprise a servomotor or may be hydraulically or pneumatically actuated. The small angular movements which can be generated by stepper motors (typically 1.8°) allow small and repeatable movements of the cutting edges to be achieved in rapid succession, thus providing an essentially continuous advancement operation on the knives.

[0013] Preferably, the positioning device further comprises a feed bar and a bell crank arranged to translate a rotational movement of the stepper motor to a lateral movement of a cutting edge such that the cutting edge is moved in a direction substantially perpendicular to the axis of rotation of the drum. Advantageously, this mechanism comprises less components than existing mechanisms and is more robust. The small angular movements generated by the stepper motor are efficiently

translated to the lateral advancement of the knife cutting edges.

[0014] Preferably, the knife cutting edges of the one or more knife modules are orientated substantially tangentially to the circumference of the rotatable drum.

[0015] Preferably, the positioning device of each knife module is actuated independently from an adjacent knife module, wherein the direction of movement of each cutting edge is in a direction substantially away from the axis of rotation of the drum.

[0016] Following replacement of some or all of the knives, it is desirable to advance each knife to the required position for grinding to take place. Some of the knives may have different lengths from one another, so it is preferable to be able to advance each knife individually. This can be achieved with the present invention since on the rotatable drum comprising a plurality of cutting edges, each knife module comprises its own independent positioning device. Other existing mechanisms do not provide such ease of adjustment free from human error and interference.

[0017] In use, the laser position sensor operates after knives have just been fitted to the rotatable drum assembly. The drum rotates slowly, preferably less than 50 rpm, so that the angular position of the drum can be sensed and the knife cutting edge is also sensed. The signal from the position sensor is associated with the knife which is being sensed and said knife is advanced rapidly to the optimum pre-grinding position. The same may be repeated for other knives arranged in the rotatable drum assembly. The positioning operation can be performed continuously or at frequent intervals to ensure the cutting edges are each maintained at an optimum position.

[0018] In operation, the position of the knife cutting edges is determined by the action of the grinder, which in turn is determined by the position of the diamond. It is envisaged that in the embodiment where the position sensor comprises a laser beam, the position sensor will not be actuated when the drum is rotating at cutting speed, as the measurement would be obscured by the flow of cut (tobacco) material.

[0019] The positioning devices of the one or more knife modules in a rotatable drum assembly may also be actuated simultaneously such that the knives or their feed mechanisms may be simultaneously and automatically retracted at high speed (i.e. moved in a direction substantially towards the axis of rotation of the drum) when knives have been expended. In other existing mechanisms, it is necessary for an operator to use tools to sequentially retract the mechanism for each knife in preparation for fitting new knives. This is time-consuming, generally requiring of the order of ten or more minutes for this operation to take place on a typical 10-knife cutting machine, during which time the machine is unavailable for production.

[0020] Preferably, the rotatable drum assembly further comprises a drum motor. Preferably, the angular position of the drum is detected by a position encoder arranged to sense the angular position of the drum and to communicate with the positioning device. Preferably, the position encoder and the positioning device communicate with each other via wireless communication.

[0021] Preferably, the apparatus comprises a control system arranged to receive and emit control signals to the knife positioning device, position sensor and position encoder.

[0022] Preferably, the control system comprises a WiFi antenna located at the axis of rotation of the rotatable drum and a static WiFi transceiver located external to the rotatable drum in communication with the position sensor. Preferably, the wireless communication system comprises a further internal WiFi transceiver located on the rotatable drum that is in communication with the individually actuated positioning device of each knife module.

[0023] Preferably, the control system comprises a processor. Status, fault or alarm information from each positioning device may be transmitted by WiFi from to the external processor.

[0024] In use, it is envisaged that the presence or absence of each knife cutting edge as determined by the position sensor will be processed by the processor to generate the appropriate command for the positioning device of each knife module. If the knife cutting edge is not detected by the position sensor, the positioning device will be commanded to advance the knife. If the knife cutting edge is detected by the position sensor, the positioning device will be commanded to retain its present position. The commands for each knife positioning device will be transmitted from the processor to the cutting drum by means of WiFi. Similarly data such as knife feed movement and positioning device errors codes can be transmitted from the devices mounted within the drum to the processor which in a preferred embodiment is located external to the drum and is static.

[0025] Advantageously, the WiFi control system requires no maintenance and has a high degree of reliability. Electrical power for the positioning device and WiFi is carried into the drum by means of slip-rings and brushes. In existing systems, signals are transmitted pneumatically or mechanically, or via slip-rings, all of which suffer from unreliability and wear, thus requiring frequent and skilled maintenance.

[0026] Preferably, the knife positioning apparatus as hereinbefore described is arranged in a tobacco cutting machine.

[0027] According to the present invention, as seen from a second aspect, there is provided a method of positioning the cutting edge of a knife module in a rotatable drum assembly, the method comprising:

providing a rotatable drum with an axis of rotation, the rotatable drum comprising a knife module, wherein the knife module comprises a positioning device and a knife with a cutting edge;

providing a position sensor remote from the knife

cutting edge, wherein the position sensor is arranged to sense the position of said cutting edge;
actuating the positioning device such that the knife cutting edge of the knife module is moved laterally in a direction substantially perpendicular to the axis of rotation of the drum;
sensing the position of the cutting edge with the position sensor;
communicating the position of the knife cutting edge to the positioning device to position the cutting edge of said knife module at a predetermined position.

[0028] Preferably, the method of positioning the cutting edge of a knife module on a rotatable drum assembly is performed with an embodiment of the knife positioning apparatus as hereinbefore described.

[0029] Preferably, the position sensor is arranged to provide a laser beam orientated substantially parallel to the axis of rotation of the drum and is arranged such that when the cutting edge of a knife module intersects said laser beam, the position sensor communicates with the corresponding positioning device to stop further movement of the cutting edge.

[0030] The actuating step may be performed after replacement of some or all of the knives by an operator.

[0031] Preferably, the rotatable drum comprises one or more knife modules each comprising a cutting edge and a positioning device. Preferably, the rotatable drum is arranged to rotate to bring a knife module into the vicinity of the position sensor such that the steps of actuating, sensing and communicating are performed to position the cutting edge of said knife module.

