

FIG. 5

DescriptionCROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Patent Application claims priority from Italian Patent Application No. 102018000003968 filed on March 26, 2018.

TECHNICAL FIELD

[0002] The present invention relates to a method and plant for grinding a flat glass article.

BACKGROUND ART

[0003] As is known, the perimeter surfaces of many flat glass articles obtained by cutting a sheet of extended glass must subsequently be ground, for example, to eliminate surface imperfections and/or jagged edges and, when required, to bevel or round sharp corners.

[0004] For this purpose, to date, the use is known of grinding machines, the so-called "double edging machines", in which the article, arranged horizontally or flat, is fed between two rows of grinding wheels; the grinding wheels simultaneously grind two opposite lateral sides of the article. After two passages in the double edging machine and a rotation of 90°, the sides of the article are completely ground. When bevelling of the corners is also required, a respective bevelling grinding wheel is added to each row of grinding wheels, positioned in cascade with respect to the grinding wheel for grinding the sides and it grinds the corners upon completion of the grinding of the sides.

[0005] Known double edging machines are valued for an elevated production of identical articles, while they find scarce value in the case of articles having different dimensions from one another. In fact, in such conditions, with every change of article, it is necessary to empty the machine and wait for the end of production and, consequently adjust the distance between the rows of grinding wheels to adapt the machine to the width of the new article. This requires relatively long setting times, which harm production.

[0006] The above mentioned problem is solved by using grinding machines, the so-called "straight grinding machines", which comprise only one horizontal row of vertical cup grinding wheels, onto which the articles, arranged edgewise, are passed, until grinding of all of the side surfaces is achieved.

[0007] When grinding of the corners is also required, after grinding of the side surfaces, the articles are transferred to a bevelling or corner rounding station, put back horizontally or arranged flat and repositioned on a grinding assembly. It follows that, on the one hand, the plants, which use straight grinding machines are extremely cumbersome and costly and, on the other, that the grinding of the corners takes long periods of time due to the transfer and repositioning of the article, which are frequently

responsible for errors, both with regard to dimensions and shapes, deriving from the essential handling and necessary overturning of the products before processing of the corners. Frequently, during the handling and successive repositioning, which are mainly performed by hand, the articles can be scratched or damaged and therefore, must subsequently be discarded.

DISCLOSURE OF INVENTION

[0008] It is an object of the present invention to provide a grinding method and plant for grinding a flat glass article, which allow the above mentioned problems to be overcome in a simple and cheap manner and, in particular, reducing the grinding times with respect to the known methods, simultaneously producing products of elevated and consistent quality with regard to dimensions and shapes.

[0009] It is a further object of the present invention to provide a grinding plant, which is primarily compact and has contained costs.

[0010] It is a final object of the present invention to provide a fully automated grinding plant, which does not require the intervention of the operator.

[0011] A grinding method is provided, according to the present invention, for grinding a flat glass article, as claimed in claim 1.

[0012] Furthermore, according to the present invention, a grinding plant is provided for grinding a flat glass article, as claimed in claim 11.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention will now be described with reference to the accompanying drawings, which illustrate a non-limiting embodiment thereof, wherein:

Figure 1 shows a plan view of a schematically and substantially block diagram of a preferred embodiment of a grinding plant for grinding flat glass articles made according to the dictates of the present invention;

Figure 2 is similar to Figure 1 and shows a plan view of a second preferred embodiment of the plant according to the present invention;

Figure 3 shows a side elevation, on a significantly enlarged scale, of a detail in Figures 1 and 2;

Figure 4 is a perspective view of the detail in Figure 3; Figures 5 and 6 show a flat glass article partially ground in the plant in Figure 1; and

Figures 7 and 8 are similar to Figures 5 and 6 and show a flat glass article partially ground in the plant in Figure 2.

BEST MODE FOR CARRYING OUT THE INVENTION

[0014] In Figure 1, a plant for grinding a flat glass article 2 is globally indicated with 1. In the described example,

the article 2 is rectangular and has two opposing flat surfaces, indicated with 3 and 4, four consecutive flat perimeter surfaces to be ground, indicated with 5, 6, 7 and 8 respectively and four corners 9 with a right angle, each delimited by a relative pair of the aforesaid perimeter surfaces 5,6,7 and 8.

[0015] Again with reference to Figure 1, the plant 1 comprises two straight grinding machines 10 and 11, which are known in themselves and comprise respective horizontal rows of grinding wheels 12 and 13 having substantially vertical cup rotation axes, parallel to each other. Then, each machine 10,11 comprises a respective flat support structure or back 14, which extends upwards from a base of the relative machine 10,11 orthogonally to the rotation axes of the corresponding grinding wheels 12,13, adapted to maintain the article 2 to be ground edgewise. Here and below, the term "edgewise" is understood to mean an article arranged vertically or in a position, which is slightly inclined, for example, by 5-7 degrees, to ensure the stability thereof resting on the back 14. Then, each machine 10,11 comprises, associated with the relative base, a motorised feeding assembly 15, known in itself, for feeding the article 2 to be ground, edgewise over and in contact with the grinding wheels 12,13.

