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

(11) **EP 2 436 480 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.04.2012 Bulletin 2012/14

(51) Int Cl.:
B24B 7/24 *(2006.01)*

(21) Application number: **11007213.9**

(22) Date of filing: **06.09.2011**

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

(30) Priority: **10.09.2010 CZ 20100682**

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(54) **The method of modifying the flat glass surface and the apparatus for carrying out this method**

(57) The method of modifying the flat glass surface is based on that the surface of a glass is worked by abrasive grains of synthetic diamond which are situated in the mass of plastic threads that are a part of a rotating brush. The glass is first tarnished using brushes with rougher abrasive grains of synthetic diamond and then tarnishing is finished using brushes with smaller abrasive grains. With the brushes, it is also possible to modify already sandblasted glass surface. The apparatus for modifying glass surface is made up of at least one rotating brush (9, 10) that is bedded in static or moveable disposition above the glass plate (5) which is to be modified, while the brush (9,10) has abrasive plastic threads (3) embedded with abrasive grains of synthetic diamond.

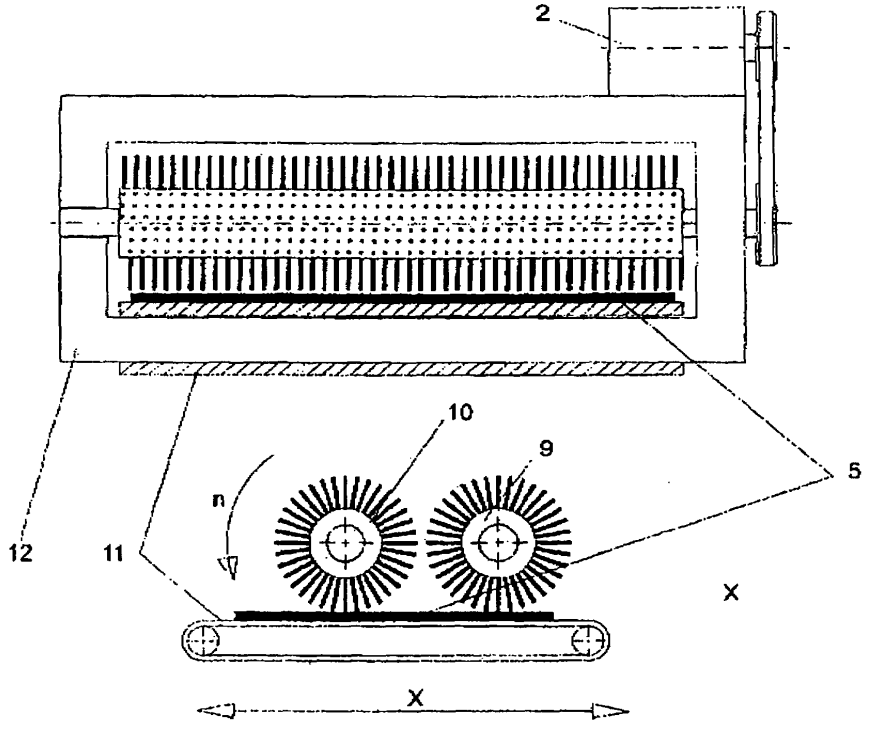


Fig. 7

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Description

Technical Field

[0001] The invention solves the problem of manufacturing a flat glass surface to a different degree of opacity or modifying a sandblasted glass surface with the goal of preserving easy-cleaning qualities. The invention also specifies the apparatus for carrying out the method needed for such modification.

