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(54) AN EDGING QUALITY CONTROL PROCESS AND AN EDGE BANDING MACHINE

(57) The present invention relates to a quality control process of the edging of a panel (11), comprising the following steps:
loading data relating to said panel (11) and relating to the process to be carried out;
processing said data;
arranging the vision group (10) as a function of the processed data;
performing control operation by the vision group (10), based on the processed data, to acquire images;
processing the image acquired to identify features of the panel (11), in particular, to identify defects.

The invention also relates to an edge banding machine equipped with a vision group (10) and a communication system between the edge banding machine, vision group, and user which implements this quality control procedure.

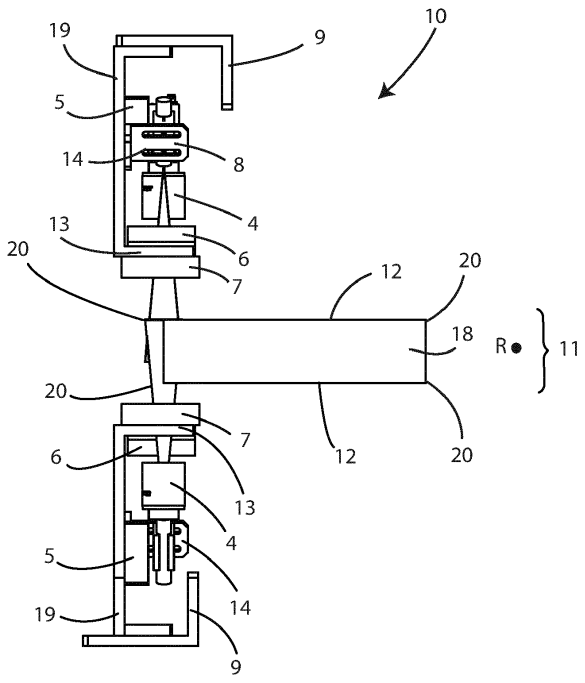

Fig. 7

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Description

[0001] The present invention relates to a quality control method of the edge banding process carried out by means of a vision group for an edge banding machine, which can be integrated into the machine itself, and a system suitable for managing the communication between the aforementioned vision group, the edge banding machine, and the user.

[0002] The vision group allows to carry out a series of specific checks relating to the edge banding of a wooden panel or the like.

[0003] Therefore, the present invention lies in the field of machinery for the quality control of panel edge banding.

[0004] One of the most important problems in the field of quality control systems in the field of panel edge banding is the creation of an effective quality control procedure and the related communication system between the edge banding machine and the vision system.

[0005] The edge banding process of a wooden chipboard panel is designed to cover the previously sectioned sides of a panel with an ennobling edge, applied by gluing. The edge should come as close as realistically as possible to the essence of the main surfaces of the panel, or otherwise aesthetically match it. The edge bander is the machine where the edge banding process takes place. This process includes several operations, including, the application of the glue on the side of the panel to be edge banded, the application of the band on that side, the dimensioning of the band itself according to the height and length of said side, and any processing, for example of rounding, at the edges of the band and/or the panel. The aforesaid processes are performed while the panel being worked is moving between an inlet station and an outlet station of the edge banding machine, along a predetermined direction.

[0006] The edge banding process can also comprise different stages, each relating to the edge banding of one side of the panel being processed. The different steps comprise at least part of the aforesaid operations and may differ, for example, as regards the non-execution of a working and /or the way of executing a working.

[0007] As it is easy to understand, there are several conditions to be respected during this type of process so that the machined panel has optimal characteristics both from a structural and an aesthetic point of view.

[0008] In fact, the aforementioned bands can be made according to different and numerous varieties not only of materials, for example, wood, metals, etc., but of colors and shapes, moreover they are glued, so it is easy to understand that gluing becomes a process to be controlled with particular attention.

[0009] The guarantee of the optimal success of the edge banding process can be provided, for example, by checking the quality of the processed panels through a vision group, which can be integrated directly into the edge banding machine. Since the series of possible defects is very wide, it is easy to understand that the visual check alone, the same for any machining step and/or worked panel and/or applied band, is not sufficient to guarantee a high level of quality of the output product.

[0010] The problem underlying the present invention is that, as previously expressed, to base the quality control operation of the banded panels on a control routine and/or processing of the acquired images not specific for the type of panel processed and/or edge used and/or the particular phase of the edge banding process implies a lower accuracy of the controls that the vision system must guarantee, thus decreasing the absolute performance of the product.

[0011] There is therefore the need, during the performance of the quality control of the processed pieces, to also consider the particular phase of the edging process and/or the peculiarities of the panel itself.

[0012] The control systems for traditional edge banding machines provide a vision system often external to the edge banding machine, which is based on the use of cameras usually aimed only laterally with respect to the panel in question and of illuminators often adjacent to the cameras themselves.

[0013] The upper and lower edges of the panel, as well as the vertical edges, if checked, are usually inspected in fixed positions and/or directions and without changing the lighting conditions.

[0014] For this reason, the field of view that can be obtained in these cases is often not the best possible, and does not or does not always have the adequate resolution and contrast to recognize the most common defects deriving from an edge banding process.

[0015] Furthermore, there are often no communication systems between the edge banding machine and the vision system itself, thus causing a decrease, for example, in the effectiveness of selecting particular defects to be searched for, not being able to communicate optimal configuration and/or post parameters processing to the vision group.

[0016] The above methods therefore do not guarantee high precision of the quality control operation, causing various drawbacks also in terms of economic and time expenditure.

[0017] A quality control procedure of the edge banding process and related communication system between a banding machine and a vision system (integrated in the aforementioned machine or independent of it) designed to perform the quality control of the machined pieces, with characteristics similar to those that will be described in detail below, it is not currently in the market.

[0018] Within the scope of the above-mentioned requirements, therefore, the main purpose of the present invention is to provide a process for the quality control of the edge banding process and relevant communication system between the edge banding machine and the vision group which allows, on the basis of the data exchanged by themselves, carrying out certain checks on the panel, configuring each time, in the best possible way,

the setup of the vision group, thus maximizing the performance and the selectivity of the quality control process.

[0019] A further scope of the invention is to realize a flexible vision group both from the hardware and software point of view, which allows recognizing the greatest possible number of defects, guaranteeing, for example, according to the peculiarities of the panel and/or of the edge and/or of the edging process step, the optimal field of view for each camera, as well as the resolution and the contrast.

[0020] The purpose of the present invention is also that of realizing a control system for edge banding machines that allows achieving optimal quality control while guaranteeing the possibility of using the machine at any working speed (i.e., guaranteeing the possibility of carrying out the quality control routine on panels that move at any speed between an input station and an output station of the edge banding machine, along a predetermined direction).

[0021] Furthermore, the object of the present invention is to implement a flexible quality control procedure, in which the post-processing of the acquired images can be streamlined both from the point of view of the operations to be performed, as well as from the point of view of the number of images to be processed.

[0022] The object of the invention is to provide a control system for edge banding machines, which can be integrated into edge banding machines even already in use, and which could also integrate any other control systems for edge banding machines.

