

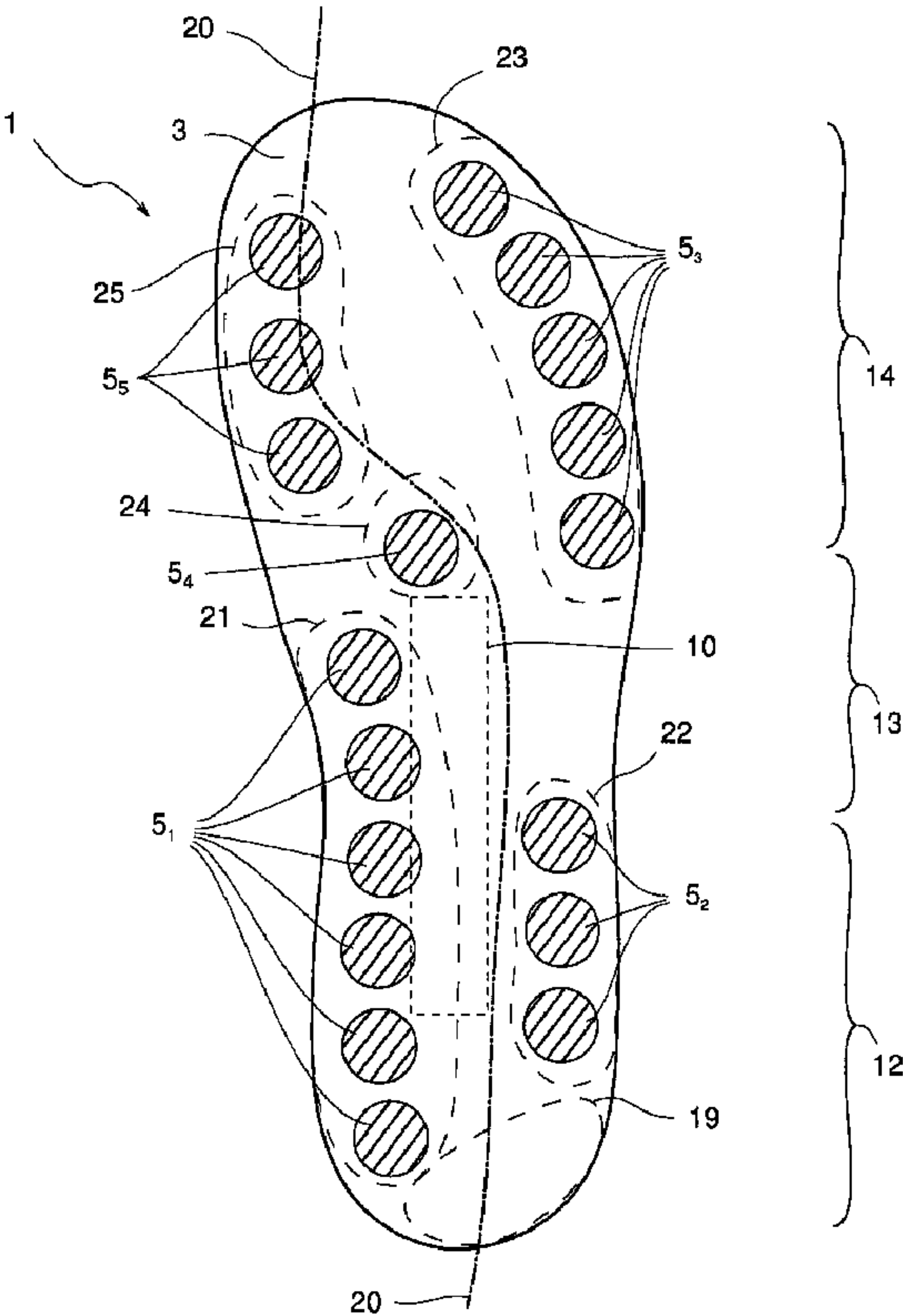


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(54) Titre : **SYSTEME D'INSERT MODULAIRE POUR SEMELLES DE CHAUSSURE**
(54) Title: **MODULAR INSERT SYSTEM FOR SHOE SOLES**



(57) **Abrégé/Abstract:**
A support customising system is described for a sole 1 of a shoe. The sole 1 comprises a relatively soft, resilient midsole 3 and an a harder outsole 4. Hard insert elements 5 are provided for inserting into vertical cavities 2 in the midsole 3. By varying the

(57) **Abrégé(suite)/Abstract(continued):**

hardnesses of different inserts 5 in different vertical cavities, a precisely-tunable pronation control effect on the wearers gait can be effected. First-order, second-order and third-order pronation control effects are described. Measures are provided for improving the accuracy of the proprioceptive (sensory motoric) effect on the wearer's foot, for example by limiting the ingress of dirt or water.

Abstract

A support customising system is described for a sole 1 of a shoe. The sole 1 comprises a relatively soft, resilient midsole 3 and an a harder outsole 4. Hard insert elements 5 are provided for inserting into vertical cavities 2 in the midsole 3. By varying the hardnesses of 5 different inserts 5 in different vertical cavities, a precisely-tunable pronation control effect on the wearer's gait can be effected. First-order, second-order and third-order pronation control effects are described. Measures are provided for improving the accuracy of the proprioceptive (sensory motoric) effect on the wearer's foot, for example by limiting the ingress of dirt or water.

10 (Fig: 1)

Modular insert system for shoe soles

Technical Field of the Invention

The present invention relates to soles for articles of footwear, in particular footwear for correcting, supporting or accommodating the gait of the wearer.

5 Background of the Invention

In addition to providing general support for the wearer's feet while walking or running, shoe soles can be manufactured such that the degree of support for the foot differs between different regions of the sole. Thus the material of the heel region, for example, which experiences the greatest impact forces, is often manufactured to provide greatest
 10 impact cushioning effect. The desired variation in support may be achieved for example by varying mechanical properties of the material of the sole, such as the shape, thickness, density, hardness and flexural characteristics. In this way, the sole may be manufactured so as to provide optimum support for the typical wearer's feet. Since gait characteristics vary significantly from person to person, footwear manufacturers design the soles of their
 15 products to cater for a broad range of gait types, based around a putative norm. Soles may also be configured to suit different types of use. For example, soles may be configured for sprinting, long-distance running, playing particular sports such as golf or tennis or cross-country skiing, or for casual wear. Running shoes require different sole configurations for different distances, and for different types of terrain.

20 The wearer is therefore obliged either to settle for a sole which will cover a wide range of uses, but will not be well configured for any of those uses, or he may purchase different footwear for different uses; different shoes for road-running and for cross-country running, for example, or different shoes for different distances.

Specialist soles are also available which are configured to accommodate or correct
 25 particular types of gait, such as over-pronation or supination. Shoes are also available with soles which are customised to a particular combination of gait-type, or sport, or use. It is possible to have soles customised for a particular person, or even for a particular foot. However, bespoke soles are expensive, and the present invention is concerned primarily with soles for footwear which can be manufactured and distributed in significant numbers
 30 as a commercial retail product.

Prior art

It has been suggested to provide a certain customizability of the support provided to a wearer's foot by means of an orthotic insole, laid on top of the integral sole of a shoe.

Such insoles may incorporate regions of different support, which are arranged to suit the particular use or gait-type. The hardness of the regions may be customised by exchanging portions of the orthotic, for example. Such a customisable orthotic is known from EP2383952, in which a shaped piece of the orthotic can be exchanged for a similarly-
 5 shaped piece having a different hardness. The orthotic described in this document thus provides a limited customizability of the support which is provided by the insole.

WO2016092353, from the same inventors as the present invention, describes a sole customising system in which hard inserts are located in cavities in the midsole. The application does not address the problem of ensuring constant and accurate sensory-
 10 motoric stimulus (see below), but nevertheless proposes an arrangement which could potentially offer a solution in that the inserts can be inserted into the cavities from the top, so that the cavity bottoms are closed by the outsole.

EP1352579 describes a midsole comprising regions of different hardnesses, so that the midsole can be customised for a particular wearer. The assembled portions of the midsole
 15 may be formed into a continuous moulding, in which case the customised sole is no longer customisable. Alternatively, the assembled portions can remain as discrete components of the sole, in which case the mechanical integrity of the sole as a whole is greatly reduced.

DE20320091 describes an adaptable insert which affords a limited customizability of the
 20 support provided at a particular region of the sole. The insert is introduced from the medial side of the sole (ie left-hand side of a right shoe or right-hand side of a left shoe) or the lateral side of the sole (ie right-hand side of a right shoe or left-hand side of a left shoe), and is held in place using a clip. The insert also includes vertical hexagonal-shaped holes into which can be inserted hexagonal pegs of a particular hardness. In this way, the
 25 effective hardness of the insert can be varied by inserting pegs which are harder than the material of the insert, which gives the wearer some control over the degree of support provided at that particular region of the sole when the insert is located in position. The midsole is provided with a wide horizontal cavity, open to one side, into which the insert can be pushed. The presence of a wide cavity reduces the overall mechanical integrity of
 30 the sole, even with the insert in place, and provides a path for water and dirt to enter the sole, and to work their way deep within the sole. The presence of the midsole material above and below the cavity means that the effectiveness of the lateral insert is reduced, in that the amount of vertical support it provides is reduced, and the total amount of vertical support provided may the sole in the region of the insert can be less accurately defined.
 35 Over time, the material of the midsole above and below the cavity, and the material of the

insert element surrounding the pegs, will lose elasticity and resilience due to the repeated compression during the gait cycle. Such insert elements are typically positioned in regions of the sole where greater support is required, which means that the repeated compression, and the consequent crushing of the insert material and the midsole material
 5 above and below the insert, will be particularly susceptible to degradation, and thereby shorten the wearable life of the shoe.

It is also important for gait-correcting insert elements to retain a constant proprioceptive effect and to remain secured in the sole. If an insert works loose, or becomes plastically compressed, or if it is contaminated by ingress of dirt or water, the customised
 10 proprioceptive pressure effect of the insert will be altered.

Brief Description of the Invention

The invention described in this application seeks to overcome at least some of the above and other disadvantages inherent in the prior art. In particular, the invention aims to provide a customisable article of footwear according to claim 1, a method according to
 15 claim 23 and a method according to claim 25. Further variants are defined in the dependent claims.

A support customising system is described below for the sole of a shoe or other article of footwear. The sole comprises a relatively soft, resilient midsole and (optionally) a harder outsole. Insert elements of various hardnesses are provided for inserting into vertical
 20 cavities in the midsole. By customising the hardnesses of different inserts in different vertical cavities, a precisely-tunable pronation control effect on the wearer's gait can be effected. First-order, second-order and third-order pronation control effects are described.

The invention and its advantages will further be explained in the following detailed description, together with illustrations of example embodiments and implementations
 25 given in the accompanying drawings. Note that the drawings are intended merely as illustrations of embodiments of the invention, and are not to be construed as limiting the scope of the invention. Where the same reference numerals are used in different drawings, these reference numerals are intended to refer to the same or corresponding features. However, the use of different reference numerals should not in itself be taken as
 30 an indication of any particular difference between the referenced features. In this description the terms hardness and durometer are used interchangeably, and numerical hardness values refer to the Shore A hardness scale.

Figure 1a shows in side view a schematic cross-section of an example shoe employing a support-customising system of proprioception-enhancing inserts.

Figure 1b shows in isometric view an example of support adjustment inserts for use in the support customising system of figure 1a.

- 5 Figure 2 shows a schematic plan view, viewed from below, of a first example sole employing a support customising system.

Figures 3 to 8 show cross-sectional schematic views of various example geometries of proprioception-enhancing inserts.

- 10 Figures 9 to 11 show cross-sectional views of various example arrangements of proprioception-enhancing inserts in a sole.

Figures 12 and 13 show transverse cross-sectional views of two example arrangements of proprioception-enhancing inserts.

Figure 14 shows a longitudinal cross-sectional view of an example arrangement of proprioception-enhancing inserts.

- 15 Figure 15 shows a transverse cross-sectional view of an example of an insert-retention arrangement.

Figures 16 to 24 show cross-sectional views of example geometries of proprioception-enhancing inserts.

- 20 Figures 25 to 27 show cross-sectional views of example sealing and retention arrangements of proprioception-enhancing inserts.

Detailed Description of the Invention

- An example of a support customising system is illustrated in figures 1a and 1b. Figure 1a depicts a schematic cross-section of a shoe with a sole 1 comprising an outsole 4, a midsole 3, bonded to the outsole 4, and a liner or insole 6 laid on the upper surface 7 of the midsole 3. The midsole 3 may be made of a resilient material, for example an elastomer such as ethyl vinyl acetate (EVA) or other suitable material. The outsole 4 may for example be constructed from a hard, resilient elastomeric material such as rubber/polyurethane, and may have a hardness which is greater than that of the midsole 3, at least at the ground-facing surface of the outsole 4. Alternatively, the midsole 3 and outsole 4 may comprise the same or similar materials, or may be contiguous,
- 25
- 30

homogenous regions of the same moulded shape. The liner or insole 6 may be of relatively thin and/or softer material and serves to provide a comfortable surface for the sole of the wearer's foot. The liner or insole 6 may be removed to expose the upper surface 7 of the midsole 3.

5 The example sole 1 illustrated in figure 1a is provided with a plurality (six are shown) of vertical cavities 2, each of which opens out through the outsole 4 and extends up towards the upper surface 7 of the midsole 3 along a vertical axis 8. The midsole 3, apart from the holes (cavities 2) which are formed in it, may be constructed of continuous material, in order to ensure the mechanical integrity of the sole as a whole. The vertical direction is
10 understood in this text to be the vertical direction when the shoe is standing flat on level ground. The vertical axis 8 is thus substantially orthogonal to the general plane 9 of the sole 1, which is taken to be generally parallel to the upper, foot-facing surface 7 of the midsole 3 and/or to the lower surface of the outsole 4, at least in the heel and/or midfoot regions 13, 14 of the sole 1. The sole 1 illustrated in figure 1a has parallel upper and lower
15 surfaces for clarity. In practice, the heel area of the sole may be thicker than the forefoot area ('positive drop'), or vice versa ('negative drop'), and/or the mid-foot zone may be thicker than both the heel and forefoot regions, for example.

The terms lower and upper used in this description are also defined in terms of the vertical axis 8. Note that the term vertical is used in this text to denote a general rather than a
20 precise orientation of the vertical cavities 2, and includes orientations which differ by up to 15 degrees, or alternatively even up to 40 degrees from the vertical axis 8 shown in figure 1a.

While only six cavities/inserts are shown in particular cross-section of figure 1a, all in the heel and mid-foot parts of the sole, it should be understood that the sole may also
25 comprise similar cavities/inserts in forward regions of the sole.

Figure 1b shows a set of inserts or plugs 5, also referred to in this description as support adjustment inserts or proprioception-enhancing inserts, which are designed for insertion into the cavities 2 in the midsole 3. In the example shown in figures 1a and 1b, the inserts 5 may be inserted into the cavities 2 through openings in the outsole 4. Inserting the
30 inserts from below has the advantage that the insertion openings are more readily accessible than if they are inserted from above. However, as discussed below, inserting the inserts through the outsole 4 renders the inserts liable to damage by over-compression (for example if the wearer steps on a stone) or by incursion of dirt or water.

The inserts 5 may also be made of an elastomeric material, for example, and they may
35 have different hardnesses from the midsole 3 and/or from one another. Some of the

inserts 5 may have substantially the same hardness as the material of the midsole 3, in order to provide a null support adjustment at a particular cavity 2. It is also possible to provide inserts 5 with lower hardnesses than the midsole 3; this may for example be useful for providing a negative support adjustment in a particular region of the sole 1 by
 5 reducing the average hardness of the region by inserting one or more inserts 5 which are softer than the material of the surrounding midsole 3.

The hardnesses of the inserts 5 may be selected from a set of predetermined hardnesses. For example, a pair of shoes having soles such as that illustrated in figures 1a may be purchased with a set of inserts 5 similar to those shown in figure 1b, with multiple
 10 alternative inserts of different hardnesses available for insertion into each cavity, and with each insert having one of a predetermined selection of hardnesses. There may be more inserts 5 in the set than there are cavities 2 in the sole 1. The midsole 3 may have a hardness in the range 30 to 70 Shore, or 45 to 60 Shore, for example, and the supplied set of inserts 5 may include some inserts having a hardness of 50 Shore, some of 60
 15 Shore, some of 70 Shore, some of 80, 90 or even 100 Shore, for example. Different inserts 5 of different hardnesses may then be fitted into the cavities 2 provided, so as to achieve the desired local support hardness at each cavity location and collectively in each region of the sole 1 provided with cavities 2. If the midsole has a first durometer, then the set of inserts from which inserts can be selected for insertion into the cavities may include
 20 inserts, each of which may have one of a predetermined plurality of durometers. The plurality of durometers may include durometers which differ from each other by between 5 and 20 Shore, including a durometer which is greater than the first durometer by between 5 and 40 Shore. As will be discussed below, the plurality of durometers may include a durometer which is the same as the first durometer and/or one or more durometers which
 25 are less than the first durometer. The first durometer of the midsole 3 may be constant for all regions of the midsole 3, or it may vary between regions of the midsole 3. In the latter case, the first durometer may either be taken to be an average durometer of the midsole 3 or a local durometer of a particular region of the midsole 3.

When the wearer puts weight on the sole, for example while walking, the inserts 5 which
 30 are harder than the surrounding midsole material serve to transfer a force from between the ground and the wearer's foot which is greater than that transferred by the surrounding midsole material. Each of these harder inserts thereby provides increased support for the wearer's foot at the location in the sole at which it is inserted. Because the inserts 5 each have one of a predetermined set of hardnesses, at least in the vertical direction, and
 35 because they extend along substantially the whole vertical depth 11 of the sole 1, or at least substantially the whole depth 11 of the midsole 3, the net vertical hardness of the

sole 1 at the location of each cavity 2 is determined exclusively, or in a great majority, by the hardness of the particular insert 5. The hardness of the outsole 4, if it is different from the hardness of the insert 5, may also contribute an effect to the net vertical hardness of the sole 1 at that location, but the contribution may be small, particularly if the outsole 4 is thin and/or the hardness difference between the outsole 4 and the insert 5 is small.