Background of the Invention

[0002] Until now, the known techniques of tarnishing flat glass can be categorized as either physical or chemical. In the first case, the techniques called sandblasting are common. Abrasive material is sped up by a stream of air under pressure and it is hurled perpendicular to the surface of the glass. During the collision with the glass surface, the abrasive grain cuts the surface of the glass in the place of collision. Some grains bounce off the glass surface and some move over the glass surface. The abrasive grain tarnishes the glass by the combination of braking up, coring and smashing of the surface layer. Used abrasive grains falls into a filling funnel and is used further. Fine-grained glass dust and a part of broken up abrasive grains are vacuumed from the place of sandblasting. Most common material from which abrasive grains are made is either corundum /Al2O3/ or silicon monoxide /SiO/ in granularity of 60 to 180 Meshes. The visual and functional properties of the sandblasted surface depend mostly on the size of abrasive grain used, the speed and the angle under which the grain collides and the shape of the grain. For example a glass surface sandblasted with brown corundum in granularity of 90 Meshes contains a lot of surface splits and deep cracks that run perpendicular to the glass surface, therefore in the direction of collision of the grain with the surface. The surface of the glass is sharp, fragile, crumbly and tilled with particles of broken up glass and sandblasting material. The surface quality is low. The surface splits make it a large absorbent surface with a tendency to absorb moisture, grease and form stains impossible to clean. The fragile surface is prone to physical damage which leads to marks on the glass that are impossible to get rid of. Sandblasting removes the surface layer of the glass into depth of one hundredth to one tenth of a millimeter. The depth of the surface splits and so the weakening of the glass depends on the size of abrasive grain used and the pressure of the air. These surface splits can complicate tempering of the glass. The energetic efficiency of sandblasted glass is low. The method of chemical tarnishing uses hydrofluoric acid to react with different components of the molten glass to produce many fluorides and fluorosilicates. Insoluble and less soluble salts crystallize on the glass surface. The crystals make up a very even and fragile structure on the glass surface, which gives the glass a matt look through dispersion of light. The surface of a chemically tarnished glass has no splits in it. It is easy to clean. The surface structure is softer than the bottom glass and is very prone to mechanical carnage. The disadvantage of chemical tarnishing is that very aggressive and dangerous compounds are used during the process.

The disclosure of the invention

[0003] The disadvantages above are eliminated by modifying the glass surface as described by the invention, which means tarnishing the glass surface with abrasive grains of synthetic diamond situated in the mass of plastic threads of a rotating brush while the glass surface is cooled down and washed through with water. The shiny side of a smooth glass plate is first tarnished using rougher abrasive grains of synthetic diamond situated in the mass of plastic threads of a rotating brush and this surface is then tarnished and polished using abrasive grains of smaller granularity situated in a mass of plastic threads of a rotating brush. Another possibility is to modify the sandblasted glass surface with abrasive grains of synthetic diamond situated in a mass of plastic threads of a rotating brush. The gist of the apparatus used to modify a flat glass surface is that it is made up of at least one rotating brush that is bedded in static or moveable disposition above the glass plate which is to be modified. The rotating brush has abrasive plastic threads with abrasive grains of synthetic diamond. Further, the rotating brush is situated either in a portal cart or in a brushing mill. Also, the gist of the invention is that there are abrasive grains of synthetic diamond with either same or different granularity in the plastic threads. The glass plate can be attached by a suction cup or it can be placed on a moving belt.

[0004] It is possible to tarnish or modify either a shiny or an already sandblasted glass by the method of brushing. Applying the brushes creates a dense network of shallow splits which appears as a matt surface due to dispersion of light. Glass modified by brushing has much better functional properties then sandblasted glass or cauterized glass. This is due to the surface splits that are created by the brushing. The decisive effect for the final visual look of the glass is character of the contact of the abrasive grain with the glass surface and the trajectory of the abrasive grain on the glass. The hardness of the abrasive material is also very important. With the use of synthetic diamond, the surface of the glass is rather tarnished than scabbed crushed and smashed. Clam-shaped splits are shallow and more or less in the parallel direction to the surface. The areas between them are flat and covered with an even network of smooth marks made by the brush. This texture due to the dispersion of light gives the glass surface an evenly matt, orientated and silkily shiny look. The surface of the glass is hard and not crumbly. The surface hardness of the brushed glass is the same as the hardness of the base material. This is a big difference from the cauterized glass, where the sur-