[0023] A further object of the invention is that of obtaining a control system for edge banding machines which is economical to manufacture with respect to the advantages achieved.

[0024] It is, therefore, object of the present invention a quality control process of the edge banding of a panel by an edge banding machine by means of a vision group, comprising the following steps:

loading first data relating the panel, and second data relating to the process to be carried out on such panel;

processing said first data and said second data, to generate third processed data;

arranging the vision group according to said third processed data;

arranging the vision group according to such third processed data;

performing control operation by the vision group, based on third data, to acquire images;

processing the image acquired by the vision group to identify features of the panel, in particular, to identify defects.

[0025] Preferably, according to the invention, it is possible to provide, after the step of processing said first data and said second data, and before the step of arranging the vision group according to said third data, the following phase:

transmitting said third data to the vision group.

[0026] Sempre according to the invention, it is possible to comprise, before the step of performing control operation by the vision group and/or after the step of processing the image acquired by the vision group during the step of performing control operations, the following step:

loading tolerance thresholds of the vision group, relative to the detected defects.

[0027] Still, according to the invention, is possible to comprise, after the step of performing control operations, the following step:

issuing a signal concerning the checks carried out by the vision group.

[0028] Further according to the invention, the step of processing the first data and the second data provides the association of the first data and the second data with a base of fourth data, in particular, organized in a table form, which allows associating such first data and second data to:

- a particular set of checks that can be carried out by the vision group;
- and/or a particular mechanical configuration of said vision group;
- and/or a particular set of settings for processing the image acquired by said vision group.

[0029] Further, according to the invention, the step of transmitting to the vision group said third processed data, may comprise:

- determination of an optimized set of checks to be performed;
- and/or determination of the optimal mechanical configuration;
- and/or determination of the set of optimal parameters for the processing of the acquired images.

[0030] It is also object of the present invention an edge banding machine equipped with a vision group that implements a quality control process for the edge banding of a panel.

[0031] According to the invention, the edge banding machine may comprise a plane for supporting and advancing along a sliding direction of a panel, wherein said vision group may comprise a first chamber having a viewing cone, provided with a first bisector perpendicular with respect to the sliding direction of the said panel; the vision group may further comprise a first backdrop located along said bisector of the viewing cone and in a position opposite to the first chamber with respect to the supporting and advancing plane.

[0032] Preferably, according to the invention, supporting and advancing the first backdrop comprises at least one of the following characteristics: it is opaque, it is uniformly colored, it is interchangeable, it comprises an il-

luminator, it has a variable coloring.

[0033] Always according to the invention, the first chamber may comprise an optic, and may be provided a first illuminator, for illuminating the edge of said panel, arranged facing the optic of said first chamber.

[0034] In this case, according to the invention, the first illuminator may be circular.

[0035] Further, according to the invention, it is possible to comprise a first laser located adjacent to the first chamber and it is inclined by a first angle.

[0036] More specifically, according to the invention, the first angle may be comprised between 10-30 degrees, in particular, it may be equal to 20°.

[0037] Still, according to the invention, it is possible to comprise first adjustment means for adjusting the position of the first laser, so as to allow adjustment of the angle of it radius with respect to the bisector.

[0038] Further, according to the invention, the first chamber may be provided with second adjustment means, to adjust its distance and the angle of said chamber with respect to the panel.

[0039] The edge banding machine of the invention may also comprise at least two vision groups, arranged reciprocally in central symmetry with respect to the supporting and advancing plane.

[0040] These and other purposes are achieved by a quality control procedure of the edge banding process and the related communication system between an edge banding machine and a vision system (integrated into the aforementioned machine or independent from it) suitable for carrying out the quality control of the machined pieces according to the invention, as will emerge better in the following of the present description of a preferred embodiment, but not exclusive by way of indication and not limitation in the accompanying drawings, in which:

- figure 1 schematically shows a perspective view of the edge banding machine;
- figure 2 relates to a front view of a first embodiment of the vision group, according to the invention;
- figure 3 shows an enlargement relating to the vertical camera viewing unit of figure 2;
- figure 4 relates to the vertical camera viewing unit of figure 2, in a perspective view from below;
- figure 5 relates to a rear perspective view of the vision group with vertical cameras of figure 2;
- figure 6 shows the vertical camera viewing unit of figure 2, in a perspective view from above;
- figure 7 schematically shows the control step of the vertical camera vision group of figure 2, in a side view.

[0041] With reference to the mentioned figures, the vision group 10 for edge banding machines 1 object of the present invention is preferably positioned (figure 1) within a hollow compartment 3, downstream of an edge banding machine 1, along which, through a supporting roller conveyor 2, the panel 11 (figures 2-7) made of different materials, for example, wood, which has to be banded, slides along a direction X and according to a longitudinal direction R in figures 1-2 and 4-7.

[0042] The panel 11 has (figure 2) two external surfaces 12, of the same size and length, parallel and opposite to each other, which correspond to the larger surfaces of the panel 11 itself; perpendicular to the external surfaces 12, there are two lateral surfaces 18, of the same size and length, parallel and opposite to each other, which correspond to the shorter sides of the panel 11. Two lateral surfaces 17 parallel to the advancing direction R, of the same size and length, parallel and opposite to each other, correspond to the longer sides of the panel 11.

[0043] Regardless of whether the vision group is integrated into the machine (of any type, even already in use) or external to the machine, correct management of the communication between the parts guarantees a higher quality of the machined pieces, as an effective communication system allows:

- to discard panels with insufficient quality requirements;
- to optimize the quality control procedure carried out, on the basis of the characteristics of the panels and/or bands to be examined and/or the particular edging process step;
- to optimize the post-processing of the images acquired by the vision system, which must be suitably processed in order to identify the greatest possible number of defects of interest.

[0044] For example, the edge banding machine can communicate to the vision group to prepare itself so as to selectively identify the probable defects relating to the particular step of the edge banding process in progress, in order to guarantee an increase in the reliability of the system itself, and significantly increase the refinement of quality control and edge banding precision.

[0045] The communication of the correct setup of the vision group and/or of the best post-processing strategy of the acquired images can be made, for example, on the basis of stored combinations of:

- settings related to the vision system, such as a particular position of a camera and relative illuminator, and
- particular defects, to be detected during a specific step of the edge banding process.

[0046] This type of innovative quality control procedure therefore provides for the possibility of:

- configure the control routine according to the particular step of the edge banding process and/or the peculiarities of the panel and/or machined edge;
- configure the post-processing parameters of the acquired images according to the particular step of the

edging process and/or the peculiarities of the panel and/or the worked edge and/or the quality requirements requested by the operator;
- keep track, for example in a database, not only of the single defect detection event but also of the optimal combinations of the vision group settings and particular defects to be detected.

[0047] The aforementioned vision group settings can be related to:

- the positioning of the cameras and associated lighting systems;
- the possible execution of particular operations of the quality control routine;
- the post-processing parameters of the acquired images.

[0048] In particular, according to a first embodiment of the present invention, which can be viewed in figure 2, the vision system has a configuration with vertical cameras.

