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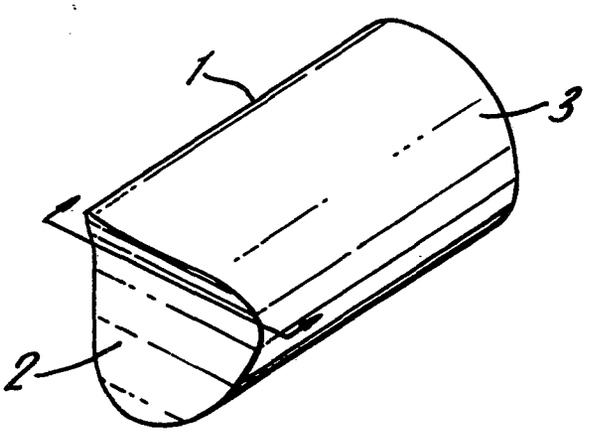
(54) **Surface treatment wheels and shoes for supporting a moving belt.**

(57) A shoe 1 for supporting a belt, e.g. a sanding belt has a belt supporting surface 2 non-linear in cross-section perpendicular to the direction of belt extension and shaped such that a belt may bend sharply around the surface 2 in its direction of extension whilst conforming to the surface 2 without stretching. A sanding wheel comprises a plurality of such shoes 1 arranged as spokes of the wheel, which may be unitary in construction, and having a sanding belt extending around the wheel.



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SURFACE TREATMENT WHEELS AND SHOES FOR SUPPORTING A MOVING BELT

The present invention relates to surface treatment wheels, e.g. sanding wheels, to surface treatment machines and to supports over which a belt may lie or be run and such that the belt can conform to the surface of the support without being stretched despite the support surface having a non-linear cross-section perpendicular to the direction of belt travel.

Endless belts are used widely for finishing shaped articles e.g. by "belt-sanding". The use of an endless abrasive belt is the most favoured method for the finishing of wooden articles. Difficulty arises in using such belts for finishing articles that have a surface other than flat in the across-the-grain direction, i.e. perpendicular to the normally preferred direction of belt travel.

For finishing surfaces which are flat or only slightly curved in this direction, the normal method is to run the belt around a rotating support drum adjacent the work piece.

Where a slight curve is to be matched, the drum is slightly waisted or bulged centrally. No more than a slight curve can be matched by this method because the belt cannot conform precisely to a drum which is not a true circular cylinder and therefore creases and suffers damage. The belts issued are substantially inelastic and therefore cannot stretch as would be necessary to conform to the surface of such a drum.

An alternative approach is to provide a long straight run of belt adjacent the workpiece and to use a shaped shoe having a surface complimentary to that of the workpiece to press the belt against the workpiece in the straight run. This succeeds because the belt is only bent substantially in the direction perpendicular to its travel. This arrangement cannot be used successfully when the workpiece presents a face to be worked that is convex in the direction of belt travel because the long straight run of belt cannot be accommodated.

The use of a belt for finishing is highly desirable because belts provide a large surface area of abrasive material, lessening the frequency of changing the abrasive. They also provide opportunity for cleaning the abrasive at a location remote from the workpiece. They are readily available as standard components in a wide choice of sizes and abrasive materials.

An alternative to the use of a belt is the use of a sanding wheel. A wheel can be used to sand concave edges

provided that the curvature of the edge is not tighter than that of the wheel itself. Further, the shape of the wheel can be such as to conform to the shape of a workpiece profile that is curved perpendicular to its length. However, if the wheel is itself abrasive, the wheel must be replaced frequently. If abrasive material is attached to the surface of such a wheel, e.g. by adhesive, then it is a relatively difficult and frequent task to replace the abrasive.

One method which has been adopted is to provide a wheel which can accept a replaceable plastics cover shaped to match a desired workpiece profile and bearing abrasive material fixed thereto. Once again, however, the replacement of the worn abrasive is relatively costly since it involves providing a new plastics cover member of the desired shape. The cover members must be factory made and will therefore only be available to match commonly used profiles or will have to be specially ordered to considerable expense.

The present invention provides a surface treatment wheel comprising a plurality of radially outwardly directed projections having end faces each providing a radially outwardly facing support surface, a treatment belt extending around the wheel and having portions supported on the support surfaces and intermediate portion extending generally radially between the said projections, wherein

the belt conforms to each support surface without stretching of the belt.

The present invention includes a surface treatment wheel for supporting a belt in conformity against a work-piece surface which surface has a non-linear cross-section transverse to the belt, which wheel comprises a plurality of radially outwardly directed projections having end faces each providing a radially outwardly facing support surface, a treatment belt extending around the wheel and having portions supported on the support surfaces and intermediate portions extending generally radially between the said projections, each support surface having substantially the shape generated by the crossing inter-section in register of cylinders each having a cross-section perpendicular to its generator produced by opposing back to back a pair of said sections of the surface to be conformed with.

The present invention includes a surface treatment wheel for supporting a belt in conformity against a work-piece surface which surface has a non-linear cross-section transverse to the belt, which wheel comprises a plurality of radially outwardly directed projections having end faces each providing a radially outwardly facing support surface, a treatment belt extending around the wheel and having portions supported on the support surfaces and intermediate portions extending generally radially between the said projections, each support surface being complimentary to

the workpiece surface and such that the length of any path leading first perpendicularly from a reference plane, which reference plane lies parallel to the direction of belt extension at the surface and lies behind the surface, to one end of the surface, then along the surface in the direction the belt extends to the other end of the surface and then perpendicularly back to the reference plane, is substantially a constant.

The present invention includes a shoe for supporting a belt, comprising a belt supporting surface non-linear in cross-section perpendicular to the direction of belt extension and shaped such that a belt may bend sharply around the surface in its direction of extension whilst conforming to the surface without stretching.

Although the shoes provided by the invention are particularly suited to supporting finishing belts, e.g. abrasive belts, they may be useful wherever a belt has to be made to conform to an awkwardly shaped profile.

A surface for a shoe according to the invention to be complimentary to any given profile, e.g. of a workpiece, may be that surface generated by the crossing intersection in register of a pair of cylinders each having a cross-section perpendicular to its generator produced by opposing back to back a pair of sections of the given profile. Thus, if it is desired to bend a belt to conform to the edge of a panel having a semi-circular convex section edge, a suitable surface for the shoe will be

that produced by intersecting orthogonally a pair of right circular cylinders of a radius corresponding to the desired profile. A right circular cylinder is one of the cylinders obtainable by opposing back to back the semi-circular sections of the edge. The surface obtained would still be suitable for use in the invention however if the cylinders were produced by opposing back to back the semi-circular sections spaced apart and joining them by, e.g. straight, lines to give a generally oval section cylinder. Further examples will be given hereafter with reference to the drawings.

It will be appreciated that the operative surface of a shoe according to the present invention differs from those previously used to carry a substantially straight run of belt slightly toward a workpiece whilst bending the belt to conform to the workpiece in that the surface is not of constant width in the direction of belt travel over the surface but is shaped back to have a greater width in proportion to the degree to which the profile of the workpiece projects toward the shoe at any level of the profile. It would be equivalent to state that the width of the support surface in the direction of belt extension is proportionately less where the surface projects further forward.

