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

(11) Publication number: **0 054 368**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **81305599.3**

(51) Int. Cl.³: **B 24 D 11/00**

(22) Date of filing: **26.11.81**

(30) Priority: **28.11.80 GB 8038235**

(43) Date of publication of application:
23.06.82 Bulletin 82/25

(84) Designated Contracting States:
DE FR GB IT SE

(71) Applicant: **Thomas Hunter Limited**
Omnia Works
Rugby Warwickshire(GB)

(72) Inventor: **Edwards, Cyril Kenneth**
27, Michel Grove
East Preston West Sussex(GB)

(74) Representative: **Adkins, Michael et al,**
Withers & Rogers 17, Waterloo Place
Leamington Spa Warwickshire CV32 5LA(GB)

(54) Improvements in or relating to a smoothing pad.

(57) A smoothing pad having a working surface (1, 33) formed with a plurality of depressions (6, 12, 30) for indicating wear of the working surface of the pad. Each depression preferably diverges towards the working surface of the pad so that the dimension of each depression in a direction transverse to its depth will diminish as the working surface wears. Each depression constitutes a reservoir for an abrasive slurry used with the pad and a gradual transition is preferably defined between each depression (30) and the working surface whereby, in use, the abrasive slurry (S'') will be encouraged to flow from each depression on to the working surface.

EP 0 054 368 A2

./...

FIG. 4

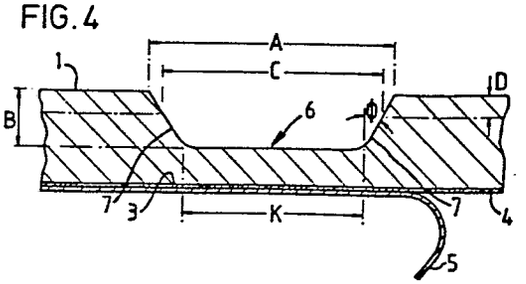


FIG. 20

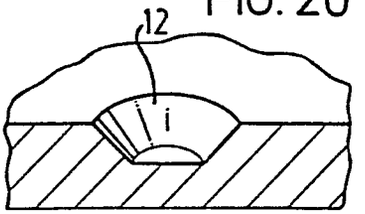
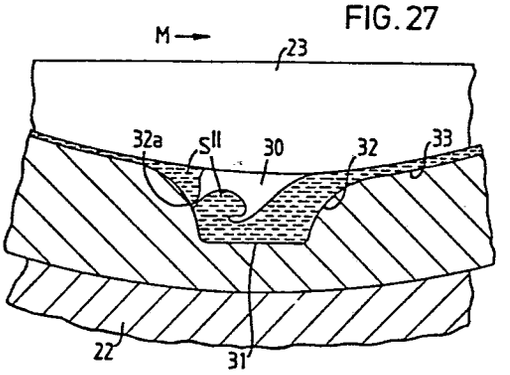


FIG. 27



IMPROVEMENT IN OR RELATING TO SMOOTHING PADS

The invention relates to smoothing pads and is particularly but not exclusively concerned with pads for smoothing the surfaces of generated lenses to prescription curvature geometrics.

Over the years, various methods of smoothing lenses have been employed using smoothing tools and abrasive slurry. In one such method, a smoothing tool of cast iron was used, the tool being formed with a smoothing face conforming to the prescription curvature of the desired lens. However, the abrasive slurry abraded the smoothing face of the tool as well as the lens and this resulted in the production of defective lenses and frequent and costly re-truing of the smoothing face of the tool. This obviously made accurate lens surfaces expensive to achieve.

It was eventually proposed to use a smoothing pad between the smoothing face of the tool and the lens, such pads conforming to and protecting the smoothing face and being easily replaceable. The use of such pads is now normal practice. The pads are formed from a variety of materials such as metal foil, perforated zinc, annealed woven wire, tempered expanded steel or non metallic materials. In use, the pads are generally adhered to the smoothing face of the tool and are usually formed

as a multi-slotted flat element which enables them to conform to the curvature of the smoothing face. The adhesive may be of a contact type applied to the back of the pad and protected by a peel-off backing paper.

It has been found that smoothing pads co-operate better with the slurry than the smoothing face of the tool and provide the optimum conditions necessary to smooth lenses rapidly and accurately to the required curvature. However, the pad itself is obviously subject to wear during smoothing operations and, if such wear becomes excessive, inaccurate lenses are produced. Moreover, if the pad wears through at any point, the curved face of the smoothing tool will once again be subject to wear.

It has been proposed to overcome such difficulties by forming in the smoothing surface of the pad a series of wear indicating grooves which, in transverse cross section, have parallel side walls. As the pad wears, the depth of the groove decreases and, when any groove disappears, it is immediately apparent to the machine operator that the pad has worn and needs replacing. A pad of this type is described in US Patent No 4,019,289.

Whilst the use of parallel side walls could be expected to indicate that wear has occurred, it is only when a groove or part thereof has completely disappeared that wear is readily noticable. This is because the eye cannot easily detect changes in depth of the parallel sided shallow grooves

particularly where there is a desirable residual slurry in the grooves. In the foregoing US Patent Specification, it is proposed to use grooves of incrementally increasing depths across the pad. In this way, the shallowest groove will supposedly disappear first and will provide an early indication of wear. Whilst an early indication of wear will be obtained if the wear occurs in the shallow groove area, the incremental depth arrangement will not help if the wear is localised in the area of the deepest grooves. In such a case, defective lenses can be produced as the operator concentrates on the shallowest grooves and believes that no significant wear is taking place on the pad. Moreover, the depths of the shallowest grooves may be obscured by residual slurry.

An object ot the present invention is to provide a smoothing pad which overcomes the foregoing disadvantage and, according to the invention, there is provided a smoothing pad having a working surface formed with at least one depression for indicating wear, said depression being formed so that the dimension of the depression in a direction transverse to its depth will change as the working surface wears.

With that arrangement, a change in a dimension of the depression in such a direction is readily apparent at every stage of wear as the change is more easily detected than a mere reduction in depth of a very shallow groove even where there is a desirable residual slurry in the depression.

Preferably the depression diverges towards the working surface so that the said dimension of wear indicating depression will diminish as the working surface wears. To achieve this, the depression may be trapezoidal

or V-shaped in cross section with its sides converging from the working surface towards the back of the pad.

