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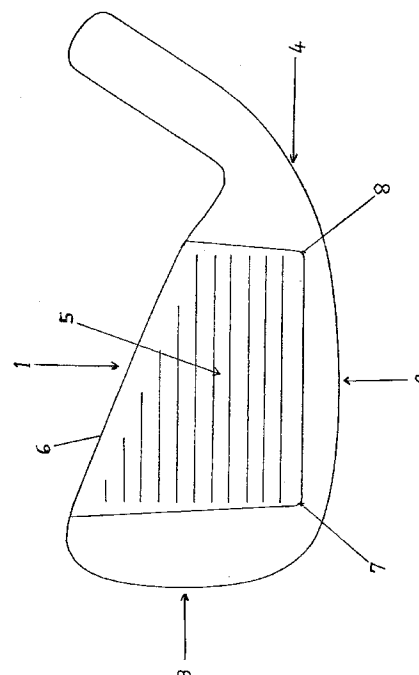
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(54) **Golf club heads.**

(57) A golf iron head has a main body and, securely attached to at least part of the front face of the main body, a face insert having a flexural modulus in the range 1 to 20 GPa, especially a face insert of a thermoplastic composite of nylon reinforced with glass fibre. There is also provided a golf iron head wherein the face insert is located in a correspondingly shaped recess in the front face of the main body and is mechanically interlocked with the recess by peripheral mating flange and groove formations, especially partial dovetail shaped formations.

Figure 1



This invention relates to the head structure of golf clubs.

In co-pending International Patent Application No. PCT/GB92/01765 there are described golf iron heads in which at least part of the ball-striking face of the head comprises at least one face-piece component selected for one or more characteristics such as surface friction, hardness, flexural modulus, resilience, specific gravity, weight and geometric configuration, in order to confer play characteristics such as to improve performance of balls struck by the head and/or to improve weight distribution in the head. Various shapes and materials for the face-piece component and various means of securing the component to the head main body are described.

It is found that, suitably, the face-piece component (hereinafter called 'face insert' or 'insert') has a flexural modulus in the range 1 to 20, preferably 2 to 10, GPa as measured at 23°C. Suitably also the face insert has a Rockwell M hardness in the range 70 to 130, preferably 95 to 115.

It is found also that one of the face insert materials referred to in the aforementioned co-pending Application is especially suitable, namely a thermoplastic composite of nylon, preferably reinforced by glass fibre. Suitable nylons, which may or may not be impact-modified, include Nylons 6, 6.6, 6.10 and 11. Examples of suitable ratios of glass:nylon are up to about 60:40 by weight. The glass fibre suitably is in the form of short fine fibres, such as of length in the range of about 0.2 to 3 mm. If desired, the composite may contain pigment, for example carbon black. Examples of suitable face insert materials are the glass fibre reinforced nylons available under the trade names 'Zytel 80G43' and 'Zytel 80G33' ex. Du Pont, which contain respectively about 43% and about 33% by weight of glass fibre.

The face insert suitably may be produced by compression- or injection-moulding. Its thickness may be, for example, in the range 1 to 4 mm, for instance 2 mm.

The material(s) of the main body of the head, to which the face insert is attached, may be selected from a wider range than those which normally are considered suitable for one-piece heads. The main body material(s) suitably may be of metal, plastics or resin, which may or may not contain a reinforcing material. For use with a glass reinforced nylon face insert, the main body material suitably is a metal, for instance steel, especially mild or stainless steel, which may be forged or cast, or a metal alloy for instance beryllium/copper or zinc/aluminium. A preferred metal is cast stainless steel.

The face insert may extend over the whole or only part of the striking face of the head. When it extends over only part of the striking face, suitably it is located at least at the normal position of impact with a golf ball by a competent golfer, which normally corresponds to the "sweet spot" of the face and usually is in the central area of the face.

Normally the face insert is secured to the head main body such that the exposed (outer) face of the insert is level with the rest of the front face of the head. Accordingly, the insert should be located in a corresponding recess in the front face of the head.