An alternative way of generating a suitable surface for a shoe according to the invention to compliment a given profile, therefore is to consider a reference plane

parallel to the desired direction of belt travel over the surface and behind the desired surface and to construct a surface which compliments the profile and is such that the length of a path in any plane parallel to the direction of belt extension over the surface and orthogonal to the reference plane, which path leads perpendicularly from the reference plane to one end of the surface, over the surface as the belt extends to the other end of the surface, and perpendicularly back to the reference plane, is a constant or substantially so.

Accordingly, the present invention includes a shoe for supporting a belt in conformity against a workpiece surface which surface has a non-linear cross-section transverse to the direction of belt extension thereat, the shoe comprising a support surface having substantially the shape generated by the crossing intersection in register of cylinders each having a cross section perpendicular to its generator produced by opposing back to back a pair of said sections of the surface to be conformed with.

Also, the invention includes a shoe for supporting a belt in conformity against a workpiece surface, which surface has a non-linear cross-section transverse to the direction of belt extension thereat the shoe comprising a support surface complimentary to the workpiece surface and such that the length of any path leading first

perpendicularly from a reference plane, which reference plane lies parallel to the direction of belt extension over the surface and lies behind the surface, to one end of the surface, then along the surface in the direction the belt extends to the other end of the surface and then perpendicularly back to the reference plane, is substantially a constant.

The invention includes a surface treating machines in which a surface treating belt, e.g. an abrasive belt, is supported for conforming contact with a surface to be treated by a shoe according to the invention, means being provided for producing movement of the belt relative to the surface to be treated.

The machine may be one in which, as in a conventional belt-sander, the movement of the belt relative to the surface to be treated is produced predominantly by movement of the belt over the shoe. Such machines will include a belt-sanding machine in which the continuous belt runs around a drive drum and a shoe of the invention.

Alternatively the machine may be one in which the movement of the belt relative to the surface to be treated is produced predominantly by movement of the shoe supporting the belt which is stationary relative to the shoe.

For instance, it may be that the belt is supported on a plurality of shoes of the invention arranged in a circle to face radially outwards, the belt following a labarynthine path having substantially radial portions

between portions lying on the support faces of the shoes, means being provided to rotate the circle of shoes as a wheel against a surface to be treated. Such a construction would normally include means for automatically or manually periodically or gradually moving the belt over its path to place a fresh portion of belt on each support surface.

The plurality of shoes referred to may be separate items held together in the appropriate places to form the wheel or may be part of a unitary structure.

By the use of such a device, benefits associated with the use of a belt may be extended to areas where wheels have previously been used for carrying out some surface treatment. Accordingly, the invention includes a surface treatment wheel comprising a treatment belt supported on a plurality of shoes according to the invention arranged in a circle to face radially outwards, the belt following a labarynthine path having substantially radial portions between portions lying on the support faces of the shoes.

Preferably means will be provided for moving an elongate workpiece progressively through a station at which it is treated by the belt.

In such a case it is preferable to also provide means to cause the support surface of the shoe supporting the belt at its contact with the surface to be treated to remain parallel to the surface to be treated despite curvature of the workpiece in its direction of movement. This will, in the case of a sanding machine, often be

necessary to avoid the changing angle between shoe surface and workpiece causing poor conformity of contact between the belt and the workpiece surface with possible consequent partial destruction of the workpiece profile or the production of unsanded spots.

Preferably, the member incorporating the support surface for the belt is of a flexible material such as natural or synthetic rubber.

The belt used is preferably tough and flexible. A particularly flexible belt suitable for belt sanding is one having a backing of Egyptian Cotton.

The invention will be illustrated by the following description of preferred embodiments shown in the accompanying drawings in which:-

Figure 1 is a perspective view of a shoe according to the invention.

Figure 2 is a side view of the shoe of Figure 1 laid against a complimentary workpiece.

Figure 3 is a perspective view of two cylinders intersecting to generate a surface having the same form as the support surface of the shoe of Figure 1.

Figure 4 is a perspective view of a second shoe according to the invention.

Figure 5 is a side view of the shoe of Figure 2 laid against a complimentary workpiece.

Figure 6 is a perspective view of two cylinders

intersecting to generate a surface having the same form as the support surface of the shoe of Figure 4.

Figure 7 is a side view of a third shoe according to the invention.

Figure 8 is an end view of the shoe of Figure 7.

Figure 9 is a perspective view of two cylinders intersecting to generate a surface having the same form as the support surface of the shoe of Figure 7.

Figure 10 is a plan view from above of an abrasive wheel of the invention.

Figure 11 is a side view of one of the shoes of the wheel of Figure 10 in contact with a workpiece.

Figure 12 is a schematic side view of a belt sanding machine of the invention.

Figure 13 is a schematic top view of the shoe assembly of the sanding machine of Figure 12.

Figure 14 is a plan view of a second sanding wheel according to the invention.

Figure 15 is a cross-section through the wheel of Figure 14.

Figure 16 is an exploded perspective view of the wheel of Figure 14.

Figure 1 shoes a shoe 1 which comprises a right circular - cylindrical shank 3 having at one end a support surface 2 over which a belt may extend in the direction shown by the arrow without stretching but conforming well

to the surface.

As shown by Figure 2, the support surface, and hence a belt conforming to it make intimate conforming contact with a curved edge 4 of the workpiece 5. The surface 2 has the form of the surface produced by the intersection of a pair of right circular cylinders of the same radius as edge 4. This surface is shown shaded in Figure 3, marked A.

It should be noted that it is a characteristic of the support surface 2 that if a plane 6 (Figure 2) is orthogonal to the shank 3 is taken as a reference plane, then any path a leading perpendicularly from the plane 6 to the surface 2, across the surface 2 (at right angles to the plane of the paper in Figure 2) and back perpendicularly to the plane 6 is of the same length. Thus the belt can follow this path without stretching.

This aspect of the surface desired is illustrated further by Figure 3A. Figure 3A shown a belt 16 running up to and away from a workpiece 5 so as to make conforming contact with the edge thereof. Reference plane 6 is shown in front of the workpiece surface. Paths f to e, d to c and b to a extend along the belt and upto the surface. In the plan view portion of the figure, it can be seen that the run of the belt across the workpiece surface at the different heights f, d and b is of a different length at each level such that the entire run from the reference plane and back is in each case the same, i.e. the lines

bab', dcd' and fef' are all of the same length. The length of the lines ff', bb' and dd' may be deduced to be that of a corresponding chord as shown in the circle on the right of the figures by considering the intersection of a circular cylinder of diameter bb' with the workpiece surface. By this means, a 'contour map' may be constructed for the support shoe surface corresponding to any workpiece surface.

Figure 4 shows a shoe 1 having a shank 3 and a support surface 2 which, as Figure 5 shows, compliments a sharply pointed edge of a workpiece 5. A belt can be run over the surface 2 in the direction shown by the arrow and will conform closely to the surface without being stretched and without forming unsupported creases.