The depression preferably constitutes a reservoir for abrasive slurry. The latter point is an important one because once relative movement begins to take place between the lens and the pad, flow of slurry therebetween tends to be restricted. There may be a gradual transition between the wear indicator depression and the working surface whereby, in use, the abrasive slurry will be encouraged to flow from the depression on to the working surface. The use of a gradual transition encourages slurry to flow out of the depression on to the surface of the pad. In cross section, the transition may be in the form of a curve extending between the depression and the working surface. In such a case, the working surface is preferably substantially tangential to the curve. By providing a gradual transition, the dimensions of the depression in a direction transverse to its depth will reduce as the pad wears and the pad will, therefore, provide the aforesaid indication of wear as well as improved slurry flow.

Preferably the width of the depression changes as the working surface wears.

A plurality of depressions in the form of wear indicating grooves may be formed in the working surface, said wear indicator grooves being arranged so that wear indicator grooves in one portion of the working surface are transverse to wear indicator grooves in another portion of the working surfa Such grooves not only indicate wear but also provide distribution channels for

the slurry. Also the grooves provide an extremely effective reservoir for the slurring during use.

Instead of using a system of grooves, the depression may take the form of one or more frusto-conical depressions in the pad, each of which tapers towards the back of the pad. A multiplicity of such depressions may be provided to give an overall indication of wear and the depressions may be interconnected by grooves in the pad surface to give improved slurry distribution. The depressions, either with or without interconnecting grooves, demonstrate ideal wear-indicating characteristics and also provide reservoirs for the slurry.

Where the pad is a multi-slotted element, grooves or other depressions may be formed in each lobe of the element defined between the slots so that each lobe includes means for indicating wear and for retaining slurry.

The aforesaid gradual transition can be used advantageously with the grooved and frusto-conical depressions embodiments.

Smoothing pads in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figures 1 to 3 are plan views of three different smoothing pads,

Figures 4 and 5 are diagrammatic representations showing cross-section a part of a smoothing pad and illustrating how the width of a wear-indicating and slurry distributing groove changes as the pad wears,

Figure 6 is a plan view of part of a worn pad of the type shown in Figure 4,

Figures 7 to 10 are enlarged cross-sections of four different smoothing pads having wear-indicating and slurry distributing grooves,

Figures 11 to 18 are plan views of eight smoothing pads having different arrangements of grooves,

Figure 19 is a plan view of a smoothing pad formed with frusto-conical depressions for indicating wear and holding slurry,

Figure 20 is a perspective cross-section of part of the pad of Figure 19,

Figures 21 and 22 are plan and perspective views respectively corresponding to Figures 19 and 20 showing the effects of wear on the pad,

Figure 23 is a plan view of a smoothing pad formed with frusto-conical wear indicating depressions interconnected by grooves,

Figure 24 is a perspective cross-section of part of the pad

in Figure 23 showing a square or rectangular cross-section connecting groove,

Figure 25 is a perspective cross-section similar to Figure 24 and showing a V-shaped cross-section connecting groove

Figure 26 is a cross-section through part of a smoothing pad having parallel sided grooves and illustrating slurry flow as a lens moves over the pad,

Figure 27 is a cross-section through part of a smoothing pad in which there is a gradual transition between the groove and the working surface of the pad to give improved slurry flow, and

Figure 28 is a diagrammatic representation of the groove in the pad of Figure 27 illustrating how the width of the groove changes as the pad wears.

Figures 1 to 3 show typical smoothing pads made e.g. from metal foil. Each pad has a working surface 1 and is formed with one or more slots 2, the slots enabling the pads to conform to various shapes of

surfacing tools. If desired the undersurface 3 (see Figure 4) of each pad may be provided with a layer of adhesive 4 for securing the pad to the smoothing tool. The adhesive layer 4 is protected by a peel-off backing sheet 5 which is removed to expose the adhesive.

Each pad is formed with wear indicating grooves 6 which extend part way through the pad as shown clearly in Figures 4 and 5.

In Figure 4, the groove is of trapezoidal cross section with the side walls sloping at an angle θ to the vertical. In plan view, the edges of the unworn groove are parallel as shown in Figures 1 to 3. The angle of inclination θ is ideally not less than 45° to provide a multiplier wear indicator facility whereby the rate of change of groove width relationship to the rate of pad surface wear is at least two to one, from which it will be seen that such a relationship can be increased by an increase in the angle θ Prior to wear, the groove width A is as follows:-

$K + 2B \tan \theta$ where

K = width of groove at its base

B = depth of groove

After wear, the new groove width C is as follows:-

$K + 2(B-D) \tan \theta$ where

D = amount of wear

Hence for only a small amount of wear there is a considerable amount of reduction in groove width. Therefore, as shown at N in Figure 6,

localised wear will show up quickly as a narrowing of the groove. Such a change of groove dimension in a direction transverse to the depth of the groove is more readily apparent than a mere change of depth which is always difficult to assess with grooves, in particular with grooves having a depth of the order of 0.005 inches and probably obscured by slurry.

In Figure 5, the groove 6 is V-shaped with sloping walls 8 and will again enable wear by width change to be readily determined. In this case the groove width A before wear is as follows:-

$$2B \tan \alpha$$ where

B = depth of groove before wear

α = angle of wall inclination from vertical

After wear, the new width C is as follows:-

$$2(B-D) \tan \alpha$$ where

D = amount of wear.

In this case the angle α is preferably not less than 45° to provide the above ratio of at least 2 to 1 between change of groove width and amount of pad wear.

Reference is now made to Figures 7 to 10. In Figure 7 the groove 6 is shown as being cut into the pad which is thereby weakened because the grain pattern of the foil is severed. The pad is particularly weak at the sharp bottom corners of the groove and is liable to tear in that region especially when the backing sheet 5 is removed. Therefore we prefer to form the grooves by rolling as in Figures 8, 9 and 10. Rolling of the grooves deforms rather than severs the grain and substantially preserves the strength of the pad. In Figure 10, recesses

9 are formed in the undersurface 3 during the rolling operation. Displaced adhesive is received by the recesses 9 to reduce the risk of distorting the bottom of the wear indicating groove 6 when the pad is applied to a surfacing tool.

In Figures 11 to 18 various groove patterns are illustrated which provide reservoirs and facilitate distribution of slurry over the working surface of the pad.

In Figures 1 to 3 and in the aforesaid US Specification, the grooves are completely straight and parallel and slurry flow through them is at its best only when the relative movement between the lens and pad is in the longitudinal direction of the grooves. However, such relative movement is normally random to prevent what is known as "tracking" and completely straight grooves do not provide ideal channels for the slurry.

With the pads shown in Figures 11 to 18 we have provided grooves generally indicated at 6 which extend in various directions to improve slurry distribution during random pad movement. Therefore even when the movement is transverse to one groove, there will be some other groove along which slurry will flow reasonably freely. For example in Figures 11 and 12 if movement is in direction X transverse to grooves 6A and 6B, slurry will be encouraged to flow along at least groove sections 6C and 6D. In Figures 12, 14,16 and 18 selected grooves are interconnected to central ducts 10 to improve distribution of slurry from one lobe of the pad to another.