Preferably, for provision of desired strength, there is a certain minimum thickness portion of head main body material behind the face insert. For instance, when that head main body portion is of metal such as steel, a suitable thickness may be at least 1.5 mm and preferably at least 2.5 mm.

The head may incorporate a support structure behind the insert, which may permit the main body portion behind the insert to be of reduced general thickness whilst retaining desired strength. For instance, that main body portion may comprise a relatively thin portion having support ribs on its rear surface.

The face insert may be firmly attached to the main body by various secure means. One means is by compression- or injection-moulding the insert directly onto the head face. Alternatively, and preferably, the insert is preformed and then secured on the head face by adhesive- or melt-bonding and/or by mechanical means.

To assist or improve bonding, the face insert may have grooving and/or other texturing on its rear surface to provide a mechanical key for the adhesive or melt. If desired the rear surface of the insert and/or the head main body surface to which the insert is to be bonded may be roughened, such as by abrading, shot-blasting or etching, to provide additional keying. The grooving may be in the form of substantially parallel line grooves in the heel-to-toe direction. An example of such grooving comprises parallel grooves of about 0.5 mm square cross-section spaced apart by about 7 mm. Preferably the grooving is not coincident with grooves which normally are present on the striking face of the insert.

The adhesive selected for employment will depend on the materials of the surfaces to be bonded. An example of a suitable adhesive for bonding a glass-reinforced nylon face insert to a main body surface of stainless steel is a two-part epoxy adhesive, eg adhesive no. '2216' ex. 3M which may be employed with a primer such as that available as primer no. '3901' ex. 3M.

Preferably the face insert and the head main body are mechanically attachable by means of complementary interlocking shape formations on the insert and body face, for instance to provide dovetail jointing of the insert to the main body, as are referred to in the aforementioned Application.

The interlocking formations generally comprise mating flange and groove formations. Suitably the flange formation is provided at the peripheral wall of the face insert and the complementary groove formation is pro-

vided at the peripheral wall of the corresponding recess in the front face of the head main body. The rear edge of the flange formation suitably may be positioned near to or coincident with the rear edge of the insert peripheral wall and the rear edge of the groove formation suitably may be positioned near to or coincident with the rear edge of the recess peripheral wall. The front edges of the flange and groove formations may be positioned remote from the front edges of the insert and recess peripheral walls, and the wall portions in front of the formations may extend substantially perpendicularly or at an obtuse angle to the front face of the head.

An example of a suitable flange width and corresponding groove depth is about 1 mm.

A suitable flange shape is a partial dovetail tenon shape and correspondingly a suitable groove shape is a partial dovetail mortise shape. The dovetail angle may be, for instance, about 45°.

A typical peripheral shape of the insert and recess is a quadrilateral shape positioned to have toe-side and heel-side edges. The recess may have a wall opening through which the insert may be passed for location in the recess. Suitably the recess extends to and is open at the top edge of the head, and the insert is located in the recess by sliding in from the top edge. The top wall of the insert may be coincident with the top edge of the head, and the sole-side, toe-side and heel-side walls of the insert and recess preferably are all interlocked by complementary flange and groove formations. The distance between the sole of the head and the recess may be, for instance, about 4 to 8 mm measured perpendicularly from the sole peripheral leading edge to the mid-point of the sole-side wall of the recess.

Preferably, to relieve stress and reduce the risk of fatigue crack generation in the insert and/ or the head main body when the head strikes a ball, the contacting corners of the insert and recess, such as the corners at the junctions of the sole-side wall with the toe-side and heel-side walls of the above-mentioned sliding insert arrangement, are radiused.

The insert should be securely attached to the head and the attachment may be permanent or may be detachable to enable substitution of a worn or damaged insert or substitution by an insert having a different property. For the latter purpose, bonding by an adhesive which can be weakened by heat or suitable chemical treatment is preferable.

The head structure described herein is suitable for employment and modification as described in the aforementioned co-pending Application.

The employment of a glass-reinforced nylon face insert is especially suitable for use in clubs intended primarily for distance play. Accordingly such an insert normally is especially useful for the driving iron and the numbers 2 to 9 irons.

