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(54) **Injection moldable plastic laps.**

(57) A lap used for the grinding, fining and polishing of glass and plastic lenses is constructed of a one-piece injection-molded reinforced polymer body. The front surface of the lap is curved and adapted to receive an abrasive pad. The rear of the lap has a

skeletal rib structure of projecting interconnected ribs. Polymers suitable for forming the lap include various crystalline polymers and copolymers having adequate chemical resistance, strength, rigidity and thermal resistance.

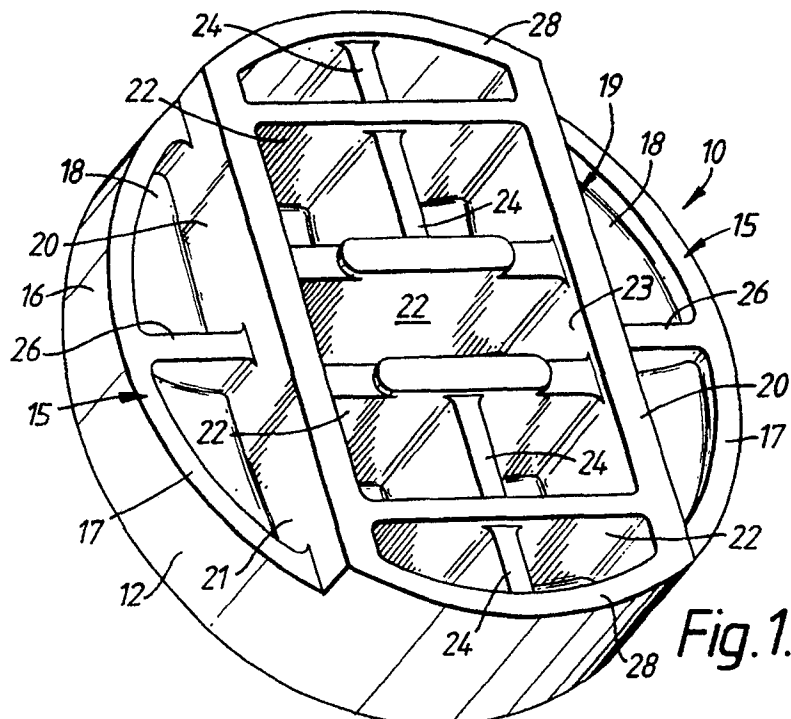


Fig. 1.

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INJECTION MOLDABLE PLASTIC LAPS

The present invention relates to a lapping article used for the grinding, fining, and polishing of glass and plastic ophthalmic lenses and, in particular, to laps made of plastic.

The lapping of glass ophthalmic lenses was originally performed by cast iron laps which were rotated and/or oscillated against a glass lens blank with loose abrasives disposed therebetween to perform grinding, fining and polishing operations on the blank. Eventually, grinding machines were developed to perform the grinding step, but the fining and polishing operations continued to be performed by cast-iron laps. Among their shortcomings, laps tended to wear rapidly, necessitating that they be frequently recut and retrued. Also, the considerable weight of the cast iron laps induced a rapid wearing of the bearings and imposed limitations on both the maximum oscillatory speed which could be attained and the energy efficiency of the lap-driving mechanism.

Eventually, the practice of using loose abrasives was phased out in favor of mounting replaceable abrasive pads on the face of the lap. Because the lap itself would then be subjected to less wear, the laps could be formed of materials exhibiting less toughness and weight than cast iron, such as aluminum and plastic for example.

Attention is directed, for example, to German OS 36 40 678 and OS-37 12 148 which describe plastic laps used in conjunction with replaceable pads. The laps described therein are of solid construction and the bottom faces thereof are provided with customary side notches and central rectangular aperture for proper mating with a face of a receiver to which the laps are to be mounted.

Due to the reduced weight of the plastic laps, the rate of bearing wear is reduced and the efficiency of the lap-driving mechanism is increased. However, room for improvement remains if further reductions in lap weight could be attained.

Furthermore, the techniques presently available for manufacturing plastic laps are limited, due to the need for achieving and maintaining a precision curvature of the pad-receiving front face of the lap. In that regard, the primary function performed by such a lap is to provide a proper shape to the abrasive pads; the pads are flexible and will assume the shape of the front face of the lap. That face must thus exhibit the true optical curvature being imparted to the lens. It is, therefore, necessary that the techniques for making the plastic laps ensure that the proper curvature of the front face will be maintained.