As well as providing for improved slurry flow, the provision of a multiplicity of grooves increases the availability of slurry because the grooves form

a reservoir for the slurry even during movement of the pad/lens.

Figures 1 to 18 are concerned entirely with grooves for indicating wear and providing reservoirs for slurry but as shown in Figures 19 to 25, the invention is not limited to the use of pads formed solely with grooves.

Figure 19 is a plan view of a smoothing pad formed with a multiplicity of frusto-conical depressions 12. As shown in Figure 20, each depression tapers towards the back face of the pad. As the pad wears, say over areas 13, 14 (Fig 21), the dimension of each depression in a direction transverse to its depth, i.e. the width or surface diameter, within the areas decreases as shown at 12'. In Figure 22, the surface diameter A before wear is as follows:-

$K + 2B \tan \phi$ where

B = depth of depression before wear

K = minimum diameter of depression

ϕ = angle of wall inclination from vertical

After wear, the reduced surface diameter C is as follows:-

$K + 2(B-D) \tan \phi$ where

D = amount of wear

As described with respect to Figures 4 and 5, the angle ϕ is preferably not less than 45° to provide a ratio of at least 2:1 between the change in surface diameter and the amount of pad wear.

In order to improve slurry distribution between the pad and the lens, the depressions 12 may be interconnected by grooves 15 as shown in Figure 23. The grooves may be of square or rectangular cross section as shown in Figure 24,

of V-shaped cross section as shown in Figure 25 or of any other suitable cross section. Where grooves 15 are provided, the number of depressions 12 may be reduced without adversely affecting the slurry retaining characteristics of the smoothing pad. Although Figure 23 shows a grid-like arrangement of grooves 15, the interconnecting grooves could be arranged in patterns such as those shown in Figures 11 to 18 with the depressions suitably located in the pad.

Referring now to Figure 26, a smoothing pad 20 has parallel sided grooves 21 (one only of which is shown) and is supported by a tool 22. In use, a lens 23 is moved in random fashion over the working surface 24 of the pad and slurry S is fed to the pad to act as a smoothing medium. A certain amount of slurry S' is contained in the grooves 21 and during relative movement it is highly desirable that some of the slurry flows out of the grooves and across the pad between the lens 23 and the working surface 24. However with the groove 21 shown in Figure 26, slurry S on the lens surface tends to be scraped off the lens by sharp lines of transition 25, 25a between the groove 21 and the working surface 24. When moving the lens in the direction M shown the slurry is scraped off at 25 and when moving the lens in the opposite direction the slurry is scraped off at 25a. Although a certain amount of slurry S' will flow out of the groove during movement of the lens, the scraping action tends to inhibit the usefulness of such flow.

Greatly improved slurry flow from the grooves can be obtained by using a groove of the type shown in Figure 27. In that Figure, the groove 30 has a flat bottom 31 and arcuate side walls 32, 32a. The side walls form a gradual transition between the bottom of the groove 30 and the working surface 33 of the pad as opposed to the sharp lines of transition 25, 25a in Figure 26. During movement of the lens 23 across the pad in the direction M shown, the curved wall 32 encourages the slurry to be drawn out of the groove by the moving lens and does not have the scraping effect of the sharp transitions . . The wall 32a has a similar effect when the lens is moved in the opposite direction. This arrangement is particularly advantageous and reduces the likelihood of dry areas void of slurry occurring on the working surface.

In accordance with the invention, the arrangement shown in Figure 27 provides an indication of wear by reduction of width. That point is illustrated well in Figure 28. Prior to wear, the maximum width of the groove is indicated at C. After wear, the width W of the groove is as follows:-

$$W = \sqrt{C - 2\ 2RD - D^2}$$

where C = Width of groove before wear has occurred

D = amount of wear

R = radius of curved side wall

Of course, once wear has occurred, the transition tends to

sharpen but within the useful life of the pad the surface of the pad is still substantially tangential to the curved side walls and the scraping action illustrated in Figure 26 is still avoided. The groove 30 also provides the multiplier wear facility by which the rate of change of groove width is greater than the rate of pad surface wear.

Instead of using curved side walls, straight or polygonal walled grooves could be used, the walls being angled sufficiently to provide the gradual transition. Moreover straight sided grooves terminating at curves for the purposes of gradual transition and wear indication by reduction of width could be provided.

The gradual transition characteristic can, of course, be used in the embodiments shown in Figures 19 to 25 so that the frusto conical depressions blend gradually into the working surface of the pad.

Although pads made in accordance with the present invention are easily checked for wear by the eye, a suitable checking instrument may be used to detect width variation even before it becomes apparent to the naked eye.

A multiplicity of relatively short grooves may be formed in the pad and, in such a case, the length of such grooves and/or their width may be arranged to change as the working surface wears.

Pads in accordance with the invention may be formed from material other than metal and need not be provided with an adhesive backing 4.

CLAIMS:

1. A smoothing pad having a working surface formed with at least one depression for indicating wear of the working surface. Characterised in that the depression (6, 12, 30) is formed so that the dimension of the depression in a direction transverse to its depth will change as the working surface (1) wears.

2. A smoothing pad according to claim 1 characterised in that the depression (6, 12, 30) diverges towards the working surface (1, 33) so that the said dimension of the depression will diminish as the working surface wears.

3. A smoothing pad according to claims 1 or 2 characterised in that the depression (6, 12, 30) constitutes a reservoir for an abrasive slurry.

4. A smoothing pad according to claim 3 characterised in that there is a gradual transition (32, 32a) between the wear indicator depression (30) and the working surface (33) whereby, in use, the abrasive slurry S" will be encouraged to flow from the depression on to the working surface (33).

5. A smoothing pad according to any preceeding claim characterised in that the width of the depression changes as the working surface wears.

6. A smoothing pad according to any preceding claim characterised in that a plurality of depressions (6) in the form of wear indicator grooves are formed in the working surface (1), the wear indicator grooves being arranged so that wear indicator grooves (6A, 6B) in one portion of the working surface

are transverse to wear indicator grooves (6C, 6D) in another portion of the working surface.

7. A smoothing pad according to claim 6 characterised in that a wear indicator groove (6A) in one porition of the working surface is connected by a further groove (10) to a wear indicator groove (6B) in another portion of the working surface.

8. A smoothing pad according to any preceding claim characterised in that depression (6) is of trapezoidal cross section.

9. A smoothing pad according to any of claims 1 to 7 characterised in that the depression (6) is of V-shaped cross section.

