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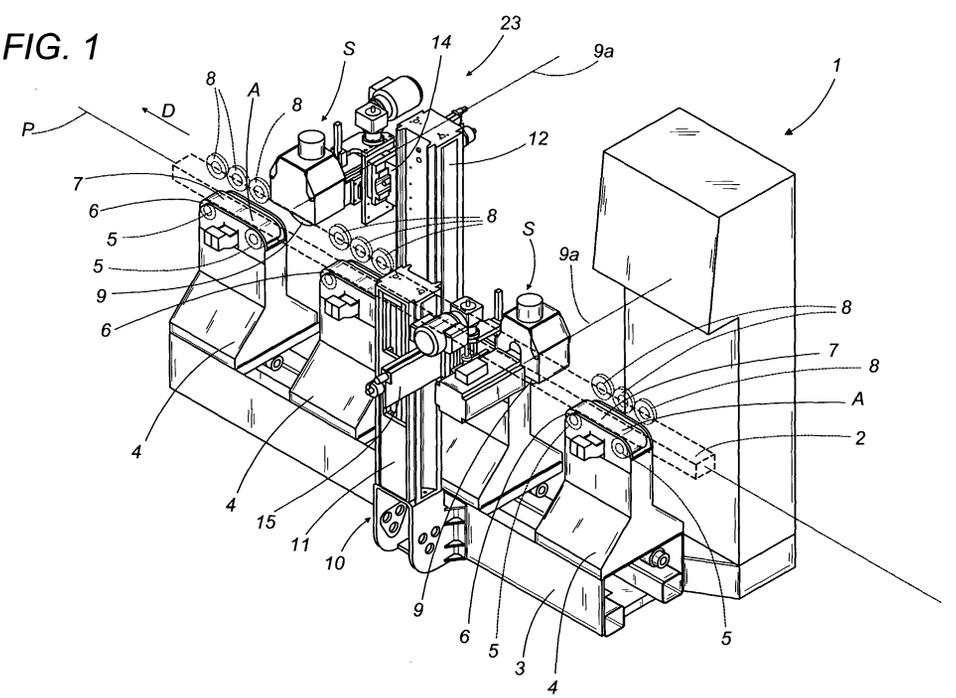
(54) A sanding machine

(57) In a sanding machine (1) comprising at least one work table (A) to support workpieces (2) of unworked material to be sanded in a defined sanding direction (D), at least one sanding wheel (9) positioned over and facing the work table (A) and having an axis of rotation (9a) that is transversal to the sanding direction (D), a conveying unit (5, 6, 8) to transmit to the sanding wheel (9) and to the workpieces (2) a relative movement in the sanding direction (D), and a motor (18) for driving the sanding wheel (9) in such a way that it rotates about its axis (9a), the sanding disk (9) can also move in a direction transversal to the sanding direction (D) and to its axis of rotation (9a), there being a second motor (22) controlled by a central processing and control unit (24) and designed to vary the distance between the axis of rotation (9a) of the sanding wheel (9) and the work table (A) according to a control signal correlated to sanding wheel (9) wear.

FIG. 1



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Description

[0001] The present invention relates to a sanding machine. The invention relates in particular to a sanding machine for long, straight workpieces made of wood, to which the present description refers but without restricting the scope of the inventive concept.

[0002] In sanding machines of known type, the workpieces are usually supported by a horizontal work table and sanded in the direction coinciding with the direction in which they mainly extend.

[0003] Normally, the workpieces are moved forward along the work table in the sanding direction by a conveyor equipped with a plurality of power-driven rollers and a plurality of idle conveyor rollers positioned one after the other along the workpiece sanding feed path. The feed path extends in the sanding direction through one or more fixed sanding stations each of which is equipped with a sanding wheel.

[0004] Each sanding wheel is positioned over and faces the work table and is power driven in such a way as to rotate about its central axis which is parallel to the work table and transversal to the sanding feed path. Also, each sanding wheel can usually be manually adjusted in height by the operator.