One way of manufacturing solid plastic laps is to extrude a solid plastic cylinder and then cut the

cylinder into disks. A curved face would then be machined into one side of the disc to define a pad-supporting surface, and the earlier-mentioned side notches and central rectangular aperture would be cut into the other side of the disc. Due to its solid construction, the lap exhibits sufficient strength to maintain the shape of the abrasive pad applied to the front surface. However, laps made by that technique are very expensive. The laps cannot be made by faster and less expensive techniques, such as high-speed injection molding, because such a large piece of solid plastic would cool much too slowly in the mold and would tend, as it cools, to shrink excessively, as well as to shrink at different rates in different directions, whereby the resulting lap would be warped and the molding cycle excessively long.

Therefore, it would be desirable to not only provide a lighter weight lap but also to provide a lap which can be made by a faster, less costly, and more accurate technique. Such a semi-finished plastic lap would also desirably be easily machinable to exact front-surface curvature on standard lap-cutting machines as has hereinbefore been done with solid plastic and aluminum laps to match the exact curvature desired on the lens surface.

The present invention relates to a lapping article used for the grinding, fining and polishing of glass and plastic ophthalmic lenses and, in particular, to laps made of plastic. The lap comprises a one-piece injection-molded polymer body with a curved front surface adapted to receive an abrasive pad for grinding, fining, or polishing a glass or plastic ophthalmic lens. Projecting from the rear side of the lap is a skeletal rib structure comprising a plurality of interconnected ribs. The polymer has fiber and/or mineral reinforcement.

In a preferred embodiment, the rear side of the lap comprises an annular outer peripheral rim extending along at least a portion of the outer circumference of the rear side, and a recessed surface disposed radially inwardly of the rim and recessed relative to the rim in a direction toward the front surface, said skeletal rib structure projecting rearwardly from said recessed surface.

Preferred polymers suitable for forming the lap include the various homo- and copolymers of polyesters, polyacetals, polyamides, polysulfides and polyimides.

The objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment thereof in connection with the accompanying drawings, in which like numerals designate like elements, and in which:

FIGURE 1 is a perspective view of the rear side of a lap according to the present invention;

FIGURE 2 is an end view of the rear side of the lap;

FIGURE 3 is a side view of the lap as viewed in the direction of arrow A of FIG. 2;

FIGURE 4 is a side view of the lap as viewed in the direction of arrow B of FIG. 2;

FIGURE 5 is a cross-sectional view taken along 5 of FIG. 2; and

FIGURE 6 is a cross-sectional view taken along line 6 of FIG. 2.

A lap 10 according to the present invention comprises a one-piece injection-molded body 12 having a curved front surface 14 adapted to receive an abrasive pad for grinding, fining, or polishing a glass or plastic ophthalmic lens. Accordingly, the curvature of the front surface corresponds to the shape of the lens surface being made. While the molded front curvature of the semi-finished plastic lap is close to the desired lens surface curvature, the final exact curvature is cut on a standard lap cutting machine as is done for solid aluminium and plastic laps.

A rear side of the body 12 comprises an annular outer peripheral rim 15 extending along at least a portion of the outer periphery of the body 12. The rim 15 includes annular ridges 16 which have rearwardly facing annular surfaces 17. Disposed radially within the confines of the rim 15 is a recessed surface 18 which is recessed relative to the rim in a direction toward the front surface 14. The recessed surface 18 is preferably curved generally complementary to the front surface 14.

Projecting rearward from the recessed surface 18 is a skeletal rib structure 19. The rib structure 19 includes a pair of parallel main ribs 20 recessed radially inwardly of portions of the rim 15 to form side notches 21 (see FIG. 3). Interconnecting the main ribs 20 are a plurality of parallel, shorter secondary ribs 22. Two of the secondary ribs 22 are spaced apart to define a central rectangular aperture 23. A plurality of intermediate ribs 24 interconnect the secondary ribs 22 and are disposed parallel to the main ribs 20. A pair of end ribs 26 extend parallel to the secondary ribs 22 and interconnect respective main ribs 18 with a ridge 16. Ends of the main ribs 20 are interconnected by curved walls 28 which define tall extensions of the ridges 16.

Preferably, the cross-sectional thickness t of the ribs and the cross-sectional thickness t' between the surfaces 14, 18 does not exceed 1.27cm (0.5 in.). Most preferably, those thicknesses are in the range of 0.25 to 0.89 cm (0.1 to 0.35 in.). As a result, the lap will cool rapidly enough to be produced by high speed injection molding.