[0016] The rows of grinding wheels 12,13 extend along two branches R1 and R2, which are parallel and transversely spaced apart from each other, of an open path R for grinding the article having a plan U shape. The path R also has a further branch R3, which joins the end stretches of the branches R1 and R2, extends transversely to the branches R2 and R3 and crosses a corner grinding station 18, which forms part of the plant 1.

[0017] The grinding station 18 houses a corner grinding assembly 19 for the article 2.

[0018] With reference to Figure 1 and, in particular, to Figures 3 and 4, the grinding assembly 19 comprises a fixed support frame 20 resting on the floor. The frame 20 is a portal frame and comprises two uprights 21 and a plurality of horizontal bars 22, which define a lying plane P orthogonal to the axes of the grinding wheels 12, wherein the article 2 is arranged edgewise. The frame 20 bears a V-shaped structure 23 with the top facing downwards and arms 24 and 25 forming between one another an angle A. In the illustrated example in Figure 3, the structure is fixed to the frame 20 and the angle A is fixed and equal to 90°. According to one variation, the arms 24 and 25 are hinged to each other or to the frame 20 and they are adjustable on the plane P for varying the angle A.

[0019] The structure 23 forms part of a positioning and retaining assembly 26, which, for each of the arms 24,25, comprises a relative row of horizontal support pegs 26,27 for the article 2, which are fixed to the relative arms 24,25 and protruding in a cantilever fashion from the support plane P. Then, the assembly 26 comprises one or more retaining suction cups 28 for the article 2, only one of which is visible in the accompanying figures, arranged

at the top of the structure 23 for retaining the article 2 against the bars 2 and resting on the pegs 26,27.

[0020] Again with reference to Figures 3 and 4, a corner grinding assembly 30 is arranged below the V-shaped structure 23, between the uprights 21, comprising a further portal structure 31, which is fixed with respect to the frame 20, comprising, in turn, uprights thereof 32 and a crosspiece 33.

[0021] Then, the grinding assembly 30 comprises a motorised grinding head 34 and a device 35 for moving the grinding head 34. The moving device 35 comprises two motorised guiding and sliding assemblies, indicated with 36 and 37, for moving the grinding head 34 in two directions X and Y, which are orthogonal to each other and parallel to the plane P, including a horizontal one. According to one embodiment, the grinding head 34 comprises only one grinding wheel rotating about an axis 38 orthogonal to the plane P. According to one variation, the head 34 comprises a row of grinding wheels positioned mutually side-by-side along the axis 38. In this case, the moving device 35 comprises a further motorised guiding and sliding assembly for moving the head along the axis 38 and selecting one of the grinding wheels in the row.

[0022] Again with reference to Figure 1, a robotic manipulator 40, which is known in itself, is arranged in the grinding station 18, inside the path R and comprises a gripping head 41, conveniently with suction cups, adapted for coupling to the article 2 and configured to move the article 2 to and from the plane P and to rotate the article 2 about an axis orthogonal to the surfaces 3,4, as will be described better below.

[0023] Again with reference to Figure 1, the machines 10 and 11, the robotic manipulator 40 and the corner grinding assembly 19 are connected to a command and control unit 42, which is configured to synchronise the robotic manipulator 40 and the machines 10,11 and to grind the corners by commanding the movement of the grinding head 34 in the directions X and Y and along the axis 38, when necessary.

[0024] In use, the article 2 is taken to an inlet 10A of the machine 10, arranged edgewise against the relative back 14, for example, with the surface 5 facing downwards and fed along the branch R1 on the row of grinding wheels 12. When the article 2 reaches the outlet 10B of the machine 10, the surface 5 is completely ground. At this point, the article 2 is picked up by the manipulator 40 and moved to the station 18 maintaining it edgewise. On reaching the station 18 or during the journey to the station 18, and assuming the corner 9A (Figure 5) has to be ground, the article 2 is rotated clockwise about an axis orthogonal to the plane P of an angle equal to half of the angle of the corner to be ground, in this particular case 45° and thus resting on the two rows of pegs 26,27. When positioning is complete, the ground surface 5A is arranged against the pegs 27, the surface 6 is arranged in abutment against the pegs 26, the corner 9A protrudes downwards past the last two pegs 26,27 and the bisector of the angle 9A lies, conveniently, in a vertical plane P1

orthogonal to the plane (Figure 3) . At this point, the article 2 is held, by means of the suction cup 28, on the plane P and against the pegs 26,27 and the grinding head 34 is moved, combining the movements in the two directions X and Y, along a circular trajectory, so as to produce a curved surface 48 (Figure 5) having a centre C of curvature arranged on the article 2 and a radius of curvature T equal to the desired corner rounding radius. The grinding head 34 is controlled by the unit 42 in such a way that the curved surface 48 produced has an end 48A tangent to an end stretch of the ground surface 5A and an end 48B, opposite the end 48A, which is recessed with respect to the surface 6, waiting to be ground, as shown in Figure 5. In Figure 5, the surface 5 to be ground is indicated with a dotted line and the ground surface 5A and surface 48, with a continuous line.