[0005] To compensate for sanding wheel wear in such a way as to keep contact pressure between the wheel and the workpieces at the required level, the operator must periodically adjust the sanding wheel by lowering it towards the work table. The frequency of these adjustments depends on the sanding wheel's rate of wear. This in turn depends on several factors, namely, the type of abrasive material of which the wheel is made, the type of wood to be sanded, the speed at which the workpieces are fed along the sanding feed path, and the quantity of workpieces processed by the wheel, expressed in metres in the sanding direction. The frequency of the adjustment operations is normally set out in a schedule defined empirically on the basis of previous work carried out under the same conditions.

[0006] The present invention has for an object to provide a sanding machine in which the above mentioned manual adjustment operations are greatly reduced or eliminated.

[0007] Accordingly, the present invention provides a sanding machine comprising: at least one work table to support unworked components to be sanded in a defined sanding direction; at least one sanding wheel positioned over and facing the work table and having an axis of rotation that is transversal to the sanding direction; conveying means for transmitting to the sanding wheel and to the unworked components a relative movement in the sanding direction; a first motor for driving the sanding wheel so that it rotates about its axis; movable means for supporting the sanding wheel and adjustment means connected to said movable support means and designed to vary the distance between the axis of rotation of the sanding wheel and the work table; the machine being characterised in that the adjustment means comprise a second motor connected to the movable support means to vary the distance between the axis of rotation of the sanding wheel and the work table, means for measuring at least one physical quantity correlated to sanding wheel wear, and processing and control means for controlling the second motor; the processing and control means being connected to the measuring means and to the second motor and being programmed to control the second motor according to the measured value of the physical quantity.

[0008] The invention will now be described with reference to the accompanying drawings which illustrate a preferred embodiment of it and in which:

- Figure 1 is a perspective view, with some parts cut away for clarity, of an embodiment of the sanding machine according to the present invention;
- Figure 2 is an enlarged perspective view, with some parts cut away for clarity, of a detail from Figure 1;
- Figure 3 is block diagram representing the sanding machine of Figure 1.

[0009] With reference to Figure 1, the numeral 1 denotes in its entirety a sanding machine for sanding long straight workpieces 2 of unworked wood.

[0010] The machine 1 comprises a base 3 supporting a plurality of identical uprights 4 positioned in line along a horizontal sanding direction D.

[0011] Each upright 4 mounts two power-driven conveyor rollers 5 whose axes are horizontal and at right angles to the direction D. Looped around each pair of rollers 5 there is an endless conveyor belt 6 whose upper branch 7 forms a portion of a horizontal work table A for supporting the workpieces 2.

[0012] Above each branch 7, at a height that is adjustable in such a way as to be substantially the same as the height of the workpieces 2 to be sanded, there are three idle rollers 8, positioned in line, with horizontal axes at right angles to the direction D. Beside each branch 7, between the branch 7 and the rollers 8, and on opposite sides of the branch 7 itself, there are further idle rollers (not illustrated) with vertical axes, which, together with the rollers 8 and the branch 7, form a conveying guide channel whose size, measured parallel to the work table A and at right angles to the direction D, is adjustable in such a way as to be substantially the same as the width of the workpieces 2.

[0013] Each conveying guide channel forms a section of a sanding feed path P extending on the work table A and in the direction D. Between one channel and the next, in the direction D, the branches 7 are connected by a plate (not illustrated) forming a portion of the work table A and a portion of the feed path P.

[0014] The workpieces 2 extend mainly in length in the sanding direction D and, during machine operation, are conveyed lengthways in the direction D and along the feed path P through a plurality of fixed sanding sta-

tions S (only two of these stations being shown in Figure 1), each of which is equipped with a sanding wheel 9.

[0015] The sanding wheels 9 are positioned above and face the work table A and are supported in pairs by the base 3, with their central axes of rotation 9a parallel to the work table A and transversal to the direction D. In particular, each pair of sanding wheels 9 is supported by the base 3 by means of a respective connecting unit 10.

[0016] Each connecting unit 10 comprises a column 11, fixed to the base 3, and a column 12, slidably fitted to the column 11 in such a way as to slide vertically relative to the latter. The sliding of the columns 11 and 12 and their relative position are controlled by a device (not illustrated) that drives the column 12.

[0017] Two opposite walls 13 of the column 12, located upstream and downstream in the direction D, have slidably mounted on them in dovetail guides corresponding slide mounting blocks 14, each of which is independently driven and runs in a vertical direction on the respective column wall 13.