As a result of such a structure, the lap can be

economically formed by high speed injection molding operations. That is, since the maximum cross-sectional thickness of the ribs and front portion is 1.27 cm (0.5 in.), the injection molded lap will cool at a sufficiently rapid rate to adapt to high speed injection molding. Furthermore, the rib structure imparts sufficient strength and rigidity to the front portion to ensue that the front surface will hold its shape during contact with a lens being made. Hence, the lens will be shaped with a proper curvature.

The polymers used in construction of the lap must, in addition to being moldable, have adequate rigidity, strength, thermal resistance, and stability to chemical attack e.g. chemical resistance to organic solvents for repeated use as a lapping tool. Suitable materials include crystalline engineering plastics. The crystallinity provides the requisite chemical resistance, and crystallinity, together with the particular molecular structure of the polymer, provides engineering characteristics such as strength and rigidity.

Chemical resistance is important because typical prescription laboratories use chemicals such as acetone or other ketones, and esters which will readily dissolve most non-crystalline polymers.

It will be understood, however, that the invention is not limited to the use of crystalline polymers but encompasses any type of polymeric material suitable for injection molding and having the requisite engineering characteristics and chemical resistance.

The specific strength and rigidity characteristics and/or other characteristics of the polymer are dictated by the particular use intended, for example, expected life of the lap, lap size and lap curvature. One skilled in the art can readily select a specific polymer having the requisite characteristics based on the polymer's known physical properties, e.g. strength and modulus values.

Examples of polymers useful in the invention include homo- and co-polymers of polyesters and polyacetals, polyamides, polysulfides, and polyimides. Of the polyamides, various nylons have good properties, but some absorb significant amounts of water and result in variation in dimensions in actual use. Other polyamides absorb less water but are more expensive. polysulfides and polyimides, while both have good properties, are significantly more expensive.

Specific examples of suitable polymers include polybutylene terephthalate, polyethylene terephthalate, polyoxymethylene, the various nylons, polyphenylene sulfide, and polyimide.

The polymer is preferably filled. While the unfilled polymer is both strong and chemically resistant, it oftentimes cannot be processed easily by injection molding because as it cools, it shrinks

excessively and differently in the flow and transverse directions. In addition, unfilled polymer can warp as it cools and thus cannot be made to hold simple tolerances. Incorporation of mineral fillers, and possibly glass or carbon fibers, or combinations thereof, allows for much less and more uniform shrinkage. Warpage will be generally eliminated, and the molded part will hold the required tolerances.

Typical short fiber glass useful as a filler consists of fine particles having a length of from about 0.015 cm to about 0.036 cm (about 0.006 to about 0.014 in.), while suitable longer fiber glass has a length of from about 0.25 cm to about 0.76 cm (about 0.1 to about 0.3 in.), with about 0.51 cm (about 0.200 in.) being typical.

The typical mineral filler is finely divided and blended calcium carbonate or mica. Filler content can range from about 10 to about 50 weight percent of the polymer composition, while the polymer itself constitutes from about 90 to about 50 weight percent. Preferred levels of filler are from about 20 to about 45 weight percent with the remainder being the polymer. The ratio of mineral to glass filler can range from 100% mineral to 25% mineral and 75% glass. Similar ratios apply to the use of carbon fiber fillers.

The following non-limiting Examples and Comparative Examples illustrate the invention.

COMPARATIVE EXAMPLE 1

A thick (3.66 cm) (1.44 in.), solid lap machined from a molded block of an unfilled polymer blend of polystyrene and polyphenylene oxide designated Noryl N-190 from General Electric company resulted in a useful but heavy lap. The lap had no chemical resistance as it can be attacked by acetone and other common laboratory chemicals such as Pad Cement Solvent, a solution of ketone and aromatic solvents defined as Coburn Optical Part Number 9839-70.

COMPARATIVE EXAMPLE 2

A thick (3.10 cm) (1.22 in.), solid lap injection molded from unfilled polybutylene terephthalate designated Valox 325 from General Electric company resulted in long molding cycles (3 minutes or more). Excessive shrinkage and warpage was observed. The lap was not usable.

COMPARATIVE EXAMPLE 3

A hollow, cored lap (maximum cross-section thickness 0.838 cm (0.330 in.); height 3.51 cm (1.38 in.)), injection molded from unfilled polyoxymethylene designated Delrin 500 from E. I.

Dupont deNemours Company resulted in a short molding cycle (less than one minute), but showed unacceptable and non-uniform shrinkage and poor dimensional reproducibility. The lap was not usable because of the warpage.