[0049] With reference to the panel 11, on surface 12 the side surfaces 18 and 17 intersect to form an angle 20, which, together with the area of surface 12 close to the side surfaces 17, is the area of interest for the control of the panel 11, when analyzed by the vertical camera vision group, as discussed below.

[0050] The vertical camera vision system comprises two vision groups 10: an upper group and a lower group, symmetrical with respect to the external surfaces 12 of a panel 11 and with the same components, but mounted in an overturned manner.

[0051] In detail, by way of example, the first upper vision group 10 with vertical camera, comprises a chamber 4 with relative vision cone with a bisector 22, placed perpendicular to the direction R in the figure, with its optic facing towards the support roller conveyor 2, to view the panel 11, which slides over it, in correspondence with the area of the upper surface 12 close to the surfaces 17.

[0052] The camera 4 is positioned on a camera support 5, which has, laterally, with respect to the sides of the camera 4 itself, fixing means 16, which can slide along slots 15 (figure 5), thus allowing to adjust the position of the camera 4 both in terms of distance and angle with respect to the panel 11 to be analyzed.

[0053] Frontally with respect to the lens of the video camera 4, the shaped support profile 19 has an opening 13, preferably circular (figures 4, 5, 6), which directs the viewing cone of the camera 4 towards the surface 12 of the panel 11.

[0054] Fixed to the support 19, on the opposite side of the opening 13, there is also an illuminator 7, for example, ring-shaped, which allows illuminating the portion of the panel 11 of interest for the analysis.

[0055] Mounted on the shaped profile 19, so as to be adjacent to the left side sx (figure 2), of the video camera 4, there is a laser 8, which is used as a profilometer, the laser 8 is inclined in such a way as to form with the trajectory of the bisector 22 of the viewing cone of the video camera 4, an angle 21, for example of 20 degrees (figure 3).

[0056] The laser 8 is mounted on the shaped profile 19 by a laser support 14, which is fixed to the shaped attachment profile 19, by means of fixing means 16, which can move within the slots 15.

[0057] Belonging to the shaped profile 19 and placed above the laser 8, there is a further L-shaped element 9, which acts as a support and protection for the vision group. The aforementioned element 9 is fixed to the shaped profile 19 by means of fixing means 16, which can move within the slots 15, thus allowing adjusting the position of the viewing unit 10.

[0058] Below the laser 8 and parallel to the panel 11, there is a backlight 6, which emits its own light, positioned in such a way as to be on the trajectory of the viewing cone of the camera 4 of the second vision group 10 with vertical cameras, which, as previously mentioned, it is located in a symmetrical position with respect to the vision group described above, but with the components mounted in an overturned manner with respect to that previously described.

[0059] The chamber 4 relating to the first upper vision group 10 uses the backlight 6 belonging to the second lower vision group 10 and vice versa.

[0060] In figure 4 the various fastening means 16 and slots 15, both of the upper and lower viewing unit 10, are easily visible.

[0061] Figure 5 is a further perspective view of the vision group 10, which gives particular importance to the detail of the upper vision group 10.

[0062] Figure 6 schematically shows the control step of the vision group 10 with vertical cameras with a side view, in which it is emphasized how the backlight 6 of the upper vision group 10 is functional to create contrast for the image to be acquired from the lower vision group 10 and vice versa.

[0063] The backlight 6 has a uniform and neutral surface, which can be used as a backdrop in the acquisition of the image relating to the part of interest of the panel 11.

[0064] The backlight 6 comprises a screen that emits its own light, of uniform and opaque color, for example, white.

[0065] The coloring is functional to create a contrast with the color of the panel 11 inspected by the vision group 10 corresponding to the aforementioned backlight 6.

[0066] As it is easy to guess, in view of the great variability of panel materials that can be worked, the possible colors are also very numerous. For this reason, the color of the backlight is not always optimal to increase the contrast of the analyzed part of the panel with respect to the background. The backlight 6 is used only if its color is compatible with that of the panel 11.

[0067] Alternatively, in order to be adaptable to all the conditions and cases for searching for the defect, the

backlight 6 can be interchangeable and/or its color can be automatically changed, so that, for example, if the panel 11 of interest is white in color, it can still be viewed using the backlights to guarantee of optimal contrast.

[0068] The ability to keep the backlight on or off and/or to change its color allows you to always make the panel contrast optimal, according to your needs, effectively making the system active. The adjustment of the active backlight is an example of a variable of the arrangement of the vision system, which can take on different values according to the particular step of the edge banding process and/or the peculiarities of the examined panel and/or edge.

[0069] By way of example only, the quality control process object of the present patent application is briefly described below, set out in the form of an optimized control routine set using the aforementioned communication system between the machine and the vision system.

[0070] The order of the steps is preferential but not essential.

A. Loading the panel data into the machine and the related required processing

[0071] Before processing, the data relating to both the panel and the related processing that will be performed must be communicated to the machine.

[0072] Communication to the machine could take place in various ways:

- the operator manually enters the information (for example by filling in the fields of a created ad hoc form);
- the machine automatically updates itself at the end of a time interval, loading the data relating to future processes, for example: from a database, from a cloud, or from a production management software.

[0073] The data relating to the panel, which must be entered in the machine, are:

- panel dimensions (thickness and length of the four sides);
- thickness of the edge to be applied;
- panel and edge band color to be applied (if they are already registered in the vision group database, or in a database in the machine control unit, they will also have a reference code);
- type of glue to apply;
- color of the glue to be applied;
- expected thickness of the glue thread;
- any direction of the weft (i.e., the direction of a possible wood grain;

this parameter must be communicated to the system to prevent the natural discoloring of the wood from being identified as defects);

- position of any grooves in the panel (as these are necessary for the assembly);
- particular shaping of the edges (if they are not simply flat).

[0074] While, the data relating to the processing, to be entered in the machine, are:

- type of treatment to be performed on the horizontal edges (if edged = 90° angle or, if rounded, the radius angle must be indicated);
- type of treatment to be performed on the vertical edges (if edged = 90° angle or, if rounded, the radius angle must be indicated);
- edging sequence (assign a number to each side of the panel and establish in which order these sides will be edged).

B. Processing of panel and processing data in the machine

[0075] The processing of the data loaded into the machine can be static, namely, it can present an archive of some kind (database, cloud, etc.) that contains a table, which allows associating the set of information loaded into the machine, for example:

- a particular set of controls relating to a specific side of the panel, to be performed with the vision group;
- a particular mechanical configuration of the vision group, optimized to control each side of the panel;
- a particular set of settings for processing the acquired images (the set of parameters for the processing may vary from one side of the same panel to the other, and also from camera to camera).

Example of setting the controls according to the data loaded into the machine

[0076] It is supposed that the edge banding sequence foresees to initially edge band any two sides of the panel that are parallel to each other.

[0077] The vision group when it is checking the 1st or 2nd edging pass does not activate the final check on the radius of the vertical edges of the head and tail, since this check would be useless (since the radius occurs when the edges glued to the two adjacent sides of the panel overlap on a vertical edge).