10. A smoothing pad according to any of claims 1 to 5 characterised in that a multiplicity of frusto-conical depressions (12) is formed in the working surface (1).

11. A smoothing pad according to claim 10 characterised in that the frusto-conical depressions (12) are interconnected by grooves (15) in the working surface.

12. A smoothing pad according to any preceding claim characterised in that the depression (6; 12; 30) has, in cross section, side walls inclined so that the rate of change in said dimensions will be greater than the rate of working surface wear.

FIG. 1

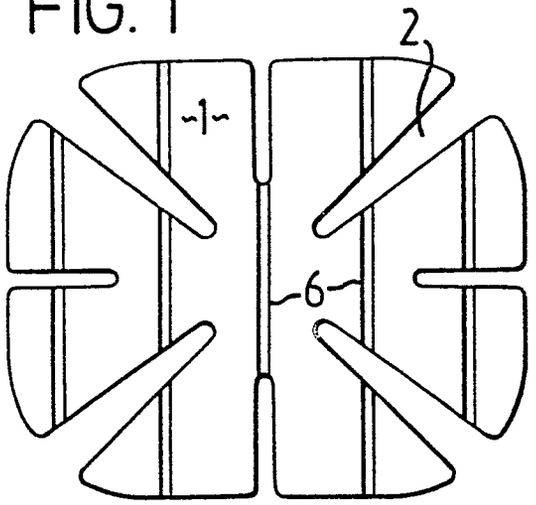


FIG. 7

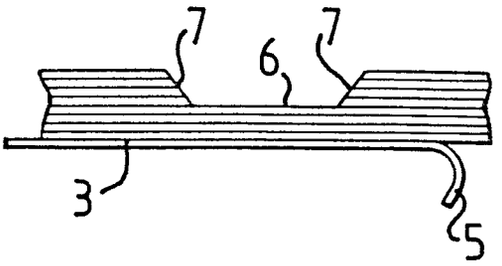


FIG. 2

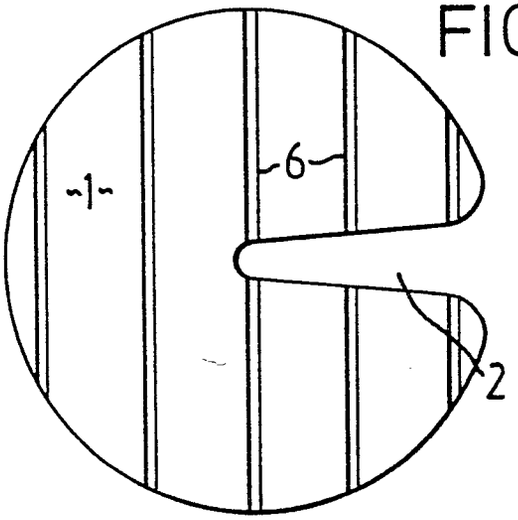


FIG. 8

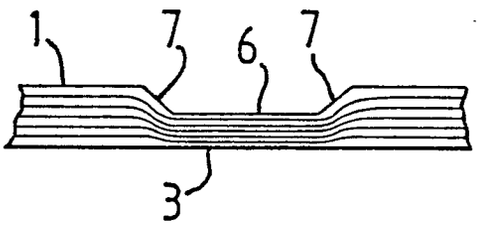
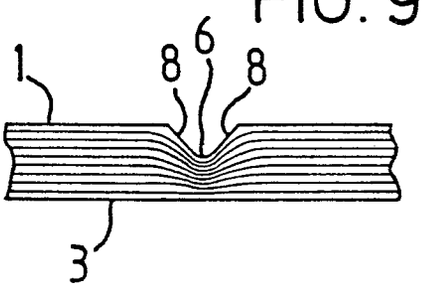