face layer is sorter than the base layer. The hard surface enables the use of any regular glue. Since the splits from brushing are shallow and smooth and the glass is not damaged much, it is possible to brush it further even before or after heat tempering. Even though this surface structure facilitates a great dispersion of light, it is minimally absorbent in the context of liquids. This means that this matt glass is very easy to clean. This is a very important feature when the matt glass is used in the interiors and exteriors. It is even possible to brush glass footage or glassware before it is finished. It is possible to brush glass that is three or more millimeters thick. When brushing a sandblasted glass surface, it is possible to make partially matt and partially clear surfaces using covering foils or to make different shades of matt glass. This way it is possible to create replicas of historical ornaments or use the glass for different art solutions. When comparing the properties of a clear brushed glass and brushed glass that was sandblasted before brushing, the clear brushed glass is much better quality. It is less disturbed and the splits are shallower, the glass is smoother, has a less absorbent surface, is easier to clean and is made on one machine in an energetically favourable process. The manufacturing of matt glass by brushing is a good alternative to the industrial process of cauterizing glass. The brushing technology is very energetically favourable, ecologic and quiet, does not produce dust and does not produce much waste. The machinery does not use aggressive and toxic materials, does not have disturbing impacts, can be a part of a production line or work separately in almost any kind of plant.

A brief description of drawings

[0005] The method of modifying the flat glass surface and the apparatus for carrying out this method are further explained on the drawings included, where the pictures represent:

Fig. 1 - photo 1000x zoomed in of a clear, brushed, matt float glass of 4 mm thickness with a single granularity of the brush

Fig. 2 - photo 1000x zoomed in of a clear, brushed, matt float glass of 4 mm thickness with two different granularities of the brush

Fig. 3 - photo 1000x zoomed in of a clear, brushed, matt glass of 4 mm thickness which was already sandblasted and then tarnished by brushing

Fig. 4 - the scheme of the apparatus for manufacturing the brushed glass with the moveable brush device

Fig. 5 - the detail of the brush device

Fig. 6 - the detail of the brush with the directions of the movement

Fig. 7 - the scheme of the apparatus for manufacturing the brushed glass with the moveable glass plate

Examples of carrying out the invention

[0006] The tarnishing of glass works in two steps. The first step is roughing i.e. eroding the hard smooth surface layer of the glass by the means of brushing. The second step is polishing of this layer to a needed quality of roughness and transparency of the surface which is also done by brushing- The brushing of the glass works by means of a rotational brush that has plastic threads in which abrasive grains of synthetic diamond are situated. The threads on the brush are radially oriented to the axis of rotation. The surface of the glass is cooled down and washed over with water. The centrifugal force stretches the plastic threads perpendicularly to the axis of rotation. The abrasive grains in the threads of the brush move circularly towards the tangent plane of the glass. As the rotating brush is moved closer to the glass surface, the abrasive grain collides with the glass surface and move over it in short straight line. The kinetic energy of the abrasive grain has to be large enough for the abrasive grain to be able to erode the surface layer of the glass. The amount of this energy is given as the product of the mass of the abrasive grain and the mass of the plastic thread multiplied by the circumference speed of the thread at the place where the abrasive grain touches the glass. When the grain with size of 80 Meshes and the circumference speed of movement 20 m/s and bigger collides with the glass surface, it erodes the hard smooth glass layer and creates many clam-shaped splits. Splits have the maximum depth of 0.005 mm and length of 0.02 mm. The thickness of the removed material is in thousandths of a millimeter. Other grains do some tarnishing and leave a network of small parallel slits aligned with the surface. When the surface layer is eroded, removing of more material gets faster, In the Fig. 1 there is the 1000x magnified photo of the surface of a clear glass type "float" with thickness of 4 mm which was tarnished by brushing. The synthetic diamond used in the brush had granularity 80 Meshes and the concentration of the abrasive grains in the mass of plastic threads was 24 %. The thread had 0.2 mm in diameter. The dense network of small surface slits is clearly visible on the photo. The quality of this surface modification depends on the granularity of the abrasive grains used. To polish the surface modified by this process it must be brushed further, using grains of smaller granularity that are embedded in the threads of the brush. By this method we remove unsettled and sharp pieces of glass from the glass surface. The surface is only covered with shallow slits as a result. Areas of the glass between them are flat and covered with an even network of smooth marks made by brushing. View-through of the glass is matt, silkily shiny on the surface, smooth on touch and has great functional proper-

ties. The Fig. 2 shows the photo of a 1000x zoomed in surface of a clear glass type "float" with thickness of 4 mm that was tarnished by brushing. In the first brush a synthetic diamond of granularity 80 Meshes having the 24% concentration of the abrasive grains in the mass of plastic threads. In the second brush a synthetic diamond of granularity 300 Meshes having the 24% concentration of the abrasive grains in the mass of plastic threads. All threads had 0.2 mm in diameter. By combining different granularities in the threads it is possible to get different mechanical and optical surface properties.