[0078] On the other hand, when the vision group is in control of the 3rd and 4th passages, that is those which provide for the edge banding of the remaining sides, it will set itself in such a way as to check the radius of the vertical edge of both the head and the tail.

[0079] If, on the other hand, the edge banding sequence were, in order, any two sides of the panel that are adjacent to each other, the vision group would not perform any radius check at the 1st pass but would perform the radius check starting from the 2nd pass and only on the vertical edge of the head. It would then perform

the radius check on the 3rd pass on the vertical edge of the head, and finally, it would perform the check on the radius on the 4th pass both on the vertical edge of the head and on the tail.

[0080] It is important to specify that the optimized set of checks related to one side is not necessarily a subset of the standard complete check routine.

Example of mechanical setting of the vision group, according to the data loaded into the machine

[0081] The general concept of mechanical setting of the vision group is divided into two detailed aspects:

1- spatial configuration (optimized) of the optical elements (cameras, illuminators, and mirrors);
2- configuration (optimized) of the lighting elements.

[0082] Here are some examples of both types of vision group setup.

1 - Examples of optimization of the spatial configuration (processed according to the data loaded into the machine)

[0083] It may be necessary to vary from time to time, depending on the side and/or the panel to be inspected, the position in the space of the optical elements that make up the vision group.

[0084] The purpose of these repositioning is to acquire the best possible images, always having the perfect focal distance and/or the best reciprocal position between the lens and the object to be framed.

[0085] In this step, the processing of the data entered into the machine results only in the determination of the repositioning to be carried out before the inspection of each side to be examined.

[0086] A typical example of this type of setting is given by the translation along Y of the front camera in order to optimize the focal distance according to the thickness of the applied edge.

2 - Examples of optimization of the lighting condition (processed according to the data loaded into the machine)

[0087] The optimal lighting configuration is mainly linked to the combination of panel - edge - glue color.

[0088] The way in which the optimal lighting configuration according to these colors is determined is as follows: ideally, whenever a new material and/or color is introduced into the production cycle (whether it is related to the panel, the edge, or the glue), an operator has to proceed with the survey of the new article or has to implement a short test phase (before starting with the actual production), during which the optimal configuration of the illuminators is determined in order to acquire images that are the best possible.

[0089] Subsequently, the new article is associated with a code which, once stored appropriately (for example in the database in the control unit of the machine, or in the vision group, or in a cloud) uniquely indicates how to set, for example, the illuminators.

[0090] In this phase, the processing of the data entered into the machine results only in the determination of which is the optimal lighting configuration to implement before the inspection of each side to be examined.

[0091] A typical example of this type of setting is given by the switching on of the backlights located in correspondence with the upper and lower cameras. This system would make it possible to make the system active, i.e. adaptable to different lighting conditions.

[0092] In fact, these backlights are swithed on only if the panel and/or edge to be inspected are dark in color (to prevent the edge of the object from being blurred, and therefore cannot be determined with certainty) but, even if they are off, their structure is, however, suitable to provide a uniform background, for example by preventing the view of what is beyond the panel itself, to ensure adequate contrast.

[0093] The image processing parameters are set according to the data loaded into the machine: the processing parameters are mainly linked to the combination of the panel - edge - glue color. Basically, in order to identify the defects, it is necessary that the acquired images are processed in order to highlight them as much as possible.

[0094] In this step, the processing of the data entered into the machine results only in determining the set of optimal parameters for processing the acquired images.

[0095] The parameters that can be set for processing are:

- blur level (for blur we mean a filter that has the effect of "blurring" the desired portion of the image. It is applied to uniform the color of the chosen region so that the defects (discolorations) are more easily identifiable);
- contrast;
- brightness;
- saturation;
- exhibition;
- threshold;
- edge detection.

[0096] Finally, in the event that the edge profiles have particular shapes (shapes that make the edges different from the usual ones, which are simply flat), the image processing could include the application of ad hoc algorithms, to correct perspective deformations and/or parallax errors due to the particular edge profile.

[0097] Also, in this case, the optimal set of processing parameters according to the panel, edge, and glue colors, is determined following a short test step (implemented before starting with the actual production).

[0098] A code is associated with each color and/or material, appropriately stored (in a database in the control

unit of the machine, or in the vision group, or in a cloud), uniquely indicating how to set the processing parameters.

[0099] It is necessary to specify that the set of processing parameters is not necessarily the same for the images acquired by each camera (indeed, the most likely thing is that the images acquired for example by the front camera have a different exposure compared to those acquired by the upper camera).

[0100] Furthermore, characterizing and recording each new material and/or color is not strictly necessary: the vision group will be supplied already equipped with a basic database (which obviously could also be very limited compared to the real working variability of a user of the edge banding machine), and the vision group, being equipped with artificial intelligence, is able to perform a rough self-setting, recognizing which is the color already present in the database most similar to the one to be checked.

[0101] Obviously, not taking a survey of every new article saves time; the disadvantage is that the preliminary test and characterization step allows obtaining the best result in terms of part inspection.

C. Transmission to the vision group of the outputs of the data processing (not essential)

[0102] Basically, the results of processing the data entered into the machine are three:

- determination of an optimized set of checks to be performed (which can be a subset of the complete check routine);
- determination of the optimal mechanical configuration;
- determination of the set of optimal parameters for the post-processing of the acquired images.

[0103] The results of the processing of the data entered into the machine affect the way the vision group operates, so it must be set accordingly.

[0104] Communication to the vision group is not essential since, as already mentioned, it could happen that the vision group is controlled directly by the Programmable Logic Controller (PLC) of the edge banding machine. If this were not the case, data transmission to the vision group could take place either via cable or wirelessly.

D. Preparation of the vision group according to the transmitted outputs

[0105] In this step, the vision group acquires the optimized configuration to inspect the side of the panel in question.

[0106] To set the optimized processing parameters, no particular preparation of the vision group is required.

[0107] The need to perform a particular set of controls and/or some characteristics of the panel - edge - glue set could instead entail the need for an ad hoc arrangement of the vision group.

[0108] Below there are some examples of setting up the vision group that may be necessary following the processing of the data entered in the machine.

1 - Examples of optimization of the spatial configuration (processed according to the data loaded into the machine)

[0109] The movements that can affect the optical elements are:

- For a front camera with respect to the panel (not shown in the figures): translation along Z according to the thickness of the panel (so that the camera is always aligned with the center of the panel, in this way the front inspection of the edge is optimized) and/or translation along the Y axis as a function of the thickness of the edge (so that the focal distance is always optimized) and/or rotation on the XY plane (so that the cone of vision is optimized according to the lighting conditions, the dimensions of the panel and/or the edge, the color of the panel and/or the edge, the feed speed of the piece);
- for the camera 4 (upper and/or lower than the panel): such cameras can, for example, translate along the Z-axis according to the thickness of the panel (so that the focal distance is always optimized) and/or along the Y-axis as a function of the thickness of the edge (so that the framed area always includes the junction area between the edge and the panel, or between the surfaces 12 and 17);
- for the annular lights relating to the camera 4: translation along the Z-axis and/or along the Y-axis, so that the lighting is optimized according to the movements of the corresponding cameras;
- backlights relating to camera 4: translation along the Z-axis and/or along the Y-axis, so that the lighting is optimized according to the movements of the corresponding cameras;
- linear illuminators relating to one or more front cameras (not shown in the figure): translation along with the Y-axis and/or rotation on the XY plane, so that the lighting is optimized according to the movements of said cameras;
- mirrors (not shown in the figure) relative to the front camera (not shown in the figure): translation along with the Y-axis and/or rotation on the XY plane, so that the vision cone of said camera is optimized according to the position of the latter;
- laser 8 relating to camera 4: translation along the Z-axis and/or along the Y-axis and/or rotation in space so that the reciprocal position of the laser and the corresponding cameras is optimal.