In view of the club play characteristics conferred by employment of the face insert, it may be desirable to adjust the loft angles of the irons in a set in order to produce a substantially uniform progression of play characteristics through the set. For instance, a set of irons in which the driving iron and the numbers 2 to 9 irons have a 2 mm thick face insert of glass-reinforced nylon such as that available under the trade name 'Zytel 80G43' or 'Zytel 80G33' may have the following features:-

Iron No	Head Weight (g)	Loft Angle (°)	Lie Angle (°)
DI	227	21 (16)	56
2	234	21 (18)	57
3	241	23 (21)	58
4	248	26 (24)	59
5	255	29 (28)	60
6	262	33 (32)	61
7	269	37 (36)	62
8	276	41 (40)	63
9	283	44 (44)	64
PW	290	49 (50)	64
SW	297	55 (55)	64

In the above Table, "DI" means driving iron, "PW" means pitching wedge, "SW" means sand wedge, and

the bracketed loft angles represent those of a conventional standard set of all-steel heads. The head weight values have a tolerance of ± 5 g and the loft and lie angles have tolerances of $\pm 2^\circ$.

The head structure described herein is illustrated, by way of example only, in the accompanying drawings, in which:-

- 5 Figure 1 is a diagrammatic front view representation of an iron head having a face insert in accordance with the invention;
- Figure 2 shows an enlarged horizontal section of the head of Figure 1;
- Figure 2a is an enlarged representation of the toe-side portion of the face insert section shown in Figure 2;
- 10 Figure 3 shows an enlarged vertical section of the head of Figure 1 (turned through 90°);
- Figure 3a is an enlarged representation of the sole-side portion of the face insert section shown in Figure 3.

As shown in the drawings, an iron head having top edge 1, sole 2, toe 3 and heel 4 portions has a quadrilateral face insert 5 located in a correspondingly shaped recess in the head main body such that the top wall 6 of the insert is coincident with the top edge of the head.

The sole-side corners 7 and 8 of the insert and recess are radiused, e.g. having a radius of curvature of about 1.5 mm, in the plane of the striking face.

The toe-side wall 9, heel-side wall 10 and sole-side wall 11 of the insert 5 have a continuous flange 12 of partial dovetail tenon shape fitting into a complementary partial dovetail mortise groove in the recess.

As shown particularly in Figures 2a and 3a, the partial dovetail shape of the flange has radiused corners 13 and 14, e.g. having radii of curvature of about 0.3 mm and about 0.5 mm respectively.

The insert 5 has grooves in the heel-toe direction on its rear surface, one of which 15 is shown in Figure 3a, providing a key for adhesive between the insert and the head body portion 16.

In Figure 1, the toe-side wall 9 and heel-side wall 10 of the insert 5 are shown to diverge slightly, e.g. at a draft angle of about 1° , in the sole to top edge direction for ease of sliding insertion of the insert into the recess from the top edge of the head. However, such divergence may be absent if desired.

Claims

- 30 1. A golf iron head having a main body and, securely attached to the main body, a face insert located in a correspondingly shaped recess in the front face of the main body and wherein the face insert is mechanically interlocked with the recess by means of mating flange and groove formations on the peripheral walls of the insert and recess.
- 35 2. A head according to Claim 1 wherein the face insert has a flexural modulus in the range of 1 to 20 GPa as measured at 23°C .
- 40 3. A head according to Claim 1 or 2 wherein the face insert has a Rockwell M hardness in the range 70 to 130.
- 45 4. A head according to any of the preceding Claims wherein the face insert comprises a thermoplastic nylon composite.
- 50 5. A head according to Claim 4 wherein the face insert comprises a thermoplastic composite of nylon reinforced with glass fibre.
- 55 6. A head according to Claim 5 wherein the ratio of glass:nylon in the composite is up to 60:40 by weight.
- 7. A head according to Claim 5 or 6 wherein the glass fibre is of length in the range 0.2 to 3 mm.
- 8. A head according to any of the preceding Claims wherein the face insert has a sheet thickness in the range 1 to 4 mm.
- 9. A head according to any of the preceding Claims wherein the face insert and recess have a quadrilateral peripheral shape positioned to have toe-side and heel-side walls and wherein the recess is open at the top edge of the head, and the top wall of the face insert is coincident with the top edge of the head.
- 10. A head according to Claim 9 wherein the toe-side, heel-side and sole-side walls of the face insert have

a continuous flange of partial dovetail tenon shape and the corresponding walls of the recess have a continuous groove of complementary partial dovetail mortise shape.