Similarly, the contribution of the insole 6 or any minor part of the midsole which extends above or below the insert 5 when the insert 5 is inserted, will also have only a small effect on the net vertical hardness of the sole 1 at the particular cavity. The term net vertical hardness is used here to indicate a measure of the compressibility and resilience of the sole in an approximately vertical direction (ie as measured along the vertical axis 8).

The vertical cavities 2 and the inserts 5 shown in the example of figures 1a and 1b have substantially parallel vertical side-walls. The cavities 2 may thus have a horizontal cross-section which is substantially constant along their length 11, for example, or they may have a tapering cross-section, any other shape which allows them to be fitted into the cavities 2 and/or subsequently removed for exchange. The horizontal cross-section of the cavities 2 and inserts 5 may be of any regular shape, such as circular, oval, ovoid, hexagonal, triangular, square or rectangular, or it may have an irregular shape. The inserts 5 and cavities 2 are advantageously dimensioned such that it is possible to fit two or more cavities/inserts into a particular gait control region of the sole 1, as will be discussed below. In this respect the cavities and inserts 5 may be formed with a horizontal cross-section which has a largest transverse dimension of between 5mm and 50mm across, for example, or preferably between 10mm and 30mm.

Because the inserts 5 are oriented substantially vertically in the midsole 3, and because they have relatively small lateral dimensions, multiple inserts 5 and cavities 2 can be located in a particular region of the sole 1 in order to adjust the net vertical hardness of sole with a fine resolution. Thus, a pronation control zone in the forefoot area 12 of the sole 1 may incorporate multiple (eg three to ten inserts), for example, each with a hardness suitable for the pronation control requirement of the wearer. The hardnesses of the three to ten inserts 5 may be the same, or they may be graded. For example, the hardnesses of the inserts may be increased from the rear-most insert 5 to the foremost insert 5.

The discussion above has related primarily to the inserts 5 and cavities 2 of a single shoe. In a pair of shoes, the inserts 5 and cavities 2 may similarly be made so that the same inserts 5 can be used in the cavities 2 of either shoe. The support customising system

may be arranged such that, multiple pairs of shoes can share the same set of support adjustment inserts 5.

The use of multiple, interchangeable inserts 5 having different hardnesses means that the support provided by the sole 1 can be finely tuned to the needs of the wearer. The support
5 may be differently tuned between the left shoe and right shoe, between different regions 12, 13, 14 of one sole 1, or even within the same region of the sole 1.

Figure 2 shows a plan view of a shoe sole 1 similar to the sole 1 shown in figure 1a, and shows in more detail how the support adjustment inserts 5 can be arranged in the midsole 3 to achieve a customised support, for example as an aid to gait correction for the wearer.
10 Figure 2 shows the midsole 3 of a left shoe, viewed from below, but it will be understood that the following description applies equally to a corresponding right shoe, although the arrangement of inserts 5 may be different between the left and right shoes.

In the example configuration of figure 2, the sole 1 comprises a heel region 19, a heel medial region 21, a heel lateral region 22, a forefoot lateral region 23, a metatarsal region
15 24 and a forefoot medial region 25. These regions are merely examples — other regions may be chosen. If there are multiple inserts 5 in each region, as shown, the support offered by the region as a whole can be adjusted precisely by including individual inserts having different durometers — either to give an overall average hardness which is equivalent to an intermediate durometer value between the available values of the
20 available inserts, or to give a graded support across the region.

Left and right feet naturally have slightly different pronation styles, due to the natural asymmetry in the person's posture and due to neurological effects which gives rise to asymmetries in gross motor control, reflected in the person's posture and gait. However, the characteristics of the landing portion 19 of the heel region should preferably be the
25 same for left and right shoes.

Because the inserts 5 of a particular region, or of multiple regions of the sole, may have the same cross-sectional shape, the inserts 5 may be made interchangeable between all cavities 2 of a particular region or between all cavities 2 of the sole. In this case many different configurations of the support offered by the sole can be achieved with a relatively
30 modest number of inserts 5.

Each insert 5 may be formed as a single contiguous piece of material, or it may be formed from two or more constituent pieces. It may be solid, for example to assure its rigidity, or it may be hollow, for example to cut down on shoe weight and material costs. It may be open at one or both ends, and it may have openings in its side wall(s).

Also illustrated in figure 2 is an ideal gait line 20, also known as the stability axis or "S-line", which indicates approximately how the wearer's foot should pronate during its heel-to-toe contact (gait cycle) with the ground. The example regions 19, 21, 22, 23, 24 are identified only approximately, and are used to illustrate how inserts 5 in the various regions can be used for controlling the wearer's gait.

The multiple cavities 2 may advantageously have the same size and shape, as illustrated in figure 2. The inserts 5 of a particular set, even if they have different hardnesses, may also have the same size and shape, so that multiple inserts 5 of different hardnesses can be interchangeably fitted into each cavity 2, and so that a particular insert 5 can be fitted into multiple cavities 2. The hind-most heel part 19 of the midsole 3 in figure 2 is shown without any inserts 5 in this example. There may be instances when it may be useful to be able to adjust the hardness of this hind-most region 19, but the illustrated example is designed to show how the support adjustment inserts 5 can be used for pronation/supination control, and the hindmost region 19 of the midsole 3 serves primarily to cushion and control the landing impact of the heel on the ground and the initial forward motion of the foot.

Medial and lateral control regions 21 and 22 can be used to control the amount of pronation during the initial phase of the gait cycle (ie following initial heel impact). By judicious choice of the hardnesses of the inserts 5_1 of the medial region 21 and the hardnesses of the inserts 5_1 and 5_2 of the medial 21 and lateral 22 control regions, it is possible to influence the degree of pronation of the foot around the stability "S-line" 20. Furthermore, the use of inserts 5 of graded hardnesses in a particular region permits a second-order control, in which not only the amount of pronation can be controlled, but also the rate of change of pronation with respect to the forward motion of the foot during the sole's contact with the ground when walking or running. Taking the six medial control inserts 5_1 illustrated in figure 2 as an example, a first-order pronation control can be obtained by selecting the hardness of the three inserts 5_2 relative to the hardness of midsole 3 and/or of the medial control inserts 5_1 . Harder lateral inserts 5_2 will encourage greater pronation, softer lateral inserts 5_2 will promote pronation less. However, by varying the difference between the durometers of the lateral inserts 5_2 , it is possible to achieve a second-order control effect. If the hardness difference between inserts along the heel to toe direction is large, for example (ie the rear-most lateral insert 5_2 is much harder than the forward-most lateral insert 5_2 , then the rate of pronation with respect to the foot's forward motion is greater. This means that the pronation occurs during a shorter time, when considered as proportion of the total contact time with the ground. On the other hand, if the hardness of the inserts 5_2 varies little along the heel to toe direction, then the

pronation-enhancing effect with respect to the foot's forward motion will be less. If the foremost lateral insert 5_2 is harder than the rear-most insert 5_2 , then this will act to reduce the rate of pronation.

The lateral and medial inserts 5_1 and 5_2 can further be used to achieve a third-order control effect, in that inserts can be selected to vary the rate of pronation. If the lateral control region 22 is provided with more cavities and inserts 5_2 , (say five inserts in a line running parallel to the heel-toe axis, for example), then the hardnesses of the five lateral inserts 5_2 can be chosen so as to vary the rate pronation along the heel-to axis. Thus, by being able to select the hardnesses of the lateral inserts 5_2 it is possible not only to vary the amount of pronation (first-order effect), but also to vary the rate at which pronation occurs (second order effect) and the axial variation in the rate of pronation (third-order effect).

By using many cavities/inserts, it is possible to vary the pronation/supination control with a fine resolution, and in many different ways. For example, it is possible to take set the hardness of the inserts 5 to take account of individual bones or bone groups in the foot. Excessive calcaneal/talar tilt can be compensated for, for example, while minimising the effect on the metatarsal or forefoot regions.

The control effects described above in relation to the interchangeable inserts 5_2 of the lateral region 22 also apply to the other illustrated regions in figure 2; the medial control region 21 with its multiple medial control inserts 5_1 , and the forefoot control regions 23 and 25, with their forefoot control inserts 5_3 and 5_5 . A single mid-foot control insert 5_4 is illustrated in midfoot control region 24, which may be included in the midfoot /metatarsal region to discourage the wearer's arch from sinking. The sole 1 may comprise such a single midfoot insert 24 on its own or in combination with one or more other inserts, as shown in figure 2, for example.

As a consequence of such finely-adjustable and adaptable gait control, it is possible to improve the wearer's gait and straighten the wearer's axial skeleton, which not only has beneficial effects for the wearer, but also promotes even wear on the outsoles 4 and therefore extends the life of the shoes.

Furthermore, if the individual inserts are replaceable, then the soles can be "tuned" for different uses, or for different wearers, or as the shoes age, or as the wearer's gait changes.

The following examples illustrate the insert hardnesses which could be chosen for different gait control purposes. The examples are based on a sole configuration similar to

that shown in figure 2, and the hardnesses given are relative to an example midsole material of hardness 50 Shore. Where different inserts hardnesses are listed for a particular region, these are listed in the order from rear-most to foremost).

Example 1: for correcting a slight supination

5 Lateral control region 22: 50 Shore, 60 Shore, 60 Shore

Medial control region 21: all 50 Shore or less

Forefoot lateral control region 23: all 60 Shore

Example 2: for correcting a delayed overpronation

Lateral control region 22: all 50 Shore (no correction)

10 Medial control region 21: 50, 60, 70, 80, 80, 60 Shore

Forefoot lateral control region 23: all 60 Shore

Example 3: for correcting severe general overpronation

Lateral control region 22: 50, 50, 60 Shore

Medial control region 21: 70, 80, 90, 80, 70, 60 Shore

15 Forefoot lateral control region 23: all 60 Shore

Example 4: for correcting early, slight overpronation

Lateral control region 22: 50, 50, 60 Shore

Medial control region 21: 70, 60, 50, 50, 50, 50 Shore

Forefoot lateral control region 23: 70, 60, 50, 50, 50 Shore

20 Example 5: for correcting delayed, slight overpronation

Lateral control region 22: all 50 Shore (no correction)

Medial control region 21: 50, 50, 60, 60, 70, 70 Shore

Forefoot lateral control region 23: all 50 Shore (no correction)

The sole of figure 2 also shows how a stiffening plate 10 may optionally be included to maintain longitudinal and torsional stiffness of the part of the sole under the arch of the
5 wearer's foot. The presence of such a plate can improve the stability of the wearer's foot with respect to the ground surface, and may increase the life of the shoe sole. The plate 10 is also visible in figures 12 to 14.

Figures 3 to 8 illustrate various example arrangements for the cavities 2 and inserts 5, as mentioned above. In figure 3, the cavity 2 comprises an opening in the upper surface 7 of
10 the midsole 3, and is closed at its lower end by outsole 4. In figure 4, the cavity 2 is shown with an opening above and below. Figures 5 to 8 show arrangements in which the cavity 2 is closed at its upper end by a minority portion (eg 10% – 20%) of the thickness of the material of the midsole 3. The inserts 5 may be secured in the cavities 2 by any suitable means. If an insert is intended to remain in its cavity permanently, then it may be glued or
15 bonded or welded in place in the cavity 2. The insert 5 may even be supplied as a liquid which can be introduced into the cavity 2 and which then sets with a predetermined hardness. Figures 5 and 6 show the cavity with and without the insert 5 inserted. The insert of this example comprises a body portion 5, which may have a hardness selected to give the desired proprioceptive stimulus pressure to the foot at that location, and an
20 outsole portion 5', which may comprise a similar material to that of the outsole 4. Alternatively, the insert may be of a single heterogenous piece of material.

The lower portion 5' (eg the outsole portion) of the insert 5 may advantageously be wider than the body portion which fits into the cavity 2. This has the following advantages which help to maintain a constant proprioceptive stimulus pressure provided by the insert 5 at
25 the location. Firstly, the broader outer part 5' abuts the lower surface 15 of the midsole element 3. This prevents the insert from being over-compressed and receding into the cavity. It also distributes the load on the insert more evenly, thereby ensuring a constant proprioceptive stimulus effect from the insert as a whole on the wearer's foot at that location. Secondly, the broader outer part 5' covers the region where the sidewall of the
30 insert body is in contact with the sidewall of the cavity. If sand, grit, dust or water is allowed to penetrate this region, which may happen in the arrangement of figures 5 and 6, for example, the accumulated matter may cause a hardening effect which will alter the proprioceptive pressure at the location and/or erode the material of the midsole 3 or the insert 5, such that the insert may work loose and drop out.

Figure 8 shows an example variant in which the insert 5 extends downward beyond the outsole 4, thereby increasing the proprioceptive pressure effect at the location. This is made possible, with a reduced risk of the insert being pushed up into the cavity, by the shoulder which abuts the lower surface 15 of the midsole 3 as described above.

5 Figures 9 to 11 show variants in which an optional plate 16 is included over all or some of the inserts 5 in order to delocalise the pressure which occurs between the foot and the individual inserts 5. The plate 16 may be hard enough and flexible enough to distribute the pressure without influencing the proprioceptive or sensory-motoric effect of graded or varied hardnesses of the inserts. The plate 16 may optionally cover the whole foot-contact
10 area of the sole or even the whole area of the sole. The plate 16 may optionally be recessed into the upper surface 7 of the midsole 3 as shown. The inserts 5 of figure 9 are shown flush with the lower surface of the outsole 4. The inserts 5 of figure 10 extend slightly (1mm to 5mm) proud of the lower surface of the outsole 4, and the inserts 5 of figure 11 are profiled and extend further, thereby further increasing the localised
15 proprioceptive stimulus pressure at the location.

Figures 12 to 14 show variants in which the cavities and inserts are angled slightly from the vertical, in a transverse direction as in figure 13 and/or in a longitudinal direction as in figure 14. The vertical axes 8, 8₁, 8₂, 8' of one or more cavities may be angled slightly outwardly or inwardly in order to enhance the effect of the choice of insert hardness. The
20 cavities of the forefoot region may be angled forwards from the vertical in order to increase an acceleration effect at the end of the gait ground contact cycle, thereby enhancing a rolling or rocking in the gait of the wearer. With this configuration it is thus possible to perform a pronation control as discussed above, in addition to enhancing a rolling gait of the wearer. The tilt angles mentioned here are preferably less than 30
25 degrees, or more preferably less than 15 degrees.

Figure 15 shows an example of an insert retention arrangement. The inserts may be retained in the midsole 3 by gluing, bonding, welding, or by form-fit, compression fit or other mechanical fitting. Advantageously, the inserts may be glued in position using an adhesive which allows the insert to be released (for example by application of heat) and
30 replaced. Alternatively, or in addition to the gluing, bonding etc, a retention element such as a peg or pin 17 may be inserted, for example transversely, as shown in figure 15, to secure the insert 5 in position so that it cannot fall out or work its way out of its cavity 2.

Inserts 5 may be made so that they can be inserted into the midsole 3 by hand, for example. Figures 16 to 27 show various configurations in which the lower (outsole) part 5' of the insert extends laterally outward of the insert body 5. The outsole 4 is provided with
35

an opening shaped and dimensioned to accommodate the corresponding lower part 5' of the insert.

Figure 16 shows a simple insert geometry in which the lower part 5' is flush with the upper and lower surfaces of the outsole 4.

5 Figure 17 shows an arrangement in which the upper surface of the lower part 5' is flush with the upper surface of the outsole 4, and the lower surface of the lower part 5' extends proud of the lower surface of the outsole 4. As with any of the arrangements described, the lower surface of the lower part 5' of the insert may be provided with a texture or tread for improved grip.

10 Figure 18 shows an arrangement in which the shoulder formed by the upper surface of the lower part 5' abuts a corresponding shoulder formed in the sidewall of the opening in the outsole 4. In this example, the lower part 5' also extends proud of the outsole 4.

Figure 19 shows an arrangement in which the lower part 5' abuts the outer surface of the outsole 4.

15 Figure 20 shows how the side surfaces of the lower part 5' of the insert may have other profile shapes such as the angled surface shown.

Figure 21 shows an arrangement in which the lower part 5' of the insert has two shoulders; a first, upper one which may be similar to the abutment arrangement of figure 16 or 17, for example, and a second, lower shoulder similar to the abutment arrangement
20 of figure 19. Two or more shoulders may be advantageous in that they provide more protection against dirt or water ingress. They also provide more surface area for bonding the insert's lower part 5' to the outsole 4 and/or the midsole 3.

Figure 22 shows how the upper part of the insert body 5 may be provided with a cavity 12 which may help to retain the insert in the cavity by vacuum suction. When vertical
25 pressure is exerted on the insert, compressing it slightly, air may be expelled from the cavity 12. When the pressure is release, the surfaces around the cavity may be drawn together by the resulting pressure differential so as to create a gas-tight seal which prevents air from re-entering the cavity 12. The cavity 12 may be deeper than illustrated. The hardness of the insert material may be increased so as to maintain the proprioceptive
30 (sensory motoric) stimulus effect with the reduced volume of solid insert material.

Figure 23 shows a two-shoulder arrangement similar to that of figure 21, in which the lower should is adapted to accommodate bending movement of the outsole 4 by being

sufficiently elastic and/or sufficiently well bonded to the outsole 4 that the lower should forms a reliable permanent seal against the ingress of dirt or water.

Figure 24 shows how the insert may be shaped to be retained in the cavity by mechanical fitting. In the example shown, the middle part of the insert body may be slightly wider than
5 the opening through which the insert is inserted, thereby preventing the insert from falling out or riding out of the cavity.

The inserts 5 may be provided with a positive-fit engagements, which may engage with corresponding recesses in the cavity wall, for example. The protrusions may alternatively be arranged in the cavity and the recesses on the insert. Figures 24 to 27 show illustrate
10 various further examples of how the inserts may be retained in the cavities by such positive fit or other mechanical interference. Such retention arrangements may be used alone or in combination.

Figure 25 shows an example in which the insert is retained in the cavity by one or more latch-rings or latching or stepped protrusions 26, 27 in the body and/or outsole part of the
15 insert 5.

Figure 26 shows an example in which the insert and cavity engage by means of a thread 28, whereby the insert can be screwed into the cavity. A slot 29 or other engagement profile may be provided for ease of turning the insert.

Figure 27 shows how a form fit insert retention may be implemented by angled or tapered
20 surfaces 30. In this case it may be advantageous to provide a special tool configured to compress the lower part 5' of the insert during insertion, so that it will pass more easily through opening of the outsole 4.