[0025] Again with reference to Figure 5, the end 48B is recessed with respect to the surface 6 to be ground of a quantity S equal to the quantity of glass, which will be removed from the article 2 during the successive grinding of the surface 6. Upon completion of the curved surface 48, the manipulator 40 picks up the article 2 and, always maintaining it parallel to the plane P, rotates it anti-clockwise by 90°, until the surfaces 5A and 8 respectively are brought against the pegs 26 and the pegs 27. In such position, the corner 9B protrudes downwards and is processed just like the corner 9A, making a circular surface 49, an end stretch 49A of which is tangent to the surface 5A and an opposite end stretch 49B of which is recessed with respect to the surface 8 to be ground of an amount equal to the thickness S1 of glass, equal or different from the thickness S and which will be removed from the article 2 during the successive grinding of the surface 8.

[0026] Upon completion of the surface 49, the article 2 is picked up by the manipulator 40 rotated anti-clockwise by 45°, moved to an inlet 13A of the machine 13 and the surface 8 fed over the grinding wheels 13 removing the thickness S1 of glass thus bringing the stretch 49B tangent to the ground surface 8. Upon completion of grinding of the surface 8, the article 2 is picked up by an operator or by a manipulator similar to the manipulator 40 and brought back to the inlet 10A of the machine 10, arranging it with the surface 7 to be ground facing downwards, then, the surfaces 7, the corners 9C and 9D and the surface 6 are ground following the same grinding steps described previously. At the outlet 13B of the machine 13, the article 2 is completely ground. If one or more of the corners 9 need polishing, for example, after making the relative curved surface, the grinding head 34 is translated along the axis 38, thus selecting a grinding buffing polishing wheel and subsequently moved along the curved surface.

[0027] The embodiment illustrated in Figure 2 relates to a plant 50, which differs from the plant 1 in some components, and the constituent parts of which are distinguished, where possible, by the same numeral references as the corresponding parts of the plant 1.

[0028] In the plant 50, the article 2 is ground along a

closed loop grinding path R', which differs from the path R in that it comprises a transversal stretch R4 facing the stretch R3 and closing the path R. In the plant 50, the stretch R4 crosses a grinding station 51, which houses a corner grinding assembly 52 identical to the grinding assembly 19.

[0029] In the plant 50, after processing the surface 5 on the machine 10, and rounding the corner 9A as described previously (Figure 7), the article 2 is transferred to the machine 13, and the surface 6 is ground before transferring it to the station 51 where the corner 9C is processed. At this point, the article 2 is rotated and brought back to the inlet 10A of the machine 10 again and fed along the path R1 processing, in succession, a surface and an adjacent corner, as described previously.

[0030] From the above, it is clear that the described plants 1 and 50 are particularly compact. The above is basically due to the fact that the grinding station (s) 19,51 are arranged between two straight grinding machines and due to the fact that, like the grinding of the perimeter surfaces, the corners are also processed maintaining the article vertical or edgewise. The arrangement of the grinding station(s) immediately downstream of one of the grinding machines 10,11 is made possible by the particular procedure according to which each corner is ground, a procedure, which comprises the processing of one of the side surfaces delimiting the corner, upon completion of the grinding of the same corner, i.e. also before the processing of the second perimeter surface, which delimits the corner.

[0031] Experimentally, it was possible to observe that such corner grinding method does not compromise the quality of the ground article in any way as the rounding curve of the corner is immediately tangent to one of the ground perimeter surfaces and becomes tangent to the other perimeter surfaces upon completion of the other perimeter surface.

[0032] The consistent, high quality of the dimensions and shape of the articles is guaranteed by the fact that the positioning of the article does not depend on the precision of the manipulator since the article is positioned by gravity. In detail, the pegs 26,27 provided in the station or stations 18,51 define a stable support, on the one hand, and, on the other, due to the effect of the convergence in a V thereof, an unvarying and efficient article centring device. Furthermore, the pegs 26,27 leave the corner to be ground significantly uncovered, so there are no limits to the increasing of the corner rounding radius. At the same time, the particular arrangement of the suction cup 28 allows the article to be held stably and effectively and, above all, the article to be gripped in an area very close to the grinding wheel 34. This allows the portion of glass extending in a cantilever fashion towards the grinding wheel to be reduced to a minimum and, consequently the vibration of the article to be prevented or, at least, minimised, which, as we know, influences the surface finishing and can compromise the integrity of the article. Thus, it follows that the described method and

plants 1 and 50 allow high quality articles to be obtained, in all of the grinding processes and at one same work island.

[0033] The fact that the article is arranged with the corner facing downwards in each of the grinding stations 19,51, allows the grinding assembly 30 to be kept at floor level, so it is easily accessible for checks and/or maintenance. In addition to this, the arrangement of the grinding assembly 30 below the article to be processed, allows the corners to be ground regardless of the dimensions of the article since the article is free to extend in height. No limitation to the dimensions of the article or to the shape thereof and consequently to the geometry of the corners is thus imposed, nor by the V-shaped structure 23, the same being adjustable upon variation of the angle of the corner to be processed. If necessary, the position of the suction cup could also be adjustable.