2 - Examples of optimization of the lighting condition (processed according to the data loaded into the machine)

[0110] The parameters of the illuminators that can be varied are:

- source on/off
- intensity of the source
- source color
- inclination of the source (halfway between spatial and lighting setting).

E. Setting tolerance thresholds in defect detection (not essential)

[0111] In this step the operator has the right to intervene on the way in which the vision group will operate in the control of the pieces produced; in fact, it can set the system tolerance level in relation to the identified defects.
[0112] The setting of the tolerance thresholds can be done in various ways:

- manually, for example by filling in the fields of an ad hoc created mask;
- automatically, for example, the operator can have the data relating to the setting of the tolerance thresholds loaded from a database, from a cloud, etc.

[0113] If the operator does not intervene directly on these tolerance thresholds, the vision group applies the default ones (set by the factory).
[0114] Below there are three examples relating to the variation of the tolerance thresholds.
[0115] It is assumed that the cameras of the vision group have a maximum resolution of 0,002 mm: this means that the vision group is potentially able to recognize a defect two-hundredths of a mm large.
[0116] Example 1. The operator can choose to set the tolerance threshold of the vision group so that, for example, defects with spatial dimensions between 0,002 and 0,1 mm are detected, but are not considered as defects.
[0117] Example 2. The identification of most defects (for example the presence of scratches, chips, bleached areas, wrong size of the applied edge, wrong applied edge, defects in the glue thread, etc.) is based on the detection, by the group of vision, of local discoloration.
[0118] In other words, defects are recognized when they are larger than the resolution of the cameras and/or their chromatic distance from the expected color is greater than a certain threshold.
[0119] The operator has the possibility to set said threshold so that, for example, on a scale in which the discoloration value is normalized to 10, the defects with chromatic distance from the expected value below level 5 are indeed identified, but they are not considered defects.
[0120] Example 3. Finally, the operator has the possibility to set the tolerance thresholds for the measurements performed: for example, a tolerance of $\pm$ 5% could be set on the measurements performed (radius measurements, the thickness of the glue wire, straightness of the edges, etc.) within which the defects are detected, but are not considered as such.

F. Processing of the panel (not essential)

[0121] The panel is edged, one side at a time, following the edging sequence defined upstream of the process.

G. Implementation of adequate control operations

[0122] In the machine, downstream of all the operating groups, there is the vision group module.
[0123] At the end of the processing, the just edged side is subjected to quality control.
[0124] The vision group only carries out the checks that have been defined in the step described in point B., following the processing of the data entered in the machine.

H. Processing of the acquired images

[0125] The images acquired by the vision group during the execution of the set of controls, defined in step B, are processed instantly, applying the parameters defined in the same step B and with the tolerance thresholds set in step E, if it occurred, or with the default tolerance thresholds.
[0126] The processing of the acquired images can take place by the processor dedicated to the vision group, or by the processor dedicated to the machine if the vision group is managed directly by this processor.
[0127] The result of the processing of the scanned images basically results in an evaluation of the edging process.

I. Sending a signal concerning the checks carried out (Not essential)

[0128] The result of the evaluation of the edging process is notified by the machine. This could happen in various ways, and addressed to various destinations.
[0129] For example, by sending signals to the operator, such as:

- sound, light, haptic alerts;
- written notifications that appear on the control panel and/or on the keypad and/or on the device owned by the operator (for example tablet, mobile phone, etc.) and/or the signal could also be produced and sent to a cloud or other.

[0130] In a further possible control routine, carried out by the system described in this patent application, the steps at points B and C can be inverted.

[0131] For this reason, it is important to emphasize that the order of the steps is not fundamental.

[0132] Furthermore, when it mentioned "data transmission to the vision group", it is meant the transmission of raw and/or already processed data to the control unit of the vision group, which could have different locations:

- Integrated into the PLC of the machine (in this case the transmission would be unnecessary, (for this reason the transmission passage to the vision group is not necessary);
- Processor dedicated to the vision group, physically placed close to the processors dedicated to the machine;
- Processor dedicated to the vision group, physically placed away from the processors dedicated to the machine (for example processor of the vision group contained in a container fixed on the rear side of the fixing structure of the optical equipment).

[0133] A communication system between a vision group for an edge banding machine, the edge banding machine itself, and the user, made as previously described and according to the examples illustrated in detail in figures 1, 2, 3, 4, 5, 6, and 7 attached, it, therefore, has the following advantages:

- Expanding and improving the overall field of vision of the vision system;
- Being able to be integrated into existing edging machines and other control systems;
- Increase the resolution of the acquired images, to have a more precise evaluation of the various defects;
- The presence of a backlight, which acts as an active backdrop, allows maximizing, from time to time, the contrast with respect to the panel examined;
- Increase the quality of the machining leaving the edge banding machine;
- More accurately evaluate any local defects and therefore imperfections of the edge banding;
- Having "leaner" processing of the acquired images, given by the reduced quantity of images that need to be acquired;
- Having "leaner" processing of the acquired images, given the fact that not always all the operations of the complete standard control routine must be performed and/or the maximum processing power is not always required in the post-processing step;
- Have a fast enough system to be compatible with the working speed in the car;
- Affect a limited production cost, compared to traditional solutions, in relation to the advantages achieved.

[0134] The invention thus conceived and illustrated here is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept.

[0135] Furthermore, all the details can be replaced by other technically equivalent elements.

Claims

1. Quality control process of the edging of a panel (11) by an edge banding machine by means of a vision group (10) **characterized in that** it comprises the following step:

   loading first data relating to said panel (11), and second data relating to the process to be carried out on said panel (11);
   processing said first data and said second data, to generate third processed data;
   arranging the vision group (10) according to said third processed data generated during the step of processing said first data and said second data;
   performing control operation by the vision group (10), based on third data, to acquire images;
   processing the image acquired by the vision group (10) during the phase of performing control operations, to identify features of the panel (11), in particular, to identify defects.

2. Quality control process of the edging of a panel (11), according to claim 1 **characterized in that** it provides, after the phase of processing said first data and said second data, and before the step of arranging the vision group (10) according to said third data, the following phase: transmitting said third data to the vision group (10).