The inserts may extend up to 5 mm or more proud of the lower surface 15 of the outsole 4, for example, thereby enhancing a sensomotoric (proprioceptive) loading-response of
25 the wearer, in which the foot alters its orientation and movement in response to localised pressure from the inserts and thereby influences the gait of the wearer.

In the above examples, the inserts 5 have been shown inserted from below into cavities 2 which extend vertically to a point below the upper surface 7 of the midsole 3. The inserts and cavities may alternatively be configured to extend right to the upper surface 7 of the
30 midsole 3 or even to protrude above the upper surface 7 so as to create a further enhanced proprioception (sensory-motoric) stimulus in the sole of the wearer's foot.

Claims

1. An article of footwear, comprising:

a sole (1) comprising a midsole part (3) of a first material having a first durometer, the midsole (3) having an upper, foot-facing surface (7) and a lower, ground-facing surface,

5 an outsole part (4), below the lower surface (15) of the midsole, the outsole having a second durometer,

a plurality of cavities (2) in a first region of the midsole (3), each cavity (2) extending along a vertical axis (8) substantially orthogonally to the upper surface (7), between the lower and the upper surfaces (7) of the midsole, and

10 a plurality of support adjustment elements (5), each of which is substantially wholly inserted into one of the vertical cavities (2) so as to adjust a vertical support hardness of the sole (1) at the location of said each vertical cavity (2);

wherein each vertical cavity (2) comprises an insertion opening in the lower surface for receiving one of the support adjustment elements (5) such that the adjustment element

15 extends through the outsole (4);

wherein the plurality of support adjustment elements (5) comprises a first support adjustment element (5) having a third durometer and a second support adjustment element (5) having a fourth durometer, different from the third durometer, wherein at least one of the third and fourth durometers is greater than the first durometer; and

20 wherein each of the adjustment elements comprises a body part for being inserted into the cavity and a lower part (5'), wider than the body part, bonded to or located in an opening of the outsole (4).
2. Footwear according to claim 1, wherein the second durometer is greater than the first durometer.
- 25 3. Footwear according to one of the preceding claims, wherein the fourth durometer is different from the third durometer, and wherein at least one of the third and fourth durometers is greater than the first durometer.
4. Footwear according to one of the preceding claims, wherein each of the first and second support adjustment elements (5), when inserted into a first one of the vertical
- 30 cavities , and the plurality of vertical cavities (2) have substantially the same cross-section as the first vertical cavity (2) in a horizontal plane (9) parallel to the upper (7) and or lower surface (15), such that the first and second support adjustment elements (5) are

interchangeably insertable into the first vertical cavity (2) through the insertion opening of the first vertical cavity.

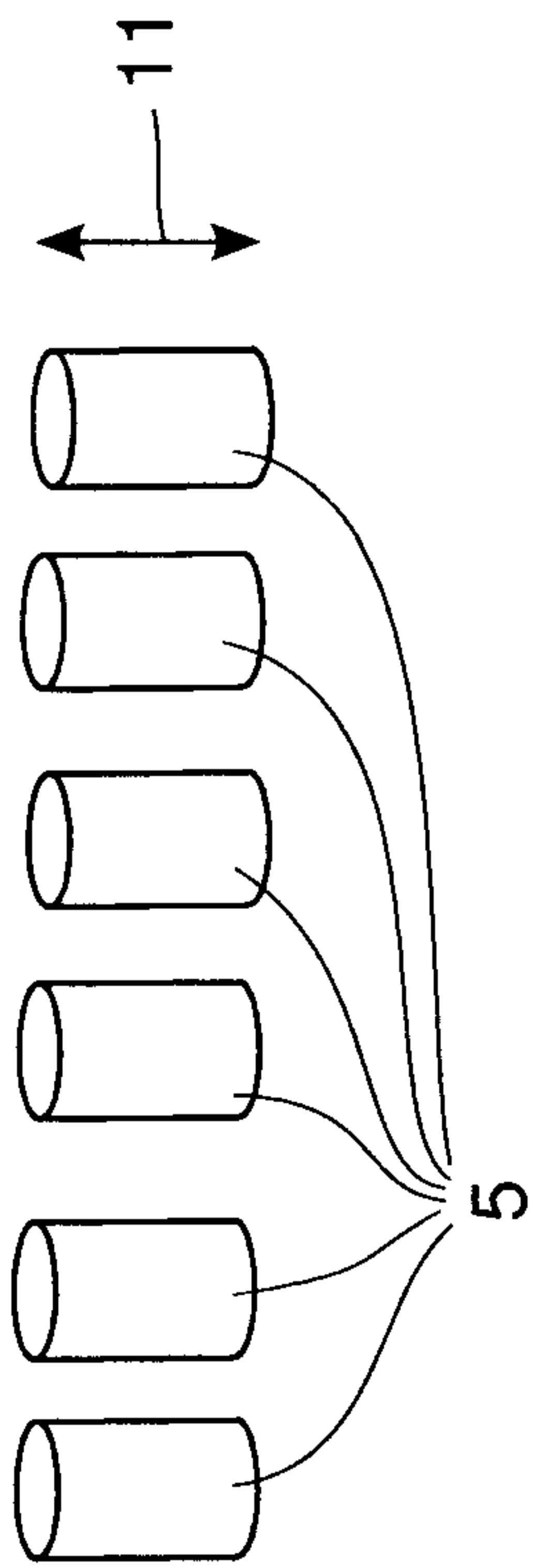
5. Footwear according to one of the preceding claims, wherein the first support adjustment element (5), the second support adjustment element (5) and a first one of the plurality of vertical cavities (2) have substantially the same vertical length (11) along the vertical axis (8).
6. Footwear according to one of the preceding claims, wherein the first and second support adjustment elements (5) and the plurality of vertical cavities (2) each has a substantially constant cross-section along at least a majority of its vertical length (11).
7. Footwear according to one of the preceding claims, wherein the first and/or second support adjustment elements (5) comprise a sensory-motoric stimulus protrusion configured to extend up to or protrude proud of the upper surface (7) of the midsole (3), so as to provide a sensory-motoric load-response stimulus to a wearer's foot at the location of the said first or second support adjustment element (5).
8. Footwear according to one of the preceding claims, wherein the first and/or second support adjustment elements (5) protrude proud of the lower surface (15') of the outsole (4).
9. Footwear according to one of the preceding claims, wherein a first plurality of vertical cavities (2) is arranged in a first gait control region (21, 22, 23, 24, 25) of the sole (1), and a second plurality of the vertical cavities (2) is arranged in a second gait control region (21, 22, 23, 24, 25) of the sole (1).
10. Footwear according to claim 9, wherein the first and second pluralities of vertical cavities (2) and the plurality of support adjustment elements have substantially the same cross-section, such that the first plurality of support adjustment elements (5) can be fittedly inserted into the vertical cavities (2) of the first and second pluralities (18, 19).
11. Footwear according to one of the preceding claims, in which the third durometer is at least 5 Shore greater than the first durometer.
12. Footwear according to one of the preceding claims, in which the fourth durometer is at least 5 Shore greater than the third durometer.
13. Footwear according to one of the preceding claims, in which the third durometer is less than or equal to the first durometer.

14. Footwear according to one of the preceding claims, in which the lower part 5' of the adjustment element extends laterally on average by at least 5% of the width of the body part wider than the opening of the cavity 2 into which it is inserted.
15. Footwear according to claim 14, in which the lower part 5' extends laterally on average
5 at least 2 mm wider than the opening.
16. Footwear according to claim 15, in which the lower part 5' extends laterally on average at least 4 mm wider than the opening.
17. Footwear according to one of claims 14 to 16, in which the lower part 5' extends laterally on average at most 6 mm wider than the body part.
- 10 18. Footwear according to one of the preceding claims, wherein the material of the midsole comprises a polyurethane material.
19. Footwear according to one of the preceding claims, wherein the material of the body part of each adjustment element comprises a polyurethane material.
20. Footwear according to one of the preceding claims, wherein the material of the outsole
15 part (5') of each adjustment element comprises a polyurethane material.
21. Footwear according to one of the preceding claims, wherein each adjustment element is provided with a retention element (17) for retaining a body part (5') of the adjustment element in the midsole.
22. Footwear according to one of the preceding claims, wherein the retention element (17)
20 is a pin, insertable transversely through the midsole and the body part.
23. A method of manufacturing a sole for an article of footwear according to one of claims 1 to 22, the method including:
- forming the midsole element (3) by vacuum-moulding the material of the midsole element around formers arranged for forming the cavities (2) with opening to the lower
25 surface (15') of the midsole element.
24. Method according to claim 23, wherein the material of the midsole element (3) comprises a polyurethane foam.
25. A method of customising the footwear of one of claims 1 to 22, so as to control the support provided to a wearer's foot by the sole, the method comprising the steps of:
- 30 determining a support requirement of the wearer's foot,

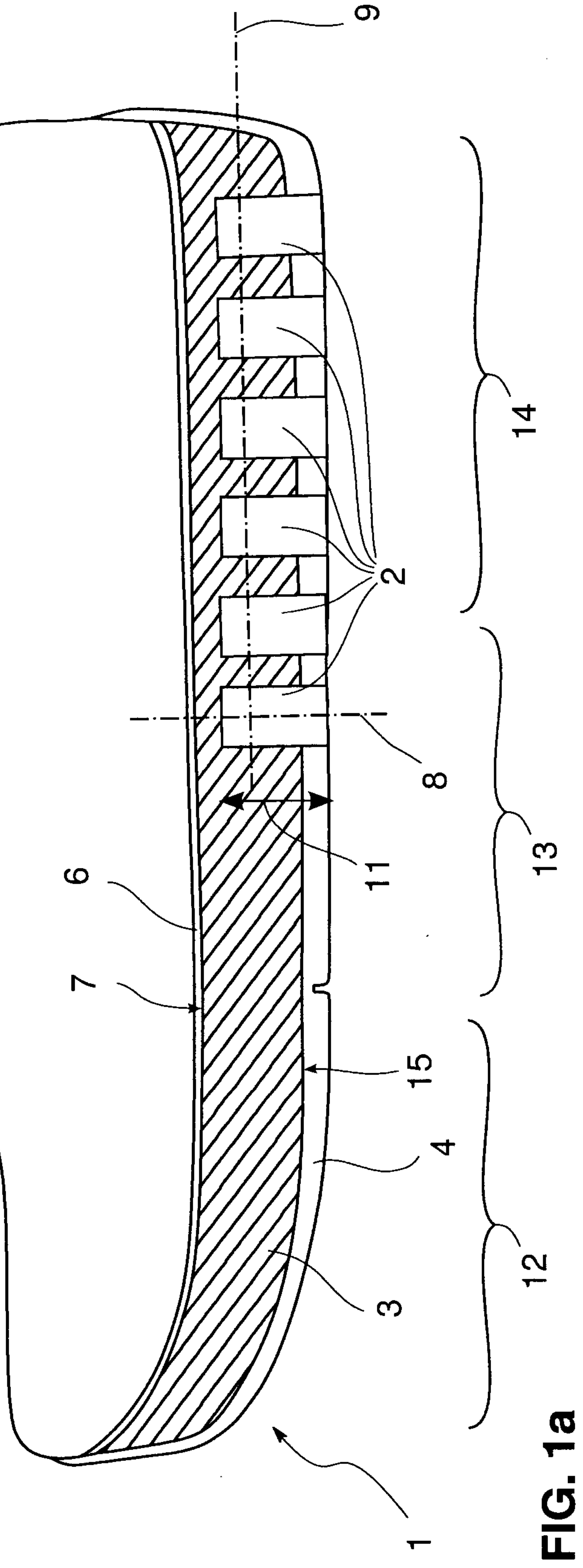
based on the support requirement, selecting said first and second support adjustment elements (5) from said plurality of support adjustment elements (5),

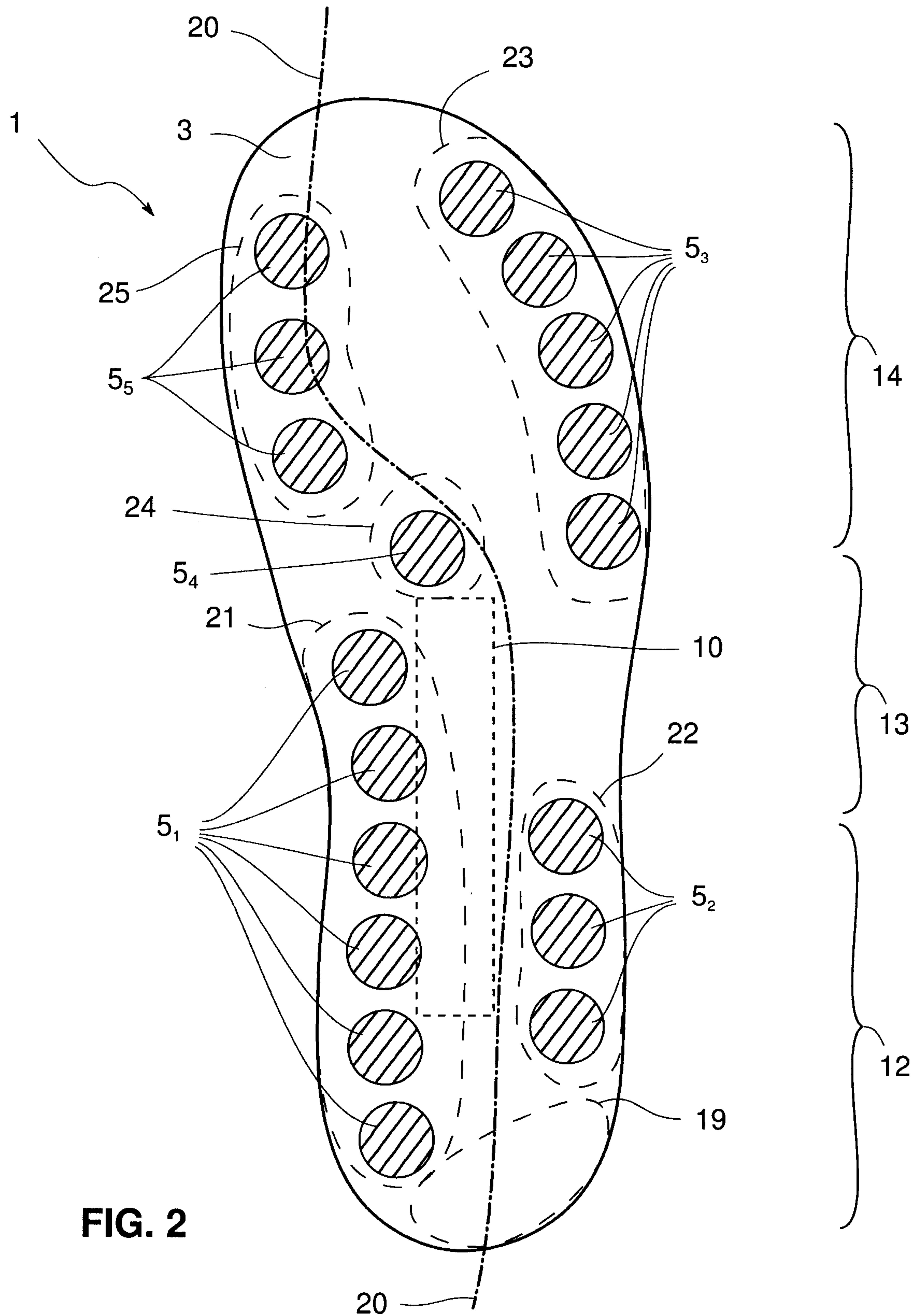
5 based on the support requirement, selecting said first vertical cavity (5), wherein the first vertical cavity is located in a third gait control region (21, 22, 23, 24, 25) for adjusting the support provided by the sole (1) to the wearer's foot for meeting the support requirement, inserting one of the first and second support adjustment elements (5) into said first vertical cavity (2).

26. Method according to claim 25, further comprising the step of inserting the other of the first and second support adjustment elements into a second vertical cavity (2) in said third
10 gait control region (21, 22, 23, 24, 25) or in a fourth gait control region (21, 22, 23, 24, 25), different from the third gait control region (21, 22, 23, 24, 25).