It can readily be seen from Figure 4 that the cross-section of the shank 3 of the shoe 1 is the same as that of the two intersecting cylinders shown in Figure 6 and is formed by opposing back to back two identical sections of the edge of the workpiece 5 of Figure 5. The surface 2 is the same shape as the surface B produced by the intersection of the two cylinders in Figure 6. The cylinders are shown intersecting othogonally and in register, that is to say with corresponding festures of the upright cylinder intersecting corresponding features in the transverse cylinder.

Figures 7 and 8 ahow a shoe 1 having a much more complex surface 2 than the shoes of Figures 1 and 4. A

belt may nonetheless be run over the surface 2 of Figure 8 in the direction shown by the arrow and will conform closely to the surface. As shown in Figure 9, the complex surface 2 of Figure 8 can still be generated by the intersection of two cylinders having a cross-section generated by joining two sections c. back to back.

It should also be noted that a reference plane 6 can be taken parallel to the surfaces 2 of the shoes of Figures 4 and 7 and paths a of constant length may be drawn just as described with reference to Figure 1.

Figure 10 shown a wheel 10 for mounting on an axle by means of a central axial aperture 11. Wheel 10 is composed of a pair of circular disks 12 lying one over the other and joined by eight posts 13. Between the disks 12 and between the posts 13 are nine shoes 1, each having its surface 2 directed radially outward. An abrasive belt 14 is arranged in a labyrinthine course over each surface 2, down the sides of each shoe 1 and around each post 13. Illustrated schematically at 15 is a device for pulling the belt around its path to bring a fresh piece of abrasive belt onto each surface 2. The wheel 10 may be used as an abrasive wheel for finishing the surface of a moulding, each surface 2 carrying the abrasive into contact with the workpiece as shown in Figure 11. Because the sanding material is a belt arranged to follow a labyrinthine or serpentine path, the length of the abrasive is considerably greater than the maximum circumference of the wheel. Hence

the abrasive need be replaced less often than if it only covers the wheels sanding surface. Also when the belt is worn-out no shaped or otherwise special parts need be discarded only the belt which is readily available as a standard item need be replaced.

The shoes may be of for instance metal, wood or plastics but are preferably of a resilient material such as rubber, either natural or synthetic.

The shoes may be either moulded in the desired shape or may be cut to shape.

Figure 12 shows a belt-sanding machine of the invention utilising a shoe 1 according to the invention. A drum 15 driven by a motor 15A drives an abrasive belt 16 around a shoe 1 and thereby sands an elongate wooden work-piece 5 having a sharp edge profile 4. Shoe 1 is mounted rigidly on vertical pin 18 which is mounted for rotation between the ends of fork arm 20.

Fork arm 20 carries the whole shoe assembly with the shoe 1 set on pin 18 so as to be able to pivot in the fork to keep perpendicular to the surface of workpiece 5. Tension in the belt is established by suitable means not shown.

The pivoting action of the shoe 1 and pin 18 is guided by the provision of a castor wheel 22 mounted for rotation on a vertical pin 21 which pin extends downwardly from a castor arm 19. Castor arm 19 is rigidly mounted at one end on pin 18 below the lowermost fork end of fork arm 20

and at its other end bears pin 21. The position of pin 21 on arm 19 is longitudinally adjustable by adjusting screw 21A. A cam surface 23 is provided beneath the workpiece and castor wheel 22 rides on this surface. The cam surface 23 and the workpiece 5 are correspondingly curved along their length and means (not shown) are provided for moving the workpiece 5 and the cam surface 23 gradually past the shoe 1 so that the workpiece 5 is progressively sanded. The castor action of wheel 22 produced by the spacing of pins 18 and 21 ensures that the shoe 1 remains perpendicular to the surface being sanded despite varying curvature along the length of the workpiece.

This effect may be better appreciated by reference to Figure 13 in which action of the castored shoe assembly to keep shoe 1 at right angles to surface 4 is shown.

The belt sanding machine shown occupies only a very small portion of the length of the workpiece and therefore lends itself to being incorporated into a wood-shaping machine of the rotary table type where a series of shaping operations are carried out on a workpiece mounted on a rotary table as the table carries the workpiece through various work stations around the table. The use of the shoe according to the invention enables the sander to deal with workpieces that present a face along its length.

Figures 14 to 16 show a second form of surface treatment wheel 10 according to the invention. Wheel 10 comprises a steel hub 23 upon which is bonded a one piece

wheel member 24 of soft rubber. Wheel member 24 is shaped by cutting or by moulding to provide a regular series of radial projections 25. Each projection 25 has a radially outwardly directed belt support face 26.

An abrasive continuous belt 14 is arranged to lie over each support surface 26 and to follow the sides of each projection back generally radially toward the centre of the hub. The belt is drawn into the spaces between the projections 25 by a number of claws 27. Each claw 27 comprises an l-shaped rod member 28 having one leg sheathed in a plastics tube 29 retained by an end washer 30 which is held at the bottom of the leg of the l-shaped rod 28 by the end of the rod being peened over as a rivet head. The other end of each claw 27 extends radially toward the hub centre above the top face of the hub 23 and passes through a respective hole 31 in a collar 33 and is locked by a grub screw 32. The collar 33 is attached to the top surface of hub 23 by a pair of screws 34.

By forcing each claw 27 radially inwards, the belt may be tensioned to a desired degree. It has been found that the tension may be chosen such that the belt tends in use to creep around the wheel, thus bringing a fresh abrasive surface gradually into action.

Each support face 26 is a counterform for a particular profile to be sanded. Each support face is accordingly shaped as has been described hereinbefore to conform to the profile to be sanded but to also support the belt

without stretching and in conformity with the support surface.

Because the supporting projections 24 are flexible and because the belt is not required to run over them at high speed, it is found that the support surface need not be particularly precisely shaped. Thus, as seen in Figure 15 each face 26 has a relatively simple shape. Shoulders 35 are cut square in the side of the projection rather than being smoothed into one continuous surface as they should ideally be. To some extent, the tense belt serves to flatten these rubber shoulders into a smoother shape. This level of departure from the ideal surface shape is quite tolerable and the belt will conform adequately to the support.

CLAIMS

1. A surface treatment wheel characterised in that the wheel 10 comprises a plurality of radially outwardly directed projections 25 having end faces each providing a radially outwardly facing support surface 26, a treatment belt 14 extending around the wheel and having portions supported on the support surfaces 26 and intermediate portions extending generally radially between the said projections 25, wherein the belt conforms to each support surface 26 without stretching of the belt.

2. A surface treatment wheel for supporting a belt in conformity against a workpiece surface 4 which surface has a non-linear cross-section transverse to the belt, characterised in that the wheel 10 comprises a plurality of radially outwardly directed projections 25 having end faces each providing a radially outwardly facing support surface 26, a treatment belt 14 extending around the wheel and having portions supported on the support surfaces 26 and intermediate portions extending generally radially between the said projections 25, each support surface 26 having substantially the shape generated by the crossing intersection in register of cylinders each having a cross-section perpendicular to its generator produced by opposing back to back a pair of said sections of the surface 4 to be conformed with.