EXAMPLE 1

A less thick (2.46 cm) (0.97 in.), solid lap injection molded from polybutylene terephthalate filled with 20% mineral and 20% glass designated Valox 735 from General Electric company resulted in long molding cycles. The lap had more controllable and uniform shrinkage and was usable over a limited range of curves.

EXAMPLE 2

A less thick (2.46 cm) (0.97 in.), solid lap injection molded from polybutylene terephthalate filled with 25% mineral designated Valox 745 from General Electric Company resulted in long molding cycles. The lap had more controllable and uniform shrinkage and was usable over a limited range of curves.

EXAMPLE 3

A hollow, cored lap (maximum cross-section thickness 0.838 cm (0.330 in.); height 3.51 cm (1.38 in.)), injection molded from polybutylene terephthalate filled with 20% mineral and 20% glass designated Valox 735 from General Electric Company resulted in a short molding cycle (less than one minute). The lap had minimum and uniform shrinkage and good dimensional reproducibility. The lap was usable and the optical surface could be machined over a full range of curves.

EXAMPLE 4

A hollow, cored lap (maximum cross-section thickness 0.838 cm (0.330 in.); height 3.51 cm (1.38 in.)), injection molded from polybutylene terephthalate filled with 25% mineral designated Valox 745 from General Electric Company resulted in a short molding cycle (less than one minute), minimum and uniform shrinkage and good dimensional reproducibility. The lap was usable and the optical surface could be machined over a full range of curves.

EXAMPLE 5

A hollow cored lap (maximum cross-section thickness 0.838 cm (0.330 in.); height 3.51 cm (1.38 in.)), injection molded from a polyamide filled with 33% glass designated Zytel Nylon 70G-33L

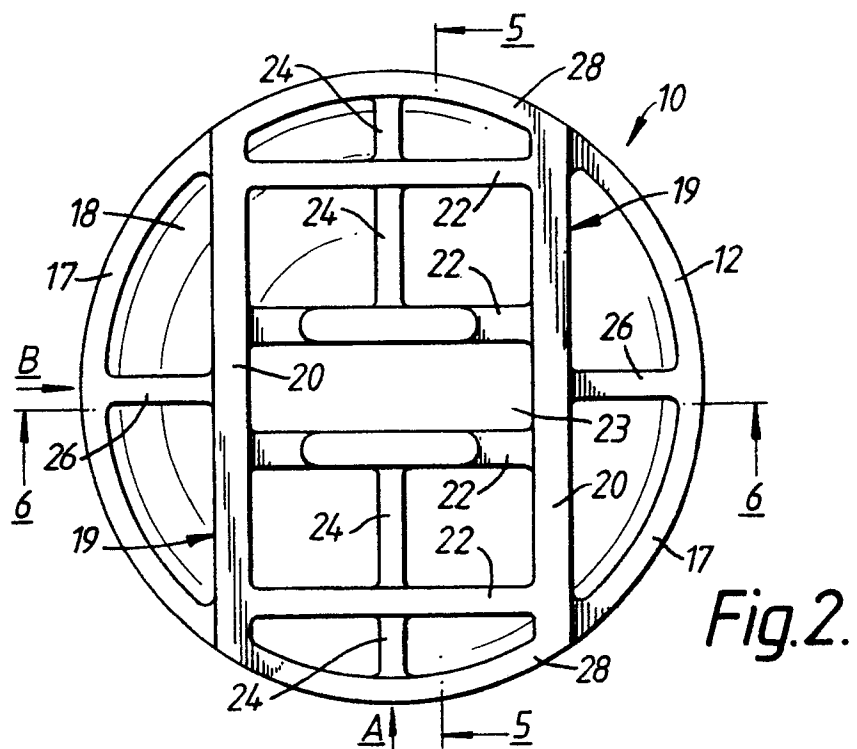
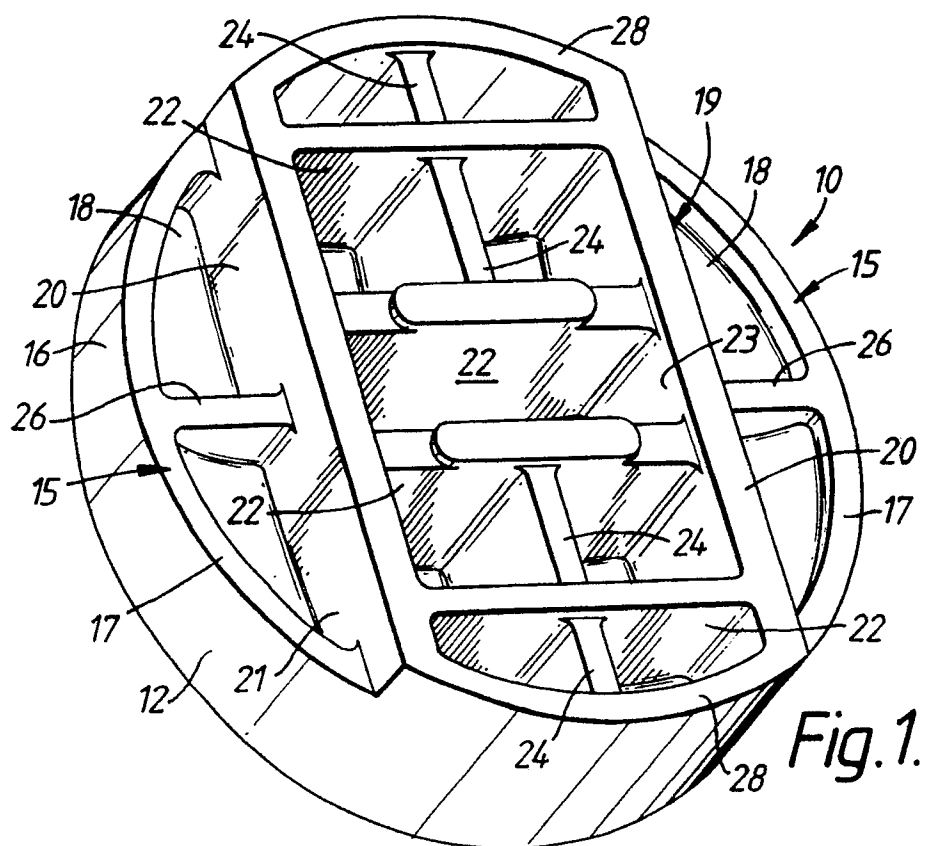
from E. I. DuPont deNemours Company resulted in a short molding cycle (less than one minute). The lap had minimum and uniform shrinkage and good dimensional reproducibility. The lap was usable over a full range of curves.