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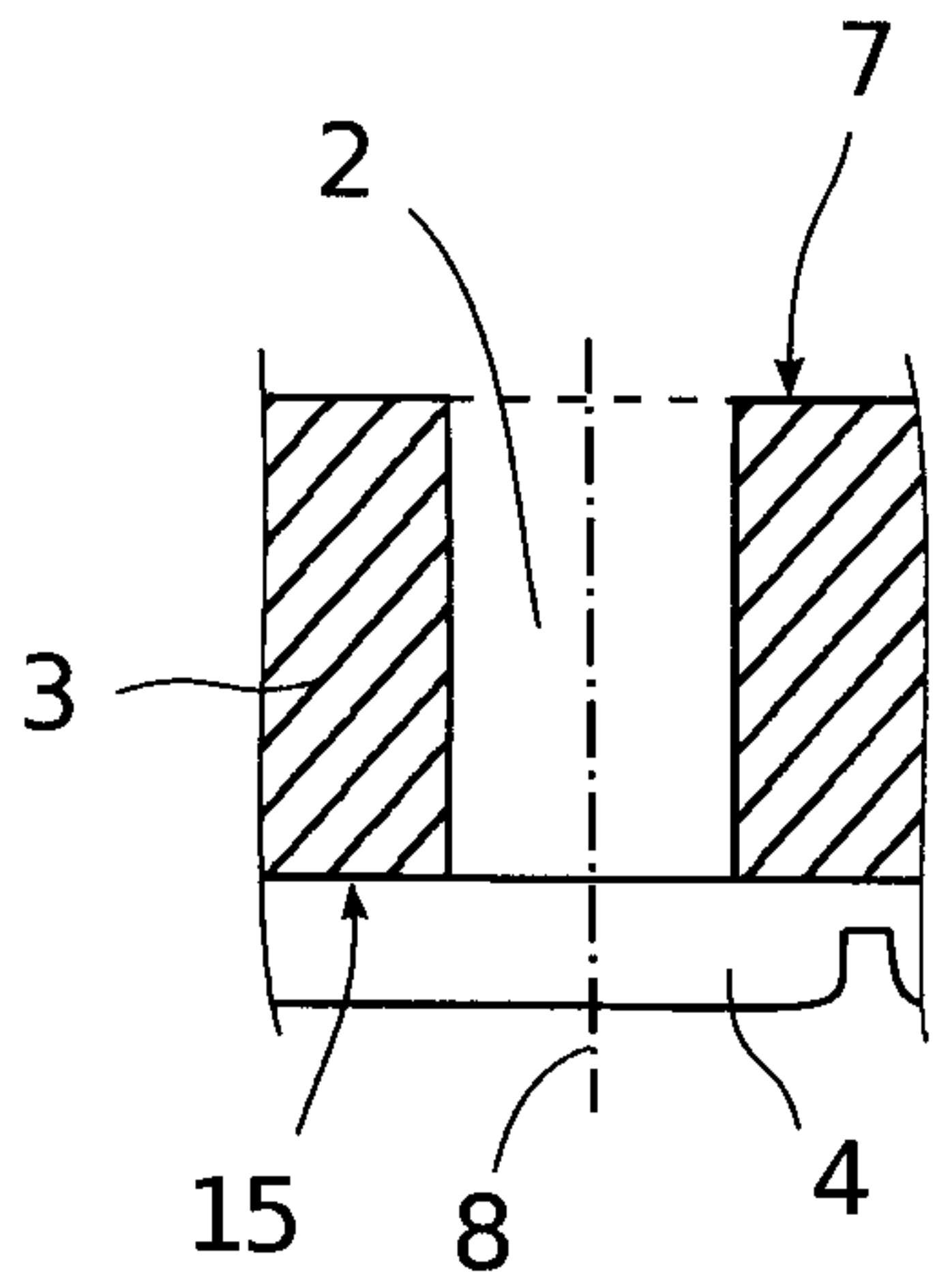