[0032] Preferably, the rotatable drum comprising one or more knife modules further comprises a position encoder arranged to identify when a knife module is in the vicinity of the position sensor such that the steps of actuating, sensing and communicating may then be performed to position the cutting edge of said knife module. In a rotatable drum with more than one knife module, the angular position of the drum is sensed by the position encoder so that the knife position as detected by the laser beam is associated with the positioning device of the correct knife module. The position encoder may communicate the angular position of the drum to the processor so that the positioning device of the correct knife module.

[0033] Preferably, the knife positioning apparatus used to perform the method of positioning the cutting edge of a knife module further comprises a control system arranged to receive and emit control signals from and to one or more of the positioning device, position sensor and position encoder.

[0034] The present invention provides a knife positioning apparatus for positioning the cutting edge of a knife in a rotatable drum assembly wherein the positioning operation is automated and does not require significant input of an operator. The positioning operation is thus simplified and operation costs are minimised. The present invention also negates the need for the operator to handle sharp knife edges or be in close proximity to moving parts within the rotatable drum assembly which minimises the risk of injury to the operator.

Specific description of the embodiments

[0035] An embodiment of the invention will now be described in detail, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional illustration of a cutting machine comprising a rotatable drum assembly that forms part of the prior art;

Figure 2 is a perspective illustration of a rotatable drum assembly for a cutting apparatus that forms part of the prior art;

Figure 3 is an illustration of the knife module of a knife positioning apparatus according to an embodiment of the present invention, the knife module comprising a positioning device and a cutting edge;

Figure 4 is an illustration of the knife module of a knife positioning apparatus according to an embodiment of the present invention, the knife module comprising a positioning device and region accommodating a cutting edge;

Figure 5 is an illustration of the positioning device shown in Figure 3 from an alternative angle;

Figure 6 is an illustration of the arrangement of cutting edges on a rotatable drum assembly and the position sensor of a knife positioning apparatus according to an embodiment of the present invention, the position sensor comprising a laser; and

Figure 7 is an illustration of part of a rotatable drum assembly comprising a wireless communication system.

[0036] Referring to Figure 1 of the drawings, there is shown a cutting machine 100 that forms part of the prior art. The cutting machine 100 has a rotatable drum assembly 101 comprising a substantially cylindrical drum 102 with an axis of rotation X that extends into the plane of the page and a plurality of knives 103 that protrude from the circumference of the cylindrical drum 102. The cutting machine 100 further comprises a mouth 104 adjacent the drum 102 and a conveyor belt 105 arranged to carry material to be cut (not shown) towards the mouth 104 where it is delivered to the drum 102 and is cut by the knives 103.

[0037] In use, the drum 102 typically rotates at a speed between 200 and 600 rpm but can rotate at much higher speeds. The arrow on Figure 1 shows the direction of rotation of the drum 102 about its axis of rotation X. As

the knives 103 cut the material that is delivered by the mouth 104, they are rapidly blunted. To compensate for this, the cutting machine 100 has a grinding wheel (or grindstone) 106 arranged to sharpen and maintain the profile of the knives 103. The grinding wheel 106 is typically composed of abrasive grit and a bonding material. The grinding wheel 106 is traversed parallel to the axis of rotation X of the drum 102, in use. It is desirable to feed the knives 103 outwardly from the drum 102 to compensate for the abrasion of the grinding wheel 106.

[0038] Referring to Figure 2 of the drawings, there is shown the rotatable drum assembly 101 typically used on the cutting machine 100 in Figure 1 that forms part of the prior art. The rotatable drum assembly 101 comprises a cylindrical drum 102 and a plurality of knives 103 that protrude from the circumference of the cylindrical drum 102. The rotatable drum assembly 101 further comprises a knife gripper 107 to hold the knives 103 in place on the drum 102 and a cavity 108 located just below each knife 103 to accommodate cut material (not shown).

[0039] Referring to Figures 3 and 4 of the drawings, there is shown part of a knife positioning apparatus 200 according to an embodiment of the present invention. In Figure 3, the knife positioning apparatus 200 comprises a knife module 202 comprising a knife support 204 and a knife comprising a cutting edge 205 (not shown in Figure 4). The knife rests upon the knife support 204. The knife positioning apparatus 200 further comprises a positioning device 206 arranged to move said knife. The positioning device 206 comprises a stepper motor 208, a nut 210 mounted on a threaded bar 212 and bell-cranks 214 arranged to advance the knife by sliding it over the support 204 in the direction of the arrow shown in Figure 3.

[0040] In Figure 5 of the drawings, there is shown the knife positioning device 206 shown in Figure 3 and Figure 4 from an alternative angle. Various components of the positioning device 206 have been labelled. The additional parts of the knife module 202 such as the knife support 204 and knife that would normally be arranged with the positioning device 206 in a rotatable drum assembly have been omitted for clarity.

[0041] The rotational movement provided by the stepper motor 208 may be translated to a lateral movement of the cutting edge of the knife (not shown) which slides over the knife support 204. The stepper motor 208 is used to rotate the nut 210 mounted on the threaded bar 212 via reduction gears 216. Lateral movement of the nut 210 is prevented by thrust bearings 219 such that rotation of the nut 210 generates lateral movement of the threaded bar 212. This movement is then translated through 90° by the bell-cranks 214 which apply thrust to the knife (in the direction shown by the arrows in Figure 4), thereby positioning the knife cutting edge 205 and advancing it when required.

[0042] In use, the knife positioning apparatus 200 will be part of a rotatable drum assembly (not shown) comprising a rotatable drum, with the knife cutting edge of the knife module 202 projecting from the circumference of the rotatable drum, similarly to the knives 103 that project from the rotatable drum assembly 101 shown in Figure 2. The advancement of the cutting edge that is actuated by the positioning device 206 is in a direction substantially tangential to the circumference of the drum, and substantially perpendicular to the axis of rotation of the drum. The positioning device 206 is also arranged so that its mechanism may be retracted ready to receive a new unexpended knife. The rotatable drum assembly may comprise additional knife modules with positioning devices that may be actuated independently of each other.