[0034] From the above, it is clear that modifications and variations can be made to the described plants 1 and 50.

[0035] In particular, the support pegs 26,27 could be replaced by flat surfaces or adjustable shaped surfaces, or not. Besides this, the plan shape of the grinding path R when open could be different, in the sense that the machines 10 and 11 and the station 18 could be, for example, mutually aligned. In this case, the grinding station 18 is interposed between the two straight grinding machines and the manipulator 40 is configured to move the articles to and from the grinding station 18.

[0036] Finally, it is clear that the described plant 1 could possibly comprise only one straight grinding machine, for example, the only machine 10 arranged upstream of the station 18 in the feeding direction of the article 2.

[0037] Again, the described plants 1 and 50 not only allow the corners to be rounded, as described, but also corners to be bevelled, creating any grinding surfaces. This is made possible by the fact that the grinding head 34 is controlled by the unit 42 and can be moved along two axes X and Y, orthogonal to each other.

Claims

1. A grinding method for grinding a flat glass article having at least two perimeter surfaces to be ground forming between one another a given angle and a first corner to be ground delimited by the same two perimeter surfaces; the method comprising the steps of arranging the flat glass article edgewise, of feeding the glass article, maintaining it edgewise, over a horizontal row of grinding wheels of a grinding machine until completing grinding of a first of said two perimeter surfaces, of feeding said article still edgewise on a row of grinding wheels of a grinding machine until completing grinding of a second of said perimeter surfaces and grinding of said first corner; **characterized in that** grinding of said first corner is carried out after grinding of the first perimeter surface

and before grinding of said second perimeter surface, maintaining the flat glass article edgewise or in a substantially vertical position.

2. The method according to claim 1, **characterized in that** grinding of said first corner is carried out by producing a circular surface having a centre of curvature on said article and having a first end tangent to an end stretch of the first ground perimeter surface and a second end opposite said first end; said second end being recessed with respect to the second perimeter surface to be ground.
3. The method according to claim 2, **characterized in that** said second end is recessed by an amount equal to the thickness of glass removed from the article during grinding of said second perimeter surface.
4. The method according to any one of the preceding claims, **characterized in that** said glass article comprises a second corner delimited by said first perimeter surface and by a third perimeter surface opposite said second perimeter surface with respect to the first perimeter surface; said first and third perimeter surface forming between one another a further given angle; said second corner being ground before grinding of said third perimeter surface.
5. The method according to claim 4, **characterized in that** said second corner is ground before grinding of said second surface and immediately after grinding of said first corner.
6. The method according to any one of the preceding claims, **characterized in that** grinding of said corner is carried out by arranging said glass article in a grinding position wherein the corner to be ground is facing downwards.
7. The method according to any one of the preceding claims, **characterized in that** grinding of said corner is carried out by rotating said article around a horizontal axis until the article is taken to a rotated grinding position, in which the bisector of said predetermined angle lies in a vertical plane, orthogonal to a plane on which said article lies.
8. The method according to any one of the preceding claims, **characterized in that** grinding of said corner is carried out by resting said perimeter surfaces on horizontal mechanical abutment elements arranged in a V and blocking said article in contact with said mechanical abutment elements.
9. The method according to any one of the preceding claims, **characterized in that** grinding of said perimeter surfaces and of said corner are carried out by feeding said article arranged edgewise along a

grinding path passing through, in succession, a first row of grinding wheels, a grinding station for grinding of said corner and a second row of grinding wheels separated from said first row of grinding wheels.

10. The method according to claim 9, **characterized in that** said article arranged edgewise is picked up at the outlet from the first row of grinding wheels, transferred into the grinding station, picked up from the grinding station and transferred into an inlet of the second row of grinding wheels by means of a robotic manipulator.

11. A grinding system for grinding a flat glass article having at least two perimeter surfaces to be ground forming between one another a given angle and a first corner to be ground delimited by the same two perimeter surfaces; the system comprising a first row of grinding wheels for machining one of said perimeter surfaces, support means for maintaining said article edgewise above said first row of grinding wheels and feed means for feeding the glass article edgewise on said first row of grinding wheels, **characterized by** further comprising a first grinding station of said first corner arranged downstream of said first row of grinding wheels in a direction of feed of said glass article; and a first corner grinding assembly housed in said first grinding station; said first corner grinding assembly comprising a fixed frame, positioning and retaining means carried by said fixed frame and defining a substantially vertical lying plane for maintaining the glass article arranged edgewise in a corner grinding position, at least one grinding wheel, a motorized assembly for movement of said grinding wheel at least in a plane parallel to said lying plane and with respect to said fixed frame, and a motorized manipulator to transfer said article away from and towards said first corner grinding station and position the article in said first grinding station; the system further comprising a control unit configured to control said manipulator and said motorized assembly.

12. The system according to claim 11, **characterized in that** said grinding wheel is arranged below said positioning and retaining means.

13. The system according to claim 11 or 12, **characterized in that** said positioning and retaining means define a V-shaped rest.