FIG. 3

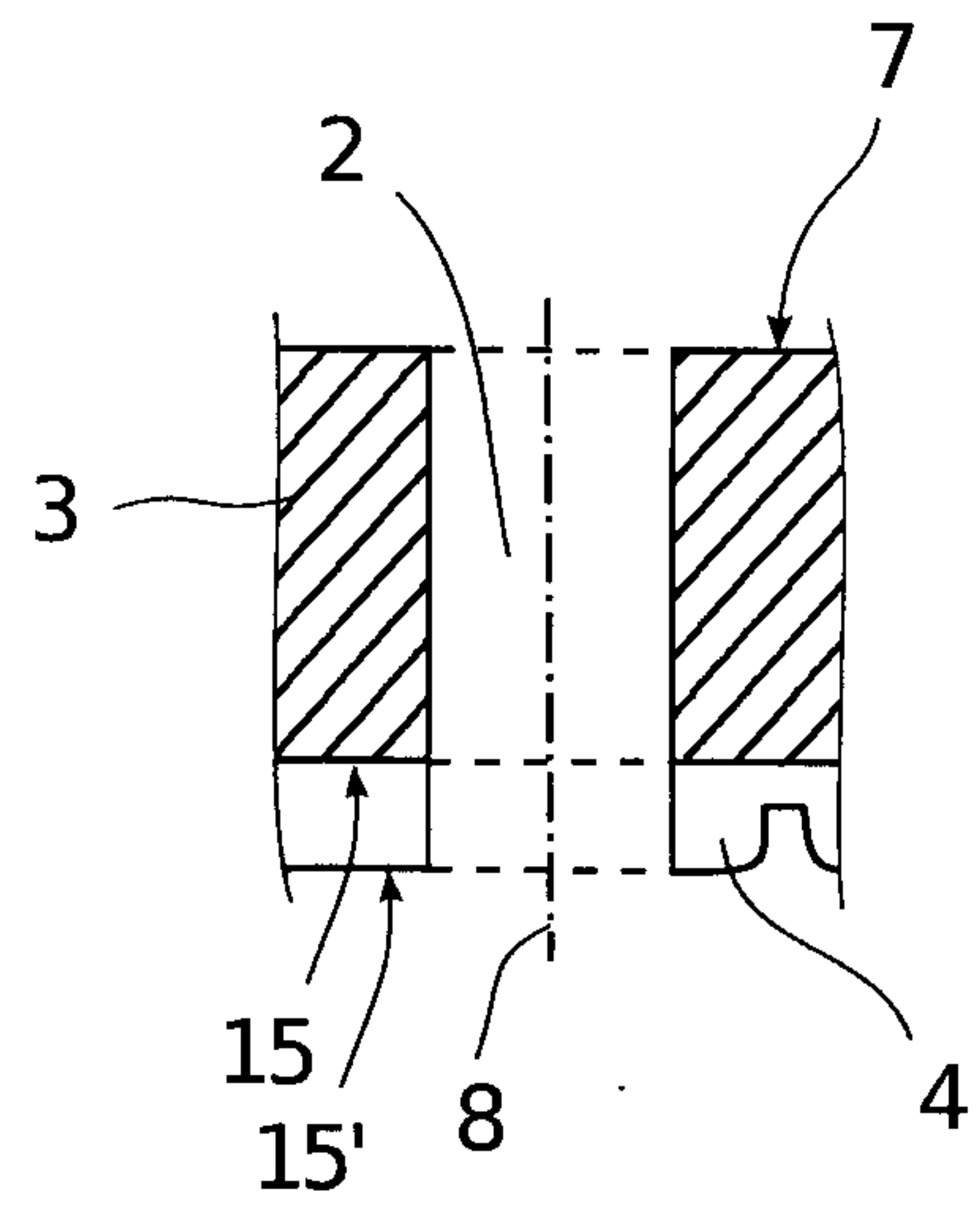


FIG. 4

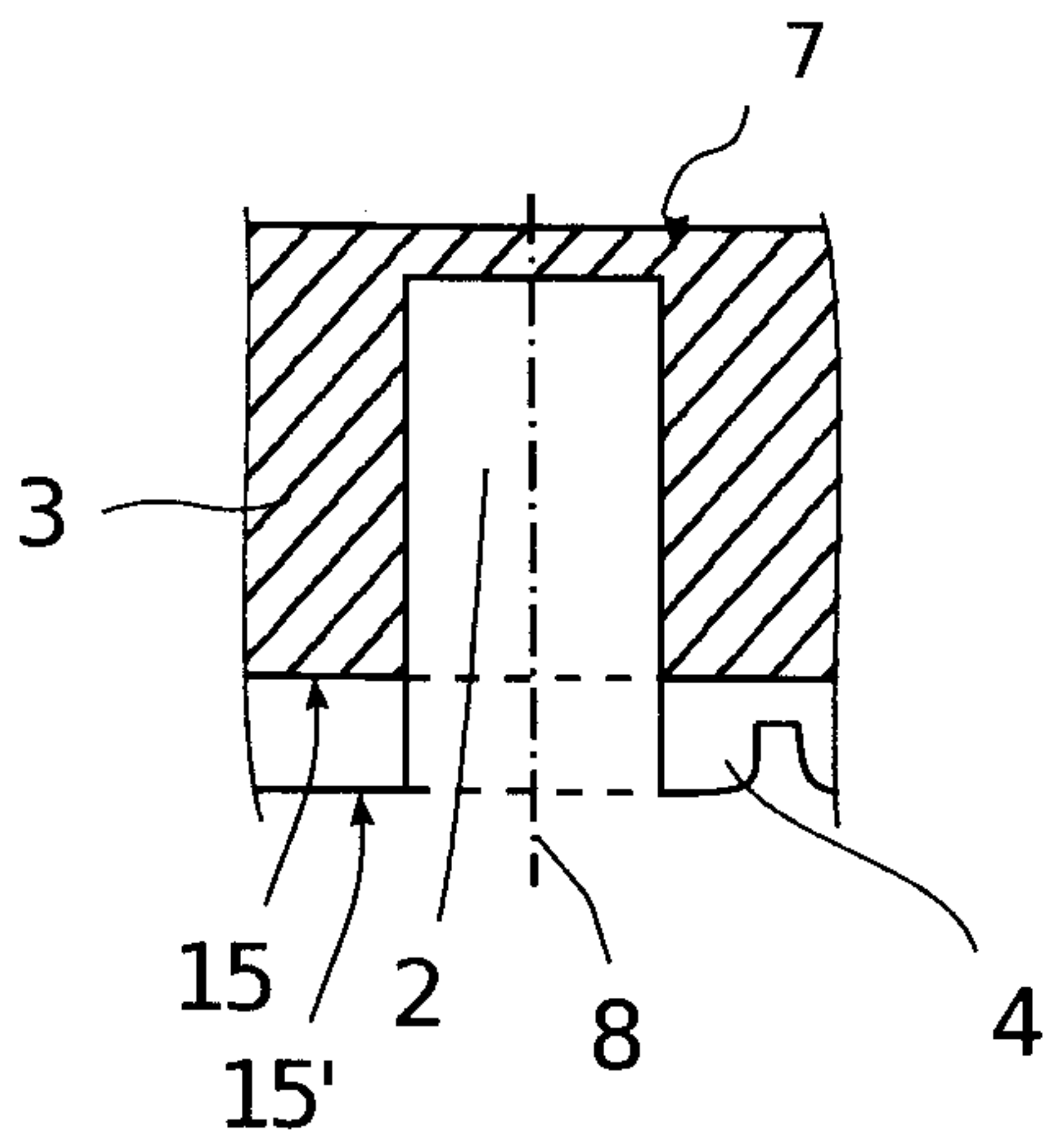


FIG. 5

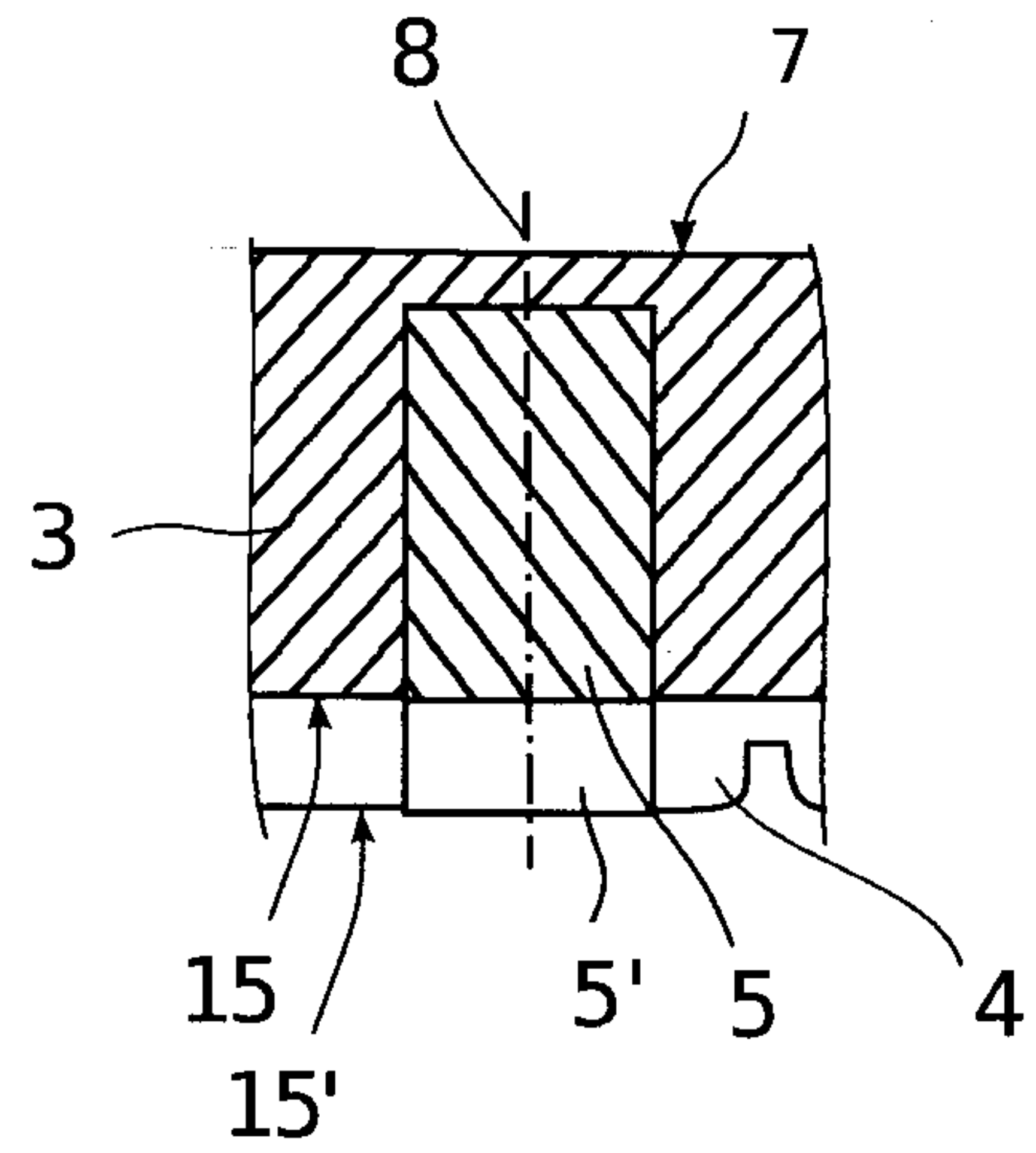


FIG. 6

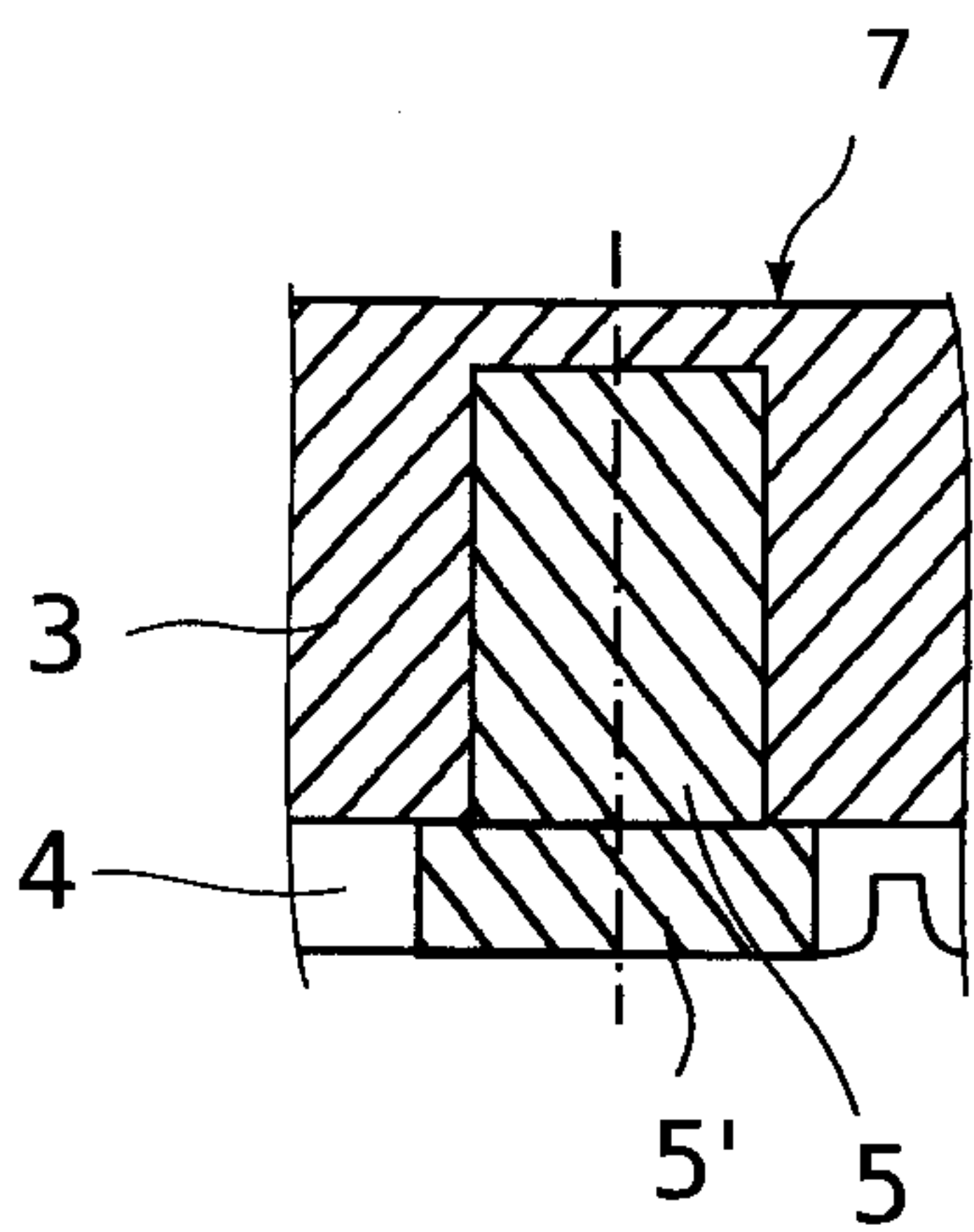


FIG. 7

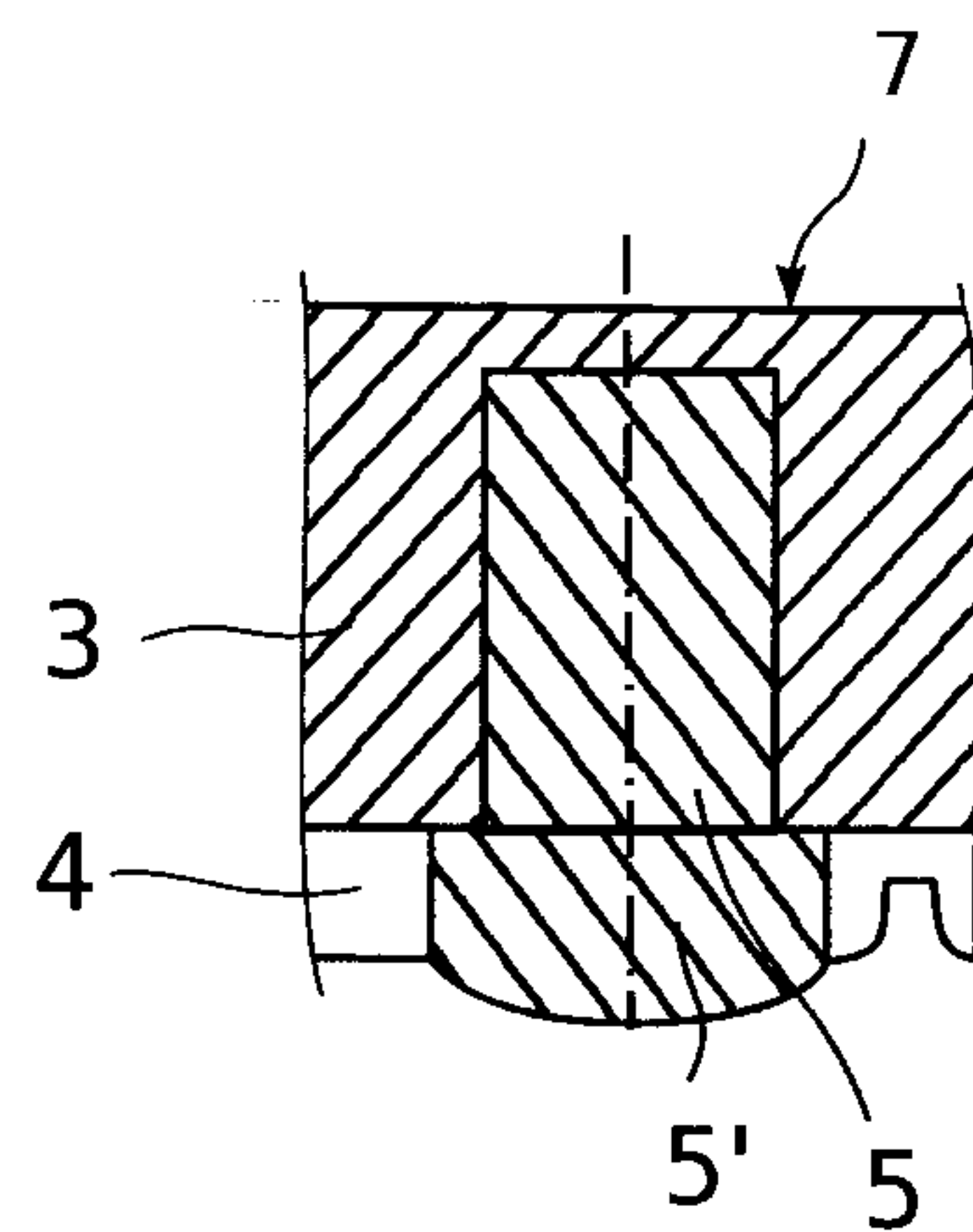


FIG. 8

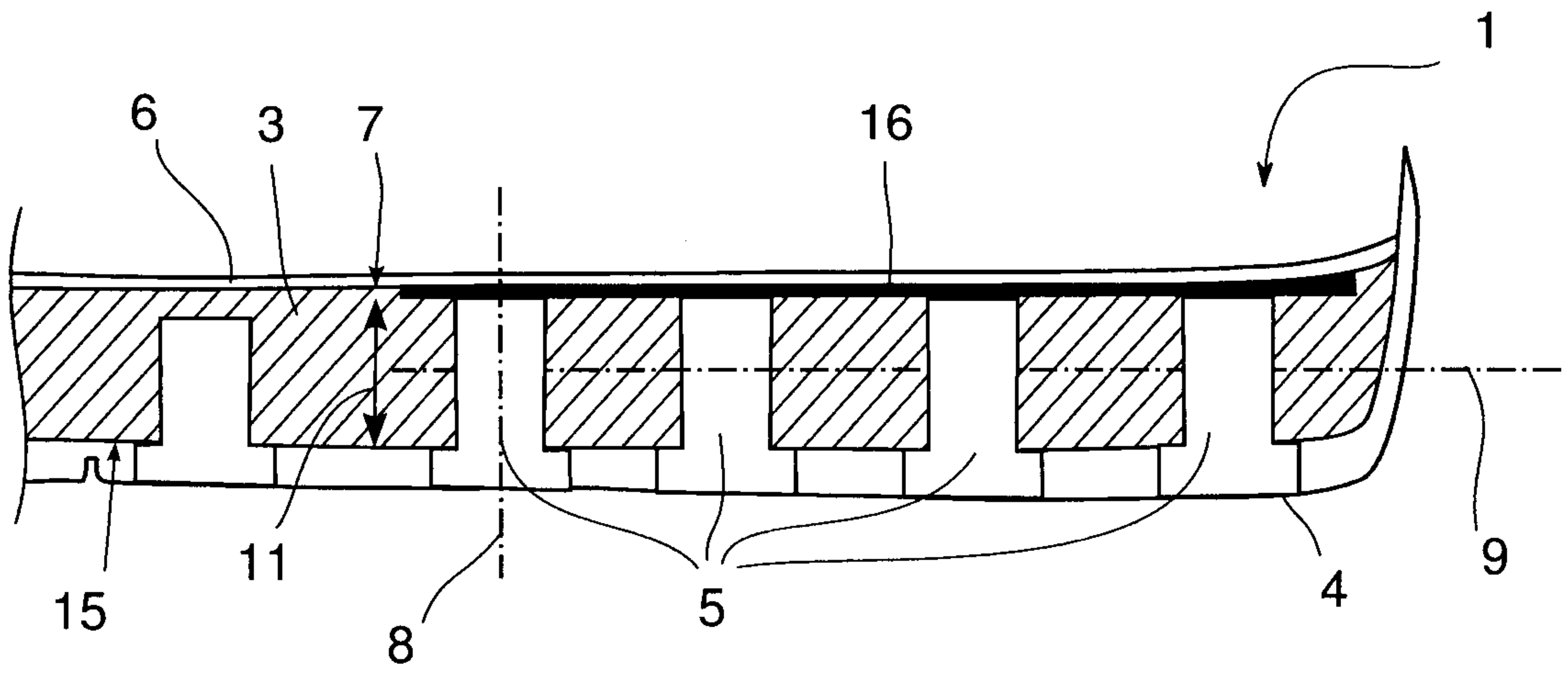


FIG. 9