3. A surface treatment wheel for supporting a belt in conformity against a workpiece surface which surface has a non-linear cross-section transverse to the belt, characterised in that the wheel comprises a plurality of radially outwardly directed projections 25 having end faces each providing a radially outwardly facing support surface 26, a treatment belt 14 extending around the wheel and having portions supported on the support surfaces 26 and intermediate portions extending generally radially between the said projections 25, each support surface being complimentary to the workpiece surface 4 and such that the length of any path leading first perpendicularly from a reference plane 6, which reference plane lies parallel to the direction of belt extension at the surface and lies behind the surface, to one end of the surface, then along the surface in the direction the belt extends to the other end of the surface and then perpendicularly back to the reference plane 6, is substantially a constant.

4. A surface treatment machine characterised in that it comprises a surface treatment wheel as claimed in any one of claims 1 to 3 mounted for rotation against a surface to be treated.

5. A shoe 1 for supporting a belt, comprising a belt supporting surface 2 non-linear in cross-section perpendicular to the direction of belt extension characterised in

that the said surface is shaped such that a belt may bend sharply around the surface 2 in its direction of extension whilst conforming to the surface 2 without stretching.

6. A shoe 1 for supporting a belt in conformity against a workpiece surface which surface 4 has a non-linear cross-section transverse to the direction of belt extension thereat, characterised in that the shoe comprises a support surface 2 having substantially the shape generated by the crossing intersection in register of cylinders each having a cross-section perpendicular to its generator produced by opposing back to back a pair of said sections of the surface 4 to be conformed with.

7. A shoe 1 for supporting a belt in conformity against a workpiece surface 4 which surface 4 has a non-linear cross-section transverse to the direction of belt extension thereat, characterised in that the shoe comprises a support surface 2 complimentary to the workpiece surface 4 and such that the length of any path leading first perpendicularly from a reference plane 6, which reference plane 6 lies parallel to the direction of belt extension at the surface 2 and lies behind the surface 2, to one end of the surface 2, then along the surface 2 in the direction the belt extends to the other end of the surface 2 and then perpendicularly back to the reference plane 6, is substantially a constant.

8. A surface treating machine in which a surface-treating belt 16 is supported for conforming contact with a surface 4 to be treated by a shoe, means 15A being provided for producing movement of the belt 16 relative to the surface 4 to be treated characterised in that the shoe 1 is as claimed in any one of claims 5 to 7.

9. A surface treating machine comprising a surface treatment wheel 10 as claimed in any one of claims 1 to 3 mounted for rotation against a workpiece further characterised in that each of the said projections 25 is a shoe 1 comprising a belt supporting surface 2 non-linear in cross-section perpendicular to the direction of belt extension and shaped such that a belt may bend sharply around the surface 2 in its direction of extension whilst conforming to the surface without stretching.

10. A surface treatment wheel characterised in that it comprises a treatment belt 14 supported on a plurality of shoes 1, arranged in a circle to face radially outwards, each shoe comprising a belt 14 supporting surface 2 non-linear in cross-section perpendicular to the direction of belt extension and shaped such that a belt 14 may bend sharply around the surface in its direction of extension whilst conforming to the surface 2 without stretching, the belt following a path having substantially radial portions between portions lying on the support faces 2 of the shoes 1.

FIG. 1.

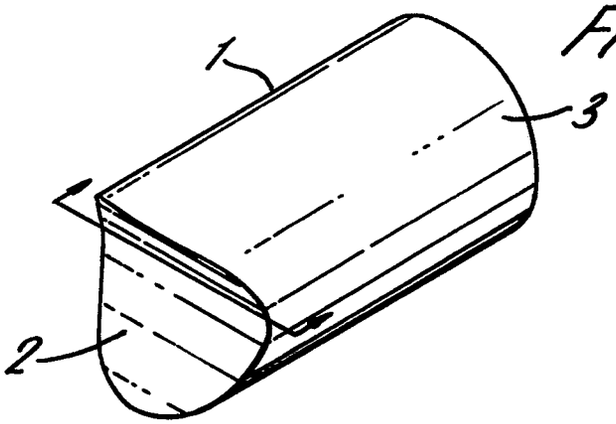


FIG. 2.

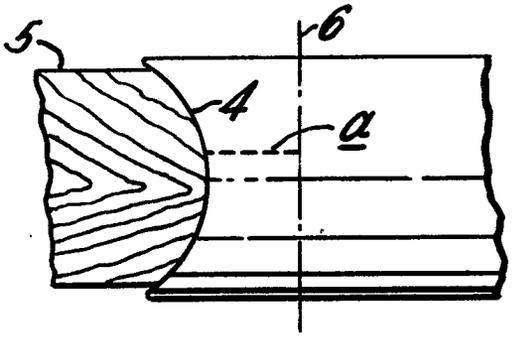


FIG. 3.

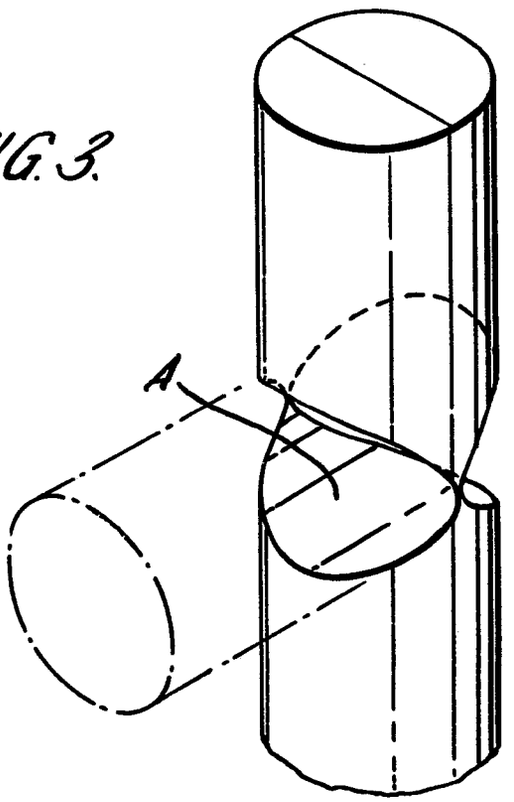


FIG. 3A.