FIG. 9



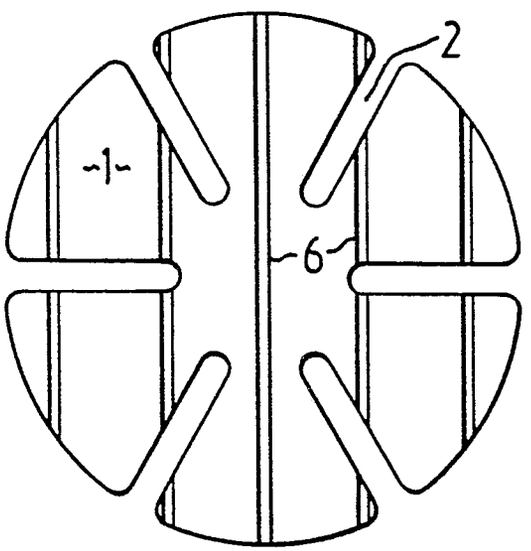


FIG. 3

FIG. 10

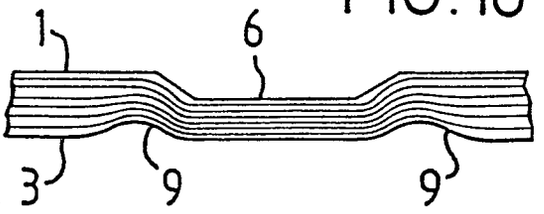


FIG. 4

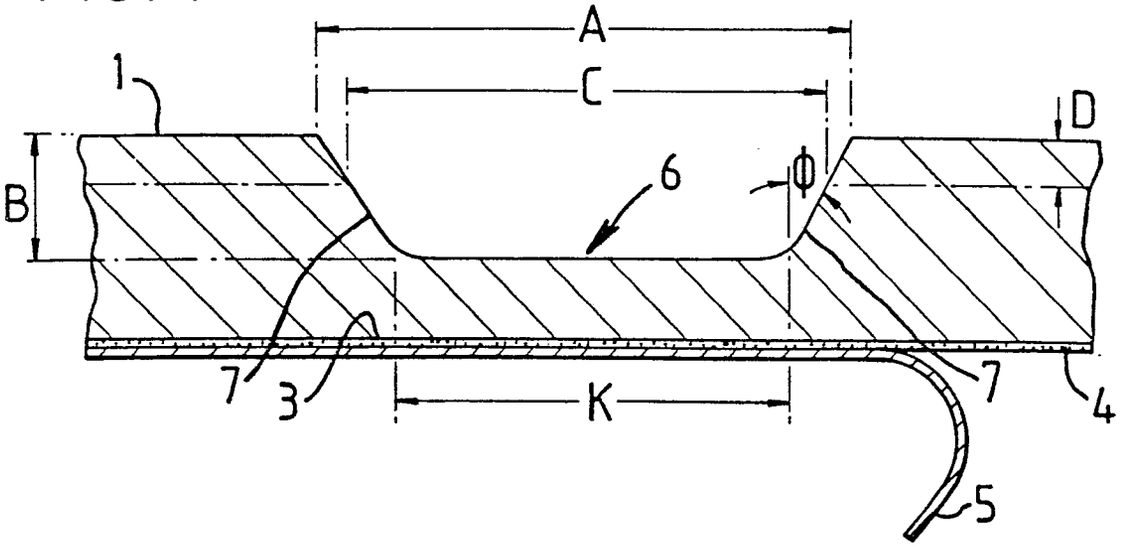


FIG. 5

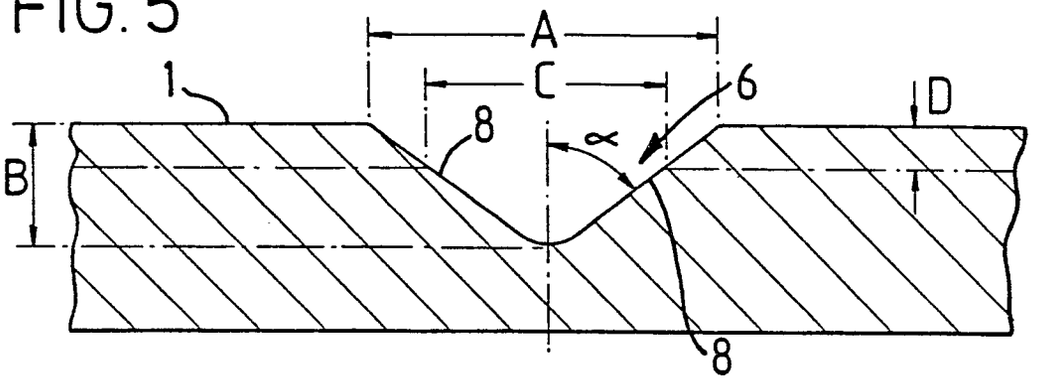


FIG. 6

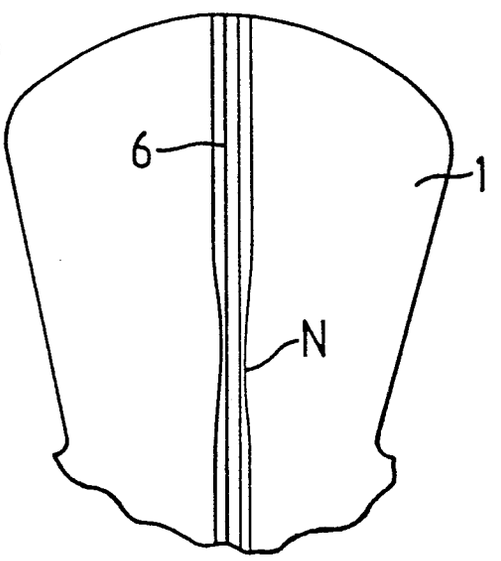


FIG.11