14. The system according to one of the claims from 11 to 13, **characterized by** having an open grinding path of the article passing through said first grinding station and along which said first row of grinding wheels extends and by comprising a second row of grinding wheels identical to, and separated from, said first row of grinding wheels and arranged along

said grinding path; said first and second row of grinding wheels being arranged on opposite sides of said first grinding station.

5 15. The system according to any one of the claims from 11 to 13, **characterized in that** said grinding path is a closed loop path, and **in that** it further comprises a second corner grinding station housing a second grinding assembly identical to said first grinding assembly; said first and second grinding stations being arranged on opposite sides of both said first and second row of grinding wheels.

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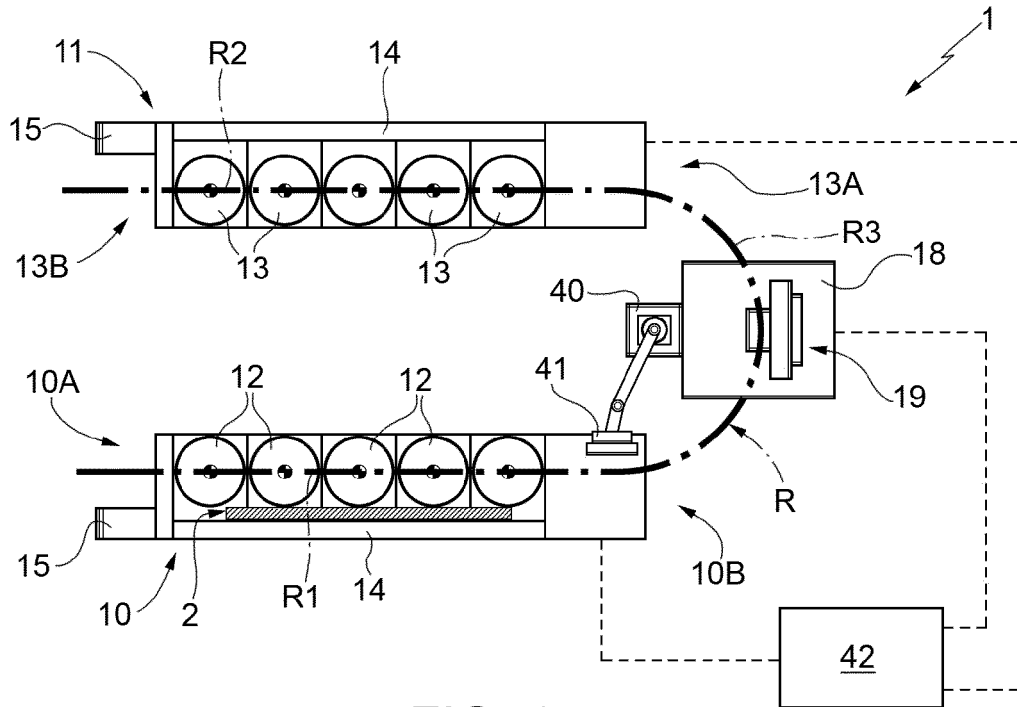


