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(54) Method for controlling the operating position of a grinding wheel used in a machine for machining edges of plates of glass, marble and similar stony materials, and machine for implementing said method

(57) In a machine for machining edges of plates made of glass, marble and similar stony materials, the edge of a plate is guided on a pre-established path line (DI) so as to be in contact with the machining surface (9A) of at least a grinding wheel (9, 9', 9"); in order to set and/or correct the operating position of the grinding wheel (9, 9', 9") depending on its wear and tear, said grinding wheel is first led in contact with a fixed reference (18) and then pushed away from the latter; said movement is interrupted when its extent corresponds to a reference value indicating that the grinding wheel (9, 9', 9") has reached a desired operating position with respect to the path line (DI).

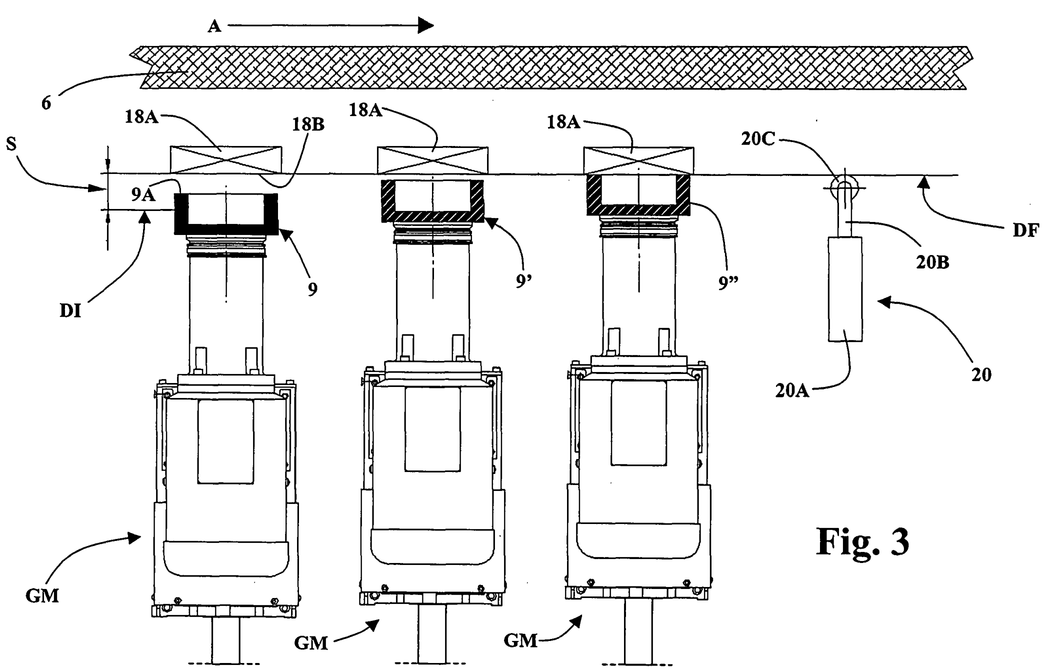


Fig. 3

EP 1 422 024 A1

Description

[0001] The present invention refers to a method for controlling the operating position of a grinding wheel used in a machine for machining edges of plates made of glass, marble and similar stony materials, and to a machine for implementing said method.

[0002] Bilateral grinding machines used for surface finishing of edges of a glass raw plate, previously cut by means of another device, comprise a grinding area defined between at least two rows of opposite diamond and polishing wheels, at least the first being designed to simultaneously remove material from those opposite edges of the plate; the various driving spindles of the wheels of each row are associated with respective shoulders of the machine, one being stationary and the other movable; the possibility to shift the movable shoulder with respect to the stationary one enables to use the machine for machining plates with different widths.

[0003] To machining purposes, the glass raw plate is guided in a first direction, so as to pass across the grinding machine in which material is removed from a first pair of opposite edges of the plate; in some cases said plate is then guided in a second direction, orthogonal to the first one, for machining its other two opposite edges in a following grinding machine, which is basically the same as the previous one.

[0004] Diamond wheels for removing material from the plate undergo wear and tear and, therefore, the mark left by the latter should be periodically checked; if necessary, after checking the marks, wheels should be repositioned depending on their wear degree.

[0005] In more traditional solutions, said grinding wheel checking and repositioning step is carried out manually, which results in a high waste of time and long manufacturing idle times.

[0006] Basically for the same reasons also the size of plates getting out of the grinding area of the machine should be periodically checked; in case the width of the plate getting out is larger than the one set for machining purposes, one or more wheels should be repositioned, in order to recover their wear degree; this is basically carried out by changing the position of the concerned grinding wheel or wheels, conveniently mounted onto respective slides. Also such kind of measure usually results in long manufacturing stops.

[0007] In more sophisticated solutions, the bilateral machine is equipped with a system for automatically detecting the wear degree of the diamond wheels and for repositioning the latter accordingly; to said purpose, the driving spindles of the wheels are provided with respective advancing means, so as to correct their position depending on the detected wear. A solution of this type is known for instance from EP-A-1 063 053, which describes a bilateral machine having a dimensional detection system for the plate getting out of the grinding area, designed to control the movement of the advancing means of the last wheel of each shoulder.

[0008] The solution also envisages means for measuring the energy absorbed by motors driving some of the grinding wheels provided for: when the energy absorbed by the motor of a wheel increases, the wheel immediately upstream from the one undergoing check is advanced by the corresponding advancing means towards the edge of the glass plate.

[0009] According to the aforesaid known system, the increase in the absorption of the motor of a grinding wheel is regarded as indicating that said wheel has more difficulty in removing material from the plate edge; said higher difficulty is due to the fact that the wheel immediately upstream from the one taken into consideration does not remove the correct amount of material because of its wear. Subsequently, the upstream wheel is advanced towards the plate edge.

[0010] The solution of the mentioned prior document is of "deductive" type and does not take into due consideration that the operating and dimensional properties of the grinding wheels to be used are not necessarily constant, i.e. the higher difficulty met by a wheel in removing material is not necessarily due to its wear. Moreover, the aforesaid known solution does not simplify the setting or change of the operating positions of the grinding wheels, which may be necessary for instance after replacing one of said wheels or because of machining changes in the grinding machine.

[0011] The main aim of the present invention is to carry out a new method enabling to control, set or change in a simple and accurate way the operating position of one or more grinding wheels, in order to obtain at the outlet of the grinding machine a plate whose size corresponds to the set size.

[0012] Another aim of the present invention is to carry out a new method, alternative to the "deductive" approach as in the prior art, for automatically correcting the grinding line, so as to compensate the wear of one or more wheels.

[0013] A further aim of the invention is to carry out a bilateral grinding machine implementing the aforesaid operating method.

[0014] In the light of achieving said aims, the object of the invention is a method for controlling an operating position of a grinding wheel used in a machine for machining edges of plates made of glass, marble and similar stony materials, having the features of the characterizing portion of claims 1. The aims of the invention are also achieved by means of a process for correcting the operating position of a grinding wheel depending on its wear and tear, in a machine for machining edges of plates made of glass, marble and similar stony materials having the characteristics of claim 11, and by means of a bilateral machine for machining edges of plates made of glass, marble and similar stony materials having the characteristics of claim 12.