[0043] The knife positioning apparatus 200 further comprises a position sensor (see Figure 5) remote from the cutting edge 204 of the knife module 202 arranged to sense the position of the knife cutting edge and communicate the presence or absence of the cutting edge to a processor. In use, it is envisaged that the processor will then processes this information and communicate the required action to the positioning device 206. If the cutting edge 205 is not detected, the positioning device is commanded to advance the knife by a pre-defined movement. If the cutting edge is detected, the positioning device is commanded to maintain its present position.

[0044] Referring to Figure 6 of the drawings, there is shown the arrangement of a plurality of knives 203 each with a cutting edge on a rotatable drum assembly 201 and part of a knife positioning apparatus 200 according to an embodiment of the present invention. Each knife 203 would normally be part of a knife module 202 located on a rotatable drum, and the knife module 202 would further comprise a positioning device as shown in Figures 3 and 4. In Figure 5, only the knives 203 of the knife modules 202 are shown while all other parts of the rotatable drum assembly 201 have been omitted for clarity.

[0045] The knife positioning apparatus 200 comprises a position sensor 220 that comprises a laser beam 222. The position sensor 220 further comprises an emitter 224 and a receiver 226 arranged so that the laser beam 222 is parallel to the axis of rotation X of the drum and coincident with the desired positions of the cutting edges relative to the circumference of the drum.

[0046] It is envisaged that following replacement of some or all of the cutting edges on a rotatable drum assembly, the drum will be slowly rotated so that the protrusion of each cutting edge can be sensed by the (laser) position sensor 220. A rotary position encoder (not shown) coupled to the drum identifies which knife 203 is in the vicinity of the laser beam 222. The stepper motor 208 corresponding to the sensed knife module 202 is then actuated until the knife cutting edge 203 is sensed by the laser beam 222 being broken. When each knife cutting edge 203 of each knife module 202 has been positioned correctly according to the laser sensor 220, sharpening of the knives 203 with the grinding wheel 106 is allowed to take place and the cutting operation of the cutting machine 100 is resumed. The laser sensing and

initial positioning of the knives takes place with the drum rotating at low speeds, typically less than 50 rpm.

[0047] Referring to Figure 7 of the drawings, there is shown part of a rotatable drum assembly 301 comprising part of a rotatable drum 302 with an axis of rotation X and a WiFi control system. The remainder of the rotatable drum 301 including the knife modules has been omitted for clarity. The WiFi control system comprises an antenna 328 mounted on the axis of rotation X of the drum 302 and an internal transceiver 330 mounted on the drum 302 arranged to communication with each individually actuated positioning device on each knife module respectively. A static WiFi transmitter (not shown) arranged to communicate with the position sensor and a machine control system (not shown) arranged to communicate with the positioning device, position sensor and rotatable drum are located externally to the rotatable drum 302. All communication signals are transmitted by means of WiFi.

[0048] In use, after replacing one or more of the knives 103, the rotatable drum of the rotatable drum assembly will be slowly rotated such that a knife cutting edge 205 is arranged to be sensed by the position sensor. The positioning device 206 corresponding to the knife module of said knife 103 will advance the knife 103 until the cutting edge is in the optimum position i.e. when the laser beam is broken.

[0049] Required position data is transmitted from the internal drum WiFi transceiver 330 to the positioning devices 206. Said position data includes the actual position of the cutting edge 103 corresponding to each position device respectively as determined by the position sensor 216 (i.e. if the laser has been broken or not). The positioning device 206 corresponding to the knife cutting edge in question responds to the position data to continue or to stop the advancement of said knife 103 as required. Status, fault or alarm information from each positioning device may be transmitted by the WiFi from the drum to the external processor. Electrical power for the stepper motors, processors and WIFI is carried into the drum by means of slip-rings and brushes

[0050] Although the preferred embodiments of the present invention relate to a knife positioning apparatus and a method of positioning the cutting edge of a knife module on the rotatable drum assembly of a tobacco cutting machine, it will be appreciated that the invention may be used to position the cutting edges of knives on a cutting machine used for processing any other material in any other industry.

[0051] It will be appreciated that any type of position sensor may be used.

[0052] The position sensor may communicate directly with the positioning device or there may be an intermediate communication step, for example, via a processor. The amount that the knife edges are moved may be determined by the position sensor which communicates to the positioning device or may be determined by the processor or by the positioning device itself in response to the position communication received from the position sensor or processor.

[0053] Although in the described embodiments the optimum orientation and position of the cutting edges is parallel to the axis of rotation of the drum, it is envisaged that in alternative embodiments, it may be desired to maintain the position of the knives at an alternative orientation i.e. angled relative to the axis of rotation.

[0054] Although the knife positioning apparatus has been described preferably for use after the replacement of one or more knives on a rotatable drum assembly with the drum rotating at relatively low speeds, it is envisaged that the knife positioning apparatus of the present invention may also operate while the cutting machine is in operation. This facilitates moving knives outwardly from the rotatable drum while it is in operation either continuously or at frequent intervals to compensate for the abrasion of the grinding wheel and to maintain the correct geometrical relationship between the edges of the knives and the extruded material being cut. This requires minimal input from a user and provides a quality standard of cut material.

[0055] In other mechanisms the intermittent advancement of knives results in momentary overheating of the cutting edge when it contacts the grindstone, which softens the cutting edge and reduces its sharpness. Continuous knife advancement minimises the heat generated by the grinding process, thus ensuring that the metallurgical characteristics of the knife are maintained.

Claims

1. A knife positioning apparatus arranged in a rotatable drum assembly comprising a substantially cylindrical drum with an axis of rotation;
   the knife positioning apparatus comprising one or more knife modules each comprising a positioning device and a knife with a cutting edge;
   wherein the positioning device is arranged to move said cutting edge in a direction substantially perpendicular to the axis of rotation of the drum;
   the knife positioning apparatus further comprising a position sensor arranged to sense the position of the cutting edge of an individual knife module and communicate said position to the positioning device.

2. A knife positioning apparatus according to claim 1, wherein the position sensor is arranged to provide a laser beam orientated substantially parallel to the axis of rotation of the drum, wherein the position sensor is further arranged to communicate the intersection of a knife cutting edge with said laser beam to the positioning device.

3. A knife positioning apparatus according to any preceding claim, wherein the position sensor communicates with the positioning device via wireless com-

munication.

4. A knife positioning apparatus according to any preceding claim, wherein the positioning device of each knife module comprises a stepper motor.