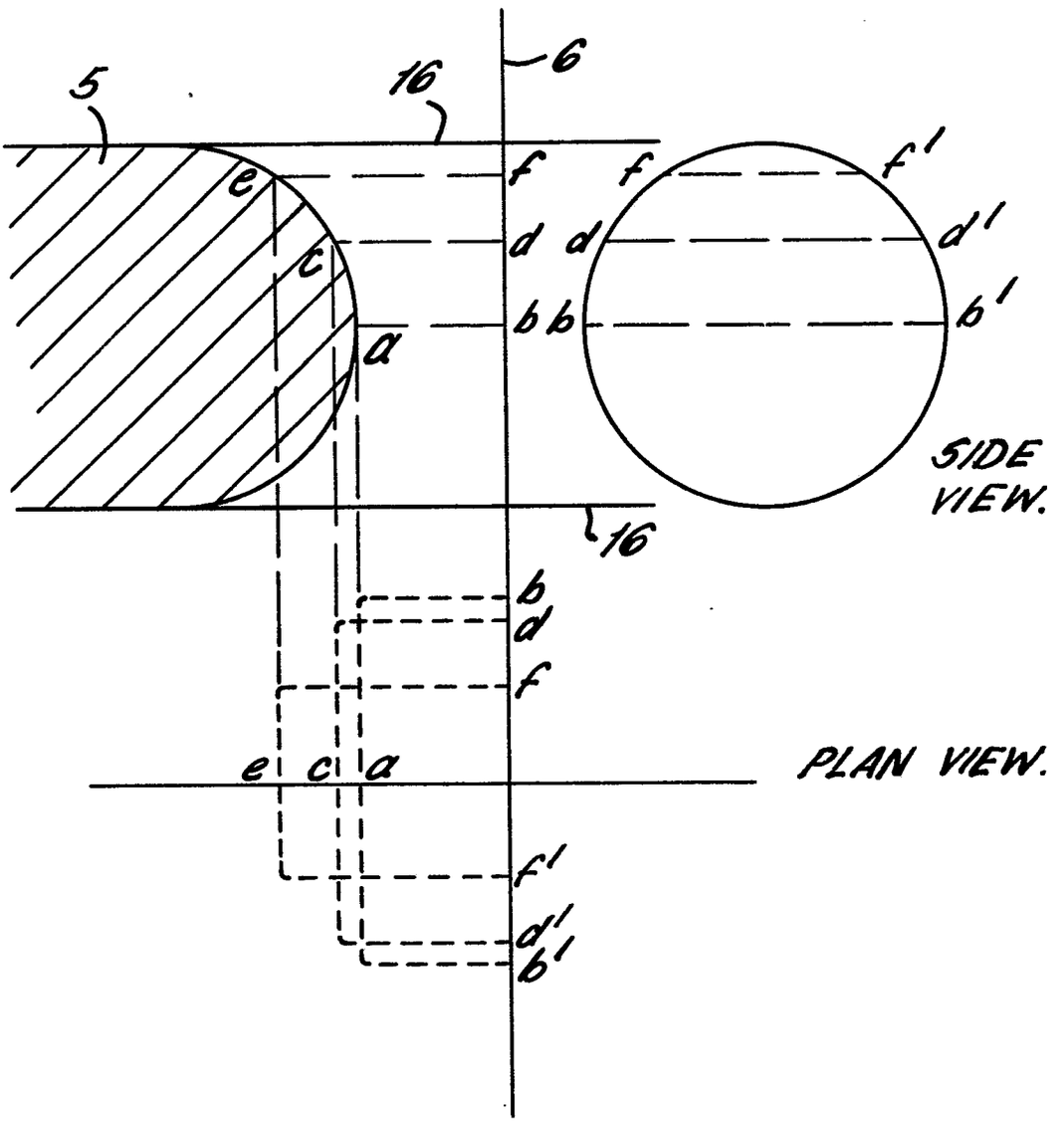


FIG. 4.

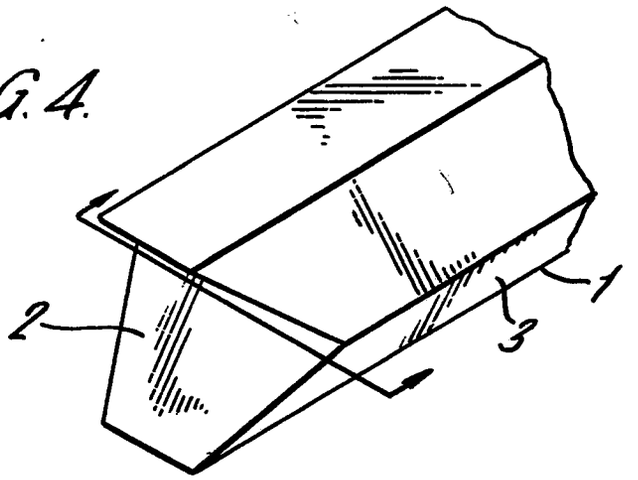


FIG. 5.

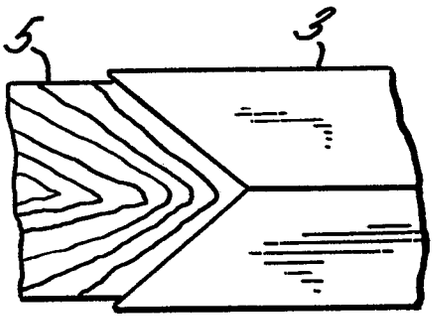
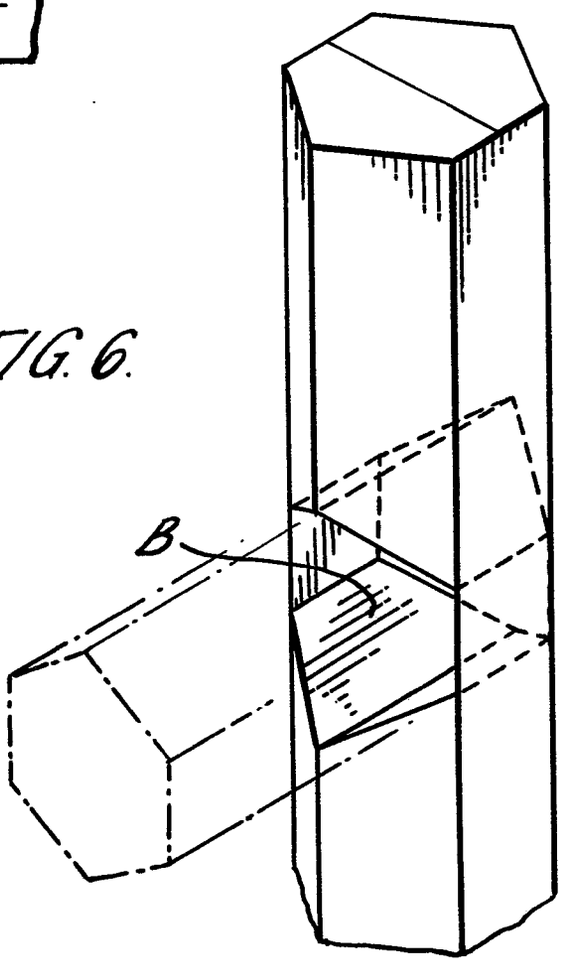


FIG. 6.