[0018] Each block 14 is slidably fitted in a dovetail guide to a power-driven slide 15 which runs along the block 14 itself in a horizontal direction transversal to the direction D.

[0019] As shown in more detail in Figure 2, each slide 15 has fitted to it a flat, vertical plate 16 positioned on the side of the slide 15 opposite the block 14.

[0020] The plate 16 in turn mounts slidably in a vertical direction a mobile block 17 that mounts a sanding wheel 9 and a first motor 18 designed to rotate the sanding wheel 9 on its axis 9a.

[0021] The plate 16 also rigidly mounts a flat horizontal appendage 19 projecting at right angles from the top edge of the plate 16, on the side opposite the slide 15, is connected slidably in a vertical direction to a bracket 20 that is integral with the block 17, and is fitted with a spacing flange 21 that mounts a second motor 22 connected to the block 17 and designed to drive the latter along the plate 16 itself.

[0022] As shown in Figure 3, the motors 18 and 22 form part of an adjustment unit 23 designed to drive the blocks 17 vertically independently of each other so as to vary, for each individual sanding wheel 9, the distance between the wheel axis 9a and the work table A.

[0023] The adjustment unit 23 further comprises a central processing and control unit 24 connected to the motors 18 and 22 through respective inverters 25 and 26 also forming part of the adjustment unit 23. The control unit 14 and the inverters 25 and 26 are serially connected.

[0024] In another embodiment which is not illustrated, the control unit 24 is serially connected to another inverter for electronically controlling the speed of the rollers 5 and, hence, of machine 1 production.

[0025] The control unit 24 is designed to drive the motors 22 independently according to a defined program and according to the value of at least one physical quantity correlated to the wear of the respective sanding wheels 9. In other terms, during sanding work and for each sanding wheel 9, the control unit 24 receives from the respective inverter 25, a feedback control signal constituted by the drive torque generated by the corresponding motor 18.

[0026] The control unit 24 is also connected to an interface 27 of the adjustment unit 23, through which the operator can follow and/or modify the production control process.

[0027] At start of work, the operator performs a setting procedure on the adjustment unit 23 using the interface 27.

[0028] The setting procedure must be performed separately for each individual sanding wheel 9 and the description that follows refers to only one of the sanding wheels 9.

[0029] In particular, the operator sets the speed of rotation of the sanding wheel 9 and measures the value of the drive torque generated by the motor 18 on no load, that is to say, when there are no workpieces 2 in the machine. The no-load drive torque value is used as the value to which the actual drive torque values are referred in percentage terms during sanding operations.

[0030] The operator then sets the required value of drive torque under load which the motor 18 should generate during sanding work. This value is proportional to a desired reference value for the pressure that the sanding wheel 9 must exert on the workpieces 2, and is closely connected to the distance between the sanding wheel axis 9a and the work table A. Indeed, the drive torque under load is equal in absolute terms to the resistant torque applied to the motor 18 by the frictional force generated by the contact between the sanding wheel 9 and the workpieces 2, this frictional force being dependent on the pressure of the sanding wheel 9 on the workpieces 2. In other terms, increasing the distance between the axis 9a of the sanding wheel 9 and the work table A decreases the drive torque generated by the motor 18 under load and the pressure of contact between the sanding wheel 9 and the workpieces 2. Vice versa, reducing the distance between the axis 9a of the sanding wheel 9 and the work table A increases the drive torque generated by the motor 18 under load and the pressure of contact between the sanding wheel 9 and the workpieces 2.

[0031] Setting the reference value of drive and resistant torque under load, and therefore, of the contact pressure between the sanding wheel 9 and the workpieces 2, is performed by placing a workpiece 2 under the sanding wheel 9 and, without moving the workpiece 2, lowering the sanding wheel onto it using the motor 22 until the required reference value is reached.

[0032] The operator may also program the control unit 24 by setting, for each sanding wheel 9, a threshold proportional to the quantity of workpieces that can be sanded by the sanding wheel 9 to reach a maximum acceptable degree of wear.

[0033] This threshold is equal to the amount of work that can be done on the workpieces 2, expressed as a number of metres measured in the direction D, that can be sanded by the sanding wheel 9 before the latter has to be moved down closer to the work table A by a defined quantity. The quantity by which it is lowered can also be preset by the operator when programming the control unit 24.