[0007] The method of modifying glass that was already sandblasted is similar. A rotating brush with abrasive grain made of synthetic diamond bedded in the mass of threads brushes the surface of the sandblasted glass. By brushing the sandblasted glass with an abrasive brush most surface defects and fragile parts are removed. The deepest craters made by the roughest fraction of the corundum used for sandblasting are the most noticeable. The surface slits made by brushing are evenly laid out and significantly shallower than these made by sandblasting. By combining the granularity of the abrasive material and intensity of the brushing it is possible to get different degrees of transparency and shades of the matt surfaces. With a glass surface modified this way the amount of the surface cracks is reduced and so is the absorptivity of the surface. This means the glass is easier to clean. By removing the unsettled parts the glass becomes much less sensitive to scraping. All this is well visible in the Fig. 3 where you can see 1000x zoomed in photo of the surface of a clear glass type "float" with thickness 4 mm which was sandblasted using brown corundum with granularity 90 Meshes and then was brushed. The brush used synthetic diamond of granularity 1500 Meshes having 12% concentration of the abrasive material in the mass of threads.

[0008] When brushing the sandblasted glass, the hard, smooth glass surface layer is already eroded and therefore the energy needed to modify the surface is lower and it is possible to use lower circumference speed of the brush. This possibility is enabled by using the covering foils. The abrasive thread works on the fragile sandblasted areas, but the covering foil remains intact due to its elasticity and protects the areas bellow it. By this method it is possible to create clear and matt parts of the surface or even create different degrees of transparency depending on the intensity of the brushing.

[0009] The apparatus for modifying glass surfaces can be vertical or horizontal (Fig. 4). On the vertical frame 8 there is a glass plate 5 fixed by suction cups 6. On the arm of the frame 8 there is a glass plate 5 fixed by suction cups 6. On the arm of the frame 8 there is the portal cart 4, in which the gritting brush 10 and the polishing brush 9, are bedded. Both brushes have abrasive grains of synthetic diamond situated in the abrasive threads 3. Both brushes are connected by cogged belts to the shaft of the electric motor 2, and they therefore rotate simultaneously (Fig. 5). The portal cart 4 moves with the brushes horizontally x and vertically y in controlled speed. The portal cart 4 also has an inlet 1 of water and on the bottom of the frame 8 there is a collecting tank 7.

[0010] The gritting brush 10 is the first to move and it removes the hard, smooth surface layer and then the polishing brush 9 follows to polish the glass. After every single path over the glass, the cart 4 with brushes 9 and 10 moves to the area of the glass plate 5 that haven't been brushed yet. The process ends when the whole plate has been brushed over. Water is fed to the areas that were brushed and flows over the glass into the collecting tank 7, from which it is reused.

[0011] Alternatively it is possible to brush the glass surface with only one brush. There is only one brush on the portal cart 4. The brush is the same as in the last case except for the abrasive threads. The first half of the brush has gritting threads. This means a thread with a synthetic diamond of granularity for example 80 Meshes and concentration in the mass of threads is 24%. The second half of the brush has polishing threads on it. This means threads with synthetic diamond of granularity for example 180 Meshes and concentration in the mass of threads is 24 %. The brush is moved on clear glass first with the gritting part to remove the outer layer of the glass. Right after the polishing part of the brush polishes these gritted areas. The final result and quality then depends on the ratio of these two parts of the brush just like it does on the granularity of the abrasive grains in the polishing part of the brush.

[0012] Another version of the apparatus is that the brushes 9, 10 are of the same width as the glass plate 5, and are statically situated in the brushing mill 12 (Fig. 7) and a moveable glass plate 5 is bedded on the moving belt 11. This setting can also work the other way which means that the brushing mill 12 moves with the brushes and the glass plate 5 is static.