[0015] The specific characteristics and advantages of the invention shall be evident from the following description made with reference to the accompanying drawings, provided as a mere non-limiting example, in which:

- Figure 1 is a schematic plan view of a machining line for the edges of plates made of glass, marble and similar stony materials comprising two bilateral grinding machines, each implementing the method according to the invention;
- Figure 2 is a partially sectioned schematic view of a grinding assembly which a grinding machine of Figure 1 is equipped with;
- Figure 3 is a first schematic plan view, partially sectioned, of a portion of a grinding machine of Figure 1, without a plate being machined;
- Figure 4 is a second schematic plan view, partially sectioned, of a portion of a grinding machine of Figure 1, with a plate being machined;
- Figure 5 is a partially sectioned schematic view of a grinding assembly which a grinding machine carried out according to a possible execution variant of the invention is equipped with;
- Figures 6 and 7 are views corresponding to those of Figures 3 and 4, in the case of a grinding machine according to the variant of Figure 5.

[0016] In Figure 1 number 1 globally refers to a line for machining the edges of glass plates, comprising two bilateral grinding machines, referred to with 2 and 3; between said machines 2 and 3 it is provided for a transfer apparatus or squaring device 4, which shall not be described because it is known per se, which is designed to lead the plates out of the machine 2 to the inlet of the machine 3. The machines 2 and 3 are similar to one another and, therefore, only the new elements of machine 2 shall be described and disclosed in further detail in the following.

[0017] The machine 2 comprises a supporting frame, with which a plate conveying system is associated; in the case shown by way of example, and as in the prior art, said advancing system comprises pairs of motorized belts 6, equipped with pressure elements or sliding blocks, which withdraw a plate being machined L and advance it in the direction indicated by arrows A. Still in accordance with the prior art the frame of the machine 2 comprises a movable shoulder 7 and a stationary shoulder 8. The stationary shoulder 8 is associated with

- a first series of grinding assemblies, referred to with GM, for removing surplus material from the edge of the plate L; each assembly GM comprises a spindle for driving a respective diamond wheel 9;
- a second series of grinding assemblies, referred to with GM1, for finishing the corners of the edges of the plate L; each assembly GM1 comprises a spindle for driving a respective diamond wheel 10;
- one or more polishing assemblies, referred to with GL, placed downstream from the series of grinding assemblies GM and GM1; each assembly GL comprises a spindle for driving a respective polishing wheel 11.

[0018] Similar grinding assemblies GM, GM1 and polishing assemblies GL are associated with the movable shoulder 7, in opposite position with respect to the corresponding assemblies of the stationary shoulder 8.

[0019] Still in accordance with the prior art, the movable shoulder 7 can be moved away or closer with respect to the stationary shoulder 8, with motorized means, depending on the width between the two opposite edges to be machined of the plates L. Assuming that the size of a raw plate getting into the machine 2 and the raw final size of the plate to be obtained at the outlet of said machine are known, the movable shoulder 7 is positioned with respect to the stationary shoulder 8 so that the total amount of glass to be removed (i.e. the difference between raw plate width and plate width to be obtained), which shall hereinafter be referred to as "machining allowance", is distributed on the two edges to be machined on a basically equal basis.

[0020] Note also that as a result of the aforesaid positioning of the movable shoulder 7 with respect to the stationary shoulder 8, the plate to be machined is guided to the inlet of the grinding area so that each of its raw edges follows an ideal straight line, parallel to the corresponding shoulder 7, 8, at a given distance from the latter; said inlet line shall be hereinafter referred to as "machine zero line". Also the modes and means for inserting the plates L on the machine zero line are known per se (see for instance components referred to with 20, 21 and 22 in EP-A-1 063 053) and shall therefore not be described here; in Figure 1 they are represented only schematically and referred to with D.

[0021] At least the assemblies GM having the diamond wheels 9 are mounted onto motorized slides, controlled by a control unit, schematically represented by block SC in Figure 1; the unit SC is equipped with a suitable programming and display device, referred to with DP.

[0022] Figure 2 schematically shows a section view, by way of example, of a grinding assembly GM, comprising a diamond wheel 9 whose driving motor is mounted onto a corresponding slide. In said figure, GF refers to a guide, integral with the movable shoulder 7, onto which a slide 11 supporting an electric motor 12 is mounted; the movement generated by the shaft 12A of the motor 12 is transferred through a gear transmission system, known per se and globally referred to with 13, to a spindle 14 supporting a respective diamond wheel 9. Number 15A refers to the shaft of a motor 15, which shaft is connected by means of a suitable clutch 15B to a threaded bar 16; on the latter a volute 17 can slide, which is mechanically connected to the slide 11; thus, by driving the shaft 15A, the slide 11 can slide on the guide GF in the direction indicated by arrow B, depending on the sense of rotation of the motor 15.

[0023] The controlled shift of the slide 11, in terms of space and speed, is managed by the control unit SC, which suitably controls the motor 15, beyond the motor 12, in per se known ways; to said purpose the assembly GM is equipped with means, not shown, for detecting the stroke end of the slide 11, for instance in form of cams and limit switches. Each assembly GM is further associated with respective means for detecting the position of the slide 11 with respect to the guide GF, schematically represented in Figure 1 by the block referred to with SP; the detection means SP can be of any known type, but in the course of the present description let us assume by way of example that they are common encoders.

[0024] The arrangement as shown in Figure 2 is the same also for the grinding assemblies GM associated with the stationary shoulder 8.

[0025] According to the invention, each shoulder 7, 8 is associated with striker or abutting means used for setting the operating position of the diamond wheels 9 and for correcting, if necessary, said position depending on the wear degree.

[0026] In the case shown by way of example, the upper portion of each shoulder 7, 8 is associated in a fixed way with a stiff vertical element, for instance made of iron rectified with a rust-proof treatment, referred to with 18 in Figures 1 and 2; the element 18, which is in such a position as not to interfere with the passage of the plates L, defines strike or abutment areas for respective wheels, as shall be evident below.

[0027] As can also be inferred from Figure 3, the element 18 is mounted so that respective areas or abutments, referred to with 18A, extend above the sliding plane of the plate L, and so that their face 18B towards a respective wheel 9, 9', 9" extends in a fixed position with respect to machine zero line, referred to in Figures 3 and 4 with DI; the horizontal distance between the face 19B and the machine zero line DI is a fixed parameter, stored in the control unit SC.

[0028] In accordance with a further feature of the invention, the unit SC is equipped with a program for controlling an initial preset function for grinding tools, i.e. grinding wheels 9, 9', 9".

[0029] The aforesaid preset program can be started by an operator by means of the device DP, for instance when a new grinding wheel 9, 9' or 9" has been mounted onto the machine 2. On the basis of said program the control unit SC controls the advance of the concerned slide 11, by means of the advancing system shown in Figure 2, towards the center of the grinding area, at a pre-established low speed; said advance goes on until the machining surface 9A of the grinding wheel 9, 9', 9" (Figures 2 and 3) gets in contact frontally with its respective abutment 18A, i.e. the surface 18B of the latter, the variation of the encoder dimension of the detection means SP thus ending its variation. The end of variation for the encoder dimension indicates that the front surface of the grinding wheel 9, 9', 9" has reached the surface 18B of the abutment 18A; the control unit SC then orders the motor 15 of the slide 11 to be turned off (which slide had however already stopped, thanks to the presence of the clutch 15B) and stores in real time the stop dimension, hereinafter referred to as "stop dimension"; the stop dimension of the assembly GM shall obviously still be stored in the control unit SC also after the machine 2 is turned off.