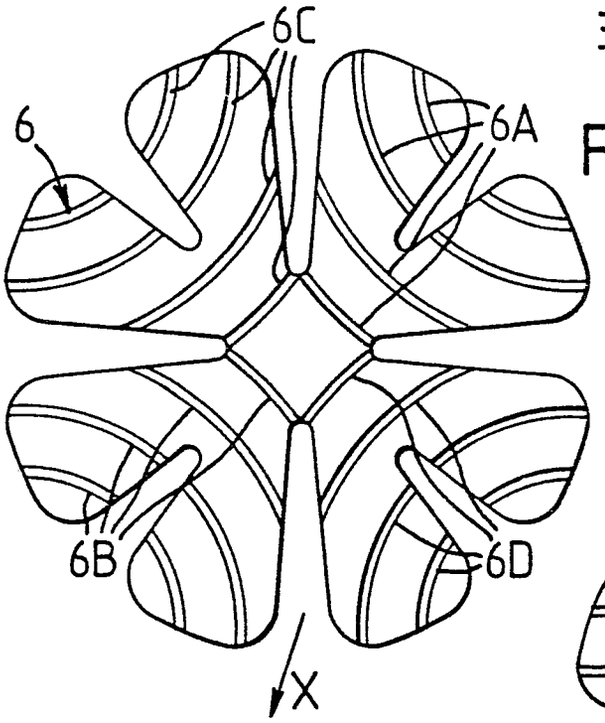


FIG.12

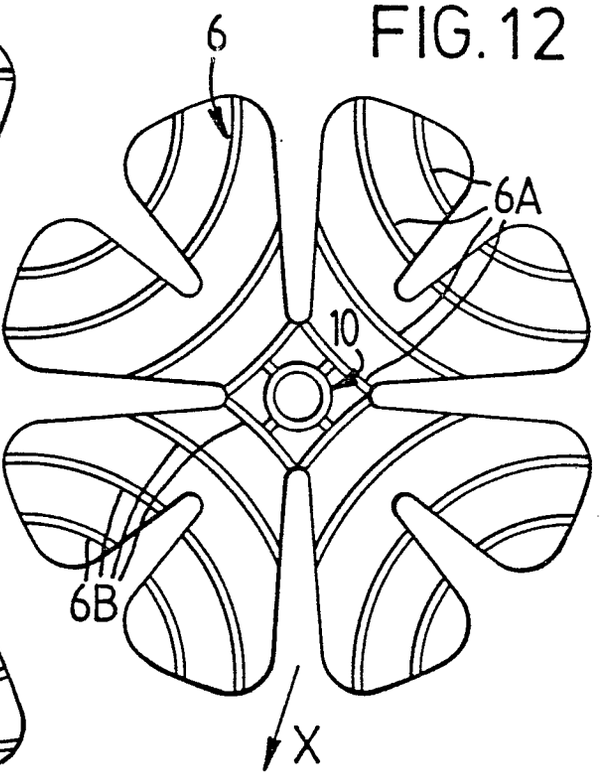


FIG.13

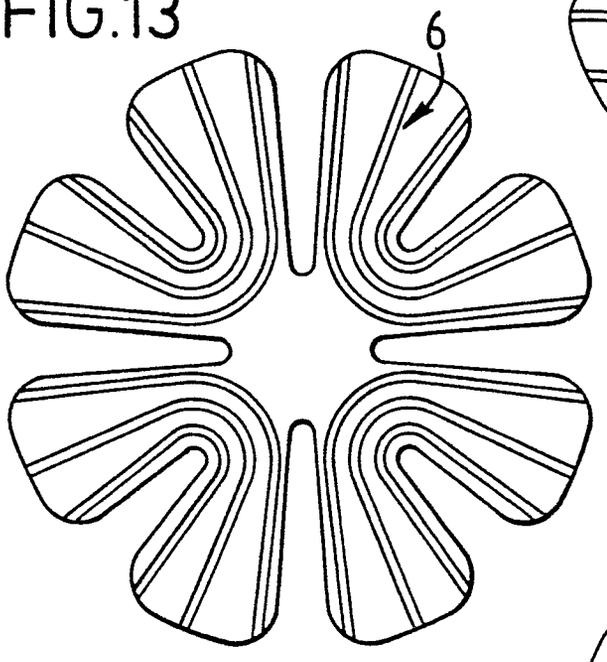


FIG.14

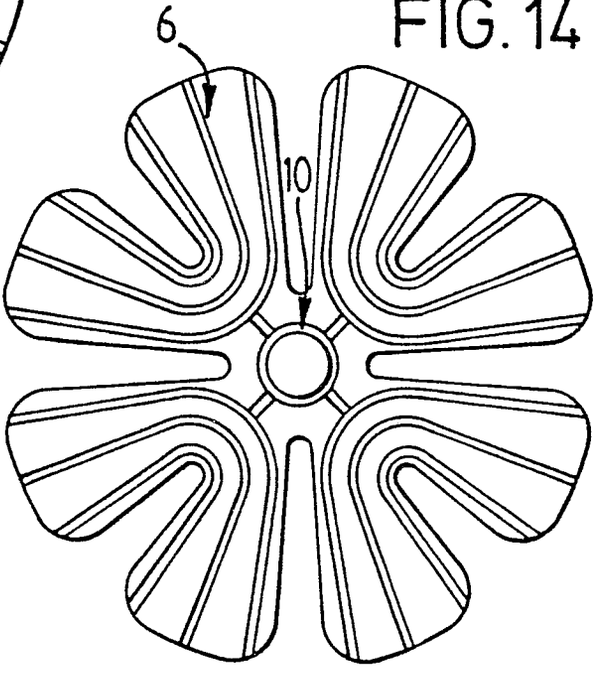


FIG. 15

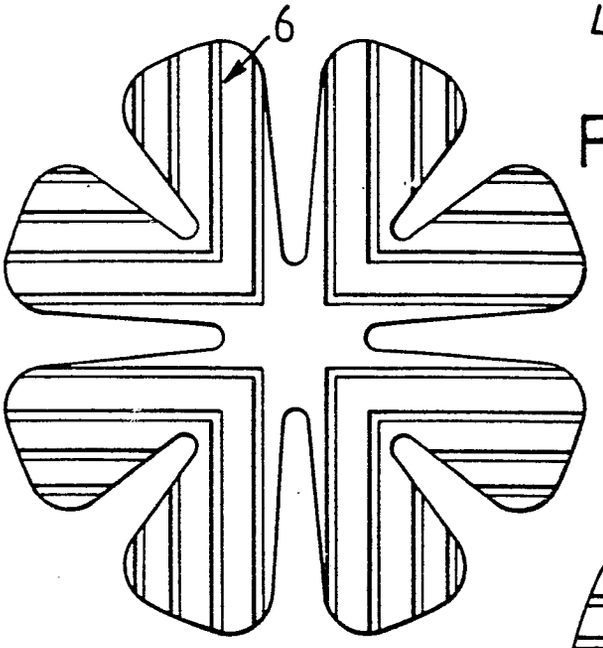


FIG. 16

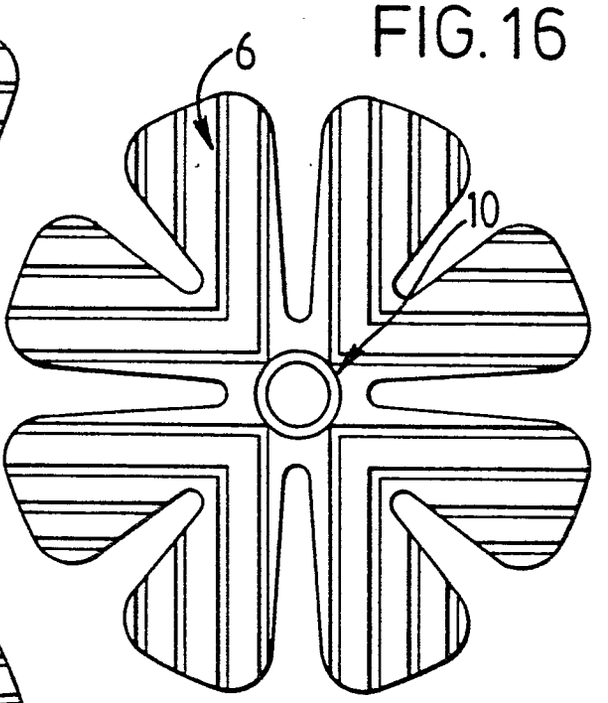