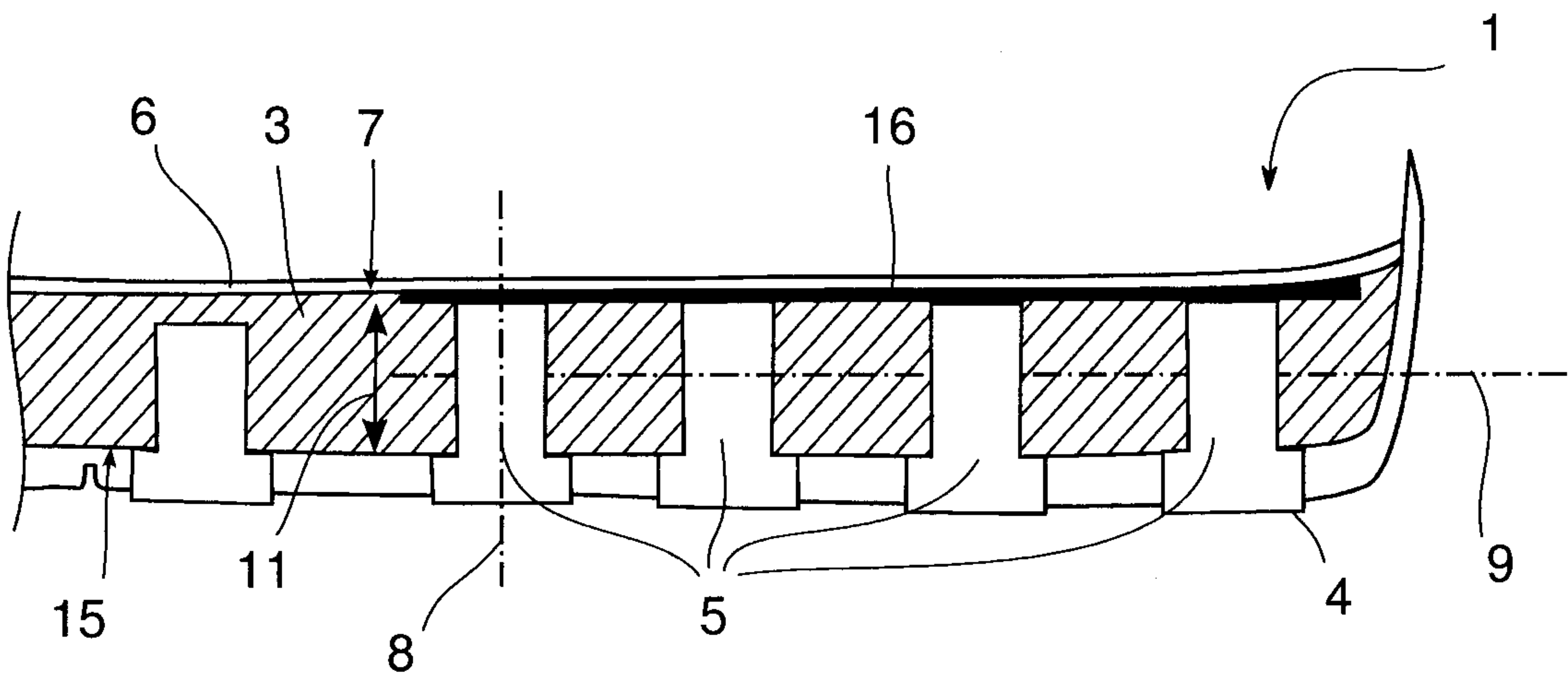


FIG. 10

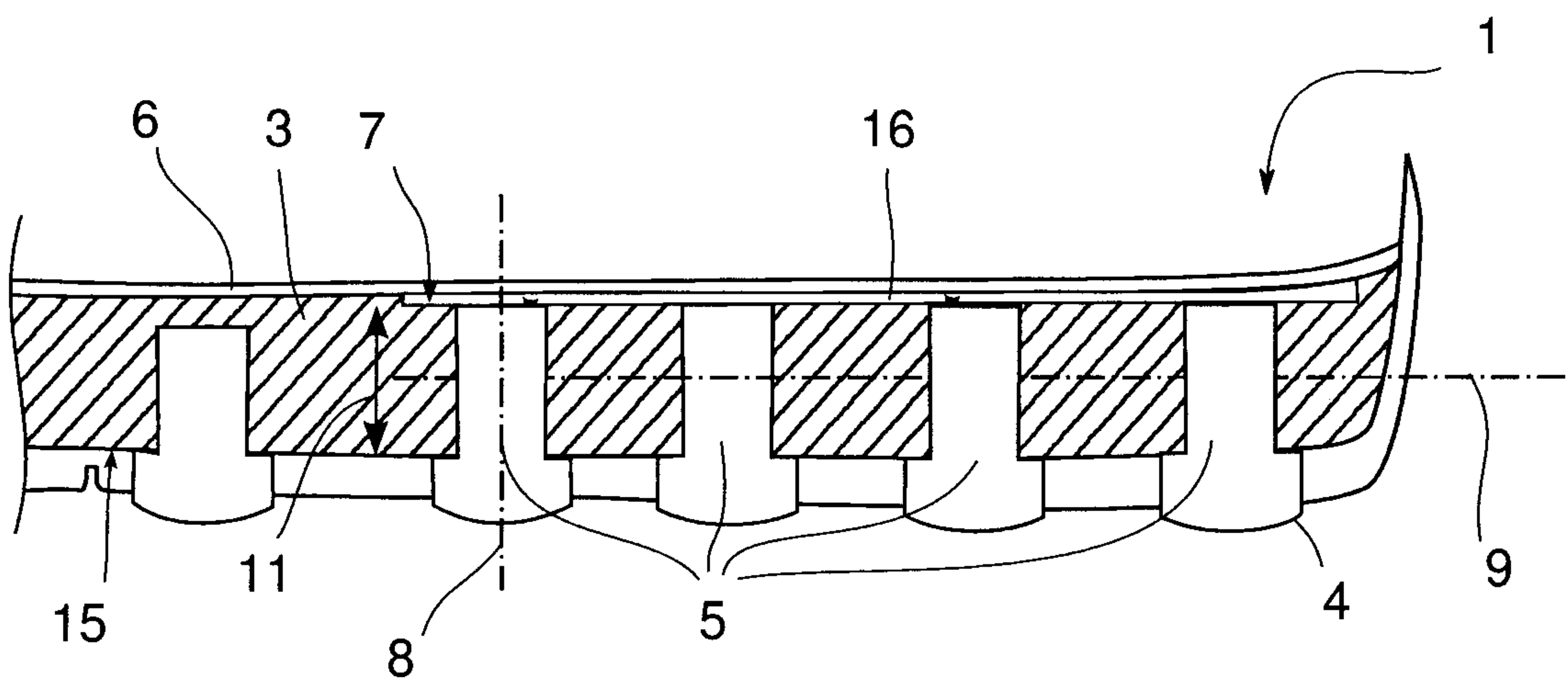


FIG. 11

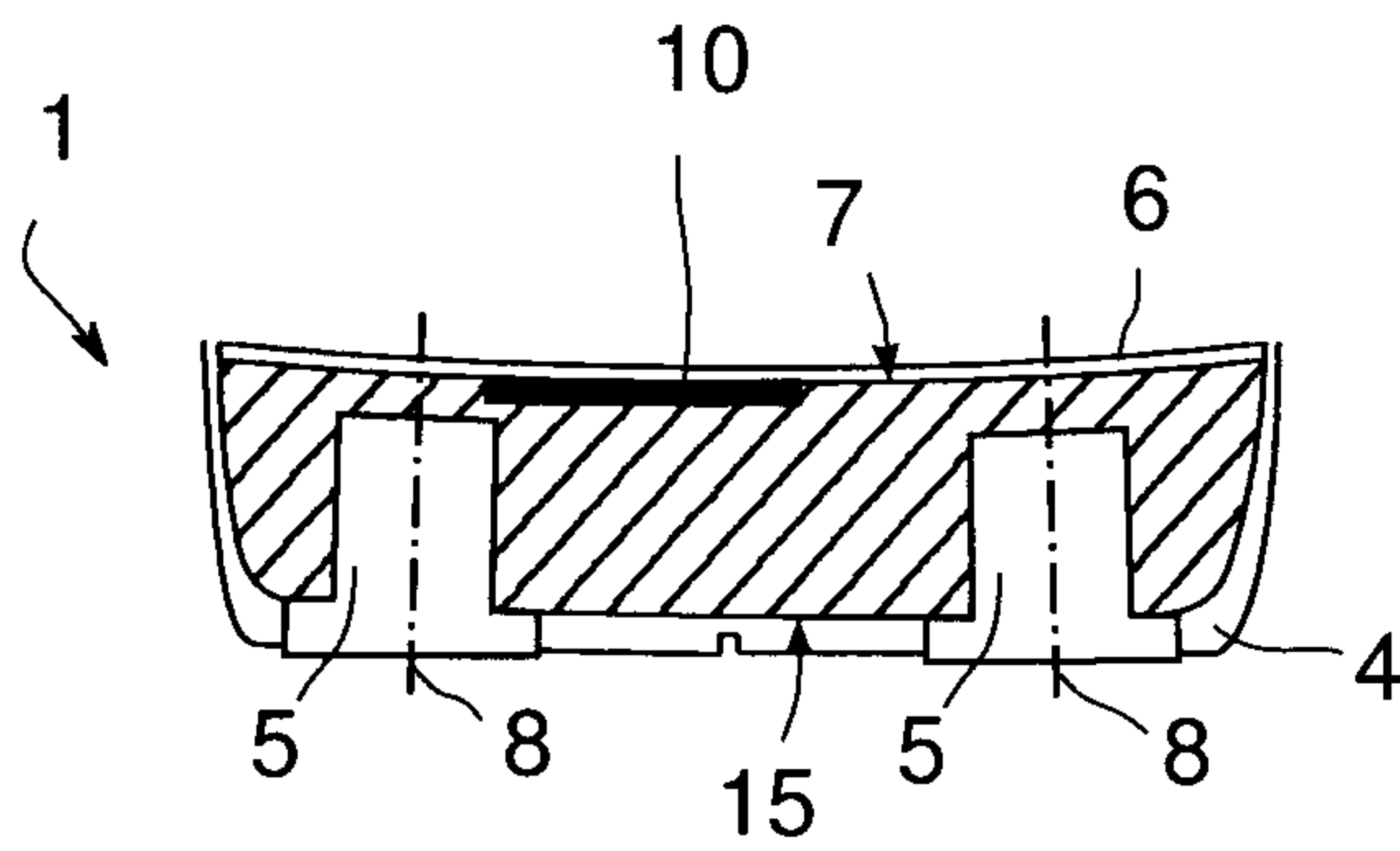


FIG. 12

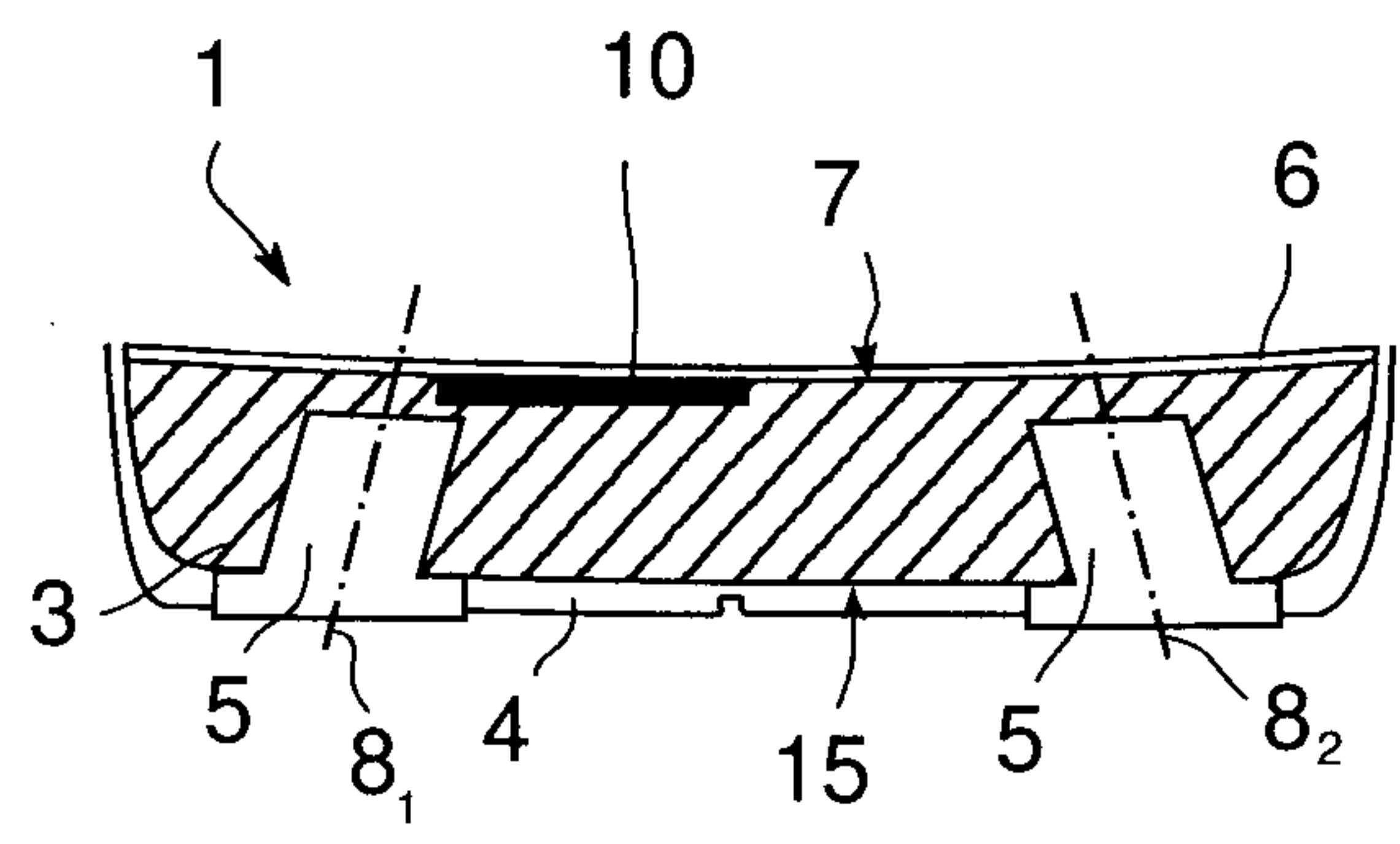


FIG. 13

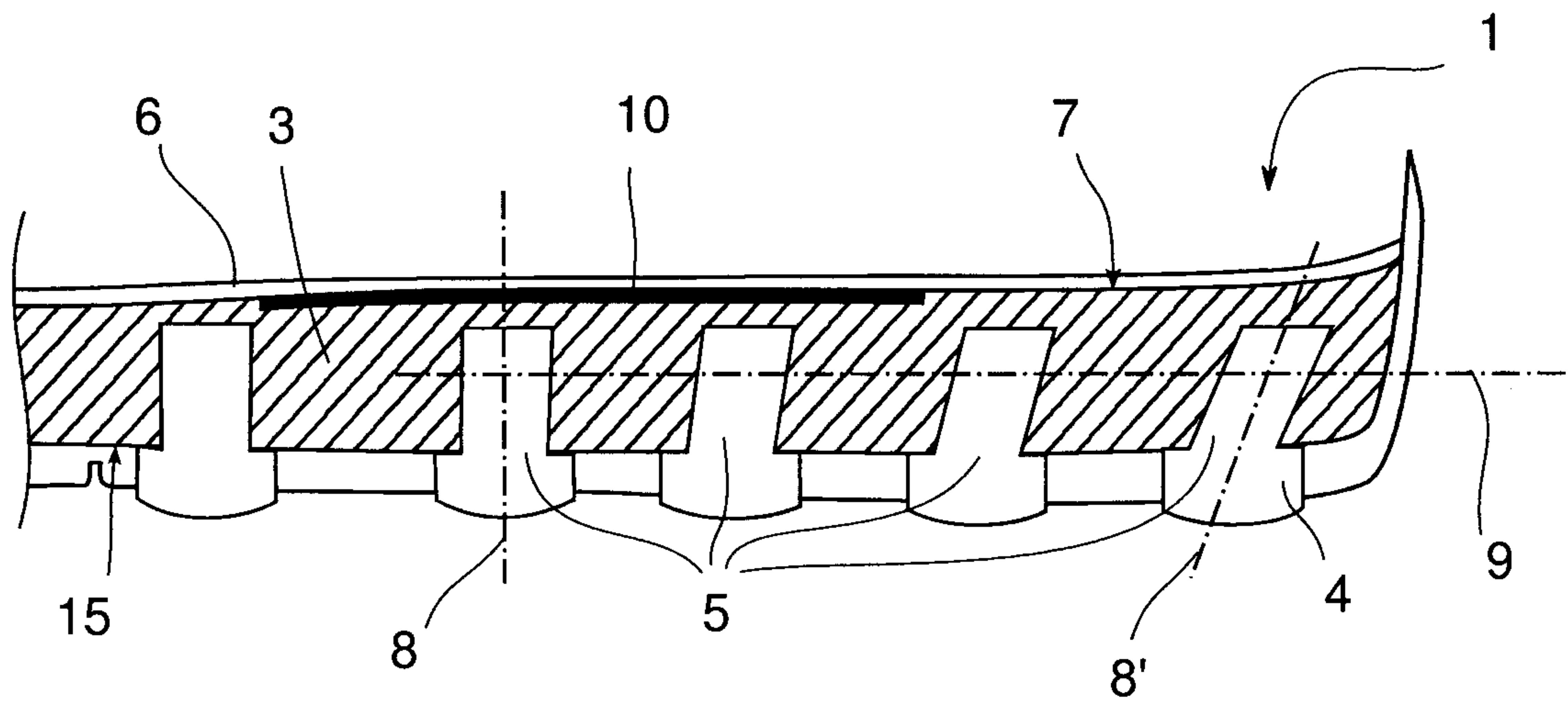


FIG. 14

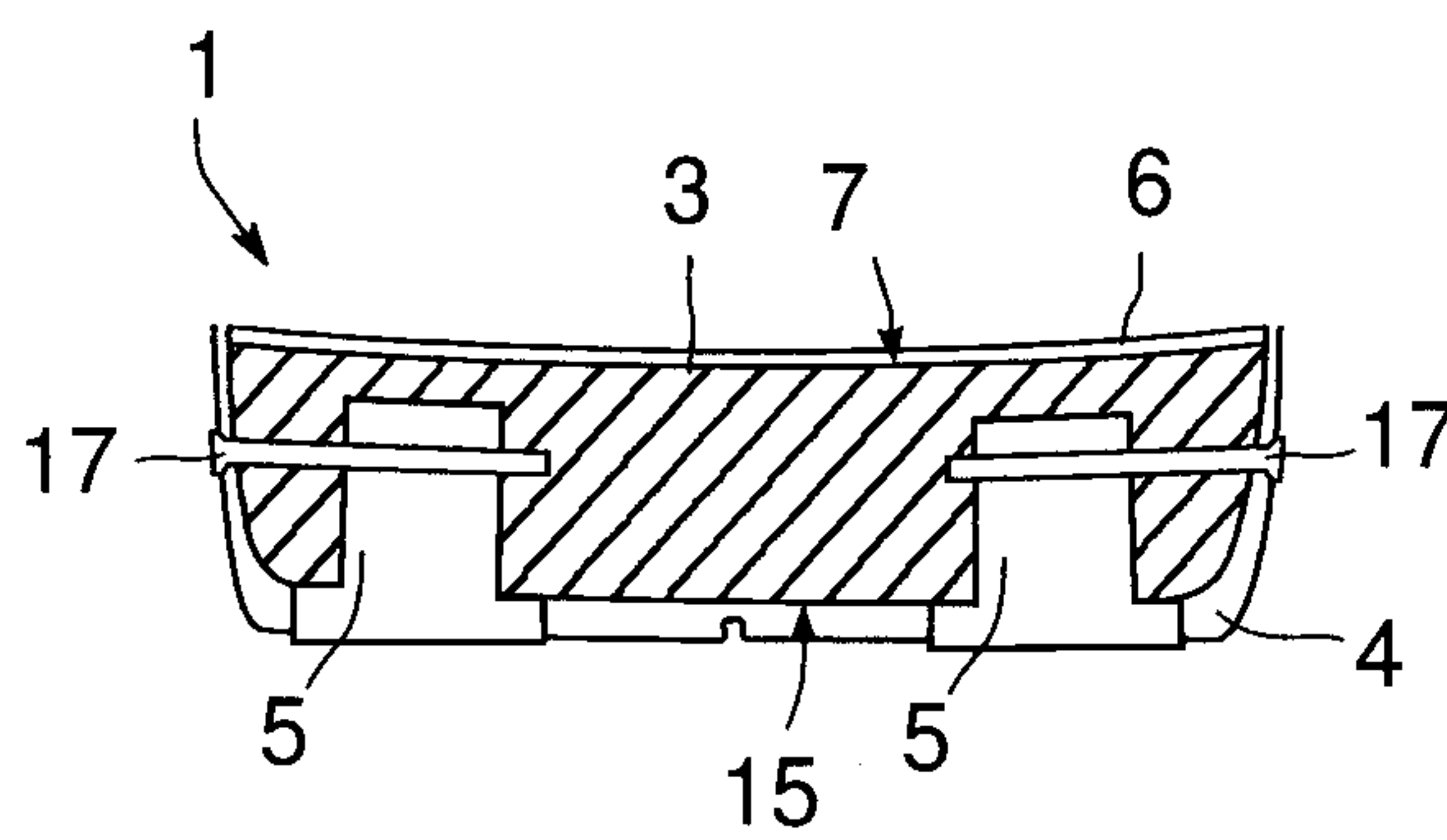


FIG. 15