3. Quality control process of the edging of a panel (11), according to one of the claims 1-2, **characterized in that** it comprises, before the step of performing control operation by the vision group (10) and/or after the phase of processing the image acquired by the vision group during the phase of performing control operations the following phase:
   loading tolerance thresholds of the vision group (10), relative to the detected defects.

4. Quality control process of the edging of a panel (11) according to one of claims 1-3, **characterized in that** it comprises, after the step of performing control operations, the following phase:
   issuing a signal concerning the checks carried out by the vision group.

5. Quality control process of the edging of a panel (11) according to one of the claims 1 to 4, **characterized in that** said phase of processing said first data and said second data provides the association of said first data and second data with a base of fourth data,

in particular, organized in a table form, which allows associating said first data and second data to:

- a particular set of checks that can be carried out by the vision group (10);
- and/or a particular mechanical configuration of said vision group (10);
- and/or a particular set of settings for processing the image acquired by said vision group (10).

6. Quality control process of the edging of a panel (11) according to claim 2, **characterized in that** said step of transmitting to the vision group (10) said third processed data, comprises:

- determination of an optimized set of checks to be performed;
- and/or determination of the optimal mechanical configuration;
- and/or determination of the set of optimal parameters for the processing of the acquired images.

7. Edge banding machine equipped with a vision group (10), **characterized in that** it implements a quality control process for the edging of a panel (11) according to one of the claims 1-6.

8. Edge banding machine (1) according to claim 7, comprising a plane (x) for supporting and advancing along a sliding direction (R) of a panel (11),
wherein said vision group (10) comprises a first chamber (4) having a viewing cone, provided with a first bisector (22), wherein said first bisector (22) is perpendicular with respect to said sliding direction (R) of said panel (11),
characterized in that the vision group (10) comprises a first backdrop (6) located along said bisector (22) of the viewing cone of said first chamber (4) and in a position opposite to said first chamber (4) with respect to said plane (x).

9. Edge banding machine (1) according to claim 8, wherein said first backdrop (6) comprises at least one of the following characteristics: it is opaque, it is uniformly colored, it is interchangeable, it comprises an illuminator, it has a variable coloring.

10. Edge banding machine (1) according to claim 8 or 9, **characterized in that** said first chamber (4) comprises an optic, and by further comprising a first illuminator (7), for illuminating the edge of said panel (11), arranged to face said optic of said first chamber (4).

11. Edge banding machine (1) according to claim 10, **characterized in that** said first illuminator (7) is circular.

12. Edge banding machine (1) according to one of the claims 8-11, **characterized in that** it comprises a first laser (8) located adjacent to said first chamber (4), wherein said first laser (8) is inclined by a first angle (21).

13. Edge banding machine (1) according to claim 12, **characterized in that** it comprises first adjustment means (15, 16) for adjusting the position of said first laser (8), so as to allow adjustment of the angle of the radius of said first laser (8) with respect to said bisector (22).

14. Edge banding machine (1) according to one of the claims 8-13, **characterized in that** said first chamber (4) is provided with second adjustment means (15, 16), to adjust the distance and the angle of said chamber (4) with respect to said panel (11).

15. Edge banding machine (1) according to any one of claims 7-14, comprising at least two vision groups (10), wherein said two vision groups (10) are arranged reciprocally in central symmetry with respect to the plane (x).

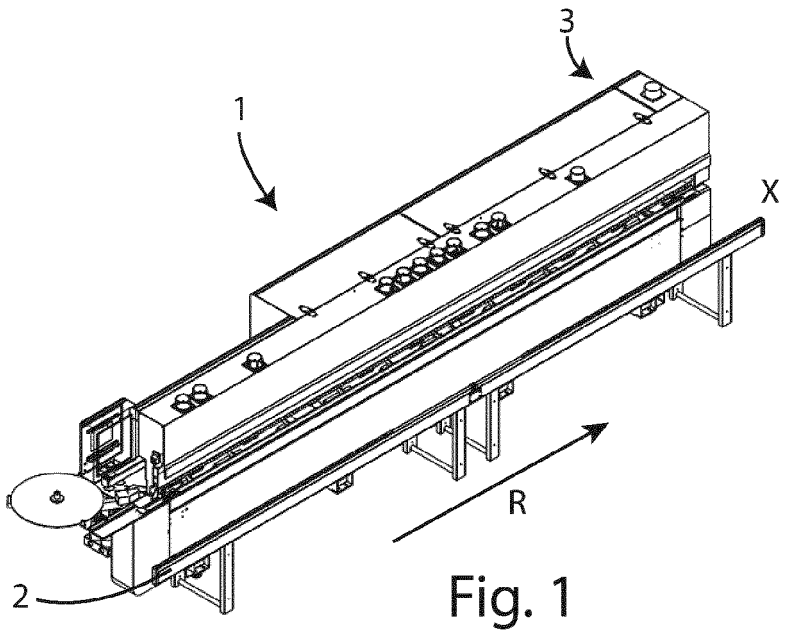
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Fig. 1

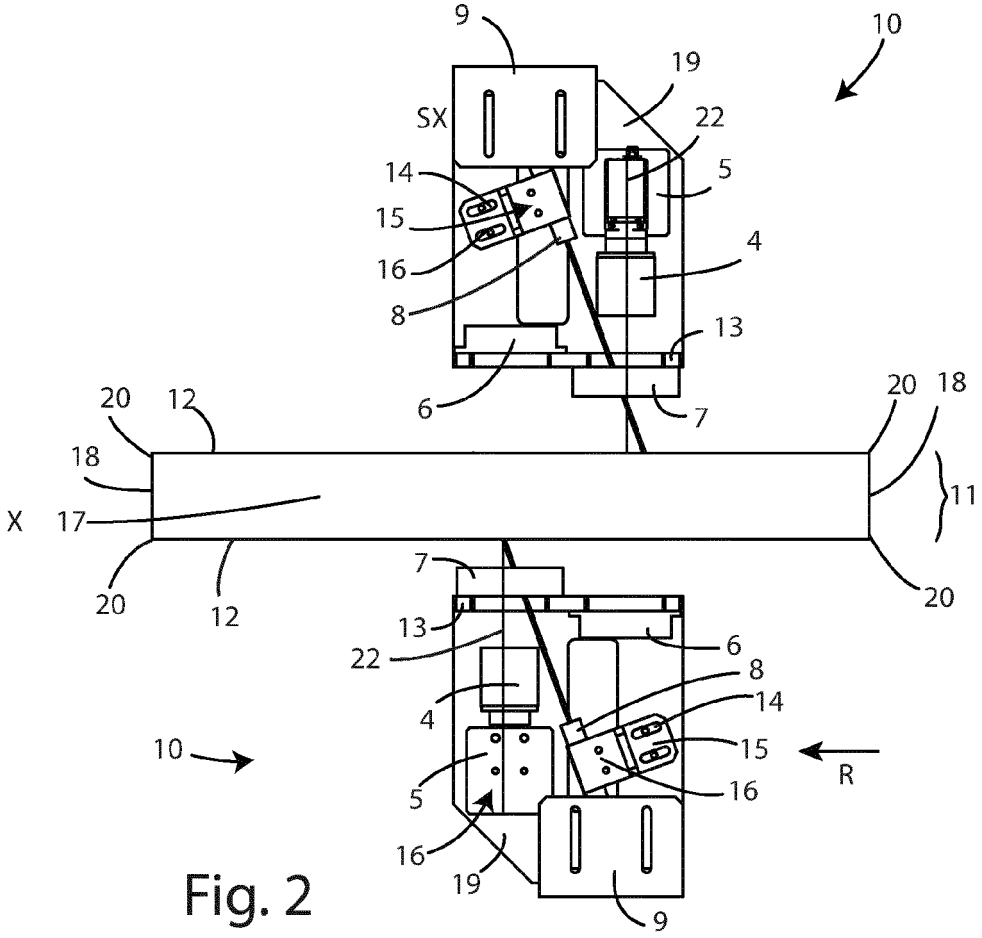
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Fig. 2