[0030] Now the slide is thus "reset" (i.e. in zero position) and, the distance between the surface 18B of the abutment 18A and machine zero line DI (which, as was said, corresponds to the edge of the raw plate) being known, the unit SC can lead the machining point of the grinding wheel 9, 9', 9" to a desired position with respect to machine zero line DI; this is achieved by driving the corresponding slide 11, starting from stop position (i.e. zero position), until the respective means SP detect a given dimension being reached by said slide, which dimension clearly corresponds to a given position of the machining point 9A of the grinding wheel 9.

[0031] Preset function can obviously be performed with any frequency by the operator, and thus not only after new diamond wheels have been mounted onto the machine 2, both simultaneously for all the grinding wheels 9, 9', 9" and selectively for each of them; in particular, said procedure is carried out whenever a new machining has to be set or the wear degree of the grinding wheels 9, 9', 9" has to be checked.

[0032] For machining purposes, by means of the control unit SC, beyond setting common machining parameters, the advancing speed for the plates L and the desired removal dimension are set for each diamond wheel 9, 9', 9" as absolute values; the control unit SC can show on the display of the device DP of Figure 1 also percentage removal of each grinding wheel 9, 9', 9" for each shoulder 7, 8. The operator in charge of the machine 2 will be helped in setting the various technological parameters by the use of working sequences stored in the control unit SC, which can be displayed on the device DP, grouped according to the different thickness of the plates to be machined and to the speeds used on the machine 2.

[0033] In accordance with a further feature of the invention, two opposite measuring units are placed in the outlet of the grinding machine 2, 3, having the form of linear encoders, one on each shoulder, referred to in Figure 1 with 20; as can be seen in Figure 3, each encoder 20 can comprise a driving cylinder 20A having a stem 20B on whose end a contact idler wheel 20C is present, ground and concentric with respect to its rotation axis; the cylinder 20A is fastened to its respective shoulder 7, 8 and is equipped with means, known per se and interfaced with the unit SC, for detecting the relative position of the cylinder 20A with respect to its stem 20B.

[0034] The linear encoder 20 is not equipped with a limit switch; that is why, in order to store the dimension of said encoder with respect to line DI, an initial setting has to be made when installing the machine 2, consisting in activating the cylinder 20A until the stem 20B leads the idler gear 20C onto an abutment temporarily positioned on machine zero line DI. Now the measuring linear encoder 20 is reset and its respective dimension is stored in a variable within the control unit SC; the aforesaid setting abutment is removed from the machine.

[0035] During machining, with a frequency selected by the operator depending on the number of glass plates getting out of the machine 2, the measure of the glass plate L being machined is required to be checked through a corresponding program which the control unit is equipped with. Said measuring program activates both encoders 20; in particular the two stems 20B are let out of their respective cylinders until each idler wheel 20C rests on a corresponding edge of the movable glass plate getting out of the grinding area; the extension of the stem 20B generates the encoder dimension, which is then stored in the control unit SC.

[0036] Note that the glass plate L getting out of the unit 2 moves normally according to a slightly undulated trajectory, however always with parallel ends; that is why, in order to obtain a correct measuring of the machined plate, the encoder dimensions of the two measuring units 20 are preferably summed up algebraically, so as to know the point-to-point difference, which, averaged out and summed to the width of the opening of the shoulder 8 with respect to the shoulder 7, defines the real dimension of the machined glass.

[0037] The size thus calculated for the plate L is compared with the theoretical size of the plate to be machined, set at the beginning on the control unit SC, and, but for a tolerance provided for in machine data, said unit SC checks whether the machined plate is acceptable in terms of size.

[0038] When the size detected for the plate L getting out during machining become larger, due to the wear of diamond wheels 9, the initial situation has to be retrieved by a series of operations on the machine 2.

[0039] Said operations consist in stopping the device D guiding the plates on the machine 2, waiting for the removal of the plates that might be present in the machine, and carrying out the automatic correction of the motorized slides 11. In order to manage the position correction of the slides 11, it is provided on the control unit SC for a suitable table in which intervention threshold retrieval parameters are stored, respectively for the last-but-one and the last diamond wheel of each shoulder, i. e. wheels 9' and 9" with reference to Figures 3 and 4, for side and for plate thickness.

[0040] The aforesaid parameters represent the maximum retrieval dimensions for each wheel 9', 9"; this means that if the error (i.e. the difference between theoretical plate and measured plate) is smaller than set tolerance, no compensation shall be carried out; conversely, if the error is between set tolerance and the retrieval parameter of the last wheel grinding 9", the control unit SC shall advance the slide 11 of the last grinding wheel 9" of an extent corresponding to error retrieval; however, if the error is between the two retrieval parameters of the last-but-one and last grinding wheel, the unit SC shall advance the last grinding wheel 9" of a extent corresponding to its retrieval parameter and the remaining difference shall be retrieved on the last-but-one wheel 9', by advancing it; eventually, if the error is larger than the retrieval parameter of the last-but-one wheel 9', the unit SC shall execute the preset function, as previously described, by means of the abutments 18A.

[0041] From the above it seems manifest that, thanks to the presence of the motorized slides 11 and of the system for controlling the position of the machining point for grinding tools, the setting of the desired marks for grinding wheels 9, 9', 9" can be carried out immediately and with no difficulty by the operator; in order to simplify mark management, as far as material removal for each wheel is concerned, the control unit SC shall be advantageously provided with a mark table for each shoulder, defined depending on plate thickness. The data to be set by means of the programming device DP, shall be those concerning the size of the finished plate to be obtained, the size of the cut plate getting in and its thickness, as well as dimensions indicated by the mark table; as was said, the partial machining allowance referred to with S in Figures 3 and 4, i.e. half the difference between final machined glass and cut glass getting in, shall be equally distributed by the machine on both edges to be machined.

[0042] By mere way of example, let us assume that Figure 4 shows a partial machining allowance S of 1.4 mm, in which case the marks I1, I2 and I3 for the three grinding wheels 9, 9' and 9" of the series can be of 1 mm, 0.3 mm and 0.1 mm, respectively; at the outlet of the last wheel 9", the whole partial machining allowance S will be removed from the edge of the plate L, so that said edge has the desired dimension, as represented in Figures 3 and 4 by line DF.

[0043] The described system enables to set with accuracy the machining point 9A of the various grinding wheels, in a simple and automated way; moreover, the control unit SC can have a convenient check function in case one might want to give the user of the machine 2 the possibility of an "empirical" measuring of wheel marks, said measuring being merely optional.

[0044] The aforesaid check function envisages at first the performance of the preset function described above, which consists as was said in leading the concerned grinding wheel or wheels in contact with their respective abutment 18A, and in storing the corresponding encoder dimension. Then the slide or slides 11 are withdrawn by unit SC until the machining point of the grinding wheel or wheels is aligned with machine zero line D1, which represents the dimension for no removal at all. Now, the desired removals being known from the mark table depending on the thickness of the plate L and the partial machining allowance being known, the control unit SC shifts the motorized slides 11 until they reach the dimensions indicated in the removal table for each grinding wheel 9, 9', 9"; if there is a difference between partial machining allowance S and total removal in the table, the control unit SC shall drive the motorized assembly shifting the movable shoulder 7, which shall be shifted of exactly said difference.

[0045] Once the desired positions for the machining points 9A of the wheels have been reached, as described above, the control unit SC activates the motors 12, thus driving the corresponding wheels, while a plate L is introduced into the grinding area; once all wheels have left their marks, though without completing the grinding of the whole edge of the plate L (as can be seen in the example of Figure 4), the advance of said plate is stopped; the motorized slides 11 are withdrawn up to a parking dimension and the plate L is removed from the grinding area, so that the various marks left can be checked empirically by the operator.