[0034] During sanding operations, the workpieces are fed through the sanding stations S one after the other along the feed path P.

[0035] Using the interface 27, the operator can choose from three different operating modes.

[0036] In a first operating mode, the instantaneous torque value of each single sanding wheel 9 is measured under load, and each single value measured is compared to the corresponding preset reference value.

[0037] The control unit 24 then uses feedback control independent of the motors 22 to adjust the values of pressure and torque applied to the workpieces 2 by each sanding wheel 9 during sanding operations so as to keep these values in line with the preset reference values. In other terms, the control unit 24 drives each motor 22 until the pressure of reciprocal contact between the corresponding sanding wheel 9 and the workpieces 2 is equal to the preset pressure reference value.

[0038] This operating mode permits extremely accurate control of sanding wheel 9 wear because the system can measure differences in the drive torque as low as 0.1% of the torque itself.

[0039] Moreover, in this operating mode, compensating the above mentioned values does not necessarily mean moving the sanding wheels 9 closer to the workpieces 2 but may also mean moving them away. This may be the case if one of the workpieces 2 is higher than the one before it or if the sanding wheels 9 have been moved too close to the work table A during the previous adjustment.

[0040] In a second, simplified operating mode, the control unit 24 does not check the actual drive torque using the feedback signals from the motors but keeps track of the total length in metres of the workpieces 2 sanded and compares this length with the threshold entered by the operator. When the threshold is reached, the control unit 24 activates the motor 22 to lower the sanding wheels 9 by the preset quantity entered by the operator.

[0041] This compensating mode is stepped, unlike the first, which is continuous. It takes into account not the actual wear of each single sanding wheel 9 measured continuously, but the estimated wear of the sanding wheels 9 in relation to the total length of the workpieces 2 on which the wheels have worked.

[0042] Thus, the physical quantity correlated to sanding wheel 9 wear is not the drive torque generated by the motors 18 but a linear measure expressing the length of the workpieces 2 which the sanding wheels 9 have worked on.

[0043] In a third operating mode, which is a combination of the two described above, the basic compensation is still of the feedback type as in the first operating mode described above. However, when feedback control is not possible, stepped compensation, as in the second operating mode described above, is activated automatically. This is particularly useful, for example, for surface brushing and all processes where the wear on the sanding wheels 9 is minimal and the values of torque under load are very close to the no-load values of the torque.

[0044] The control unit 24 is also connected to a read and write memory unit 28 forming part of the adjustment unit 23 so that the set of sanding parameters used for each sanding wheel 9 and for each type of workpiece 2 and process can be stored in an archive.

[0045] This set of parameters, also known as «recipe», includes the values of sanding speed, no-load torque, actual torque under load and the type of compensation.

[0046] A recipe may be an existing collection of parameters that has already been saved and that can be downloaded to the control unit 24 or it may be a new collection of parameters created when the need arises and saved to the archive.

[0047] The possibility of using an existing archive is a considerable advantage in practical terms, especially when the first compensating mode is being used. Once the values of torque with and without load have been defined for a particular type of sanding wheel 9 working at a particular sanding speed, it is not necessary to set the torque values using the inverter 25 to capture the actual torque values each time. Instead, all that needs to be done is to call up existing parameters from the archive.

[0048] The invention described can be subject to modifications and variations without thereby departing from the scope of the inventive concept. Moreover, all the details of the invention may be substituted by technically equivalent elements.

Claims

1. A sanding machine comprising: at least one work table (A) to support unworked components (2) to be sanded in a defined sanding direction (D); at least one sanding wheel (9) positioned over and facing the work table (A) and having an axis of rotation (9a) that is transversal to the sanding direction (D) ; conveying means (5, 6, 8) for transmitting to the sanding wheel (9) and to the unworked components (2) a relative movement in the sanding direction (D); a first motor (18) for driving the sanding wheel (9) so that it rotates about its axis (9a); movable means (17) for supporting the sanding wheel (9) and adjustment means (23) connected to said movable support means (17) and designed to vary the distance between the axis of rotation (9a) of the sand-

ing wheel (9) and the work table (A); the machine (1) being **characterised in that** the adjustment means (23) comprise a second motor (22) connected to the movable support means (17) to vary the distance between the axis of rotation (9a) of the sanding wheel (9) and the work table (A), means (25) for measuring at least one physical quantity correlated to sanding wheel (9) wear, and processing and control means (24) for controlling the second motor (22) ; the processing and control means (24) being connected to the measuring means (25) and to the second motor (22) and being programmed to control the second motor (22) according to the measured value of the physical quantity.