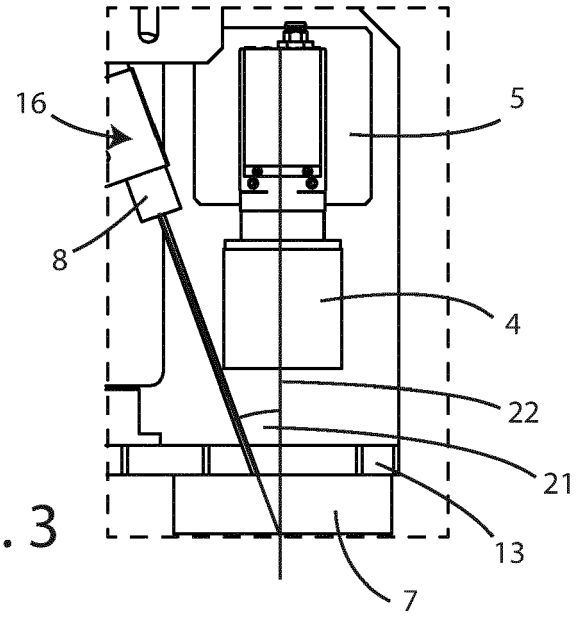
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Fig. 3

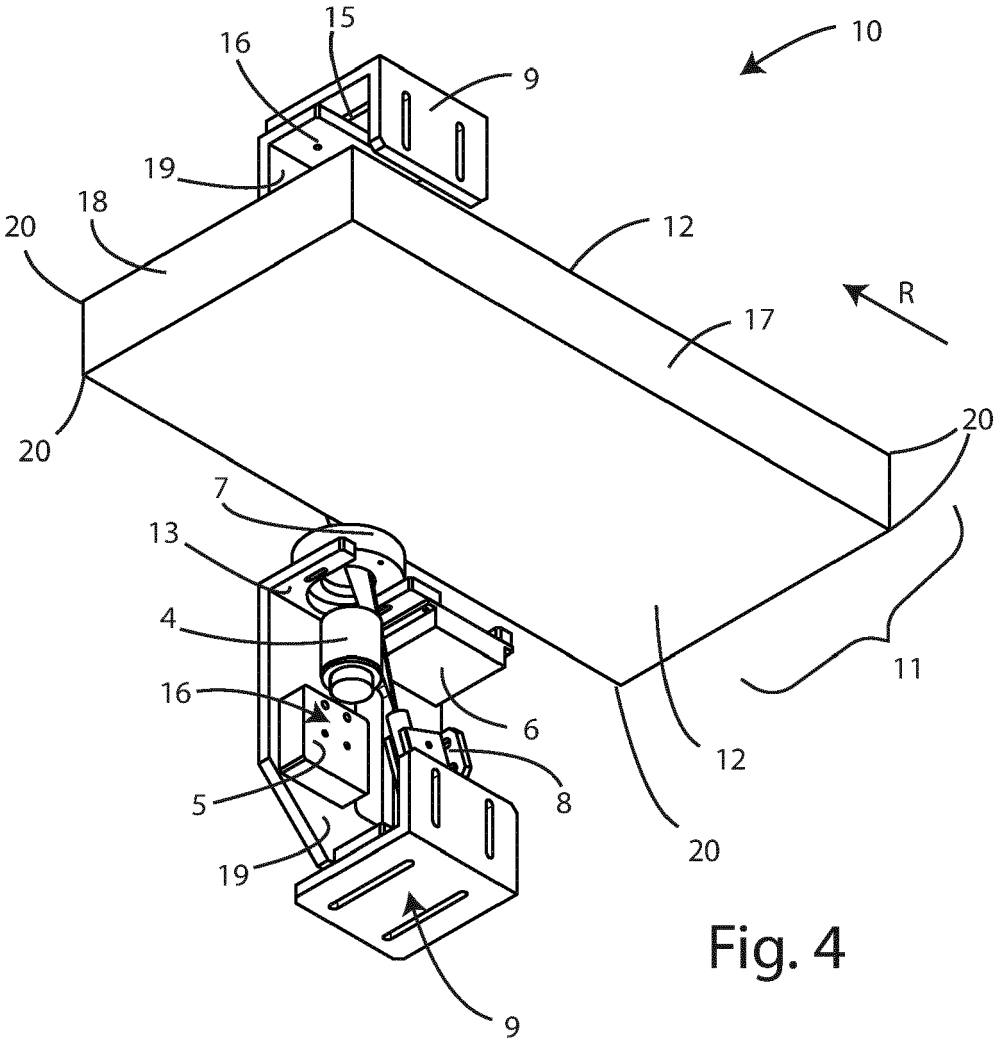
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Fig. 4

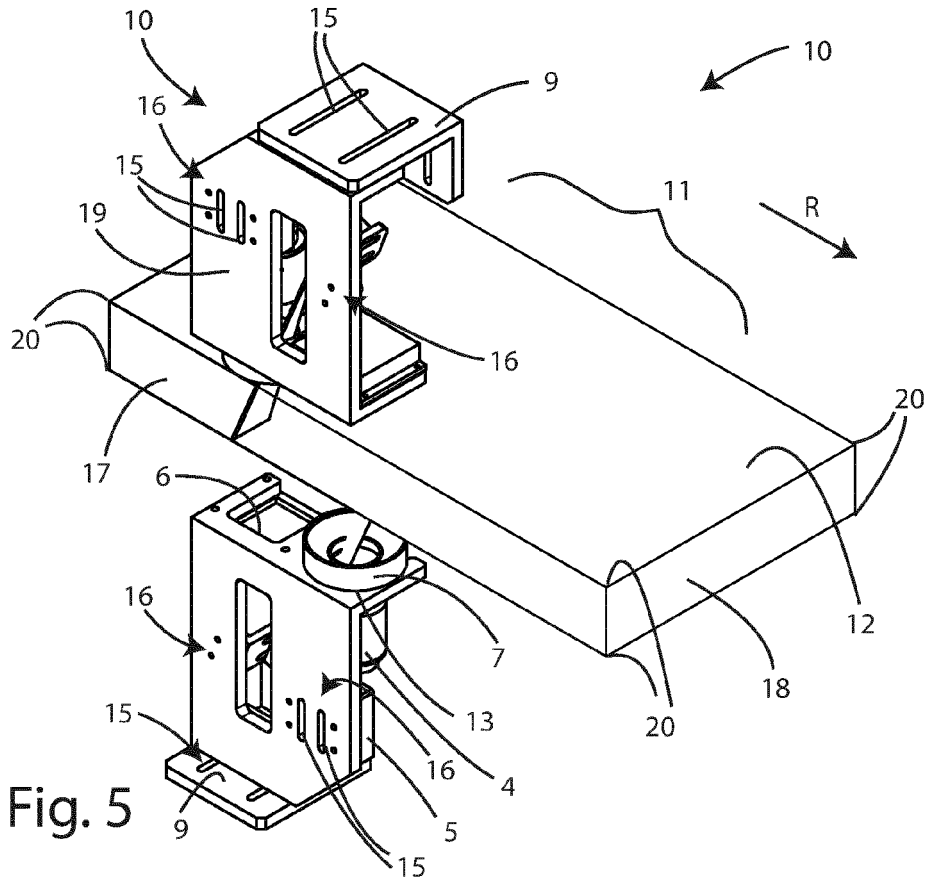
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Fig. 5