[0046] In a possible embodiment of the invention, the motor 12 of each wheel can be associated with a digital ammeter, schematically referred to with 21 in Figure 2, used as control instrument by the unit SC for ensuring a correct technological use of said wheel, on the basis of control parameters stored in said unit. The aforesaid parameters are used by the unit SC for controlling the optimal rotation speed of the grinding wheels 9, 9', 9" depending on the absorption of their respective motors 12 and on the variation of machining resistance due to the removal of irregular glass present on plate edge (the so-called "cutting shoe").

[0047] In order to perform said kind of control, the system is also provided with an inverter for each pair of opposite assemblies GM, thanks to which the rotation speed of the respective motors 12 can be adjusted; in Figure 1 IN refers to the inverter of only one assembly GM. For each pair of assemblies GM equipped with inverter, a current absorption datum concerning the motor 12 and a given intervention threshold for avoiding the oscillation phenomenon are set on the control unit SC; if absorption tends to rise, the control unit SC drives a proportional, instantaneous increase in the number of revolutions of the motor 12, thus increasing tool removal capability; the speed increase will thus reduce the stress on the tool, and therefore amperage will sink, until rotation goes back to standard values. Also wheel usage parameters (in terms of absorption and rotation speed) will be stored in technological table in the unit SC.

[0048] If the other two edges of the plate L getting out of the machine 2 have to be machined, the squaring unit 4 of Figure 1 directs said plate towards the machine 3, in per se known ways. This is then followed by the machining, on machine 3, of the two edges of the plate L orthogonal with respect to those that have been previously machined on machine 2. The working of machine 3, as far as the features of the invention as described before are concerned, is the same as the one of machine 2; by the way, it should be pointed out that in case of lines as the one shown, one control unit SC can be provided for managing both units 2 and 3.

[0049] Obviously, though the basic idea of the invention remains the same, construction details and embodiments can widely vary with respect to what has been described and shown by mere way of example, however without leaving the framework of the present invention.

[0050] In a possible application the plate dimensional reading means, i.e. measuring encoders 20, can be used for performing an automatic retroactive adjustment control on the tool 9. Said system provides that even only the slide 11 of the last assembly GM is motorized, i.e. the assembly having the wheel 9" of Figures 3 and 4. Here automation consists in measuring the plate L at the outlet of the single machine 2, 3 by means of the sensors 20, and in case the computed difference between theoretical plate and measured plate is below the intervention threshold of the last grinding wheel 9", the control unit SC automatically adjusts the advance of the slide 11 of the latter, in order to make up for said error; the detected difference can alternatively be shown only on the display of the device DP.

[0051] The invention has been previously described with reference to front mark wheels 9, 9', 9", i.e. driven by a horizontal axis spindle; however, it is obvious that the idea underlying the invention applies also in case of tangential mark wheels, i.e. in which the respective spindle has a vertical axis, for machining operations commonly known as "round flush". Said case is shown in Figures 5, 6 and 7, where the same reference numbers as in the previous figures are used.

[0052] To said purpose Figure 5 shows a grinding assembly GM comprising the guide GF and the corresponding slide 11, as well as the corresponding driving and motion transmission means 15, 15A, 15B. In the case shown by said figure the slide 11 is associated with a second vertical guide, referred to with GF', which is operatively associated with a respective slide 11', the latter supporting the motor 12 driving the grinding wheel 9, which is here a tangential mark wheel. 15A' refers to the shaft of a motor 15', which is connected to a threaded bar 16'; on the latter a volute 17' can slide, which is mechanically connected to the slide 11'; thus, by driving the shaft 15A', the slide 11' can slide vertically on the guide GF, in the direction indicated by arrow C, depending on the sense of rotation of the motor 15'; this is done in order to position the wheel 9 in the suitable point with respect to the edge of the plate L to be machined.

[0053] In the case shown in Figure 5, in order to perform preset function, the grinding wheel 9 will be first lifted by means of the advancing system GF', 11', 15', 15A', 16', 17' until the machining surface 9A is arranged parallel to the abutment or reference surface 18B. Then the wheel 9 will be advanced towards the element 18 by means of the advancing system GF, 11, 15, 15A, 16, 17 up to stop position; this will be followed by the withdrawal of the wheel 9 up to the necessary dimension and its lowering.

[0054] Figures 6 and 7 show the working principle of grinding assemblies like the one shown in Figure 5, which, as can be inferred, is identical to the one previously described with reference to Figures 3 and 4.

[0055] The invention can obviously be carried out also in order to use the machine 2 or 3, as previously described, for machining only one edge of the plates L.

[0056] The described method also applies to the polishing assemblies GL, for checking and retrieving the wear of their grinding wheels 11, as well as to the corner finishing assemblies GM1, through a suitable positioning of the abutments 18A.

[0057] In the case previously shown by way of example, the element 18 has a globally embattled shape, so as to have abutments 18A separate one from the other, but said element could obviously have another shape, for instance as a simple vertical plane defining a continuous surface 18B.

[0058] The element 18 with the abutments 18A could also be vertically movable, so as to be selectively shifted between a rest position and a working position between the machine zero line D1 and the slides 11; thus, the assembly GM of Figure 2 would be able to correct the position of the respective grinding wheel also without removing plates that might be present in the machine, by carrying out the following cycle of operations:

- complete withdrawal of slide 11 with the concerned grinding wheel 9,
- lowering of element 18 to its working position,
- advance of slide towards element 18 up to detection of stop dimension,
- lifting of element 18 to its rest position,
- linear shift of slide 11 so as to bring the grinding wheel machining point to desired position with respect to machine zero line D1, as previously described.

[0059] Finally, it is obvious that, although the preceding description has been made with reference to a grinding machine for glass plates, the same ideas can be used for carrying out machine for machining edges of plates made of marble or other stony materials.

Claims

1. Method for controlling an operating position of a grinding wheel (9, 9', 9") used in a machine (2, 3) for machining edges of plates made of glass (L), marble and similar stony material, said machining comprising the passage of a plate (9) across a grinding area, where in said grinding area at least a first edge of a plate (L) gets in contact with a machining surface (9A) of at least a first grinding wheel (9"), said machining surface (9A) undergoing wear and said first edge following when entering said grinding area a pre-established path line (DI), said method being **characterized in that** it comprises the following operations:

    1.1) advancing said first grinding wheel (9") up to a stop position, in which said machining surface (9A) is in contact with a reference surface (18B) placed at a first given distance from said path line (DI);
    1.2) moving said first wheel (9") away from said reference surface (18B) with a linear shift, detecting at the same time the progressively increasing extent of said shift starting from said stop position;
    1.3) interrupting said shift when said extent corresponds to a reference value indicating that said machining surface (9A) has reached a second given distance from said path line (DI).

2. Method according to claim 1, where in said grinding area a second edge of the plate (L), opposite said first edge, gets in contact with a machining surface undergoing wear of at least a second grinding wheel, opposite said first grinding wheel, said second edge following while entering said grinding area a respective pre-established path line, the setting of an operating position of said second grinding wheel being performed by operations similar to operations 1.1), 1.2), 1.3).

3. Method according to claim 2, where one or more further grinding wheels (9', 9) are provided, arranged parallel to at least one between said first and second wheel (9"), the operating position of said further wheel or wheels (9', 9) being settable by operations similar to operations 1.1), 1.2), 1.3).