5. A knife positioning apparatus according to any preceding claim, wherein the positioning device of each knife module comprises a servomotor.

6. A knife positioning apparatus according to claim 4, the positioning device further comprising a feed bar and a bell crank, wherein the feed bar and bell crank are arranged to translate a rotational movement of the stepper motor to a lateral movement of a knife cutting edge such that the cutting edge is moved in a direction substantially perpendicular to the axis of rotation of the drum.

7. A knife positioning apparatus according to any preceding claim, wherein the knife cutting edges of the one or more knife modules are orientated substantially tangentially to a circumference of the rotatable drum.

8. A knife positioning apparatus according to any preceding claim, wherein the positioning device of each knife module is actuated independently from an adjacent knife module, wherein the direction of movement of each knife cutting edge is in a direction substantially away from the axis of rotation of the drum.

9. A knife positioning apparatus according to any preceding claim, wherein the positioning device of the one or more knife modules are actuated simultaneously, and wherein the direction of movement of each cutting edge is in a direction substantially towards the axis of rotation of the drum.

10. A knife positioning apparatus according to any preceding claim, wherein the rotatable drum assembly further comprises a motor and a position encoder, the position encoder being arranged to sense the angular position of the drum and a knife module and wherein the position encoder is arranged to communicate with the positioning device of said knife module.

11. A knife positioning apparatus according to claim 10, wherein the position encoder, position sensor and the positioning device communicate with each other via wireless communication.

12. A knife positioning apparatus according to any preceding claim, wherein the apparatus comprises a control system arranged to receive and emit control signals to the positioning device, position sensor and position encoder.

13. A knife positioning apparatus according to any preceding claim arranged in a tobacco cutting machine.

14. A method of positioning the cutting edge of a knife module in a rotatable drum assembly, the method comprising:

providing a rotatable drum with an axis of rotation, the rotatable drum comprising a knife module, wherein the knife module comprises a positioning device and a knife with a cutting edge;
providing a position sensor remote from the knife cutting edge,
wherein the position sensor is arranged to sense the position of said cutting edge;
actuating the positioning device such that the knife cutting edge is moved laterally in a direction substantially perpendicular to the axis of rotation of the drum;
sensing the position of the knife cutting edge with the position sensor;
communicating the position of the knife cutting edge to the positioning device to position the knife cutting edge of said knife module at a predetermined position.

15. A method according to claim 14 performed with a knife positioning apparatus claimed in any of claims 1-13.

16. A method according to claim 14, wherein the position sensor is arranged to provide a laser beam orientated substantially parallel to the axis of rotation of the drum and is arranged such that when the knife cutting edge of a knife module intersects said laser beam, the position sensor communicates with the positioning device of said knife module to stop further movement of the knife cutting edge.

17. A method according to any of claims 14-16, the rotatable drum comprising one or more knife modules each comprising a positioning device and a knife with a cutting edge, wherein the actuating step is performed after replacing of some or all of the knives by an operator.

18. A method according to any of claims 13-17, the rotatable drum comprising one or more knife modules each comprising a positioning device and a knife with a cutting edge, wherein the rotatable drum is arranged to rotate to bring a knife module into the vicinity of the position sensor such that the steps of actuating, sensing and communicating are performed to position the cutting edge of said knife module.

19. A method according to any of claims 13-18 the rotatable drum comprising one or more knife modules

each comprising a positioning device and a knife with a cutting edge, wherein the rotatable drum further comprises a position encoder arranged to sense the angular position of the drum and thus identify which knife module is in the vicinity of the position sensor and wherein the steps of actuating, sensing and communicating are performed to position the cutting edge of said knife module.

20. A method according to any of claims 13-19, wherein the apparatus further comprises a control system arranged to receive and emit control signals from and to one or more of the positioning device, position sensor and position encoder.