[0013] The apparatus works in the way that the gritting brush 10 starts working and then the polishing brush 9 follows. The usual granularity of the abrasive grains glass is between 60 to 90 Meshes for roughing, for polishing the granularity between 300 to 1500 Meshes is used in the concentration of 24%. For better elasticity the thread is curly. The thread is 60 mm long with diameter of 0.2 mm. The suitable circumference speed of the disk for brushing clear glass is 20 m/s or more, it is less for sandblasted glass. The disk is moved over the surface of the glass perpendicular to the axis of rotation with the speed between 0.2 to 1.5 m/min. There is plenty of cooling water fed to the place that is being brushed. The cooling water in combination with the mechanical work of the brushing threads cleans the surface of the glass from the fine dust that is created in the process. Due to the plastic properties of the threads, they hardly grind and do not soil the surface in any kind of noticeable way.

Applicability of the invention

[0014] The machinery for brushing glass can be made

in graduated sizes, depending on the need and formats of the modified glass plates. Matt glass is nowadays very commonly used in architecture, construction industry and furniture industry.

Claims

1. The method for modifying the surface of the flat glass **characterized in that** the glass surface is tarnished with abrasive grains of synthetic diamond situated in the mass of plastic threads of a rotating brush while the glass surface is cooled down and washed through with water.

2. The method for modifying the surface of the flat glass according to the claim 1 **characterized in that** the shiny side of the glass plate is first tarnished using rougher abrasive grains of synthetic diamond situated in the mass of plastic threads of a rotating brush and this surface is then tarnished and polished using abrasive grains of smaller granularity situated in a mass of plastic threads of a rotating brush.

3. The method for modifying the surface of the flat glass according to the claim 1 **characterized in that** the gritted glass surface is tarnished with abrasive grains of synthetic diamond situated in a mass of plastic threads of a rotating brush

4. The apparatus for modifying the surface of the flat glass **characterized in that** it is made up of at least one rotating brush (9,10) that is bedded in static or moveable disposition above the glass plate (5) which is to be modified, while the brush (9,10) has abrasive plastic threads (3) with abrasive grains of synthetic diamond.

5. The apparatus for modifying the surface of the flat glass according to the claim 4 **characterized in that** the rotating brush (9,10) is bedded in the portal cart (4)

6. The apparatus for modifying the surface of the flat glass according to the claim 4 **characterized in that** the rotating brush (9,10) is bedded in the brushing mill (12)

7. The apparatus for modifying the surface of the flat glass according to the claims 4 to 6 **characterized in that** the abrasive plastic threads (3) contains the abrasive grains of synthetic diamond of equal granularity

8. The apparatus for modifying the surface of the flat glass according to the claims 4 to 6 **characterized in that** the abrasive plastic threads (3) contains the abrasive grains of synthetic diamond of various granularity

9. The apparatus for modifying the surface of the flat glass according to the claims 4 and 5 **characterized in that** the glass plate (5) is fixed in the frame (1) of the apparatus by attached by the suction cups (6)

10. The apparatus for modifying the surface of the flat glass according to the claims 4 and 6 **characterized in that** the glass plate (5) is fixed on moving belt (11) bedded in the brushing mill (12)