4. Method according to claim 3, where

    4.1) at the outlet from said grinding area a width dimension of the plate (L) is measured, meaning the distance between said first and second edge,
    4.2) the detected width dimension is compared with a preset theoretical width dimension.

5. Method according to claim 4, where in order to automatically correct the operating position of at least said first wheel (9") the following operations are provided:

    5.1) associating said first grinding wheel (9") with a respective pre-established intervention threshold value,
    5.2) computing the difference between the detected width dimension and the theoretical width dimension, and
    5.3) if said difference is smaller than the threshold value, advancing at least said first grinding wheel (9") towards said first edge.

6. Method according to claim 5, where operations as

operations 5.1), 5.2) and 5.3) are carried out also to automatically correct the operating position of at least said second grinding wheel (9").

7. Method according to claim 5, where the following operations are further provided:

7.1) envisaging setting a dimensional tolerance between the detected width dimension and the theoretical width dimension,
7.2) envisaging at least a further grinding wheel (9', 9) arranged parallel to said first grinding wheel (9), which is associated with a respective pre-established intervention threshold value, said further grinding wheel (9', 9) operating upstream from said first grinding wheel (9") with reference to the passage direction (A) of the plate (L), and
7.3) if said difference
7.3.1) is smaller than said dimensional tolerance, the operating positions of said first grinding wheel (9") and of said further grinding wheel (9', 9) are not changed;
7.3.2) is between said dimensional tolerance and the threshold value of said first grinding wheel (9"), the latter is shifted of an extent corresponding to said difference;
7.3.3) is between the intervention threshold of said first grinding wheel (9") and the threshold value of said further grinding wheel (9', 9), said first grinding wheel (9") is shifted of an extent corresponding to its threshold value and said further grinding wheel (9', 9) is shifted of an extent corresponding to the value of said difference minus the threshold value of said first grinding wheel (9");
7.3.4) is larger than the threshold value of said further grinding wheel (9', 9), the aforesaid operations 1.1), 1.2), 1.3) are carried out.

8. Method according to claim 7, where operations as operations 7.1), 7.2), 7.3) are carried out also for at least said second grinding wheel (9") and at least a further grinding wheel (9', 9) arranged parallel to said second grinding wheel (9") and upstream from the latter, with reference to the passage direction (A) of the plate (L).

9. Method according to claim 2, where the control is provided of the rotation speed of said first and second grinding wheel (9"), on the basis of the current absorption of their respective motors (12) and of the variation of machining resistance due to the removal of irregular glass present on the respective plate edge.

10. Method according to claim 9, where said speed control is carried out by means of the following operations:

10.1) setting a rotation speed for each motor (12) and a respective current absorption datum;
10.2) measuring the current absorption of each motor (12), and
10.3) if the measured absorption is higher than the set absorption datum, increasing the number of revolutions of the motor (12), said increase of the number of revolutions aiming at causing a decrease of the stress on the respective grinding wheel (9"), and therefore a decrease of current absorption, up to the retrieval of the set rotation speed.

11. Process for correcting the operating positions of a first grinding wheel (9") depending on its wear, in a machine for machining edges of plates made of glass, marble and similar stony materials in which the edge of a plate (L) is guided on a pre-established path line (DI) so as to be in contact with at least a grinding wheel (9, 9', 9"), **characterized in that** in order to carry out said correction, the first grinding wheel (9, 9', 9") is firstly led in contact with a fixed reference (18) and then moved away from the latter, the moving away being interrupted when its extent corresponds to a reference value indicating that the grinding wheel (9, 9', 9") has reached a correct operating position with respect to the path line (DI).

12. Bilateral machine for machining edges of plates made of glass (L), marble and similar stony materials, for implementing the method according to at least one of the claims 1 to 10 or of the process according to claim 1, having

- a frame (7, 8) comprising a stationary shoulder (8) and a movable shoulder (7), each shoulder being associated with a plurality of grinding assemblies (GM, GM1, GL), each assembly (GM, GM1, GL) comprising a respective grinding wheel (9, 10, 11) having a machining surface (9A) undergoing wear, a grinding area being defined between the grinding assemblies (GM, GM1, GL) associated with the stationary shoulder (8) and the grinding assemblies associated with the movable shoulder (7),
- directing means (D) designed to guide said plate (L) so that at least a first edge of the latter follows a given path line (DI) when entering said grinding area,
- conveying means (6) designed to trail said plate (L) across the grinding area so that at least a first edge of said plate (L) gets in contact with the machining surface (9A) of a respective wheel (9, 10, 11),
- driving means (10, 11, 15) designed to shift lin-

early, in a direction basically perpendicular to said path line (DI), at least a first one of said assemblies (GM) comprising said first wheel (9),

- means (SP) for detecting the position of said first assembly (GM),
- a control system (SC) comprising means (DP) for setting and storing operating parameters,
- striker or abutment means (18) operatively positioned at a given distance from said path line (DI) and defining a fixed reference surface (18B),

where the machining surface (9A) of said first wheel can be led in contact with the reference surface (18B) following an advance of said first assembly due to the actuation of the respective driving means (10, 11, 15).

13. Machine according to claim 12, **characterized in that** said first wheel is selected in the group consisting of: grinding wheels (9) for removing surplus material from said first edge, grinding wheels (10) for finishing corners of said first edge, polishing wheels (11), wheels for chamfering or round flush operations.

14. Machine according to claim 12, **characterized in that** at the outlet of said grinding area sensor means (20) are provided for detecting a width dimension of said plate (L).

15. Machine according to claim 12, **characterized in that** means (N) are provided for controlling the rotation speed of a motor (12) driving said first grinding wheel (9) depending on its current absorption.