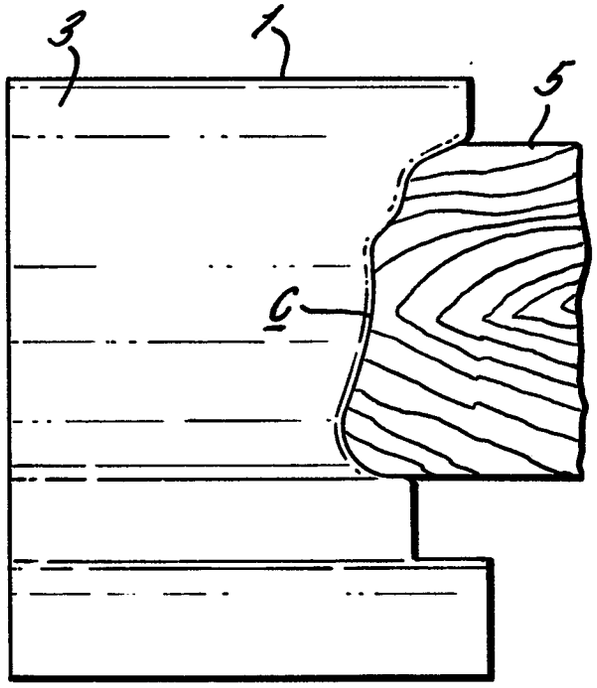


FIG. 7.

FIG. 9.

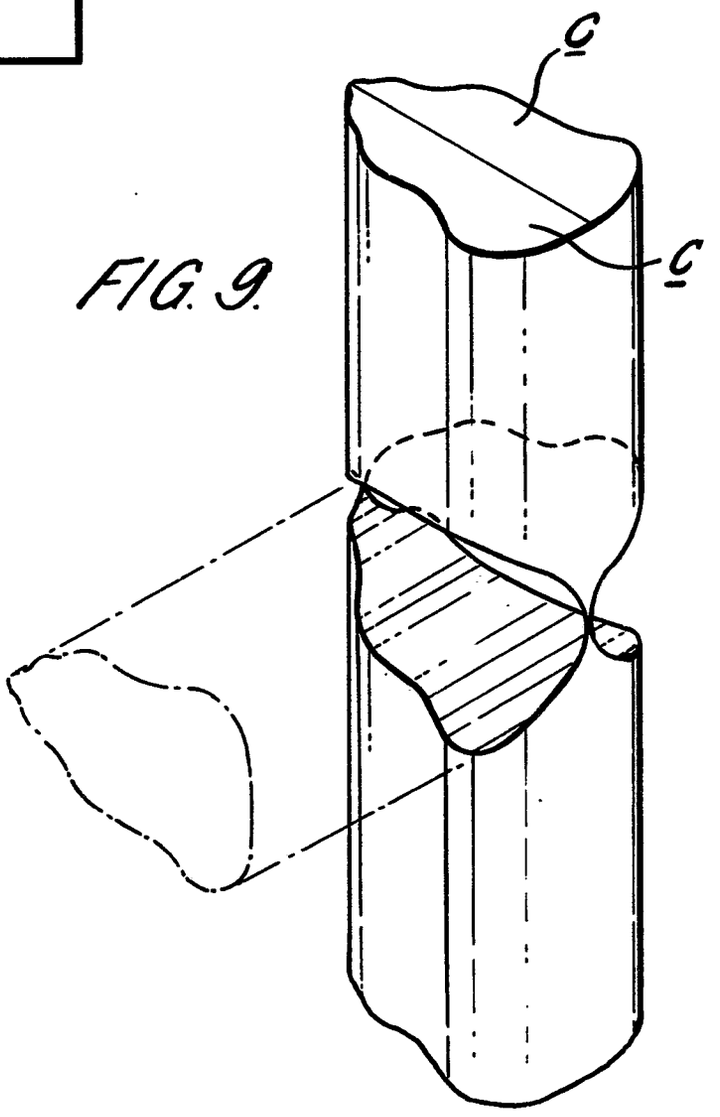


FIG. 8.

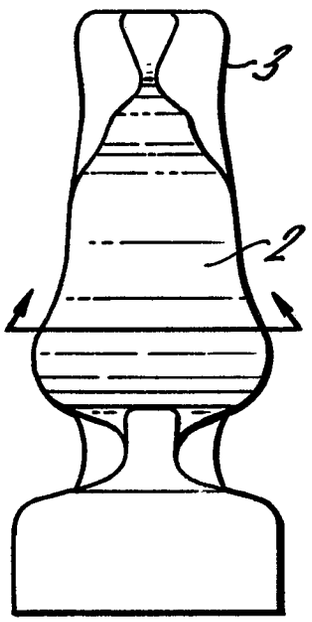


FIG. 10.

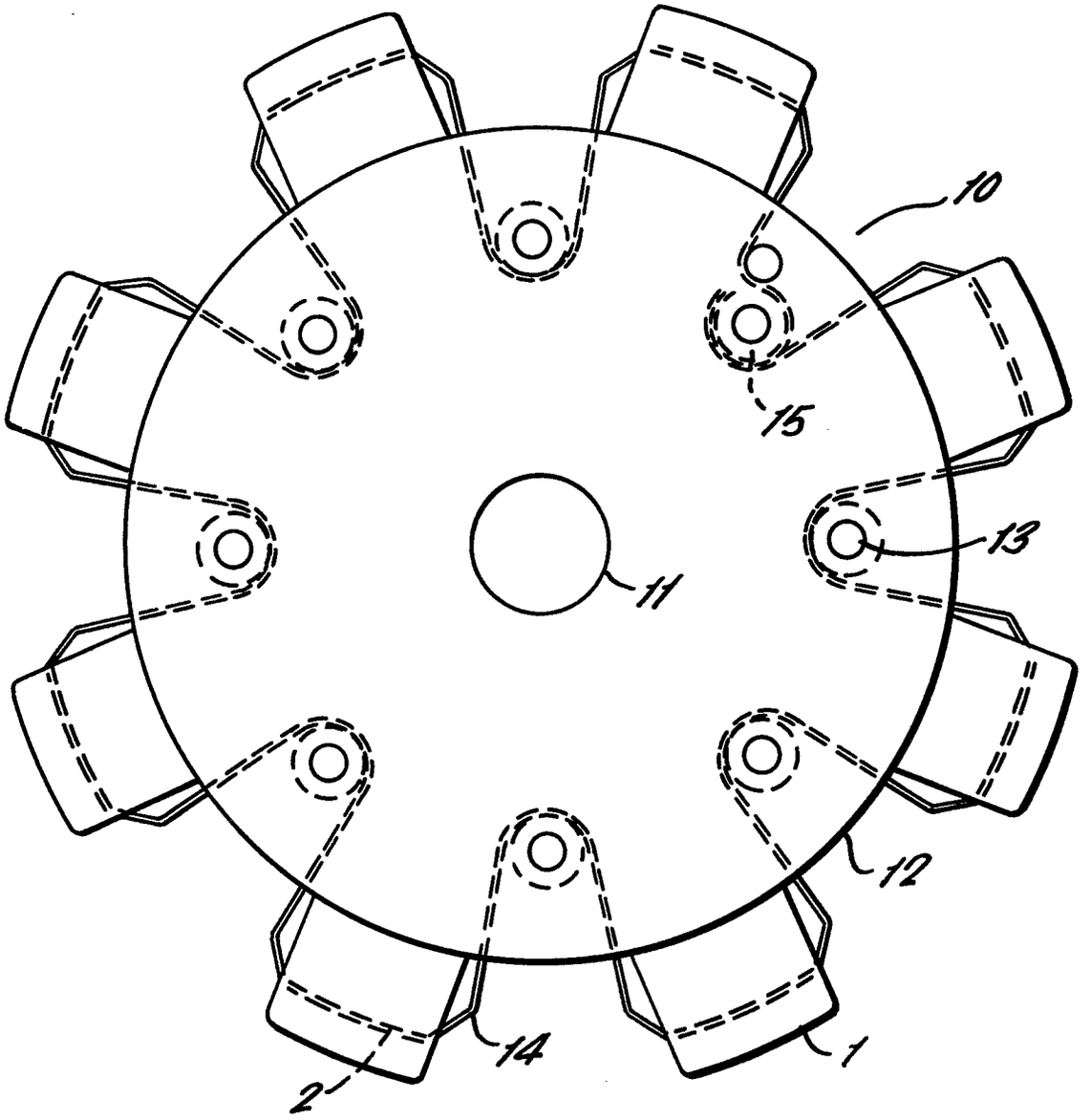
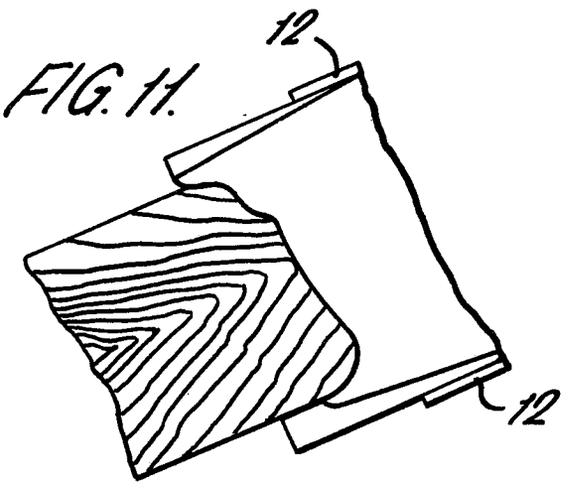