Fig. 1

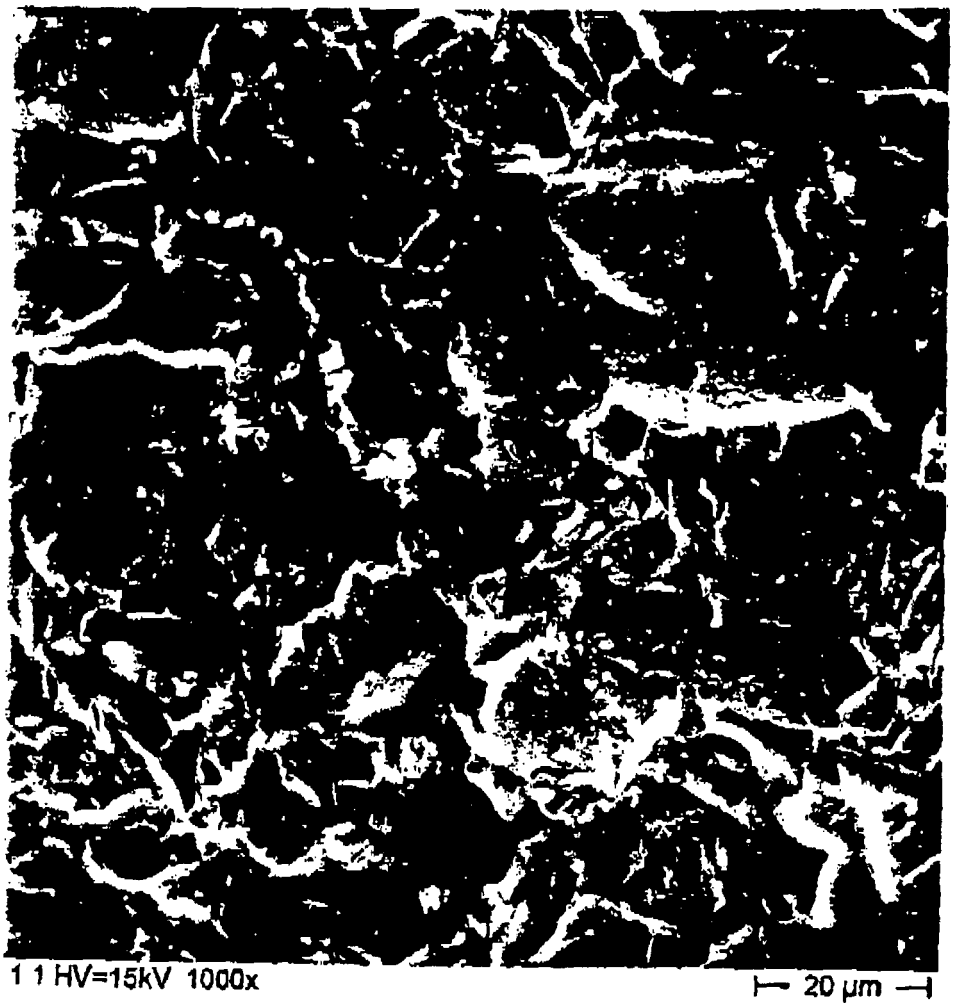


Fig. 2



Fig. 3



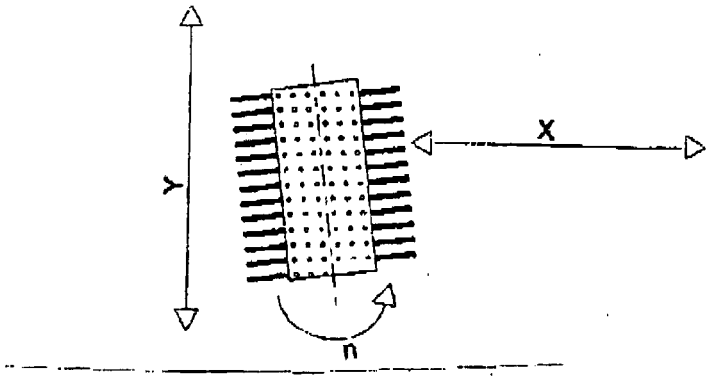


Fig. 6