FIG. 17

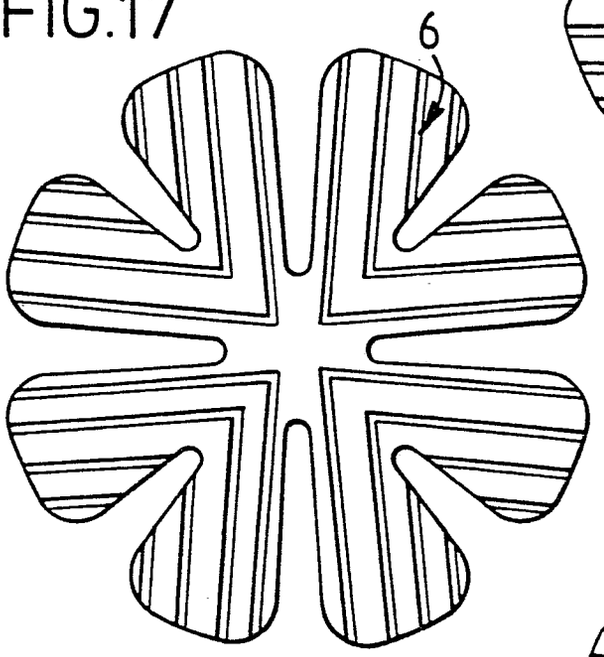


FIG. 18

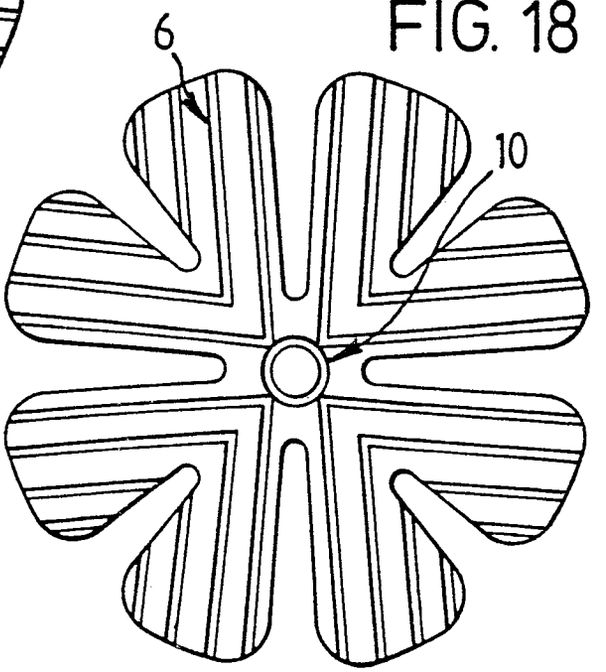


FIG. 19

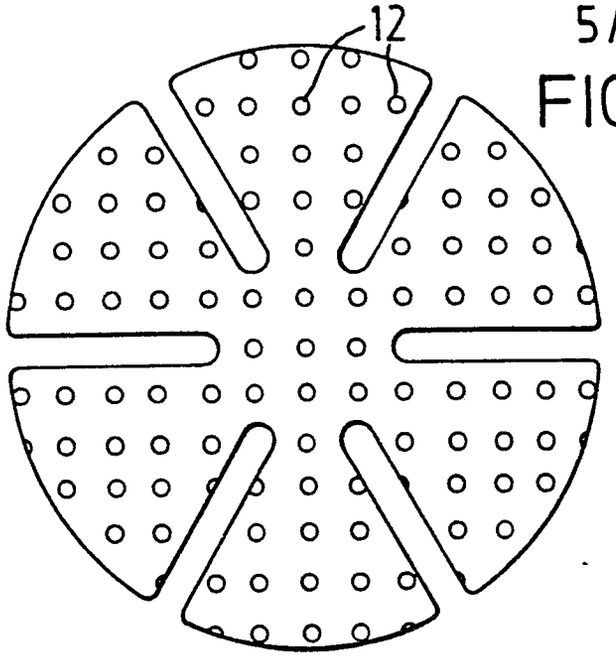


FIG. 20

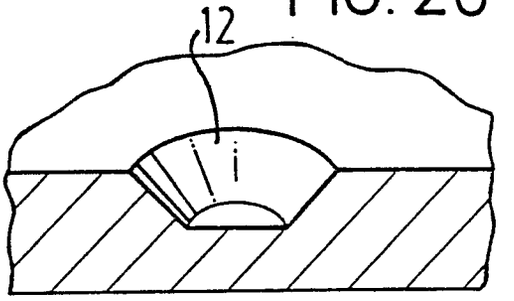


FIG. 21

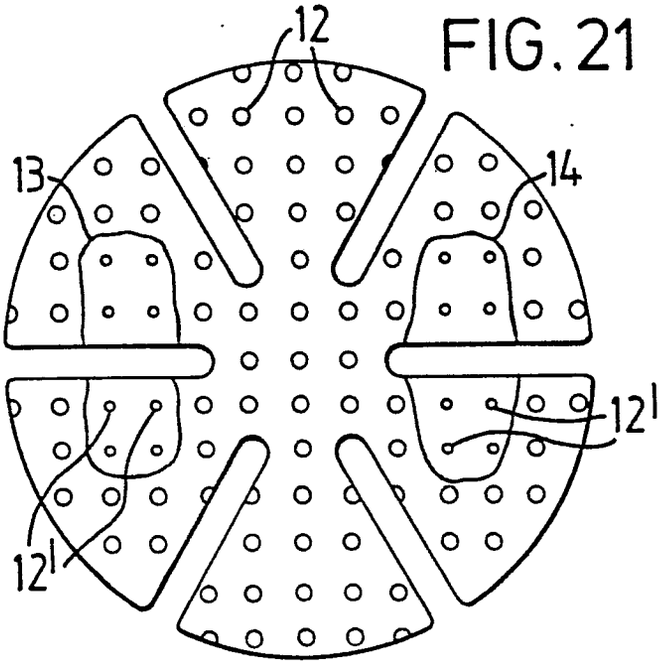


FIG. 22

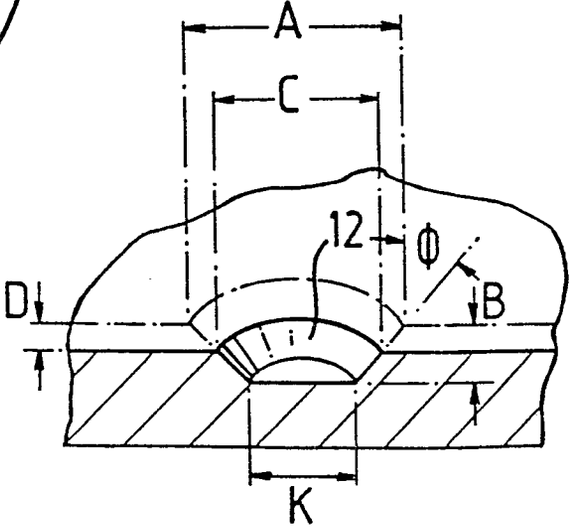