2. The machine according to claim 1, **characterised in that** the processing and control means (24) are connected to the second motor (22) and drive the second motor (22) until the pressure of reciprocal contact between the corresponding sanding wheel (9) and the unworked components (2) is equal to a preset pressure reference value.

3. The machine according to claim 2, **characterised in that** the physical quantity measured is proportional or equal in absolute terms to the resistant torque applied to the motor (18) by the frictional force generated by the contact between the sanding wheel (9) and the unworked components (2).

4. The machine according to claim 3, **characterised in that** the physical quantity measured is the drive torque generated by the first motor (18) during sanding of the unworked components (2).

5. The machine according to any of the foregoing claims from 1 to 4, **characterised in that** the adjustment means (23) comprise a read and write memory unit (28) connected to the processing and control means (24) and designed to store a plurality of data sets; each data set comprising the measured values of the physical quantity.

6. The machine according to claim 1, **characterised in that** the processing and control means (24) are programmable so as to be able to preset a threshold proportional to the quantity of unworked components (2) that can be sanded before the sanding wheel (9) exceeds an acceptable degree of wear, and to drive the second motor (22) until the sanding wheel (9) reaches the preset threshold.

7. The machine according to any of the foregoing claims from 1 to 6, where the unworked components (2) are long, straight workpieces extending mainly in the sanding direction (D), **characterised in that** it comprises at least one fixed sanding station (S) at which the sanding wheel (9) is positioned; the conveying means (5, 6, 8) comprising at least one transporting element (6) for transmitting to the workpieces (2) a movement through the sanding station (S) in the sanding direction (D).