Claims

1. A lap for holding an abrasive pad in the manufacture of ophthalmic lens surfaces comprising a body having front and rear sides, a curved front surface formed on said front side and a skeletal rib structure comprising a plurality of interconnected ribs projecting from said rear side, said body being of one-piece injection-molded construction of a fibre and/or mineral reinforced polymer.
2. A lap according to claim 1, wherein said rear side comprises an annular outer peripheral rim extending along at least a portion of an outer circumference of said rear side, and a recessed surface disposed radially inwardly of said rim and recessed relative to said rim in a direction toward said front surface, said skeletal rib structure projecting rearwardly from said recessed surface.
3. A lap according to claim 2, wherein said rim comprises an annular ridge having a rearwardly facing annular surface.
4. A lap according to claim 2 or 3, wherein said skeletal rib structure includes two parallel first ribs recessed radially inwardly relative to portions of said rim to define two side notches, said rib structure including additional ribs extending between said first ribs.
5. A lap according to claim 4, wherein said additional ribs include parallel second ribs defining a central generally rectangular aperture.
6. A lap according to claim 5, wherein said additional ribs include at least two third ribs extending between said first ribs and said rim.
7. A lap according to any foregoing claim, wherein each of said ribs has a cross-sectional thickness of not greater than 1.27 cm (0.50 in.).
8. A lap according to claim 7, wherein each of said ribs has a cross-sectional thickness of not greater than 0.89 cm (0.35 in.).
9. A lap according to claim 8, wherein each rib has a cross-sectional thickness in the range of

from 0.25 to 0.89 cm (0.10 to 0.35 in.).