FIG. 23

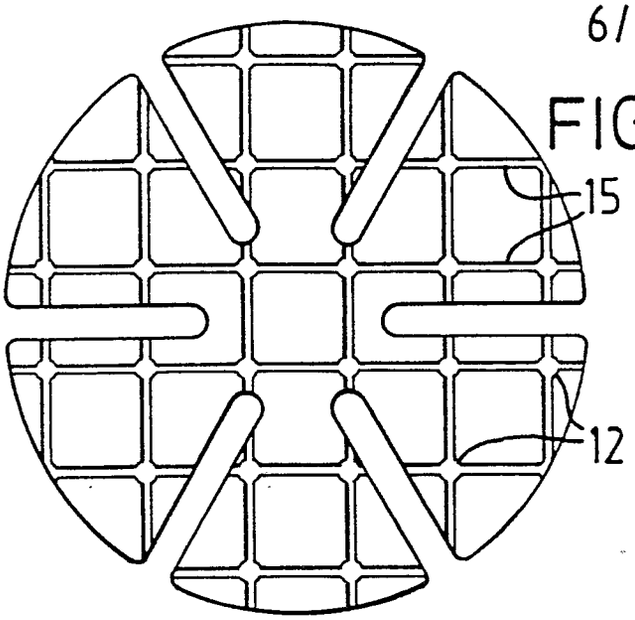


FIG. 24

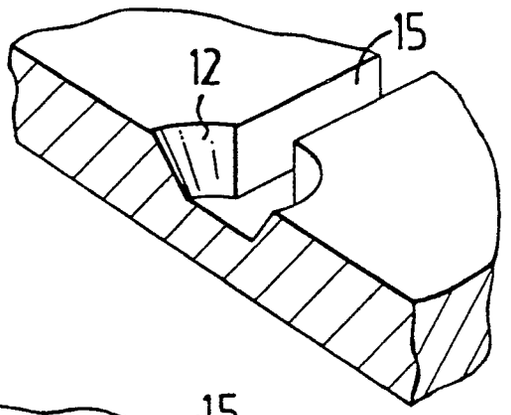


FIG. 25

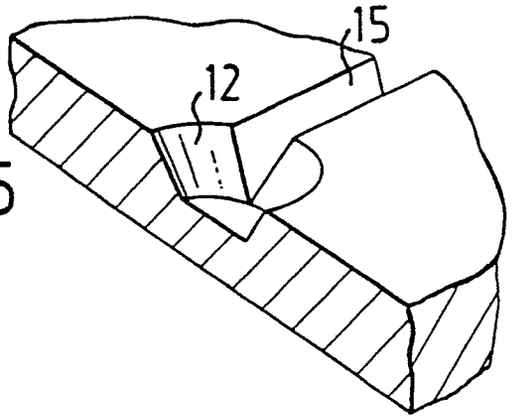


FIG. 26

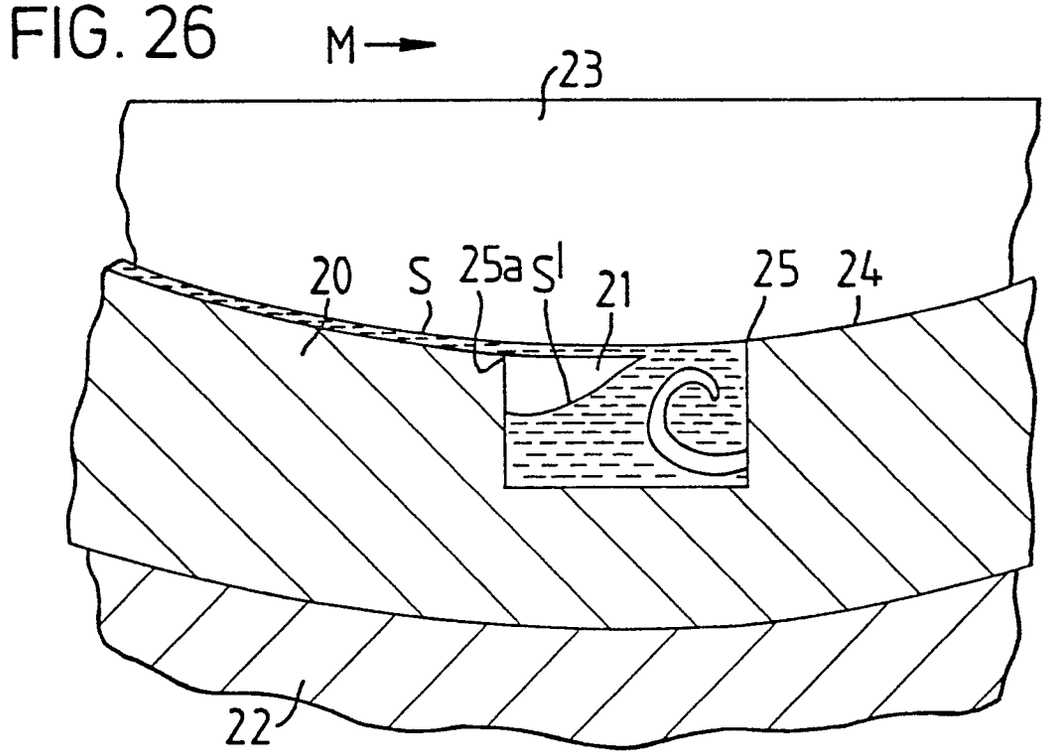


FIG. 27

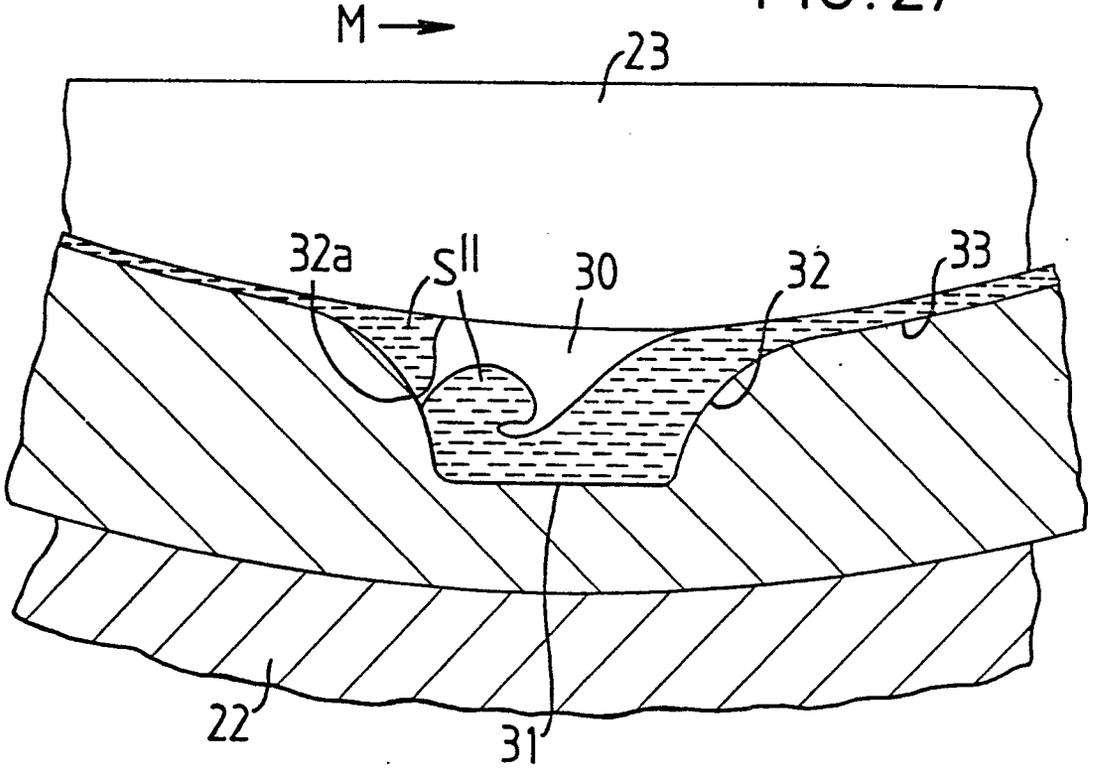


FIG. 28