FIG. 11.



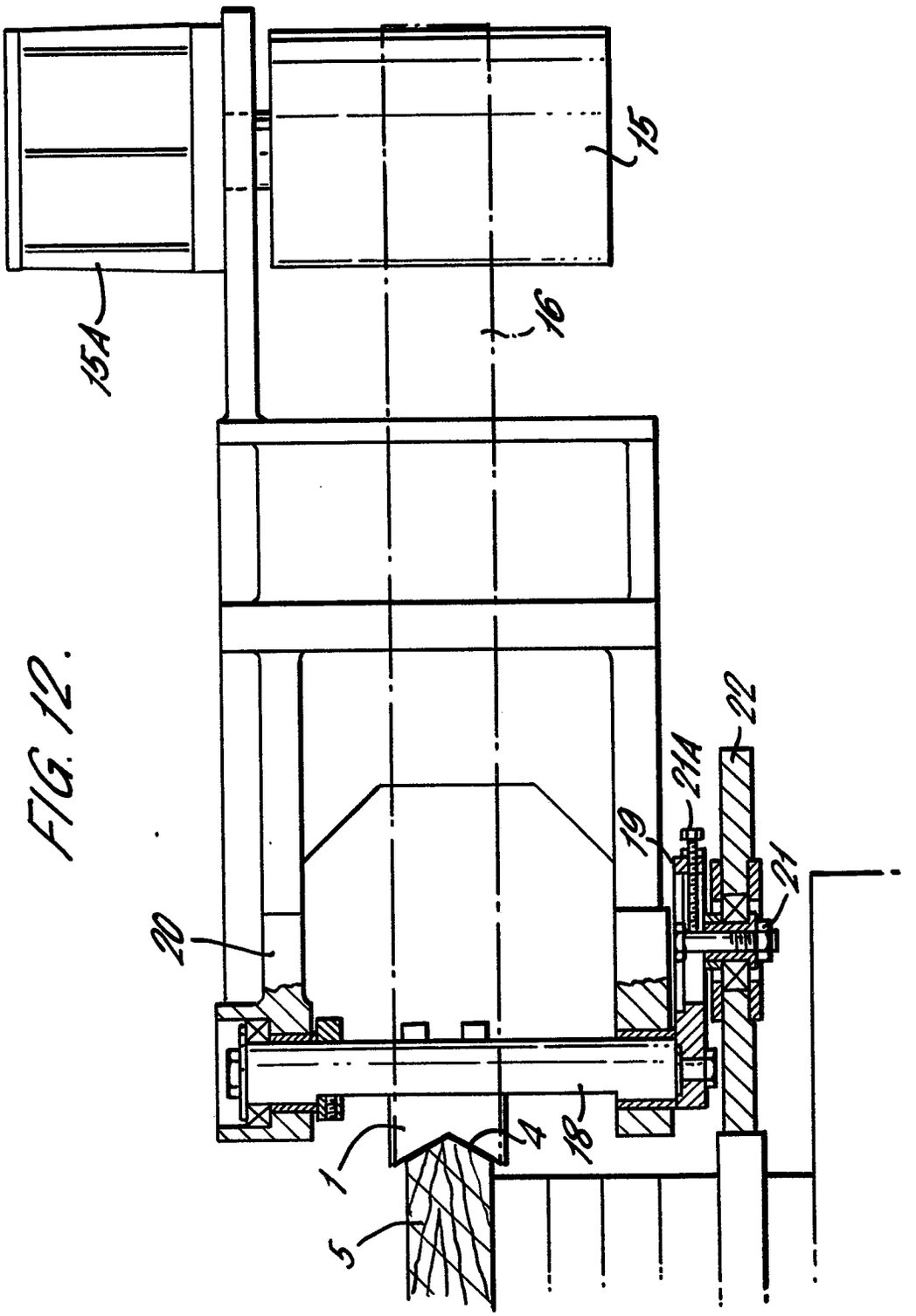


FIG. 12.

FIG. 13.