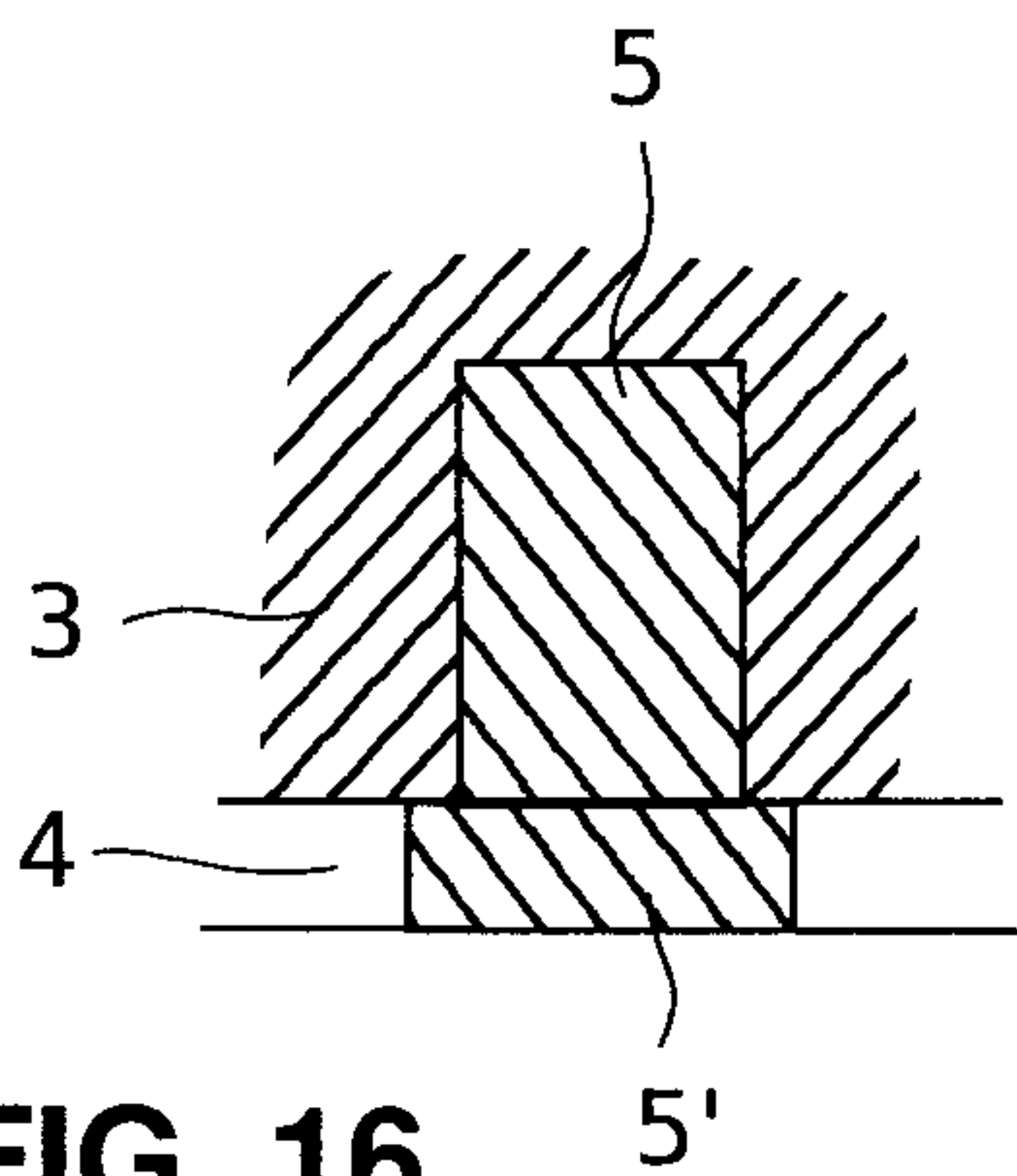


FIG. 16

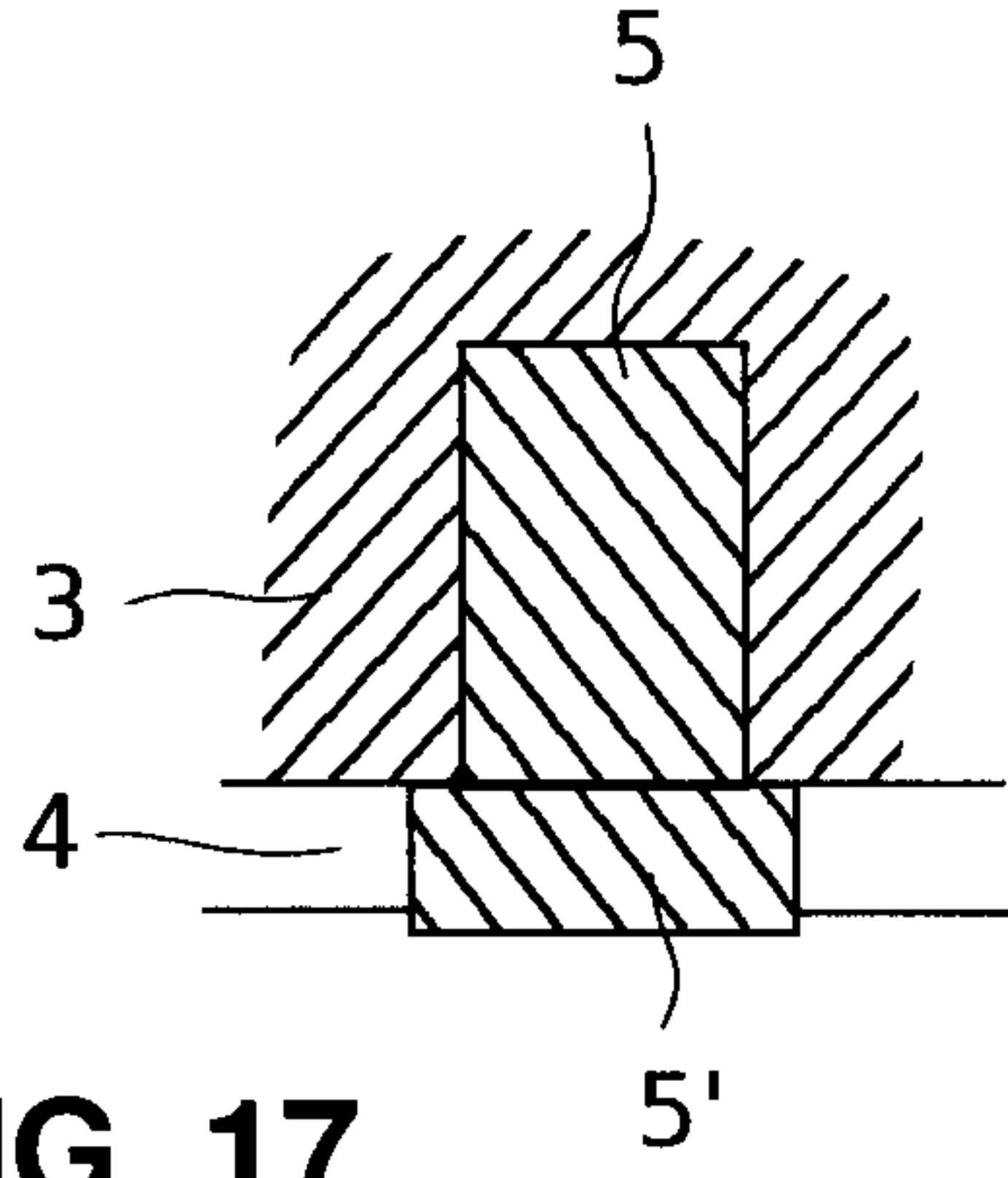


FIG. 17

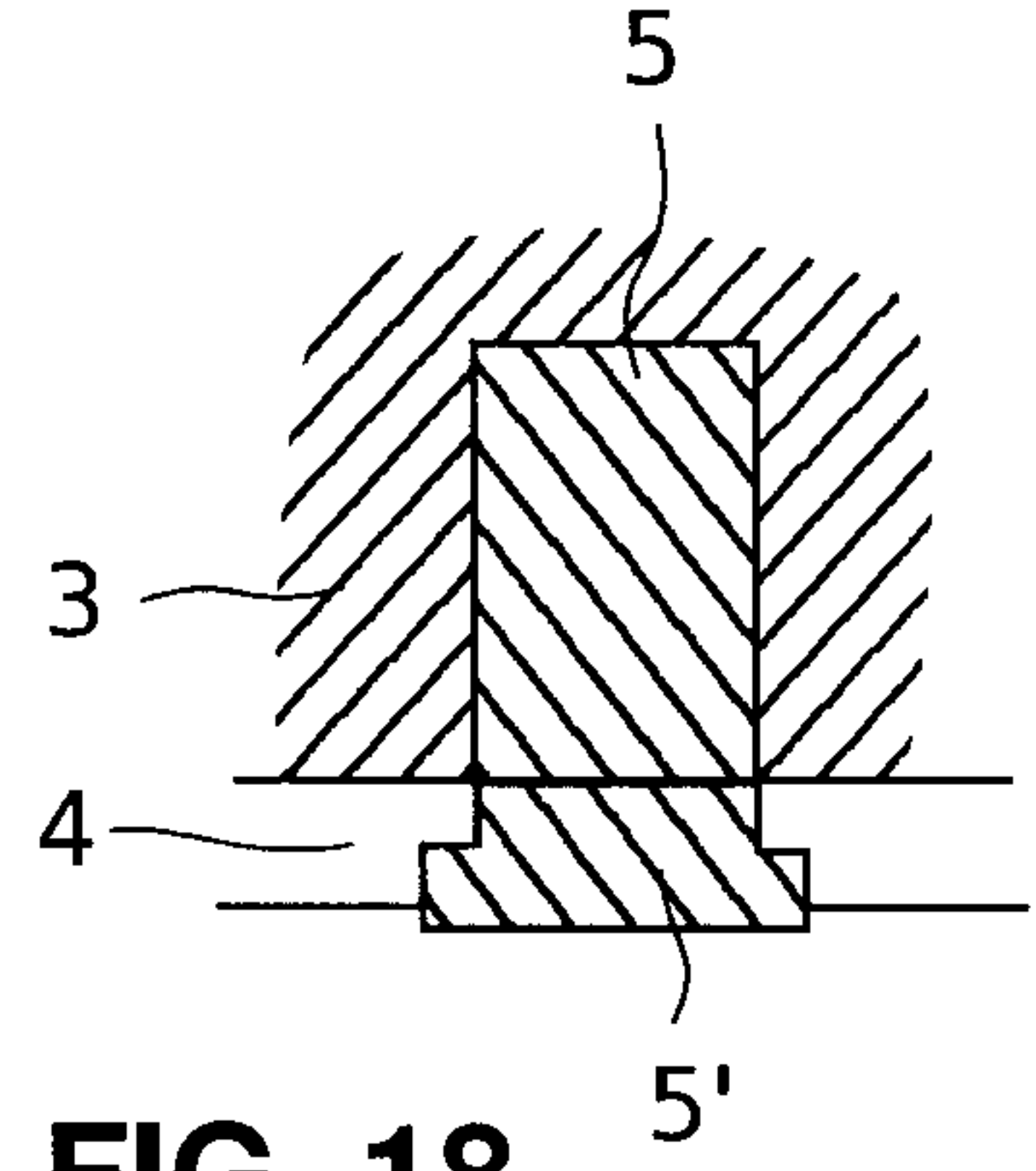


FIG. 18

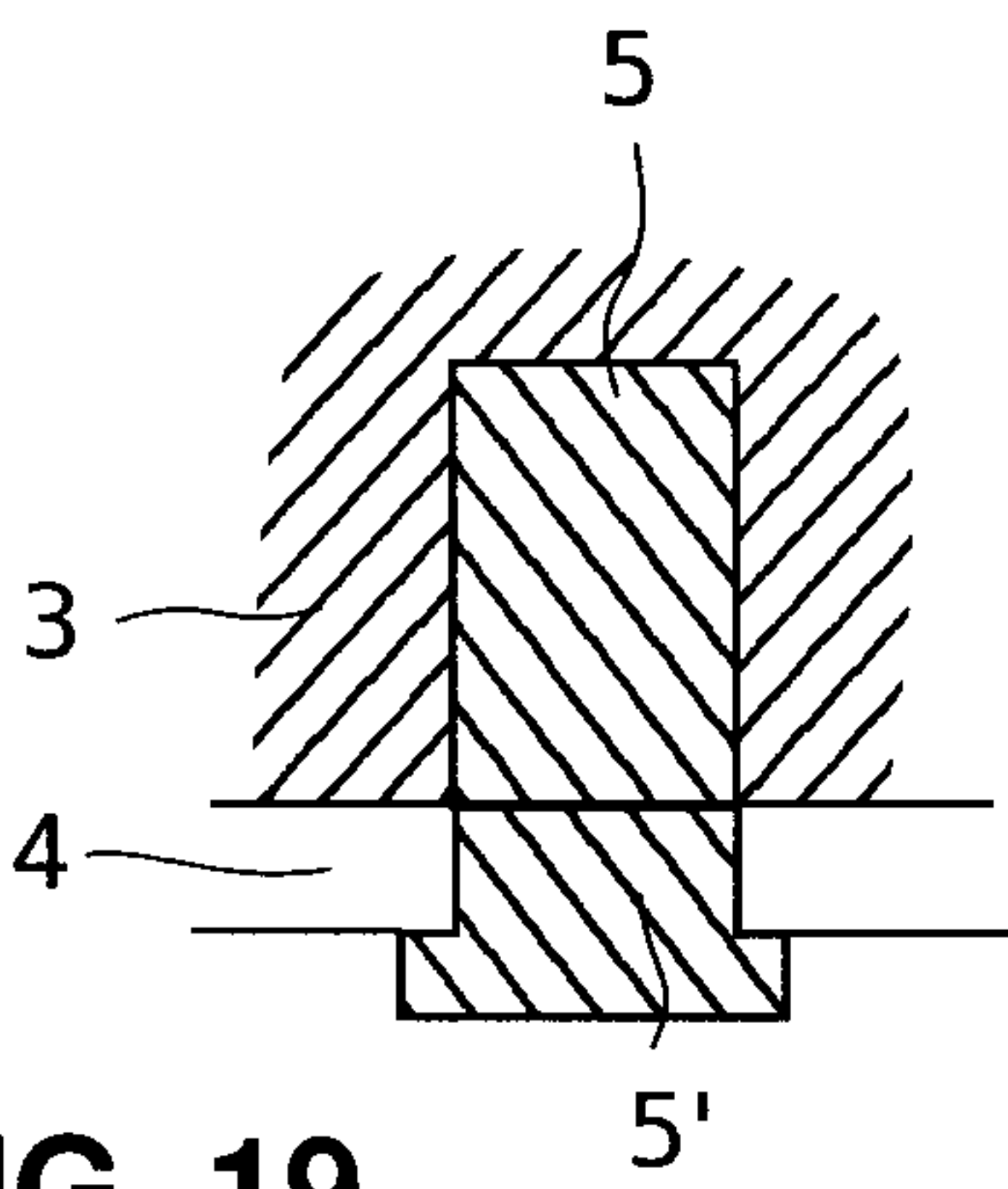


FIG. 19

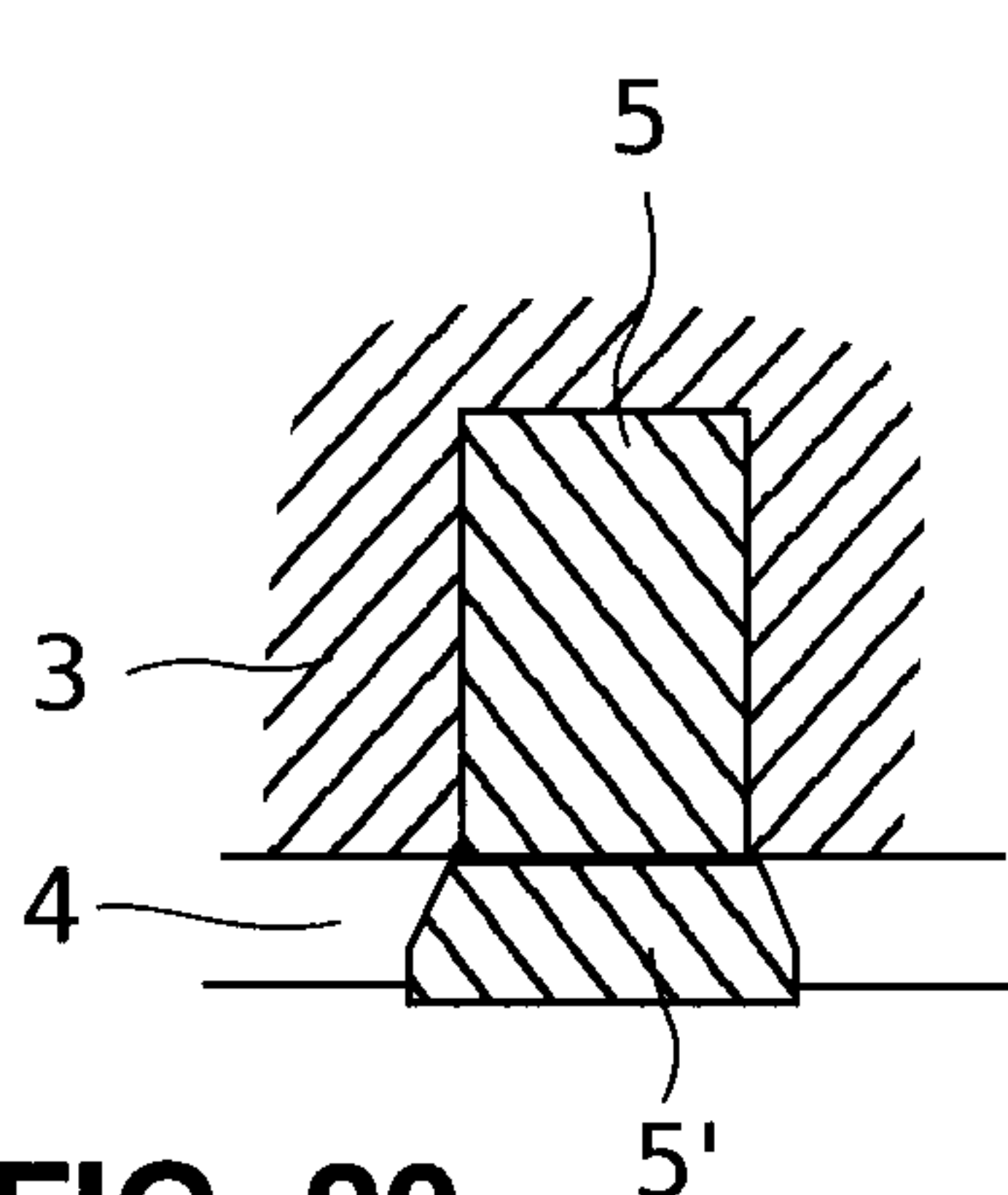


FIG. 20

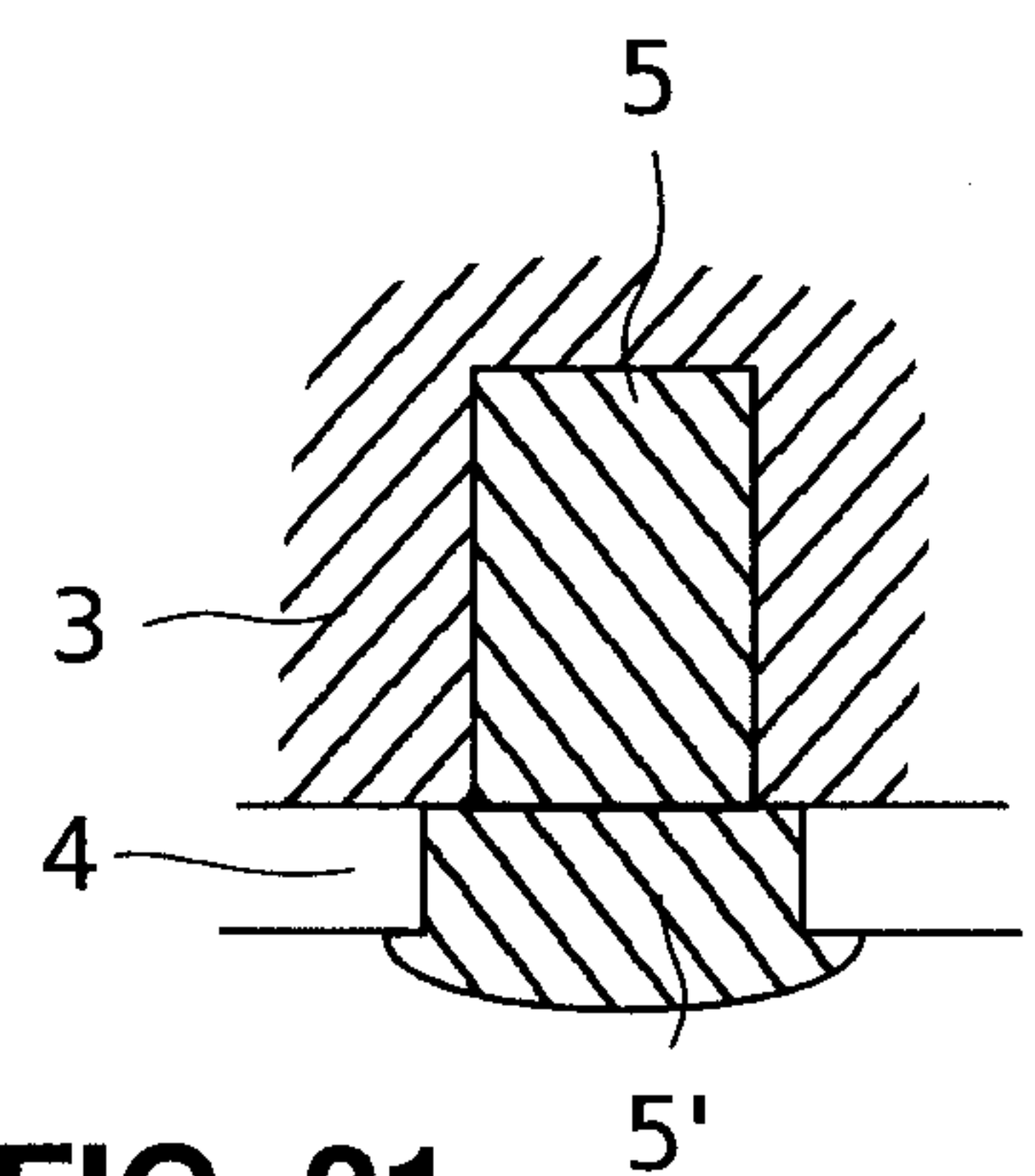


FIG. 21