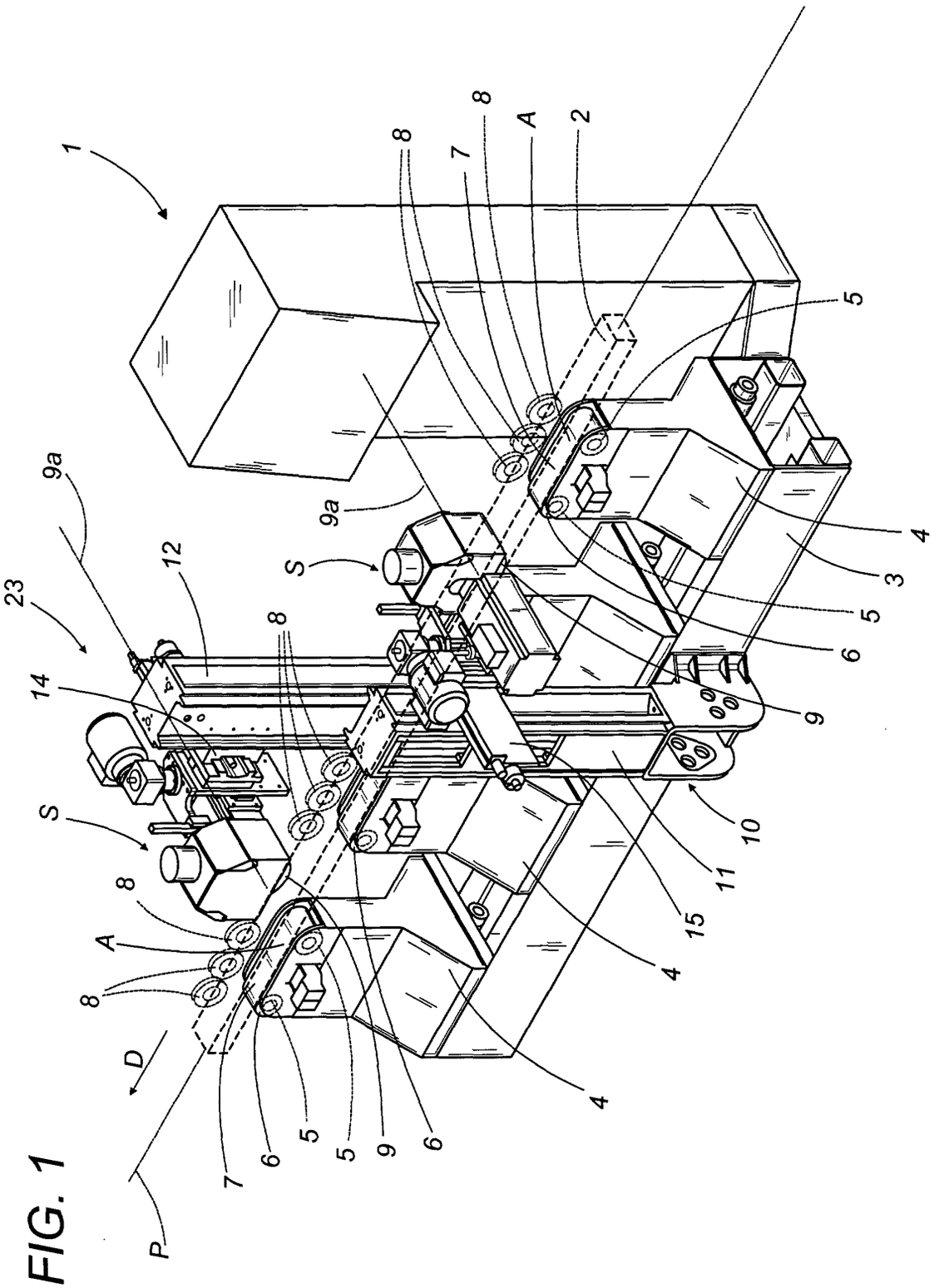

FIG. 1

FIG. 2

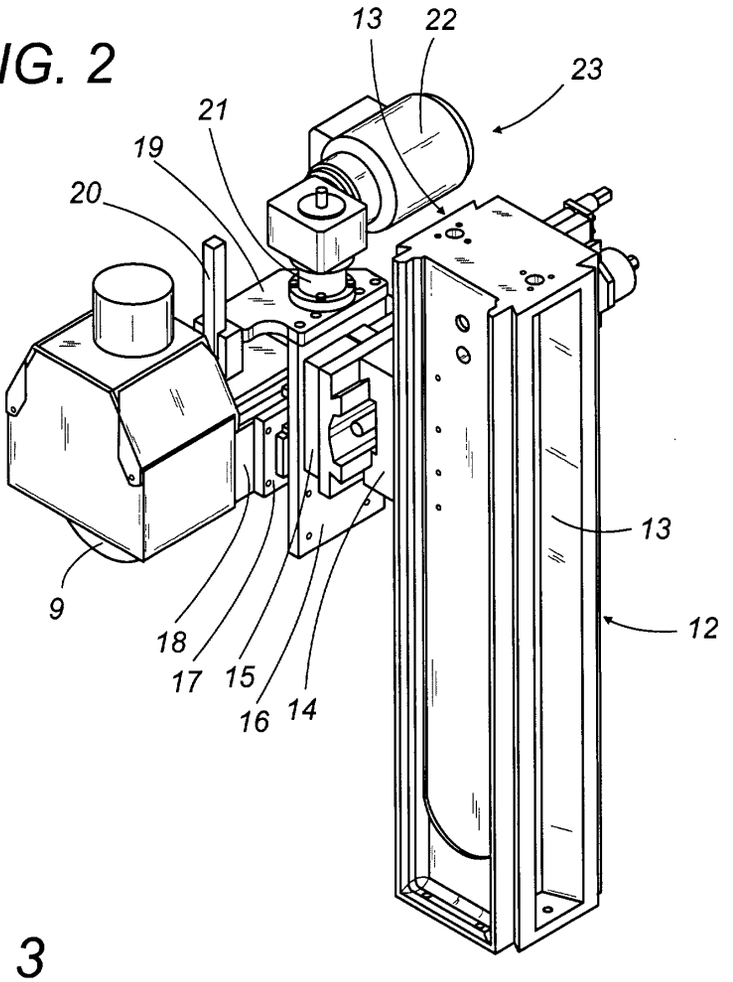

FIG. 3