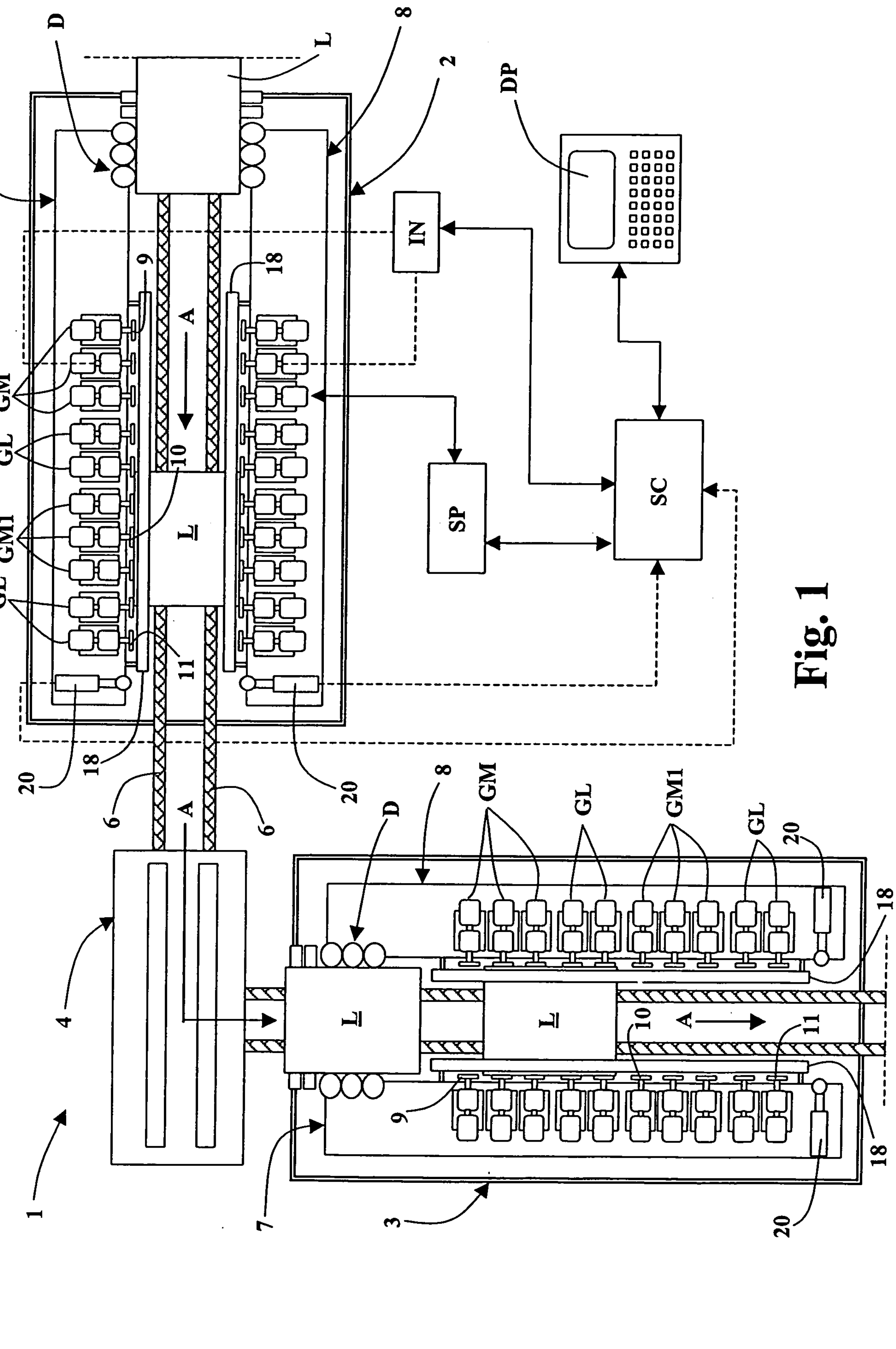


Fig. 1

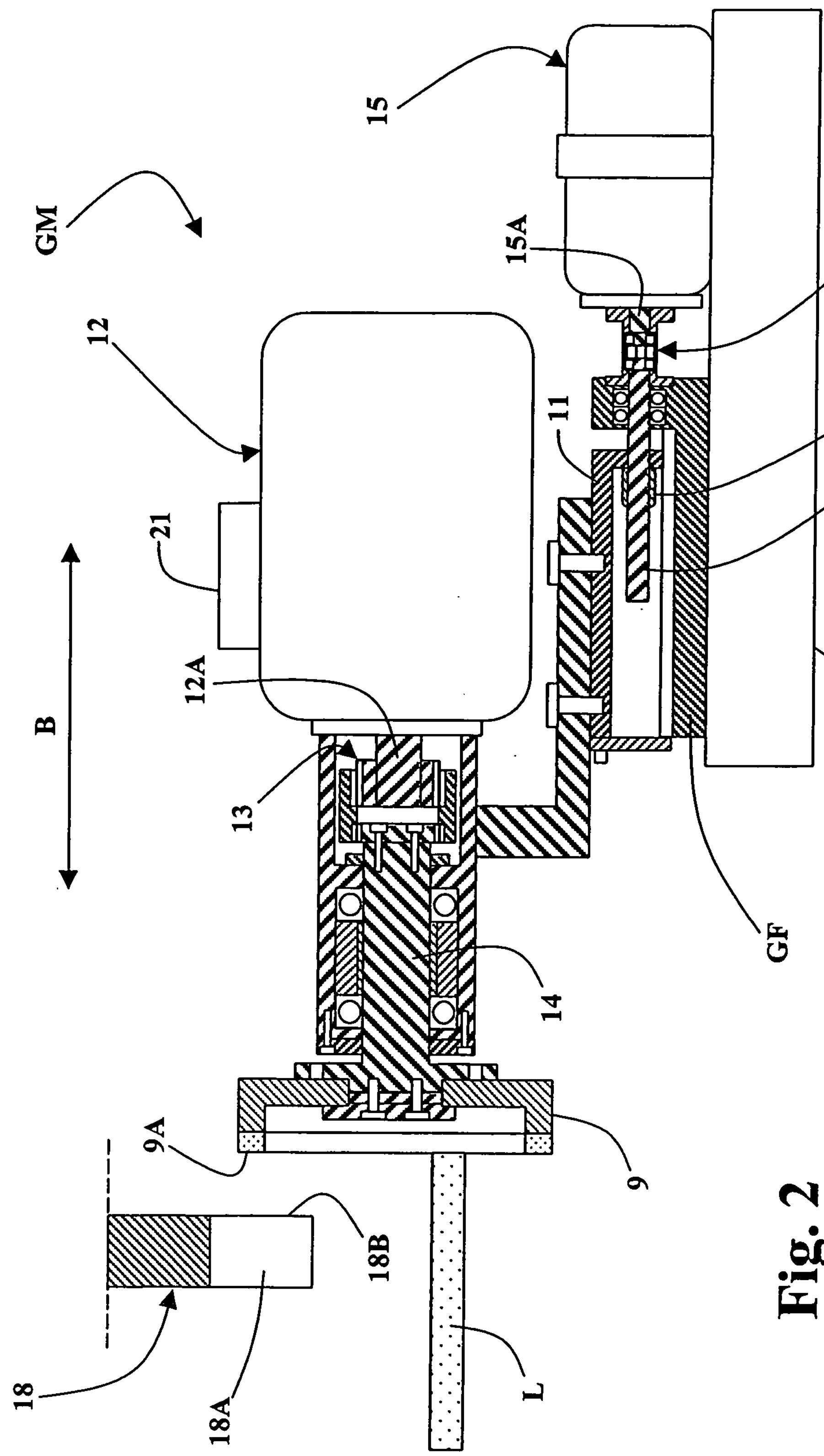


Fig. 2

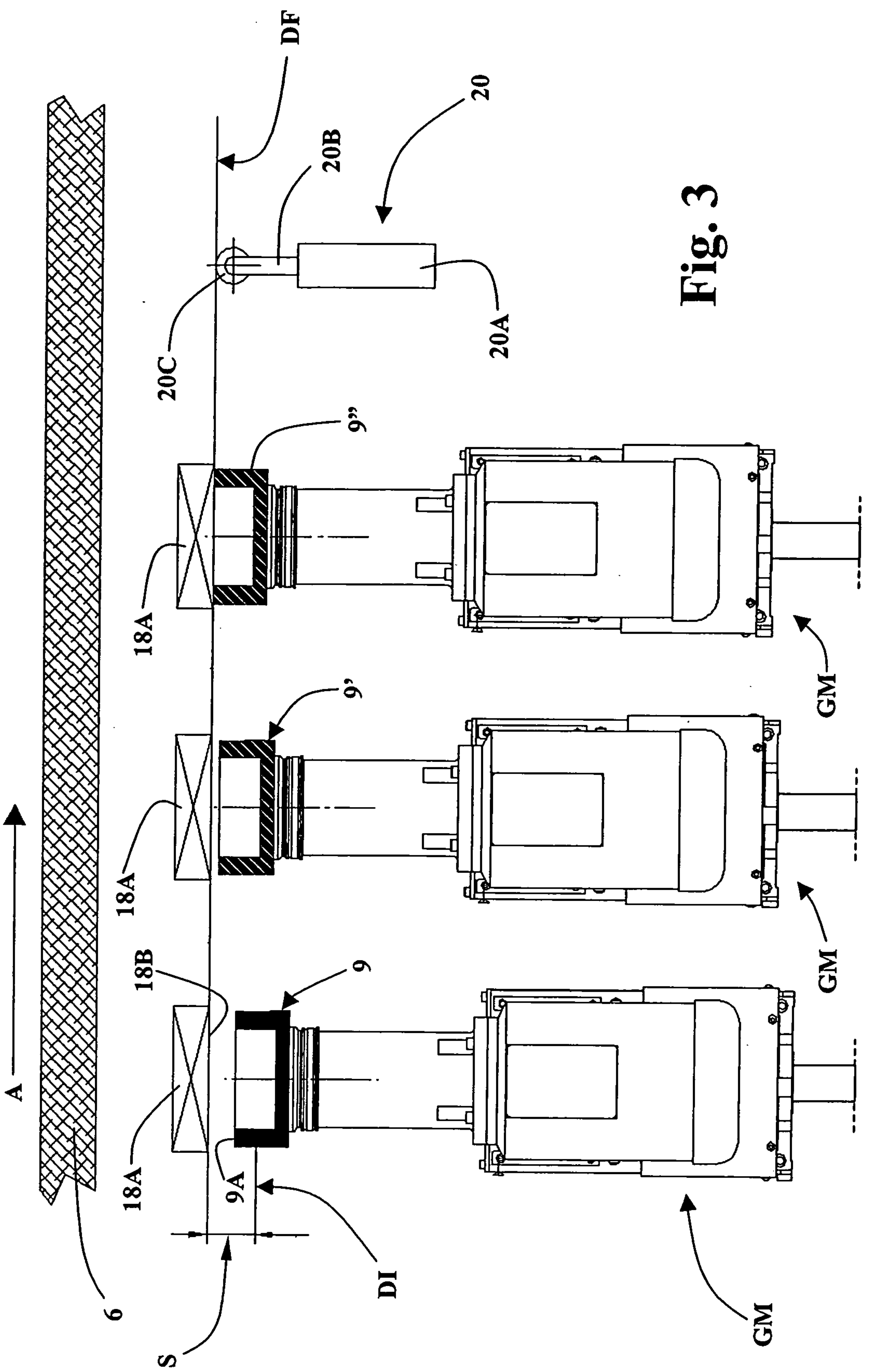


Fig. 3

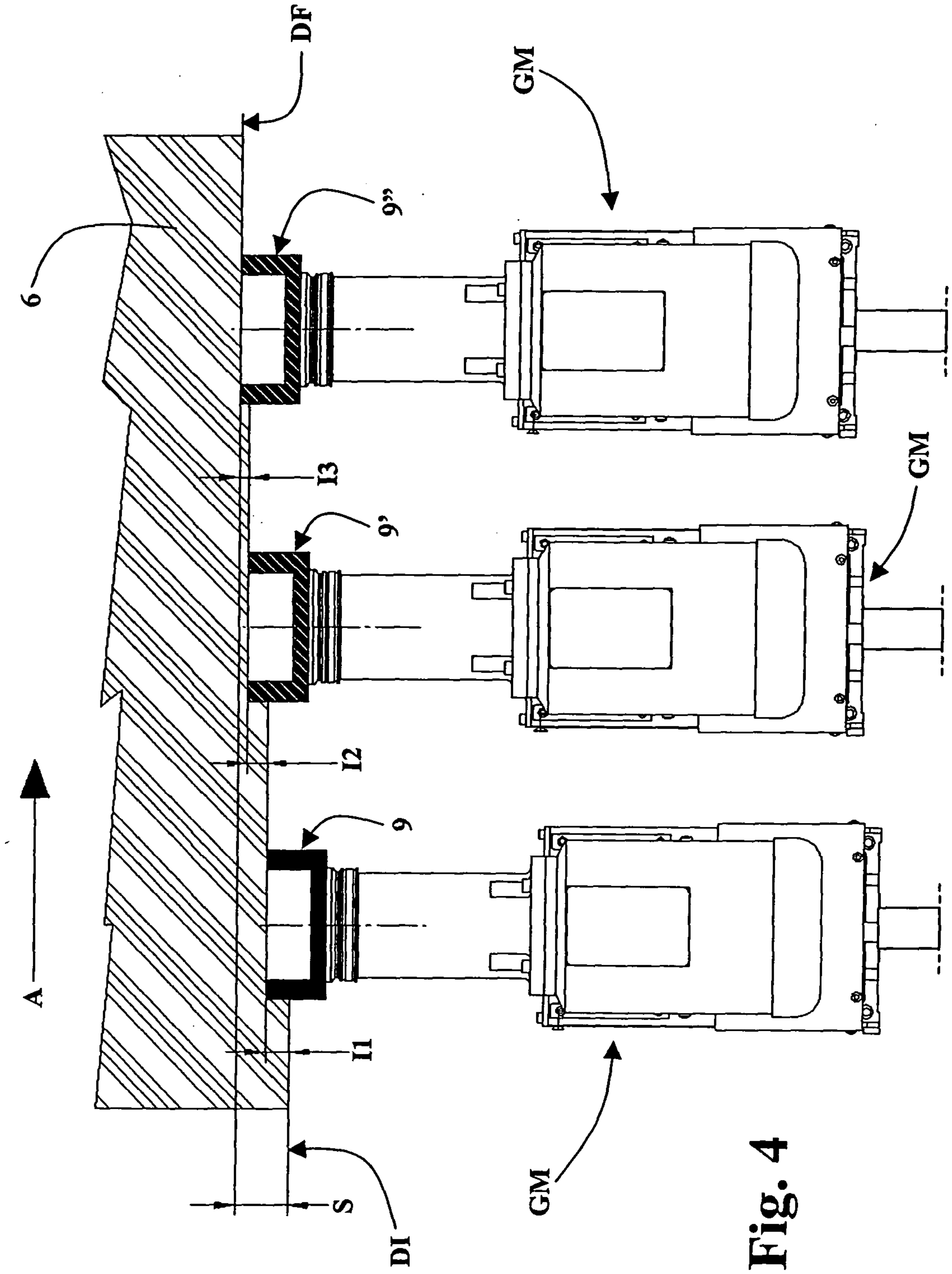


Fig. 4