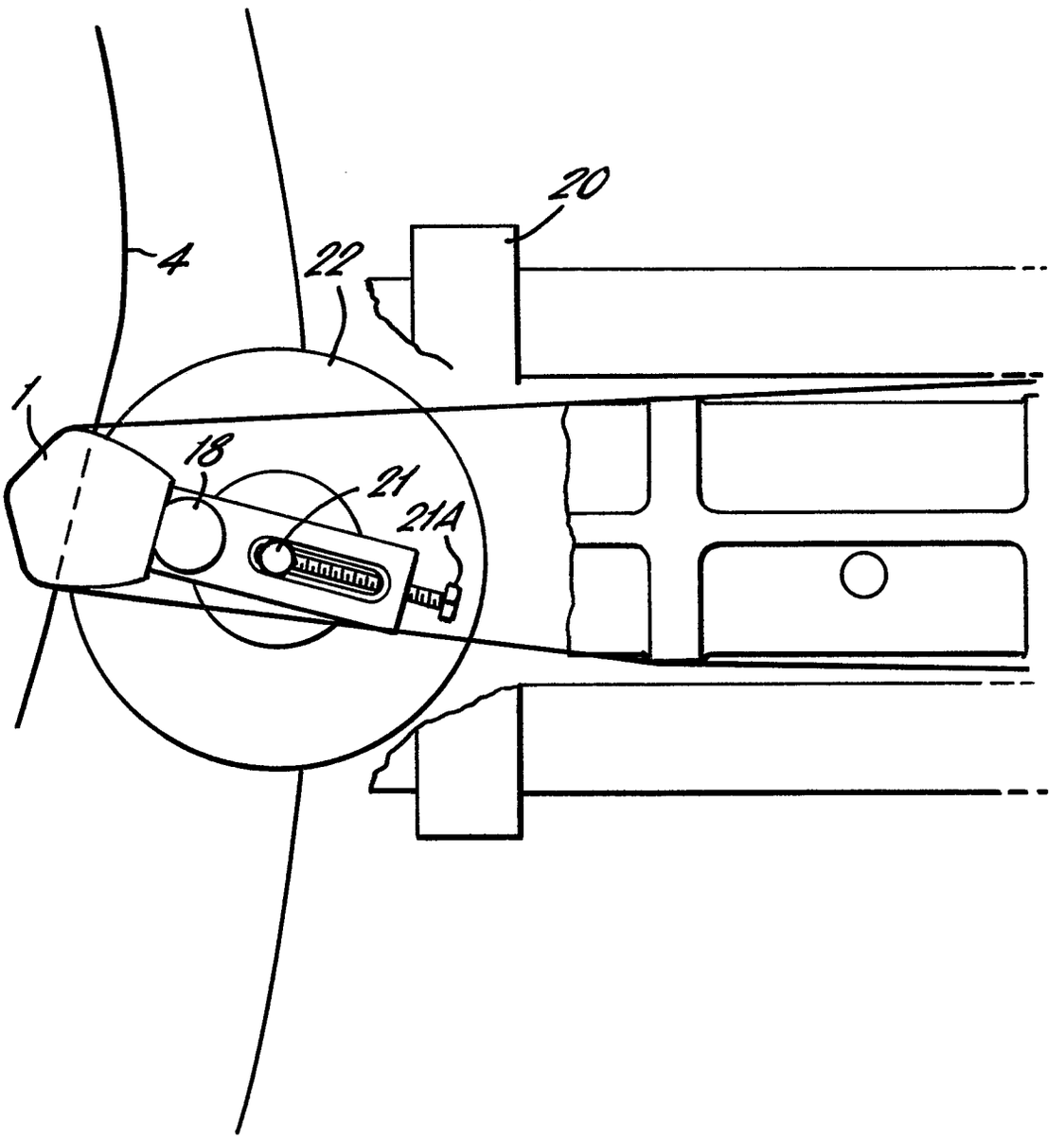


FIG. 14.

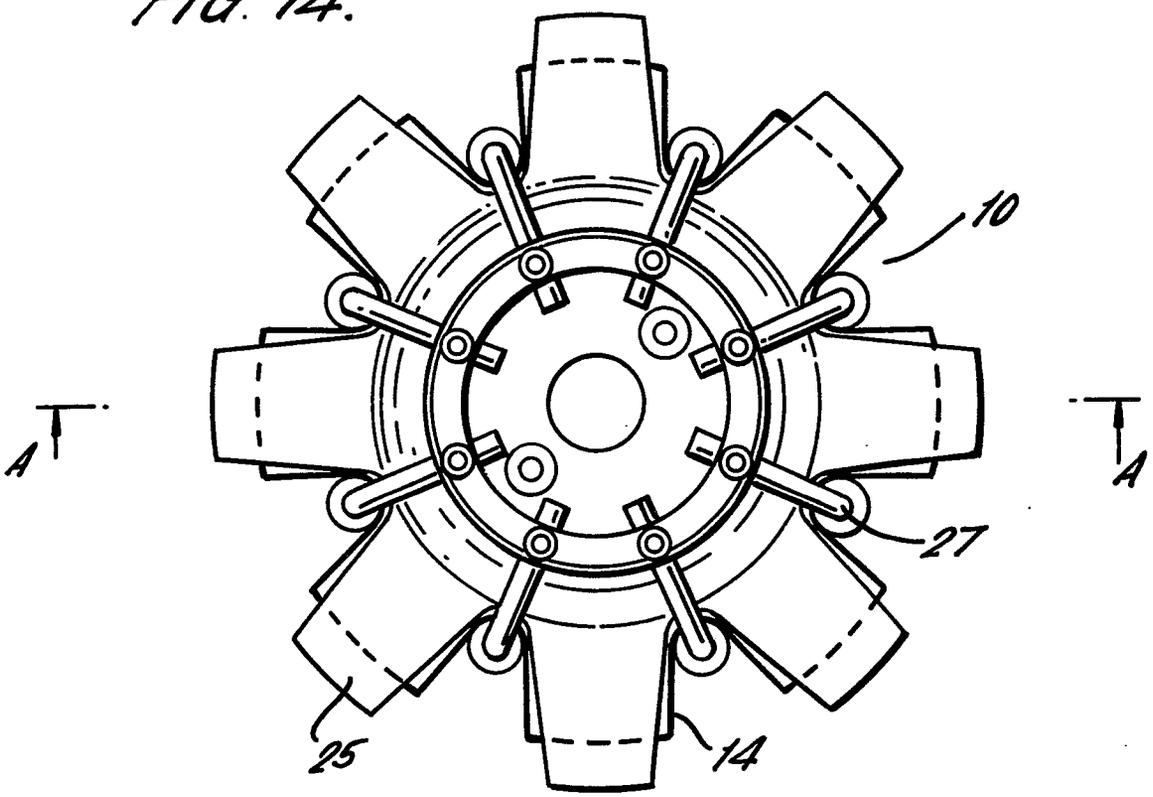


FIG. 15.

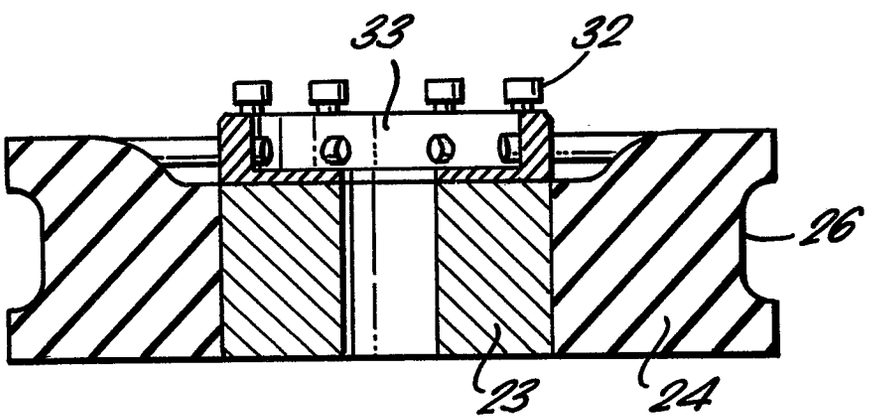


FIG. 16.