- 5 **11.** A head according to any of the preceding Claims wherein the rear edges of the flange and groove formations are coincident with the peripheral wall rear edges of the face insert and recess, and the front edges of the flange and groove formations are remote from the peripheral wall front edges of the face insert and recess.
- 10 **12.** A head according to any of the preceding Claims wherein the contacting corners of the face insert and recess are radiused.
- 15 **13.** A head according to any of the preceding Claims wherein the face insert has grooving on its rear surface to provide a mechanical key for an adhesive, said grooving being out of coincidence with grooves which may be present on the front face of the face insert.
- 20 **14.** A set of golf clubs comprising a series of irons having heads according to any of the preceding Claims.
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Figure 1

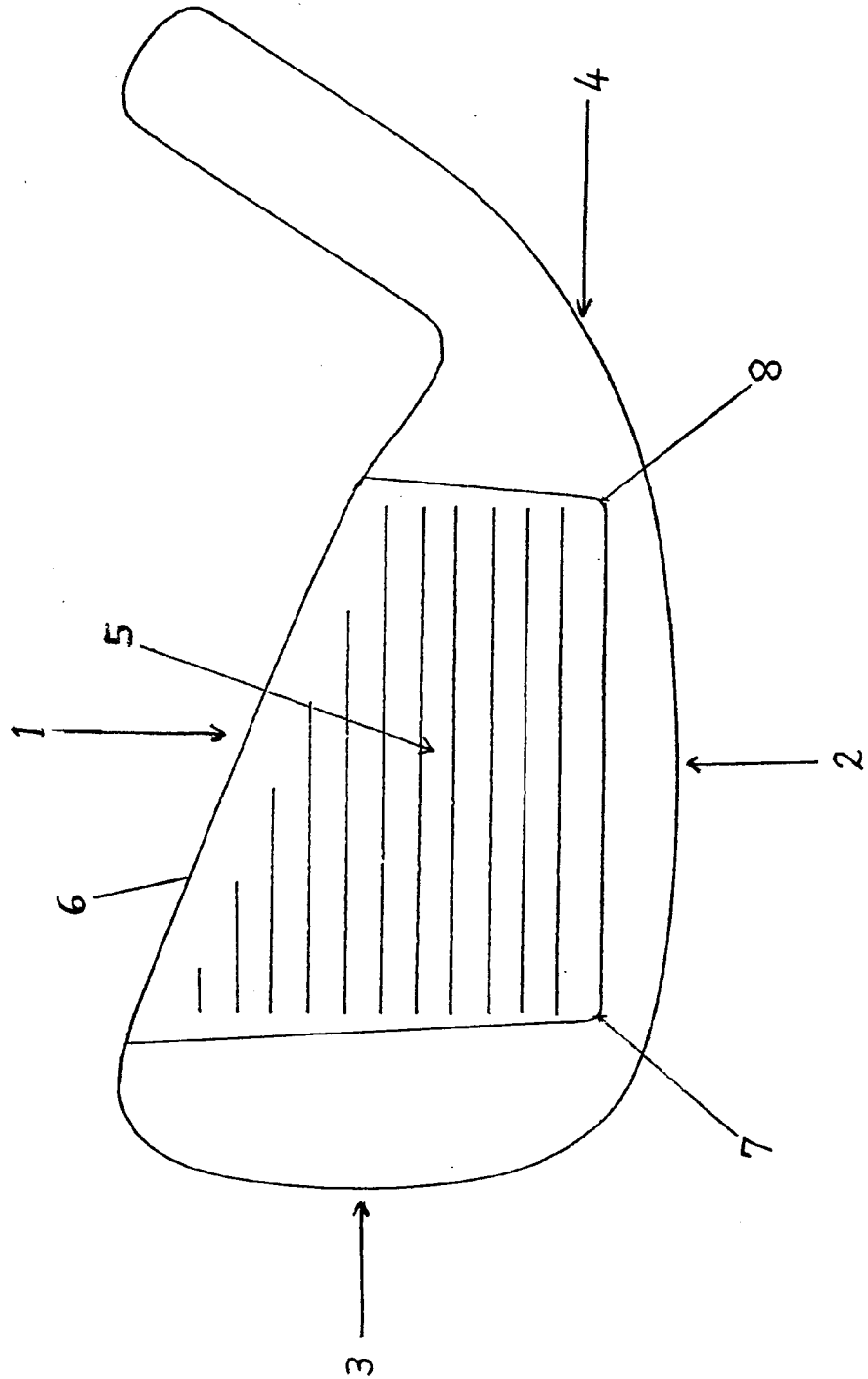


Figure 2

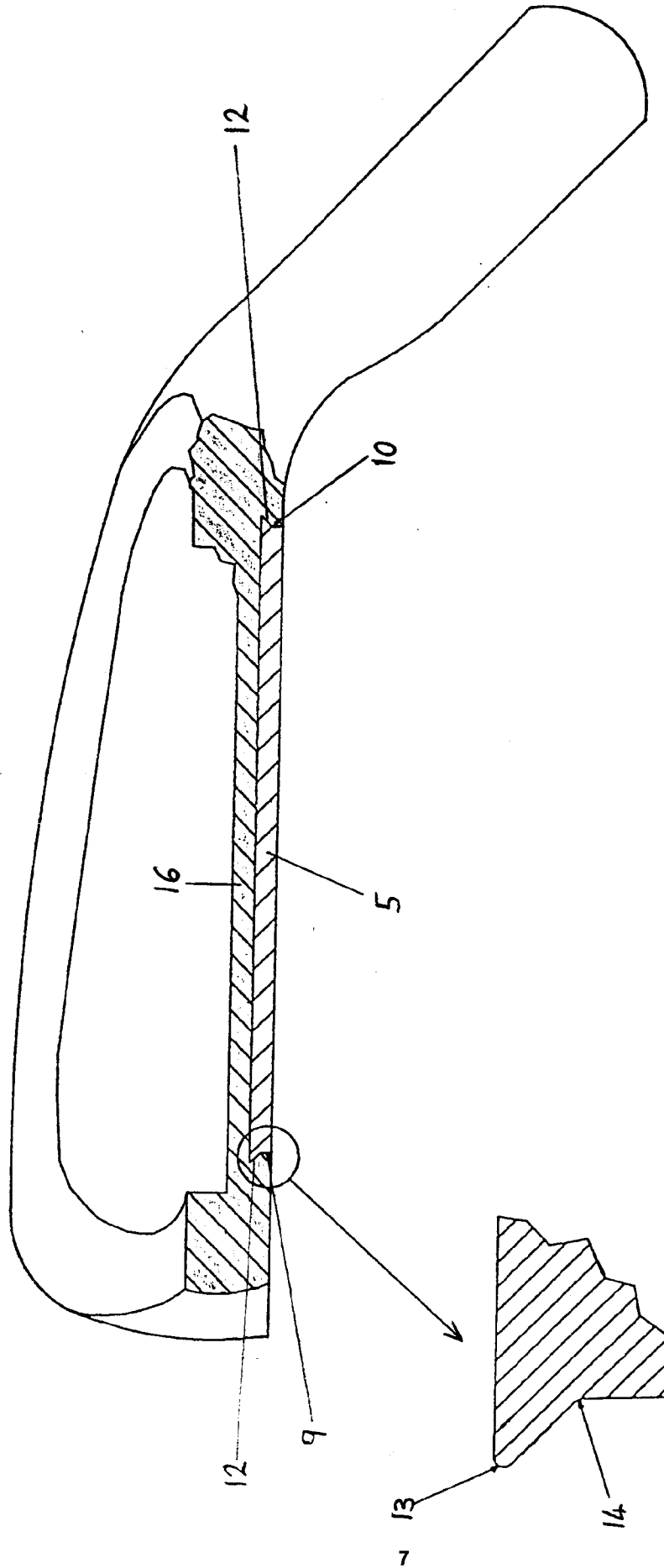


Figure 2a

Figure 3

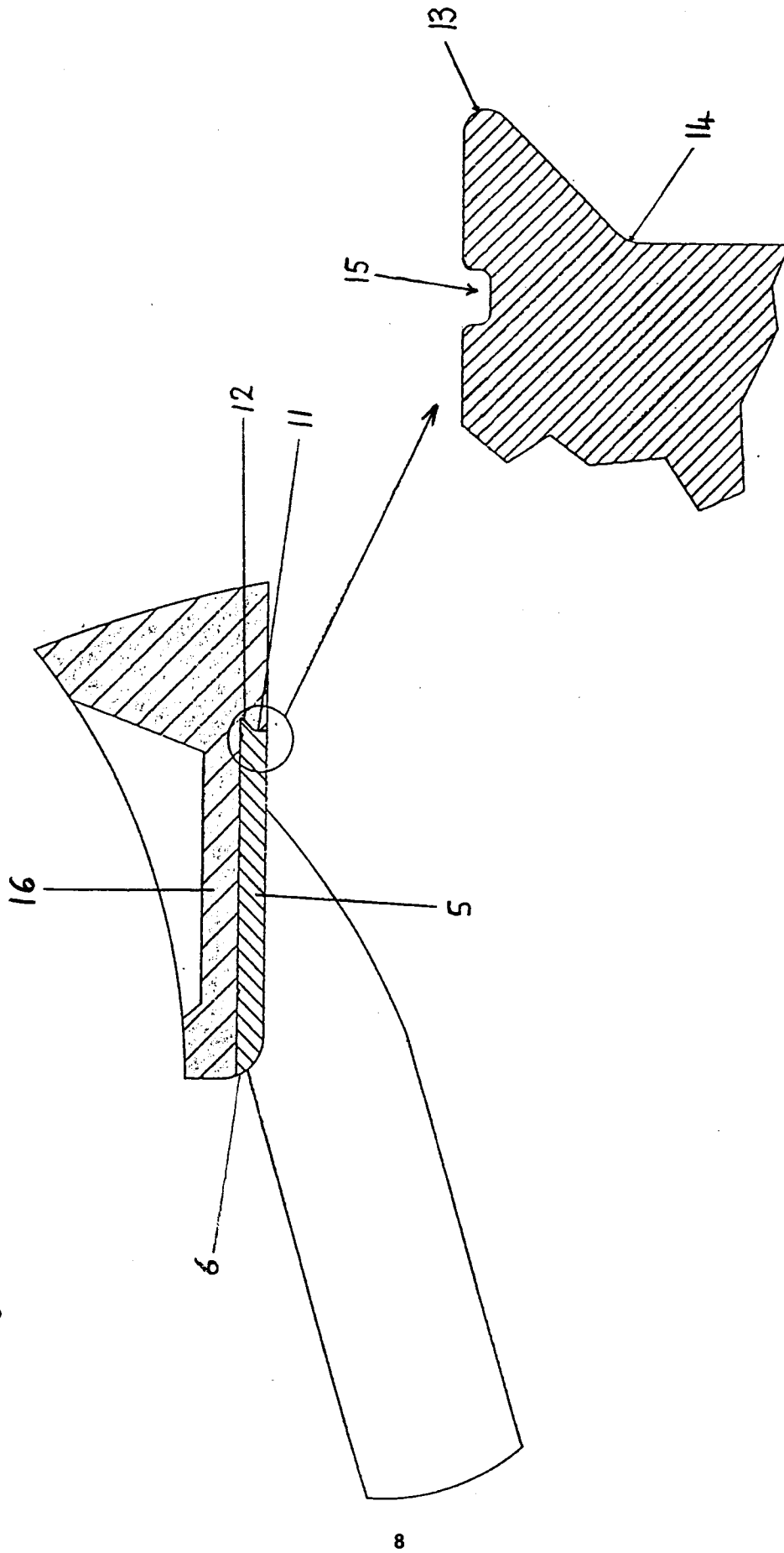


Figure 3a