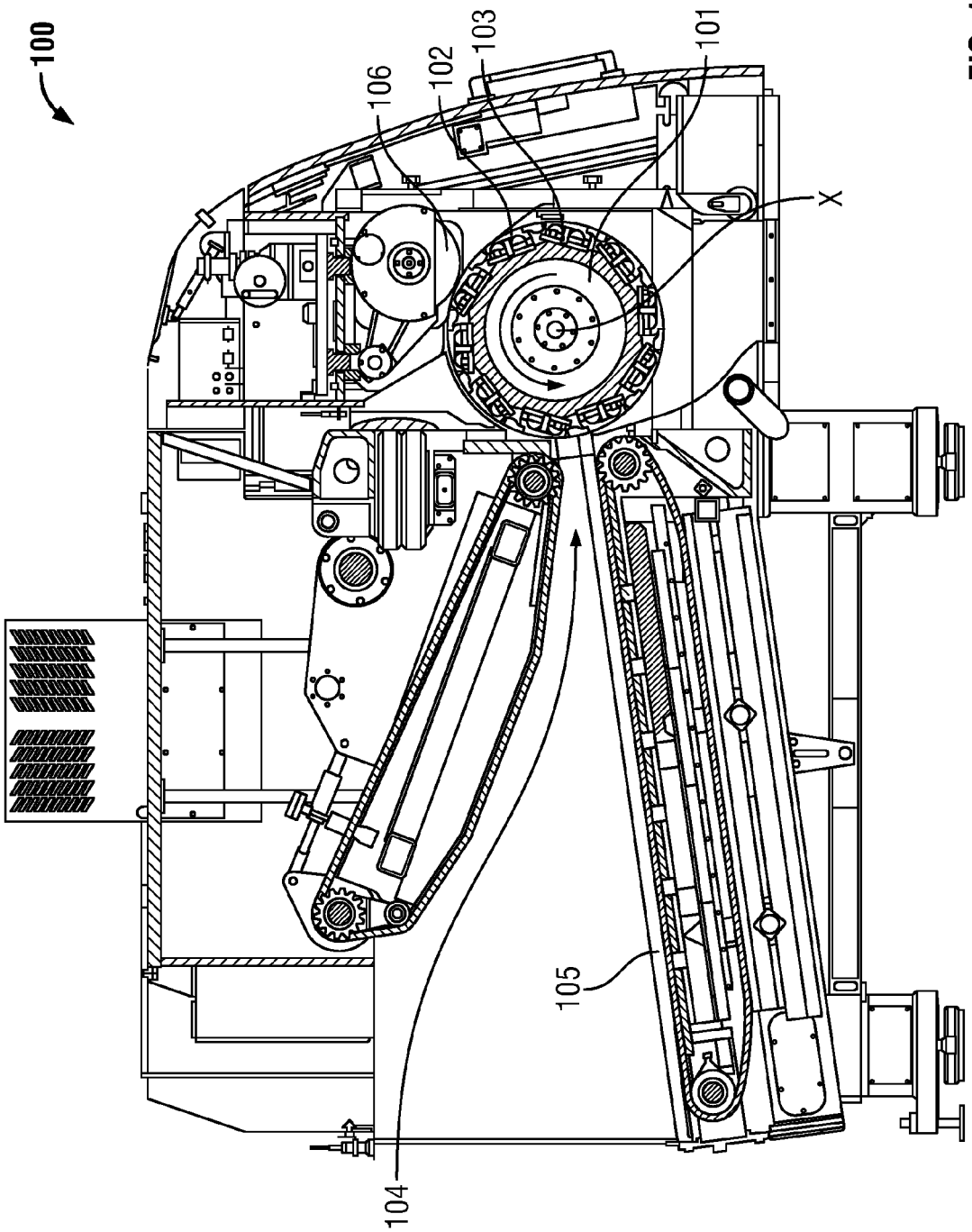

FIG. 1
(PRIOR ART)

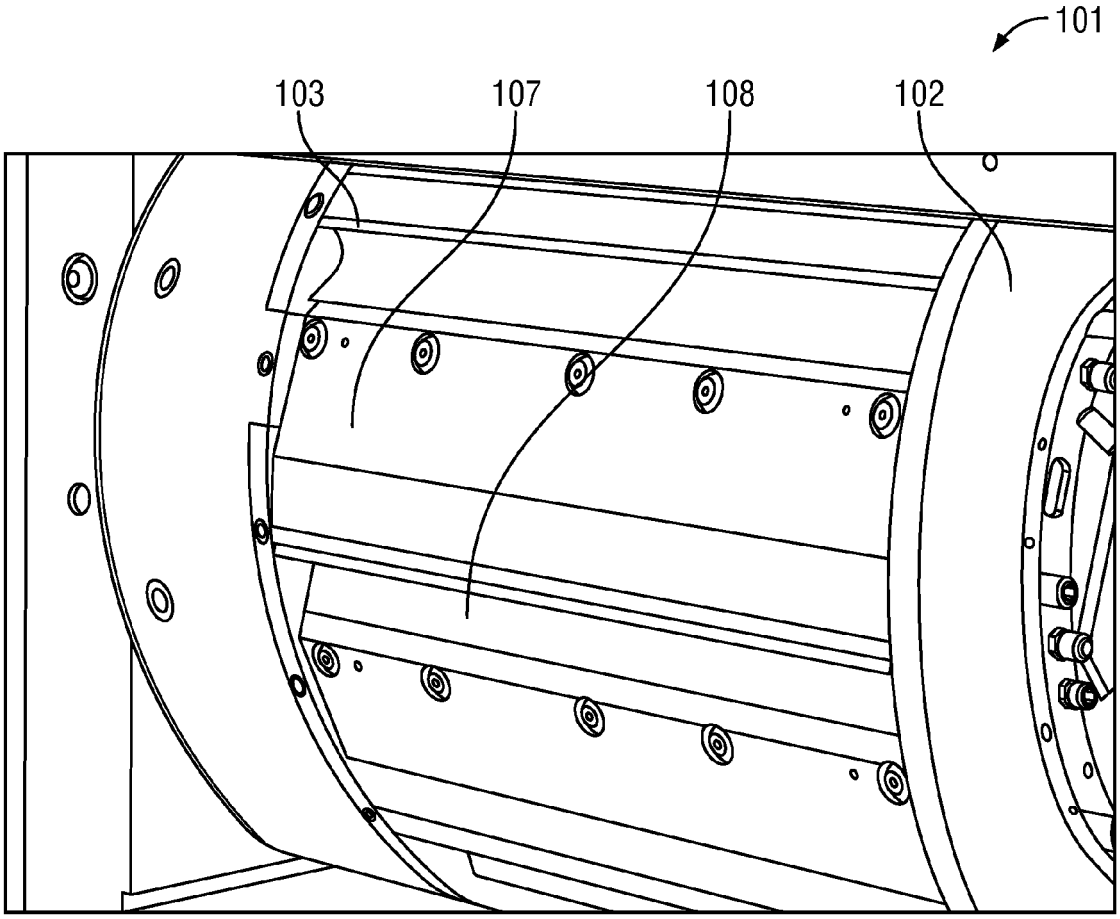

FIG. 2
(PRIOR ART)