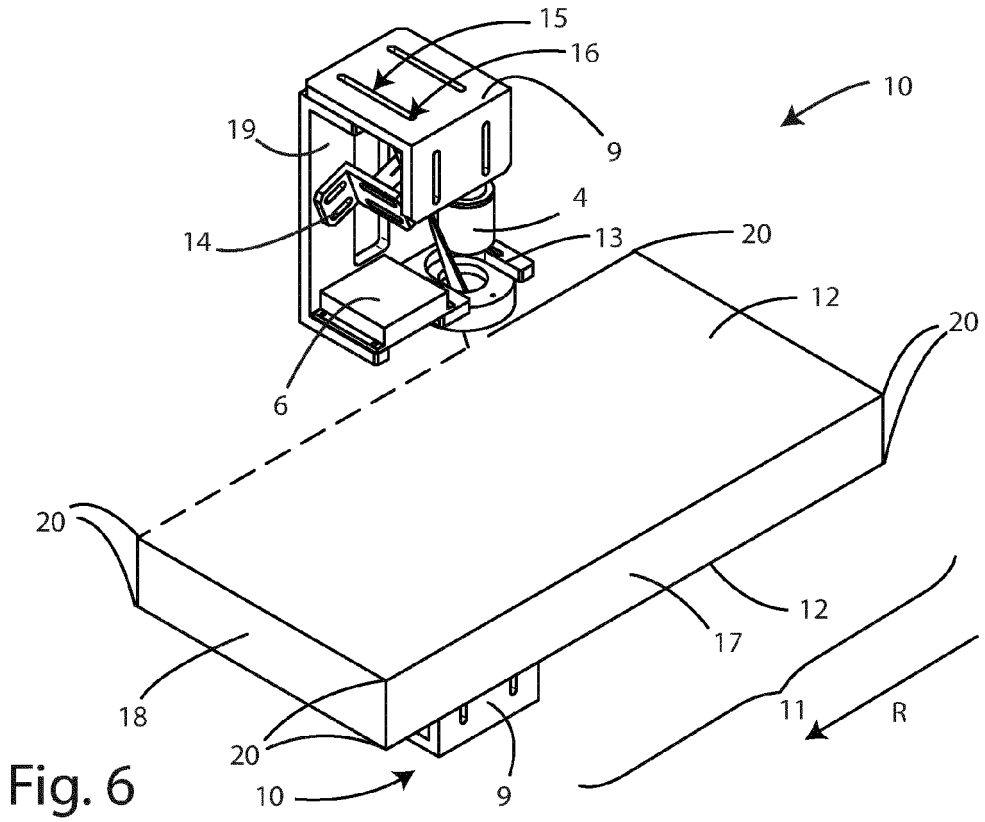
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Fig. 6

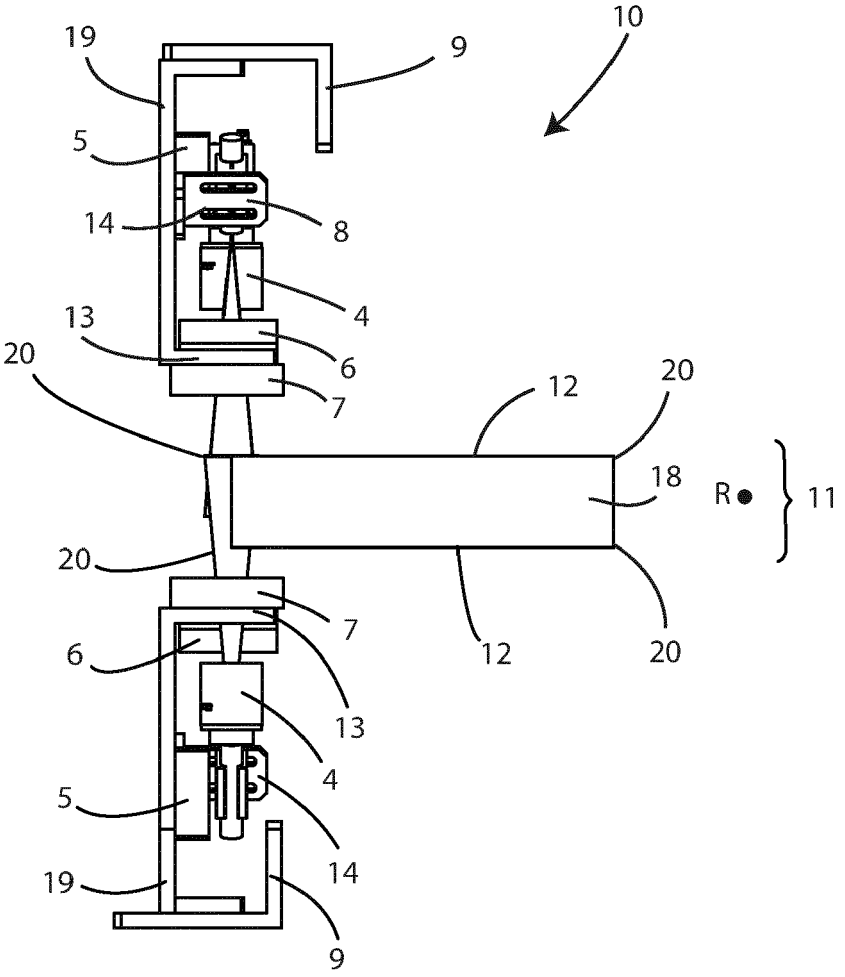

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 20 20 3203

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 1 464 470 A2 (SCM GROUP SPA [IT]) 6 October 2004 (2004-10-06) * abstract * * paragraphs [0008], [0015], [0016], [0019], [0020], [0037], [0038] * * figures * -----	1-15	INV. B27D5/00

TECHNICAL FIELDS SEARCHED (IPC)

B27D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 March 2021	Hamel, Pascal

CATEGORY OF CITED DOCUMENTS

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24-03-2021

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