FIG. 1

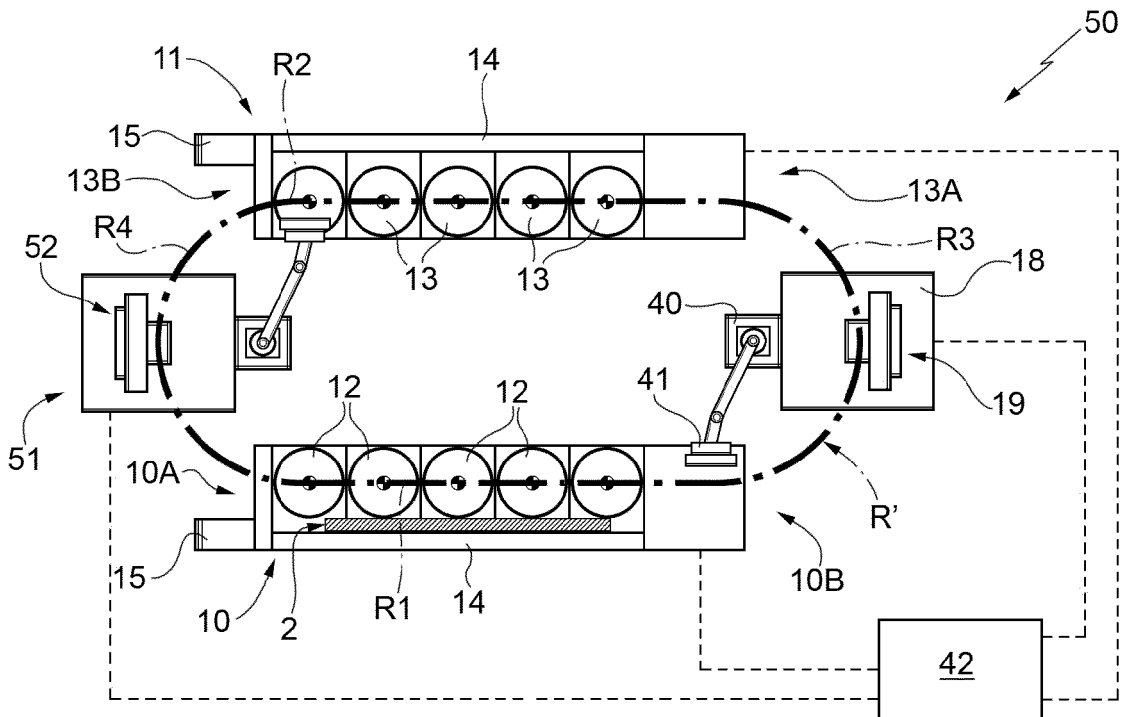


FIG. 2

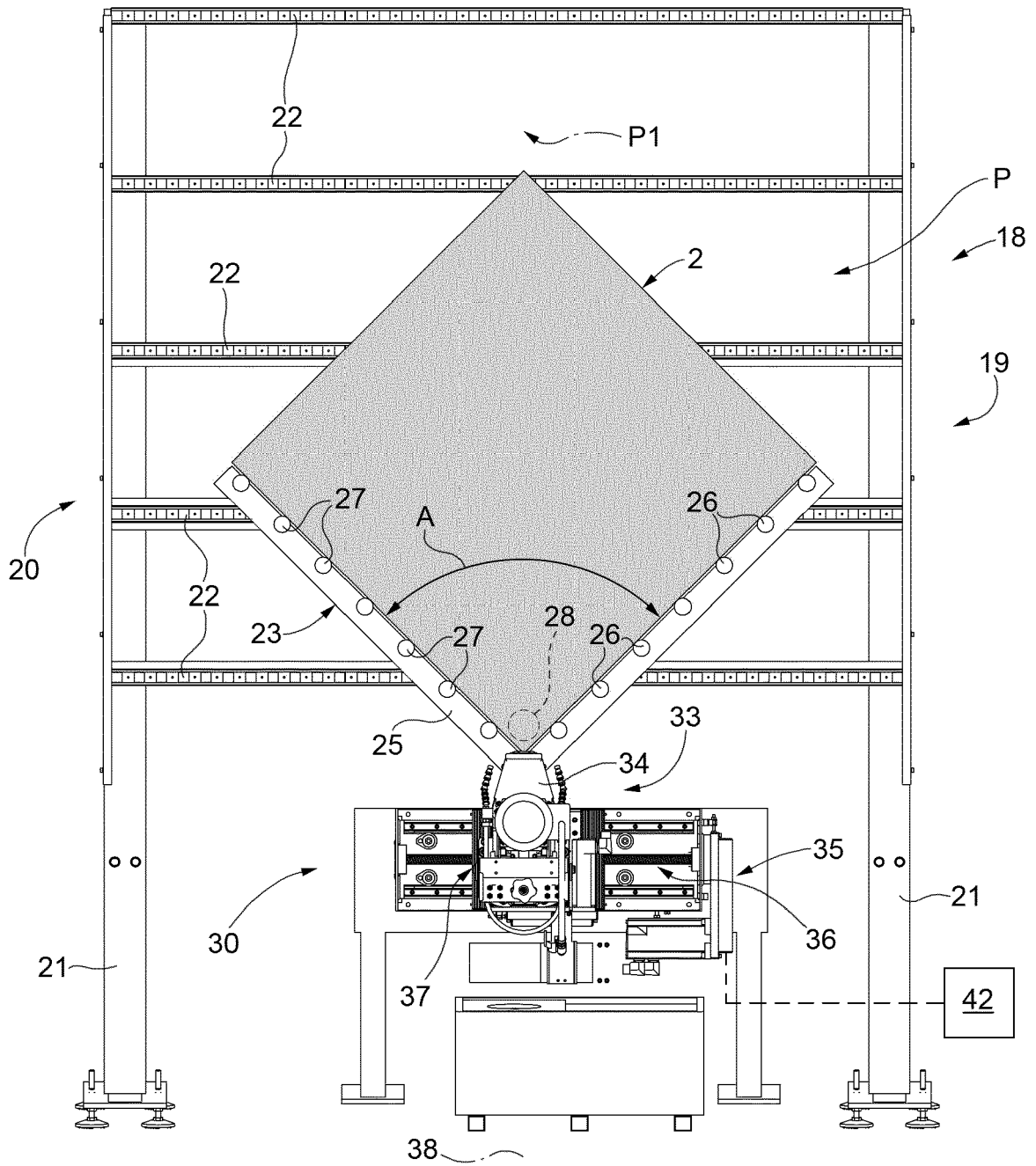


FIG. 3

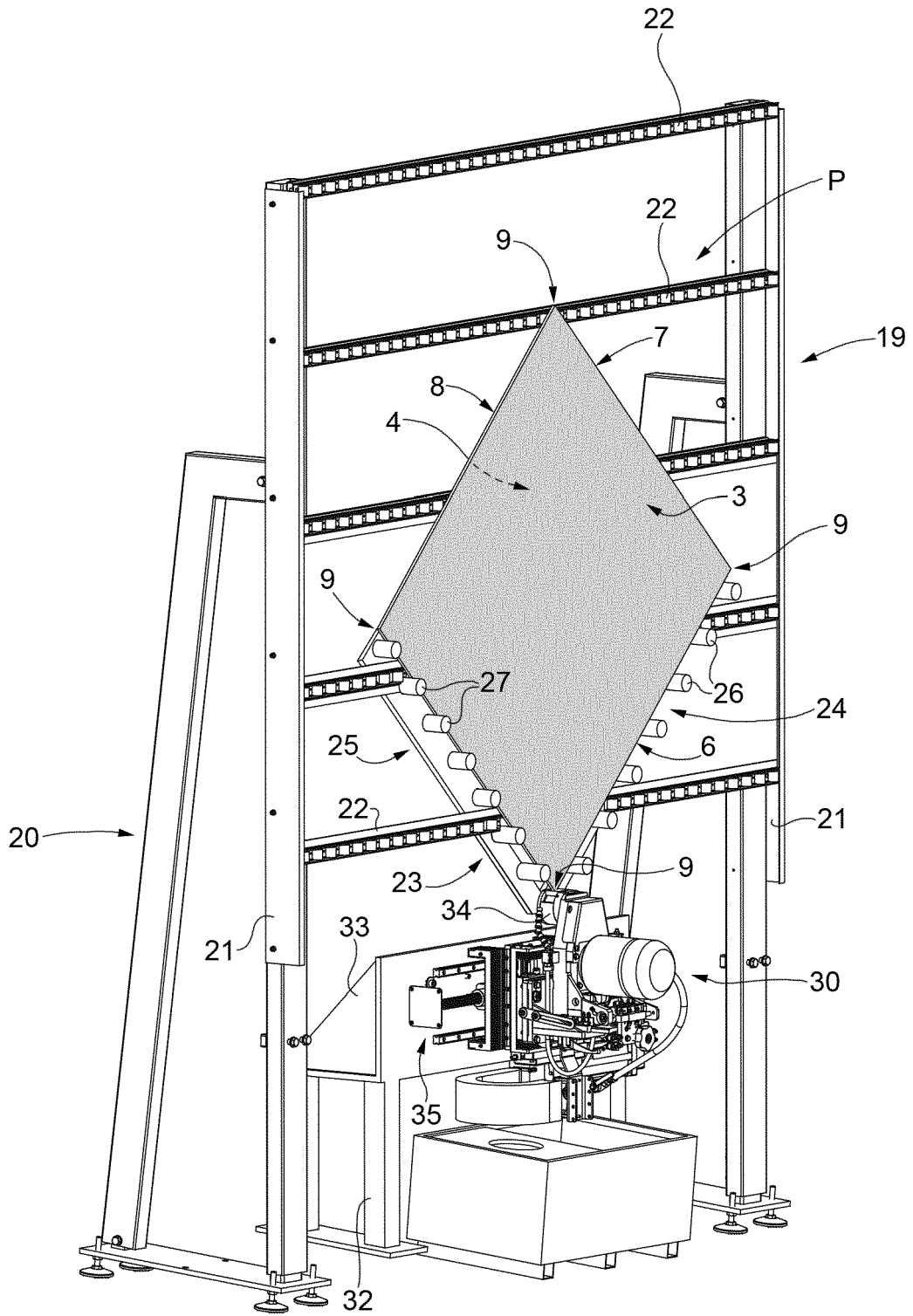


FIG. 4

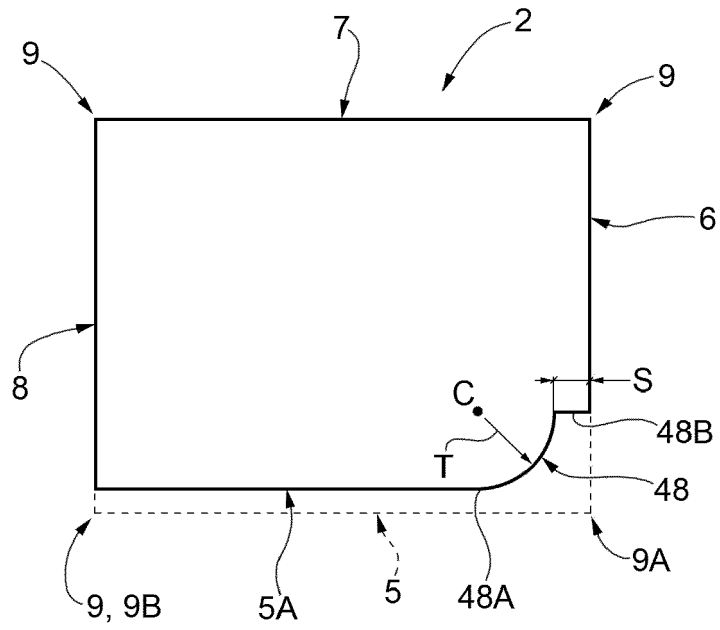


FIG. 5

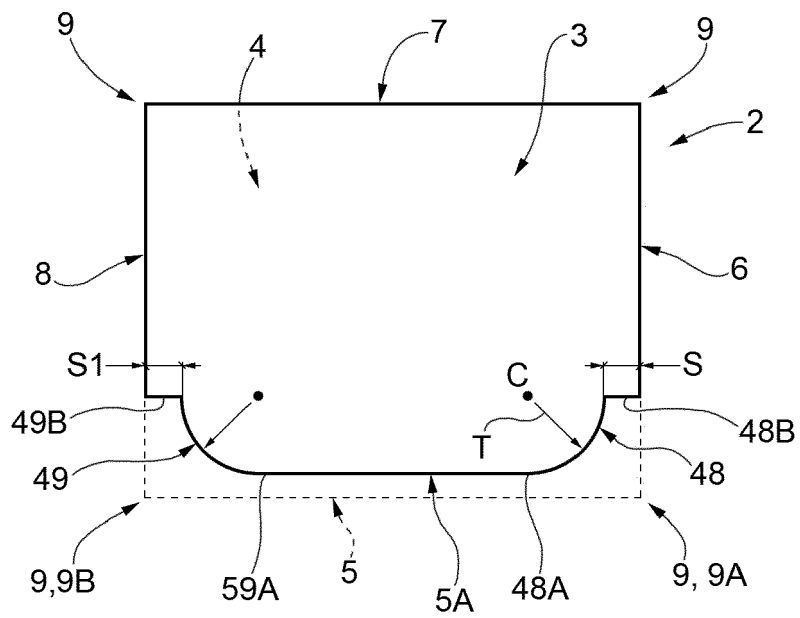


FIG. 6

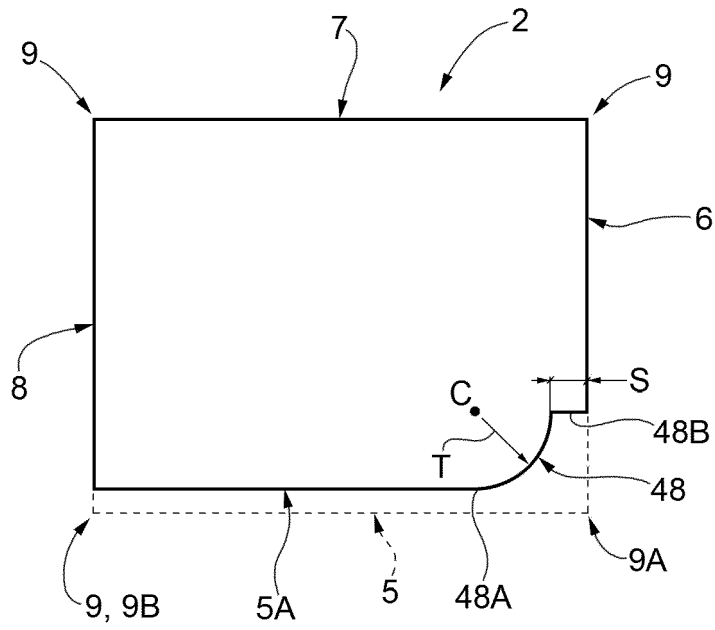


FIG. 7

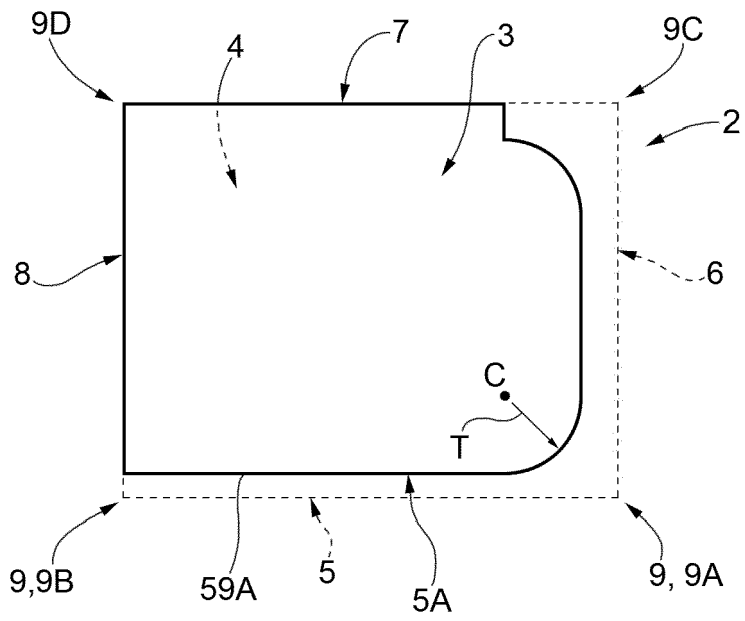


FIG. 8



EUROPEAN SEARCH REPORT

Application Number
EP 19 16 5266

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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	WO 2018/020430 A1 (ELETTRMECCANICA BOVONE SRL [IT]) 1 February 2018 (2018-02-01) * page 5, line 34 - page 10, line 17 * -----	1-15	INV. B24B9/10 B24B41/00
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A	EP 2 762 273 A1 (DENVER SPA [SM]) 6 August 2014 (2014-08-06) * claims 1-16; figures 1-11 * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			B24B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 June 2019	Examiner Koller, Stefan
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ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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