10. A lap according to any foregoing claim when appendant on claim 2, wherein a maximum thickness between said front surface and said recessed surface is 1.27 cm (0.50 in.).
11. A lap according to claim 10, wherein said maximum thickness is 0.89 cm (0.35 in.).
12. A lap according to any foregoing claim, wherein the fibre and/or mineral reinforced polymer comprises a fibre and/or mineral filler material and a polymer.
13. A lap according to claim 12 wherein the polymer and filler material are in the combination of from 20 to 45 wt.% filler and from 80 to 55 wt.% polymer.
14. A lap according to claim 12 or 13, wherein the filler is a combination of from 100 to 25 wt.% mineral and from 0 to 75 wt.% glass.
15. A lap according to any one of claims 12 to 14, wherein the polymer is a crystalline polymer.
16. A lap according to claim 15, wherein the polymer is selected from a polyester, a polyacetal, a polyamide, a polyimide, or a polyphenylene sulfide.
17. A lap according to claim 16, where the polyester is polybutylene terephthalate or polyethylene terephthalate.
18. A lap according to claim 16, where the polyacetal is polyoxymethylene homo- or copolymer.
19. A lap according to any one of claims 12 to 18, wherein the filler includes short fibre glass having a particle size of from about 0.015 to about 0.036 cm (about 0.006 to about 0.014 inch) in length.
20. A lap according to any one of claims 12 to 19, wherein the filler includes long fibre glass having a particle size of from about 0.25 to about 0.76 cm (about 0.1 to about 0.3 inch) in length.
21. A lap according to any one of claims 12 to 20, wherein the filler includes calcium carbonate and/or mica.



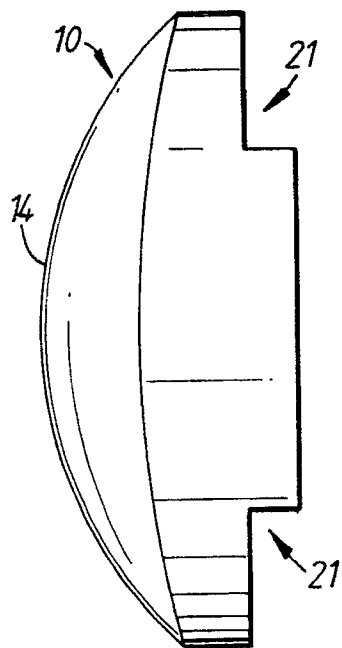


Fig. 3.

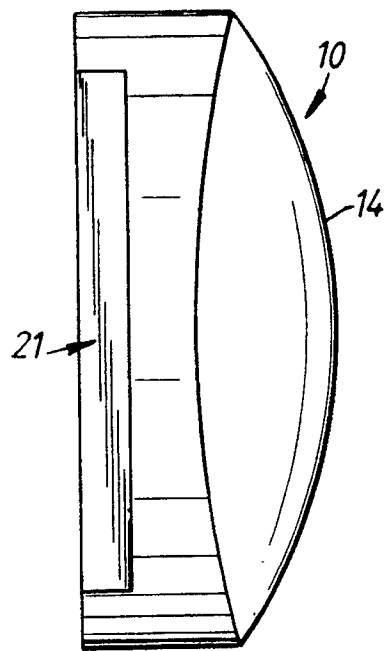


Fig. 4.

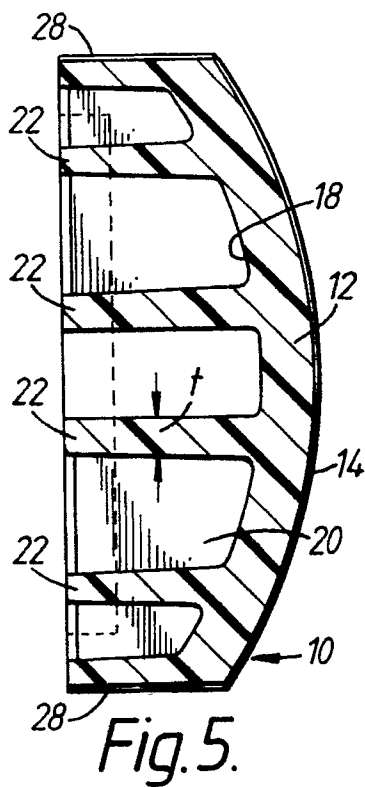


Fig. 5.

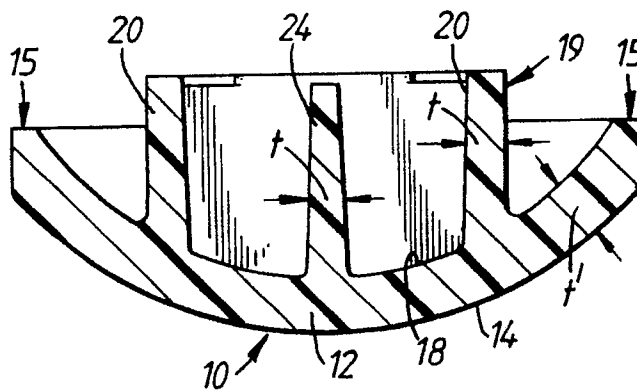


Fig. 6.