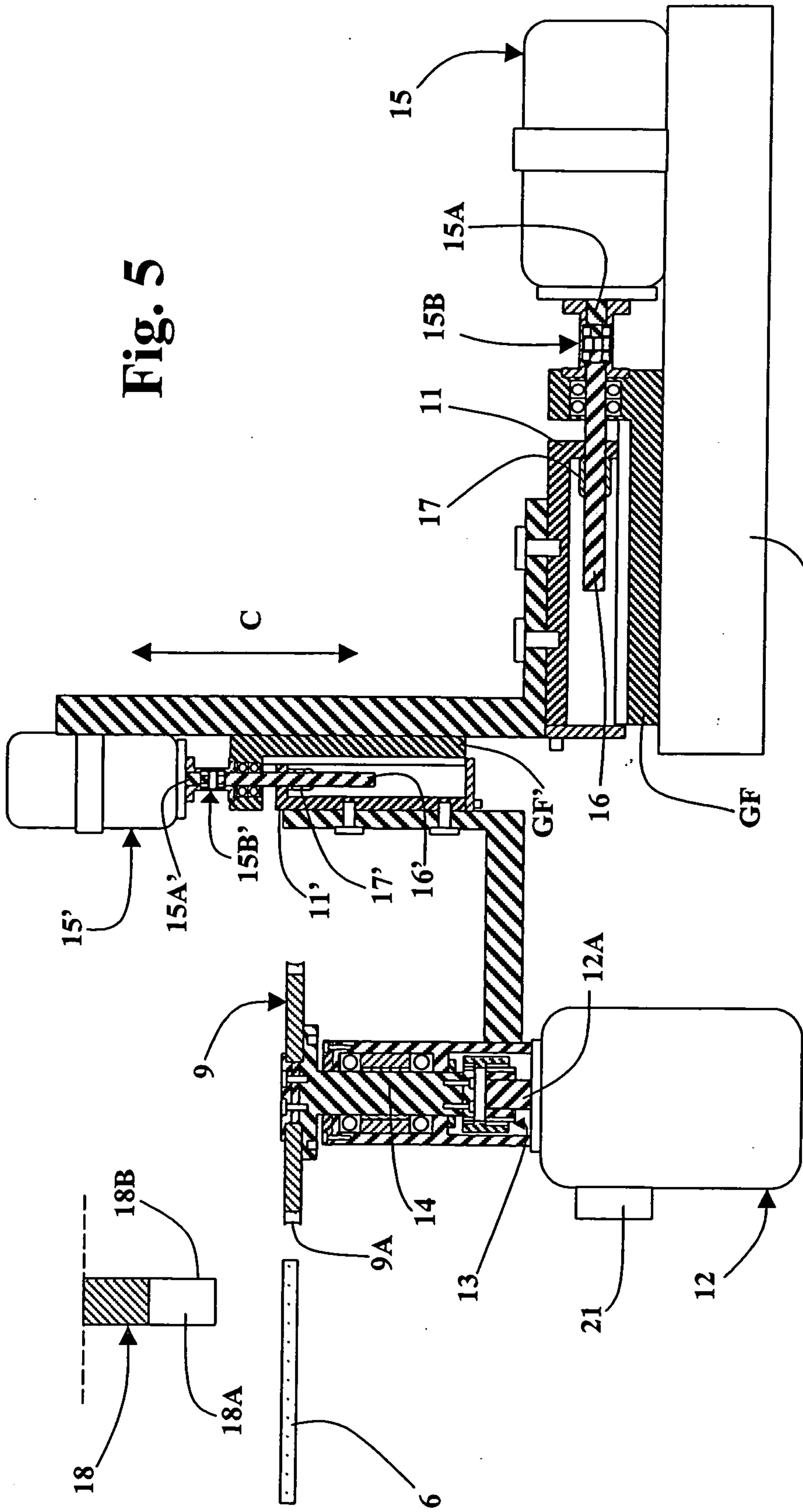

15
15A
15B
11
17
C
16
8
GF
GF'
15'
15A'
15B'
11'
17'
16'
12A
9
14
9A
13
21
12
18B
18
18A
6

Fig. 5

Fig. 6

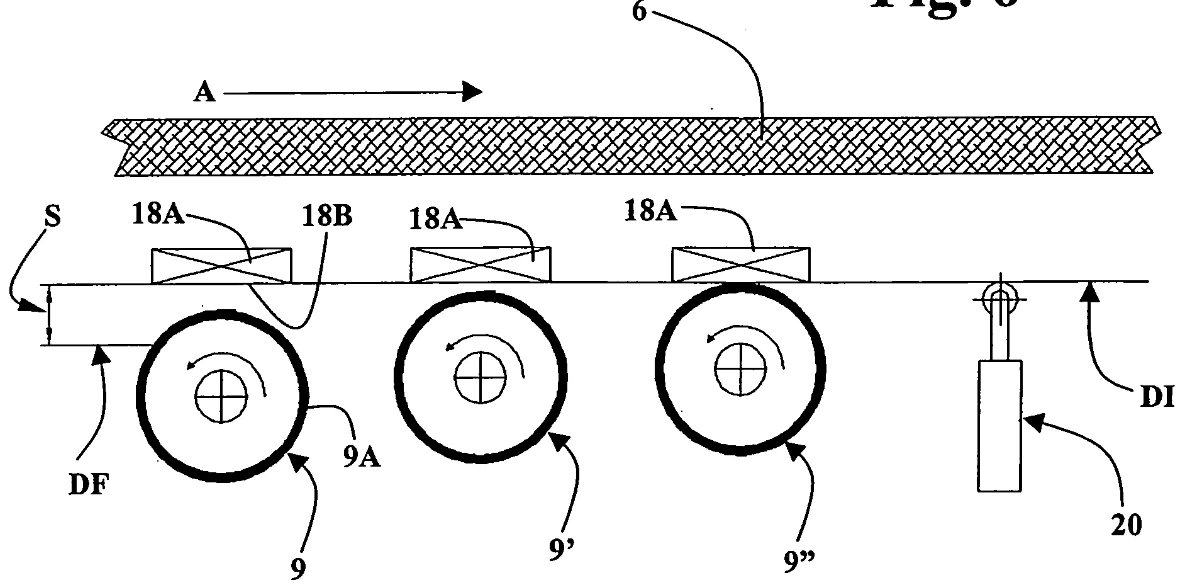
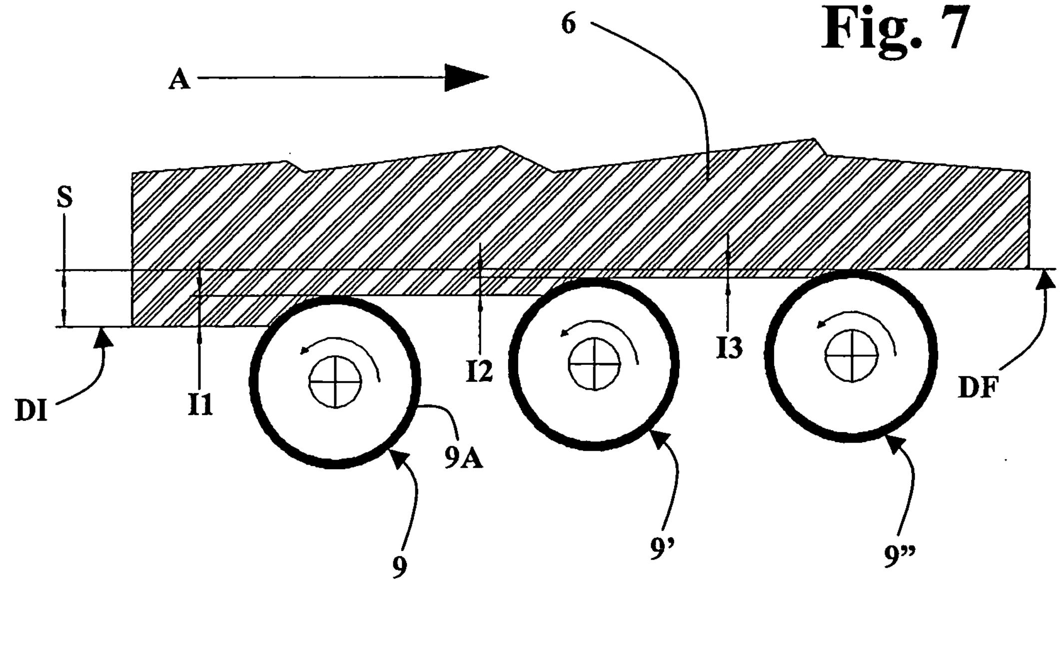


Fig. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 03 02 6311

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	1 March 2004	Do Huu Duc, J

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