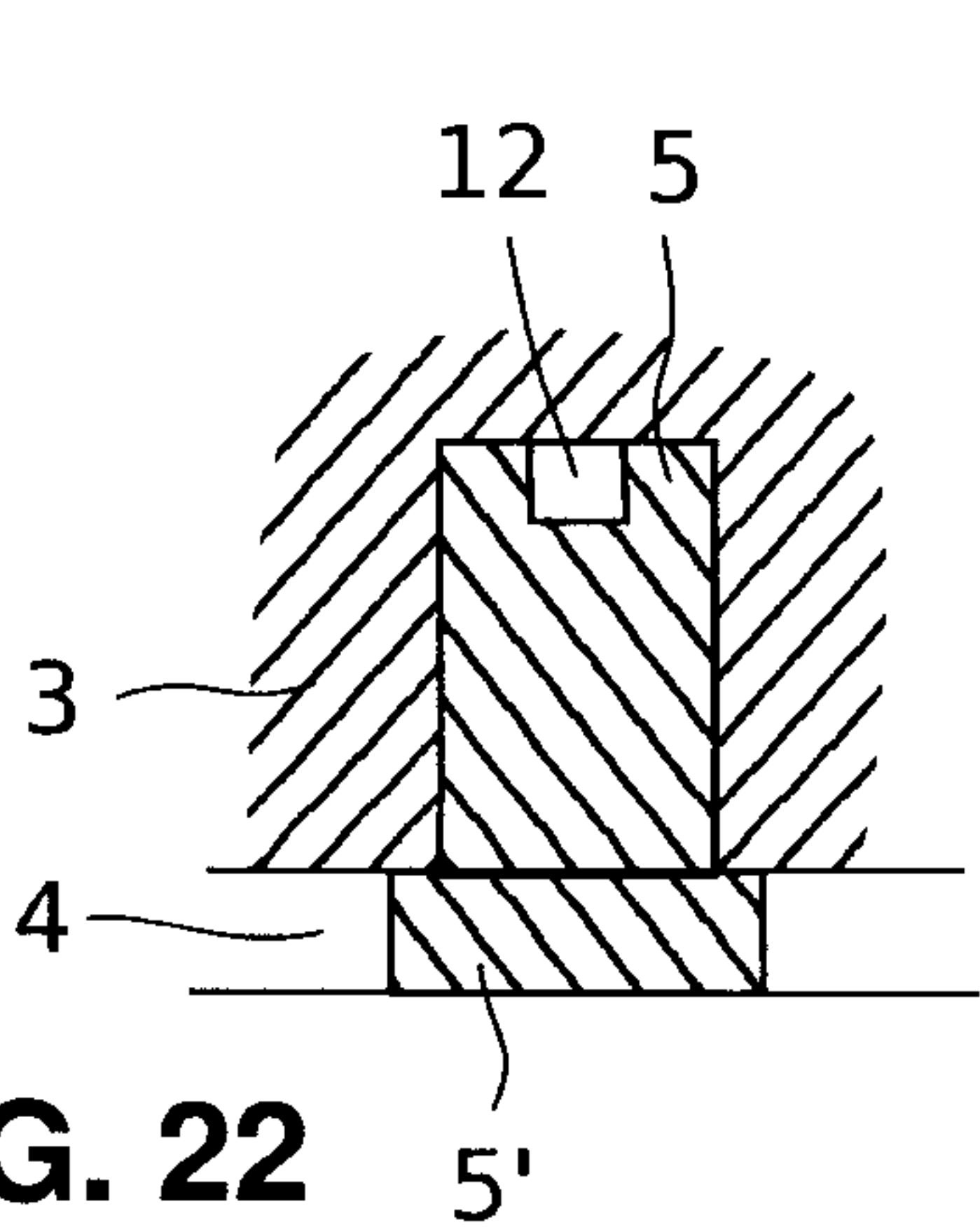


FIG. 22

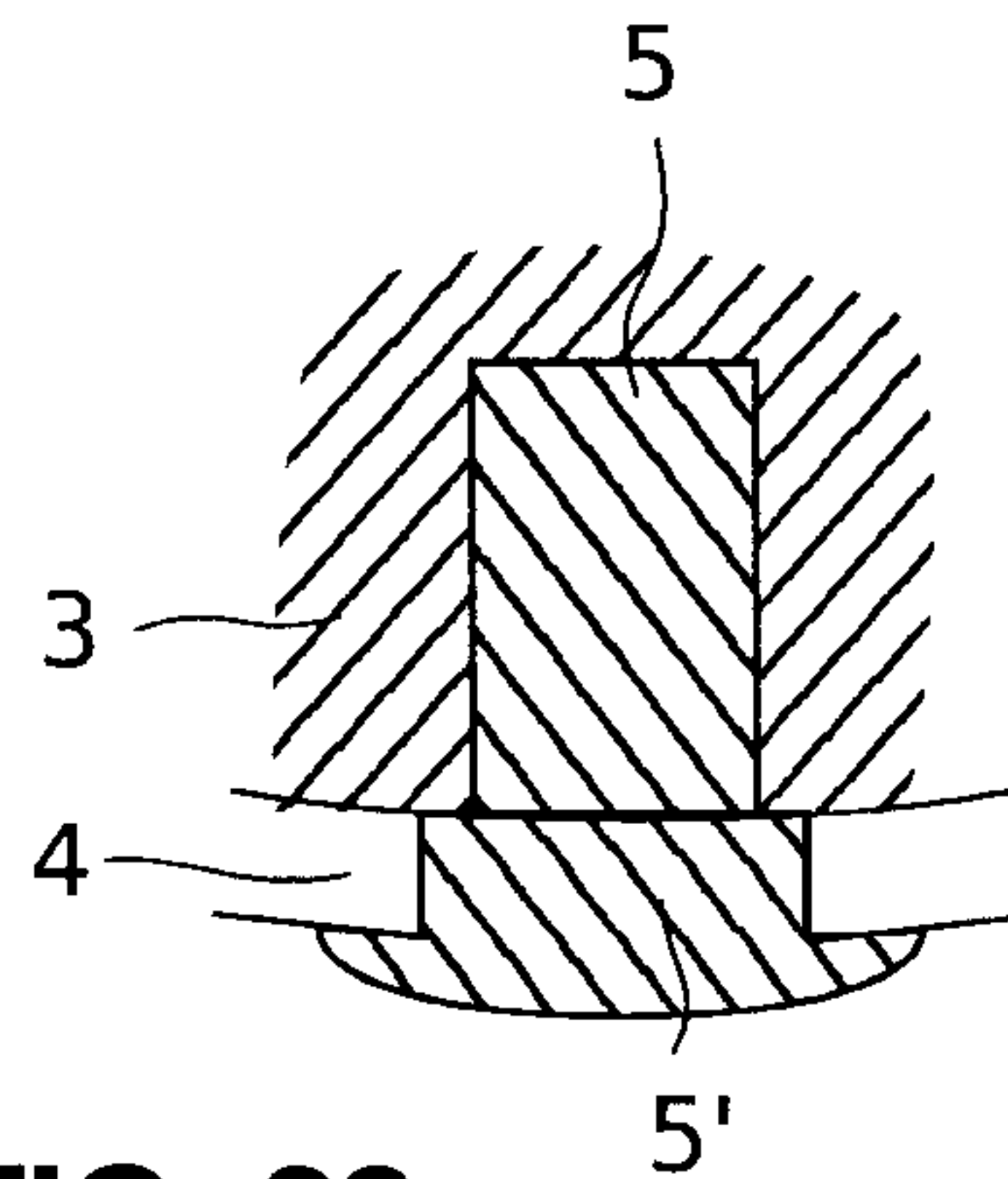


FIG. 23

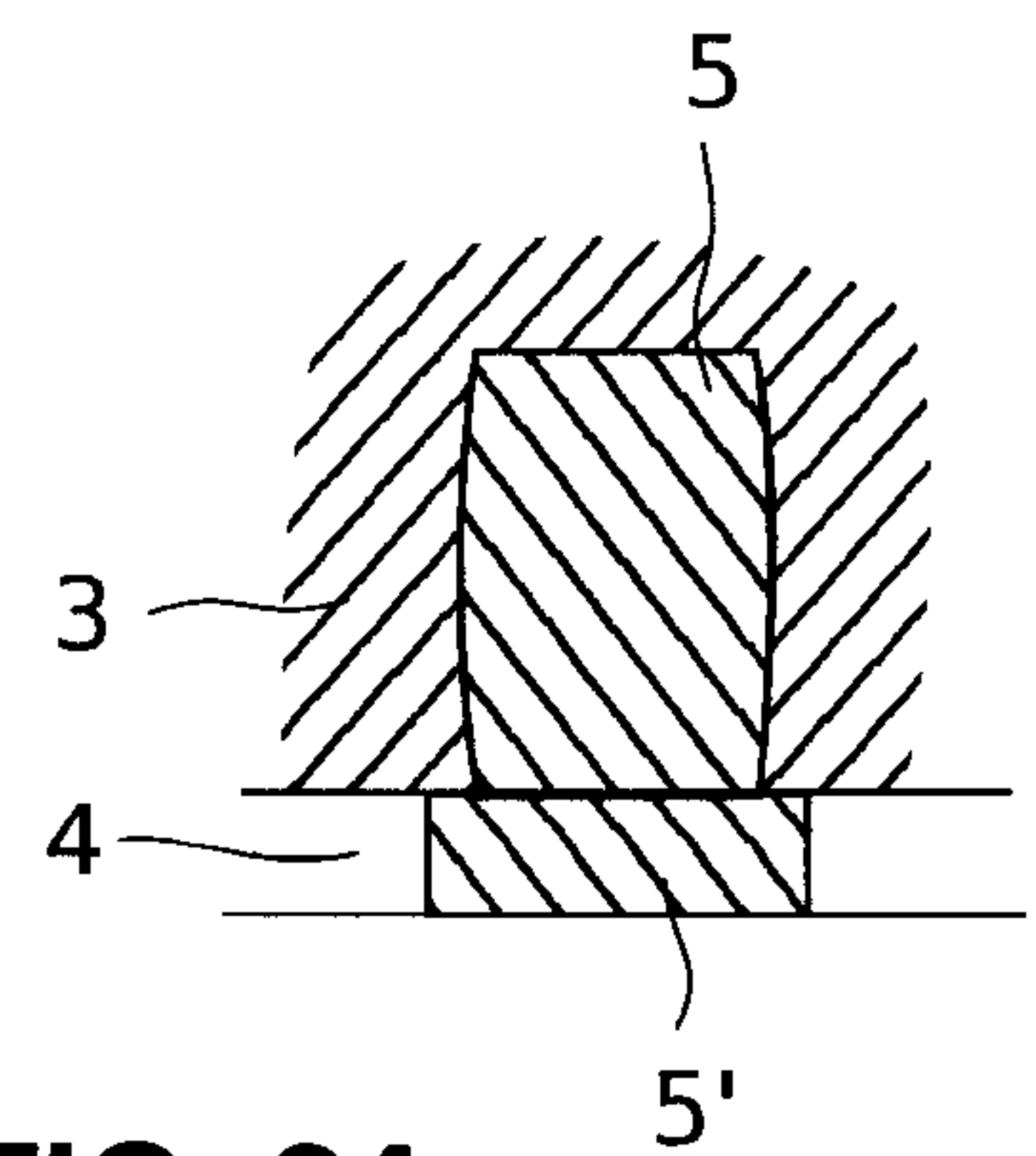


FIG. 24

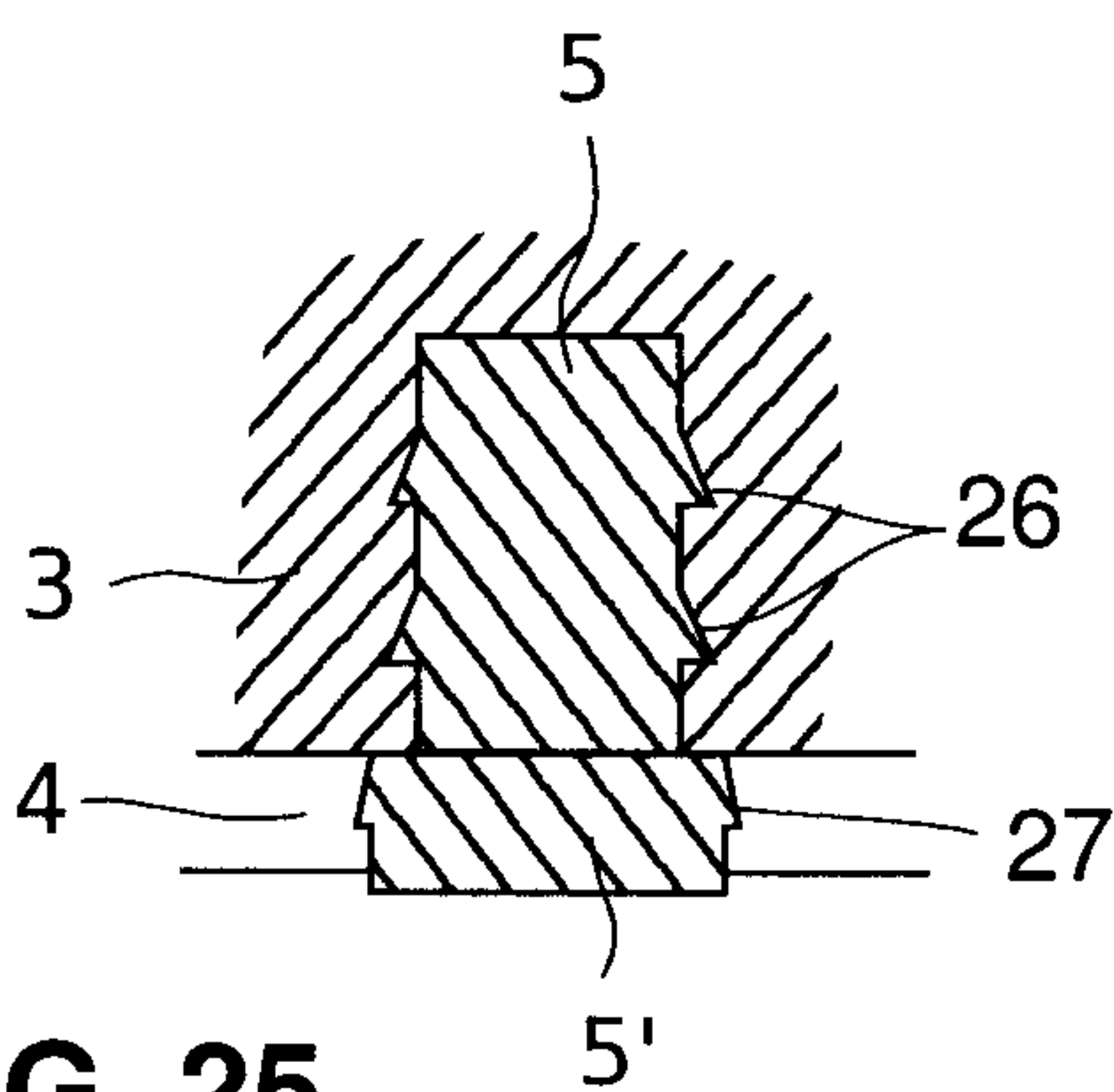


FIG. 25

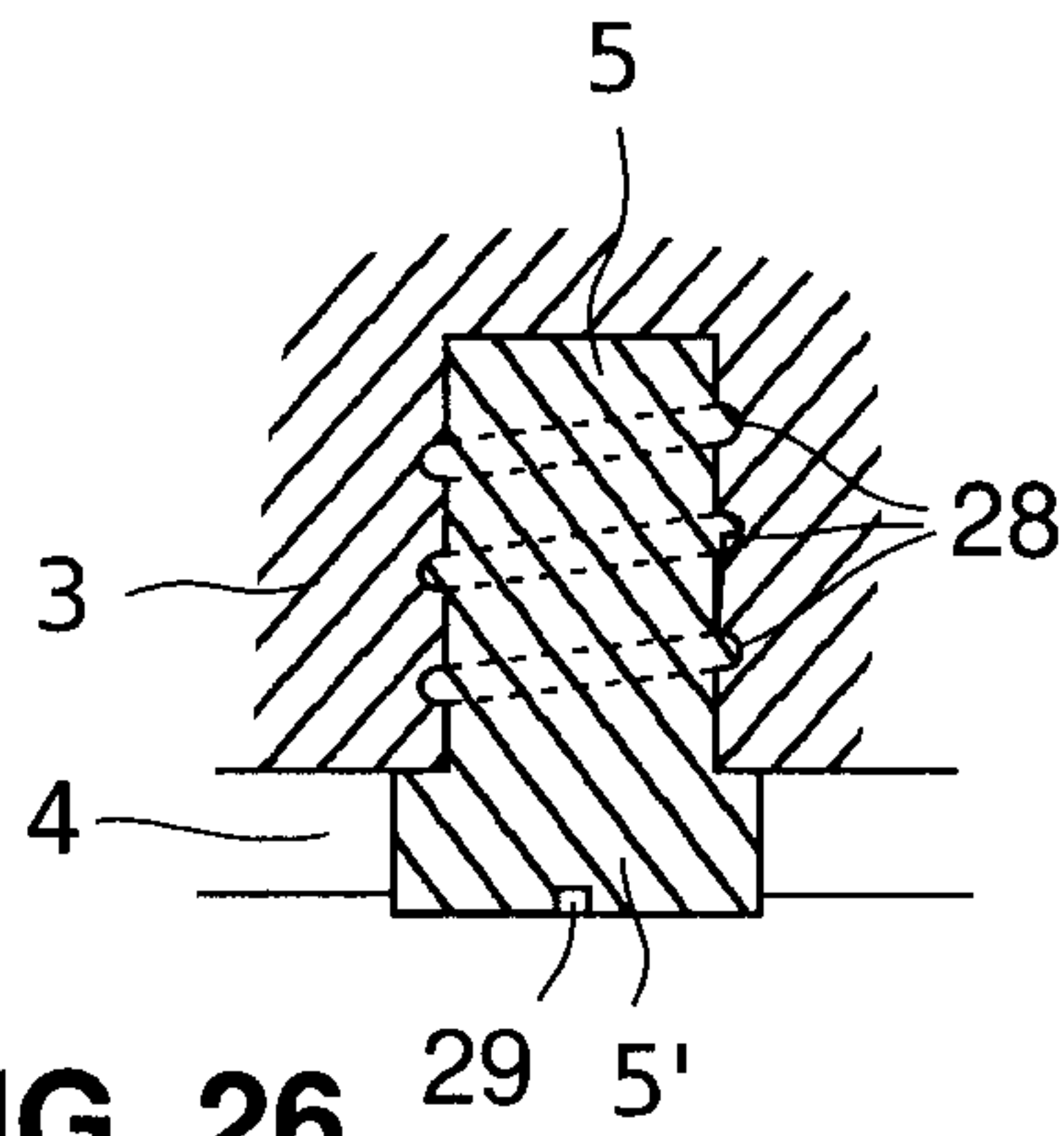


FIG. 26

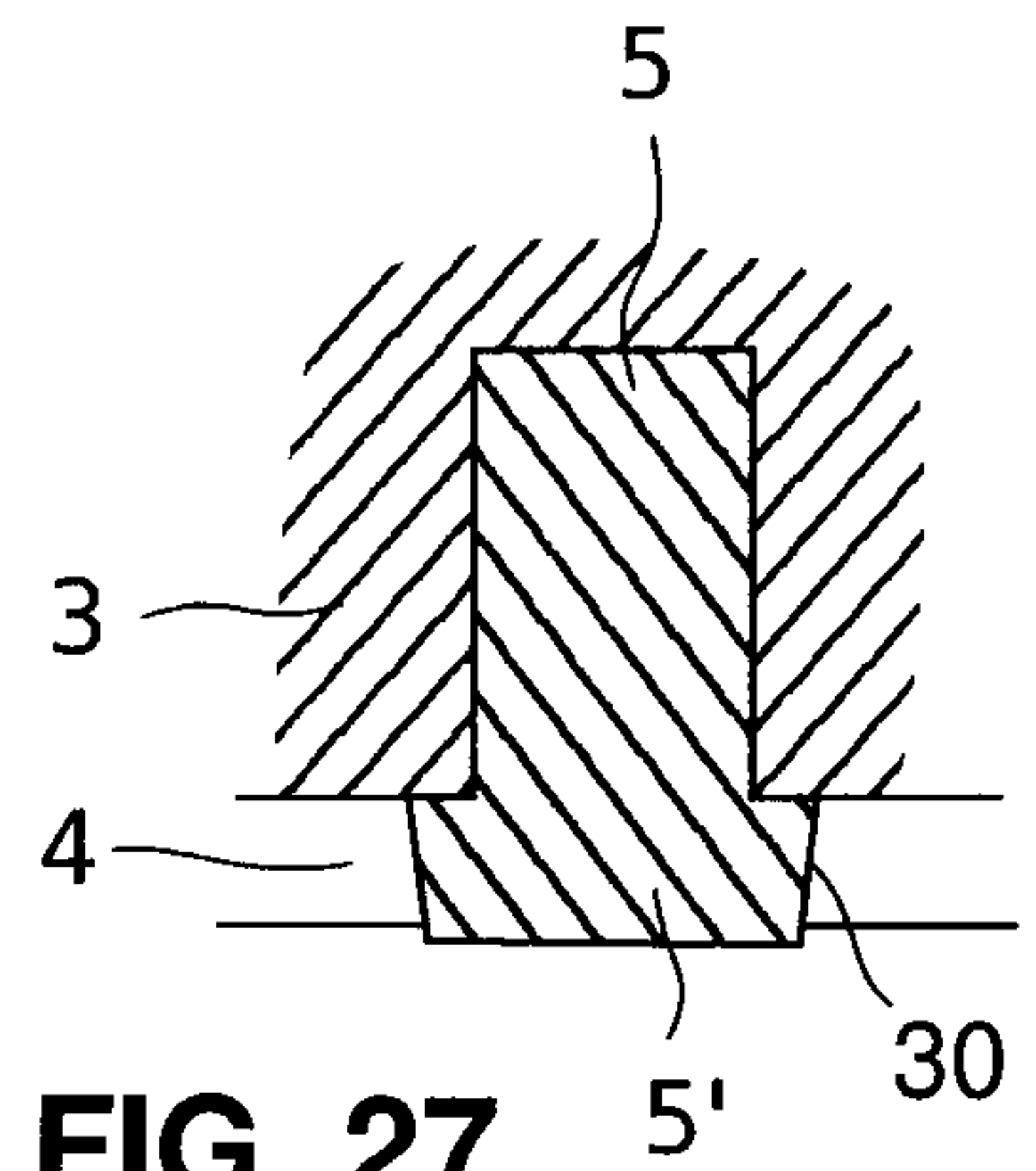


FIG. 27