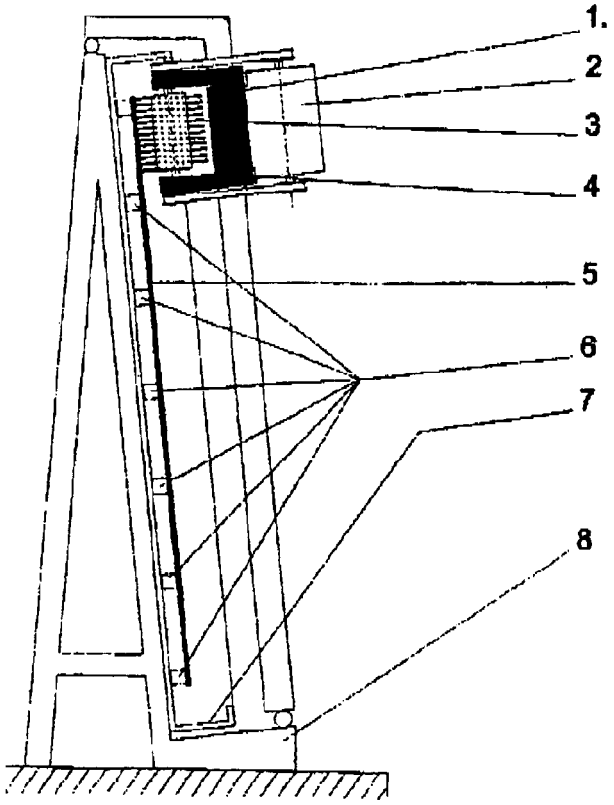


Fig. 4

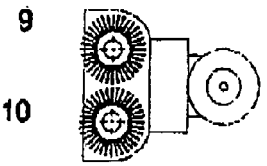


Fig. 5

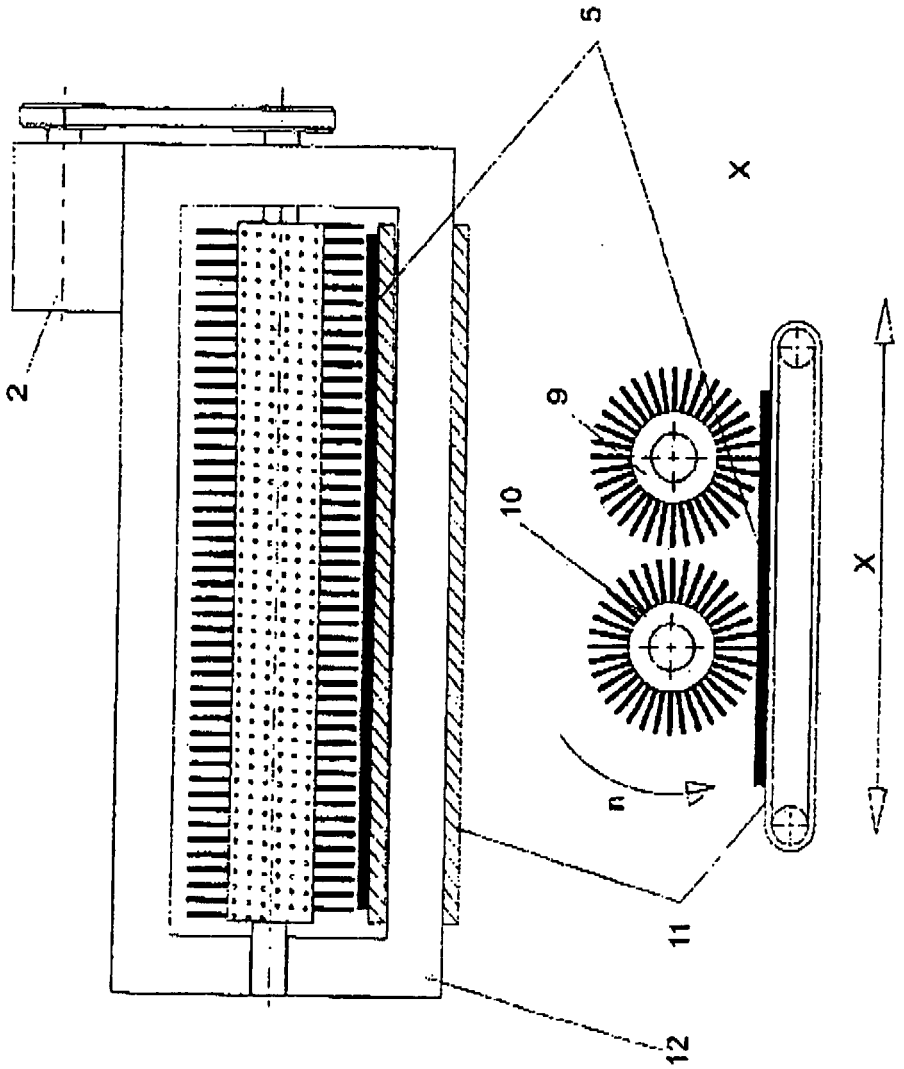


Fig. 7