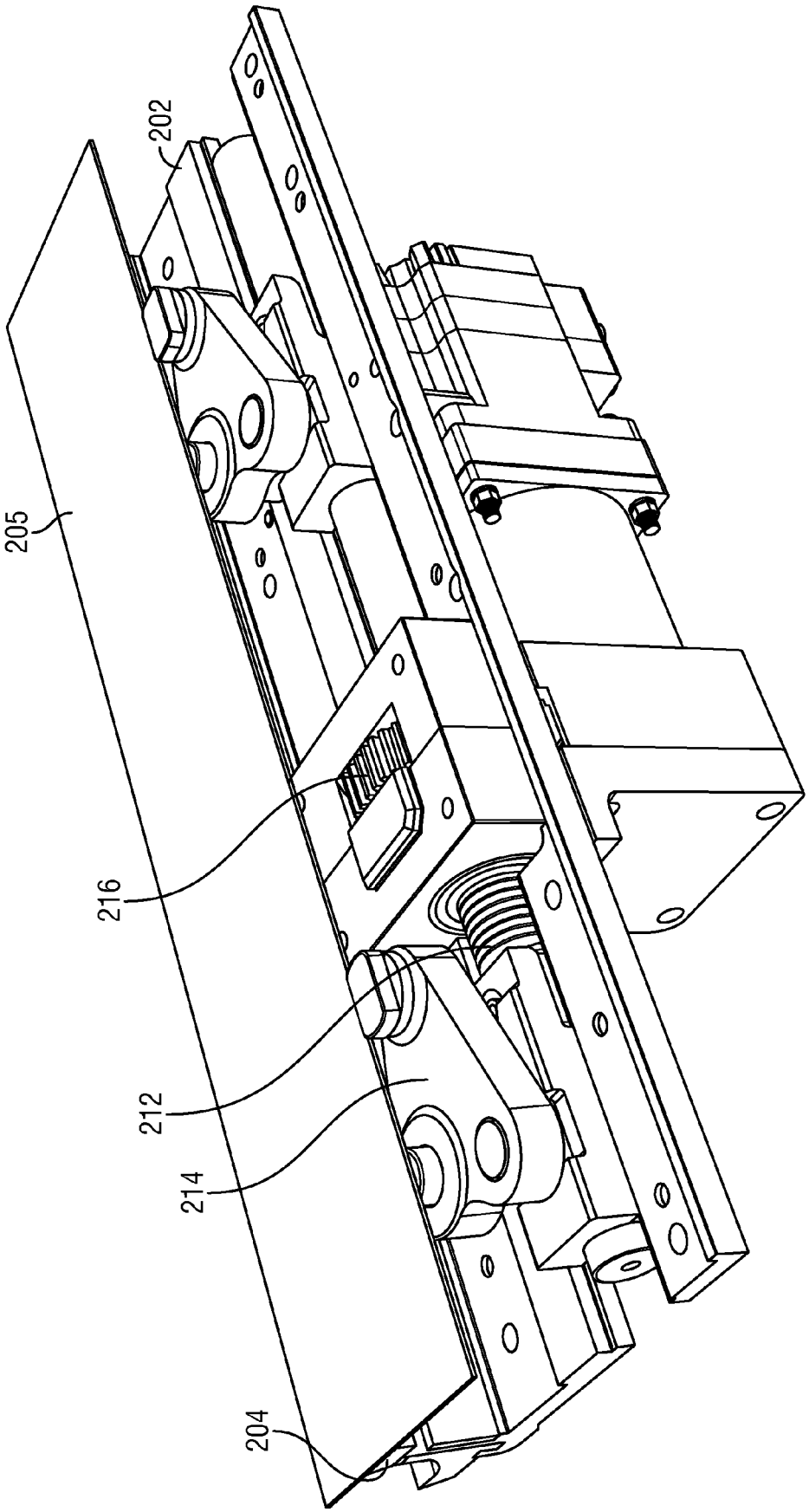

FIG. 3

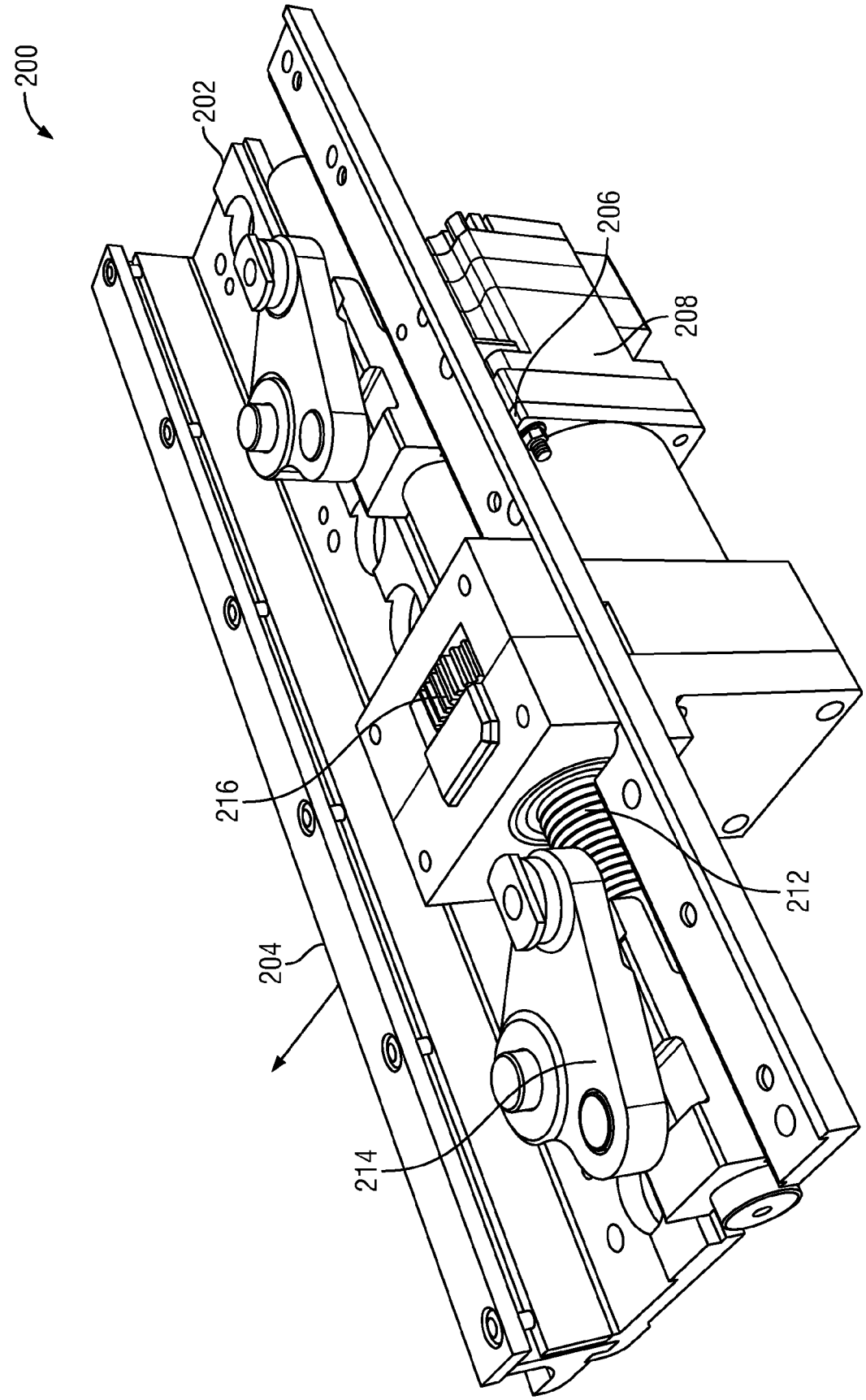

FIG. 4

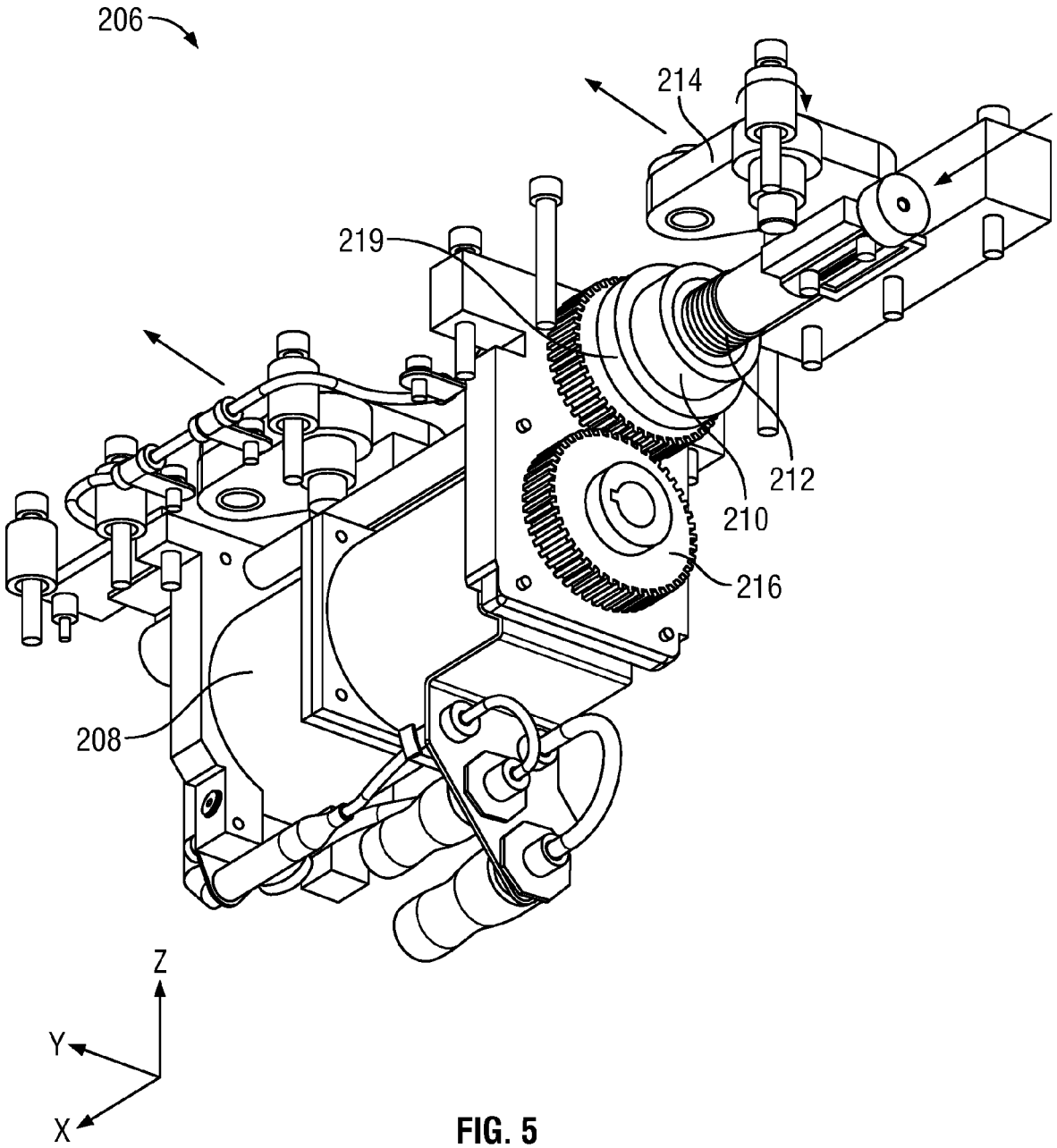

FIG. 5

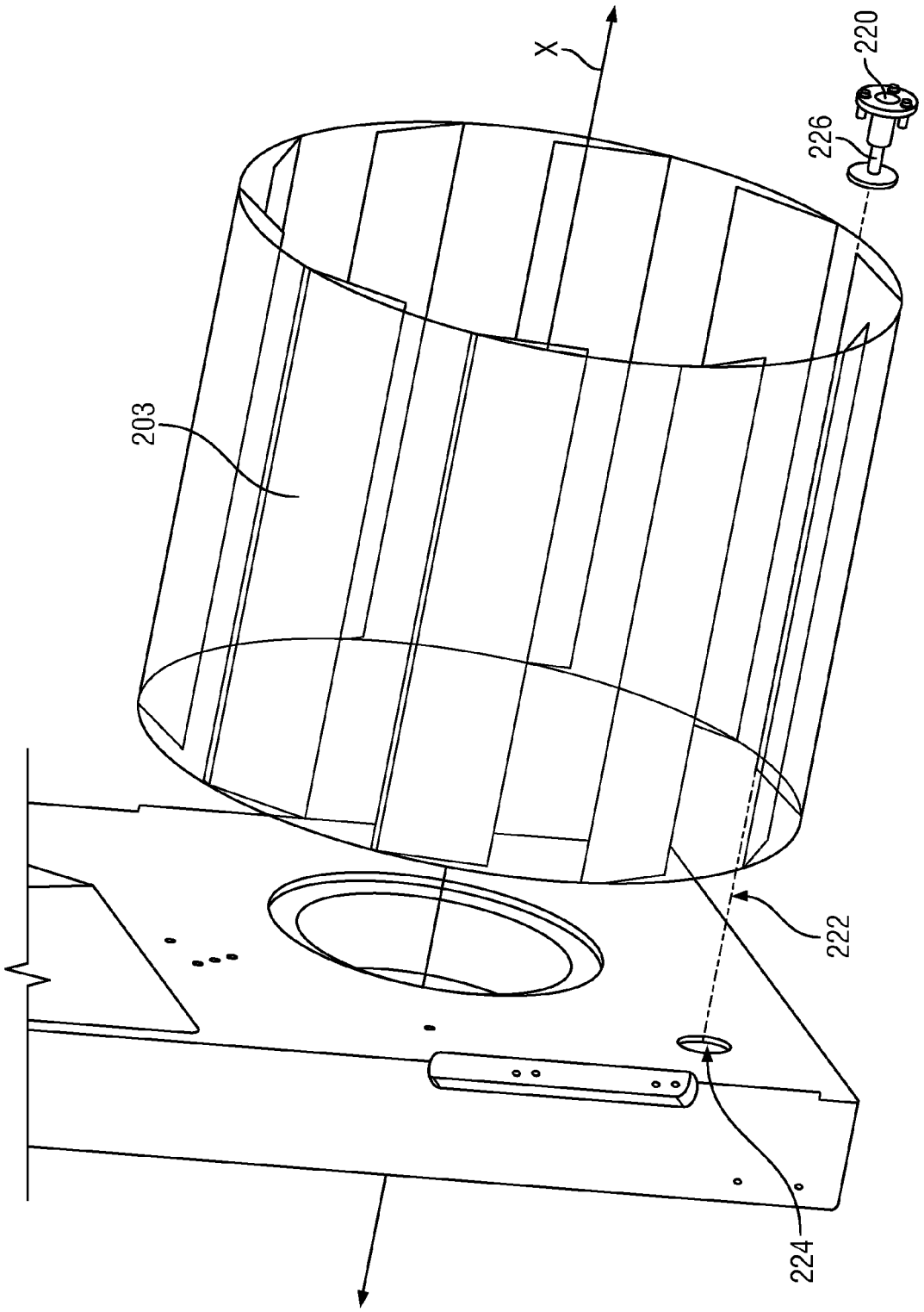

FIG. 6

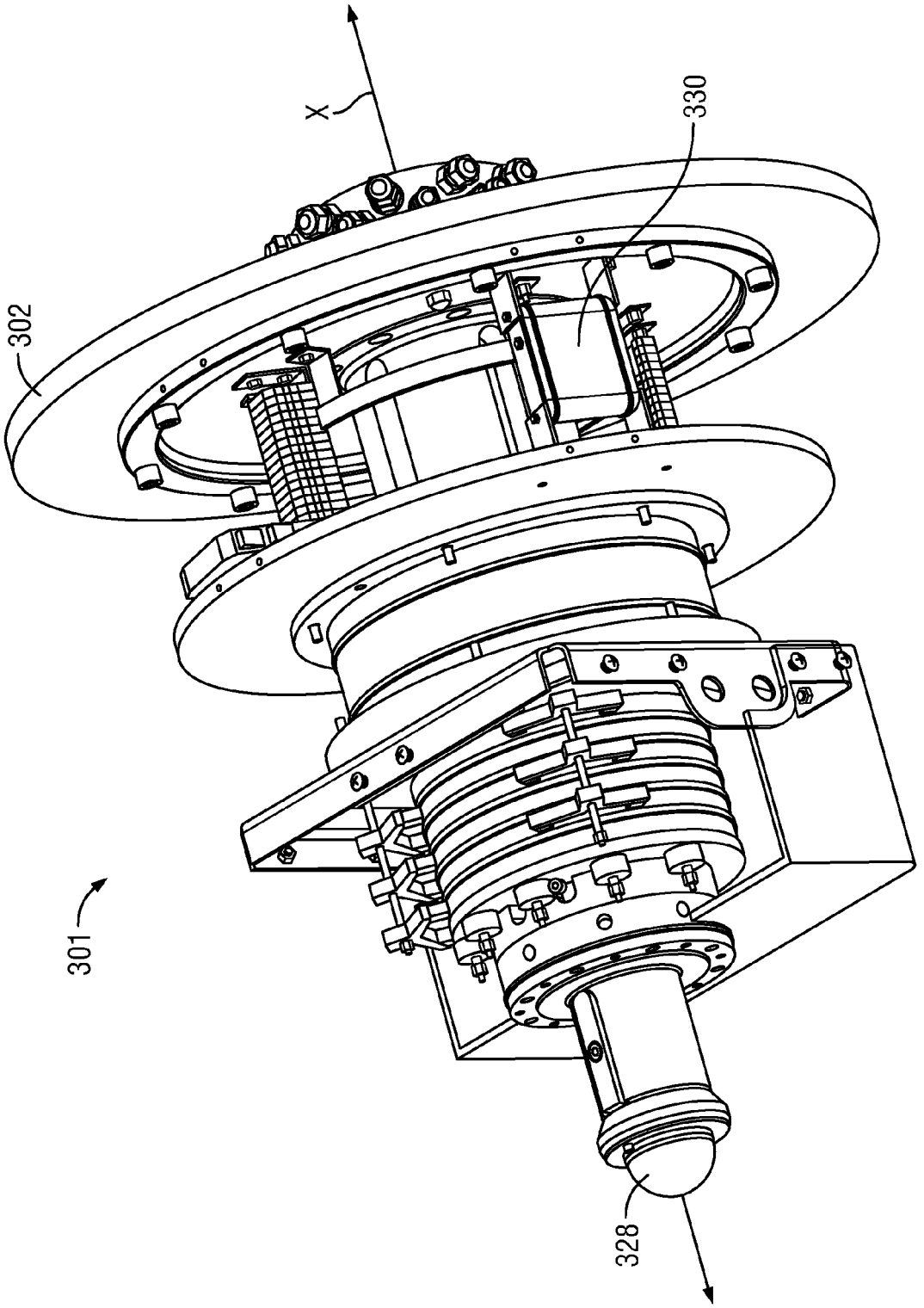

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 15 17 4766

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 481 303 A1 (HAUNI MASCHINENBAU AG [DE]) 1 August 2012 (2012-08-01)	1-4, 8-12, 14-20	INV. A24B7/12 B26D1/36
Y	* figures * * paragraph [0018] - paragraph [0023] * * paragraph [0025] * * paragraph [0027] * * paragraph [0029] - paragraph [0030] * * claims 1-5, 8, 11-12 *	5-7,13	B26D5/00 B26D7/12 B26D7/26
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A24B
B26D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 October 2015	Engel, Katrin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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D : document cited in the application
L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

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

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