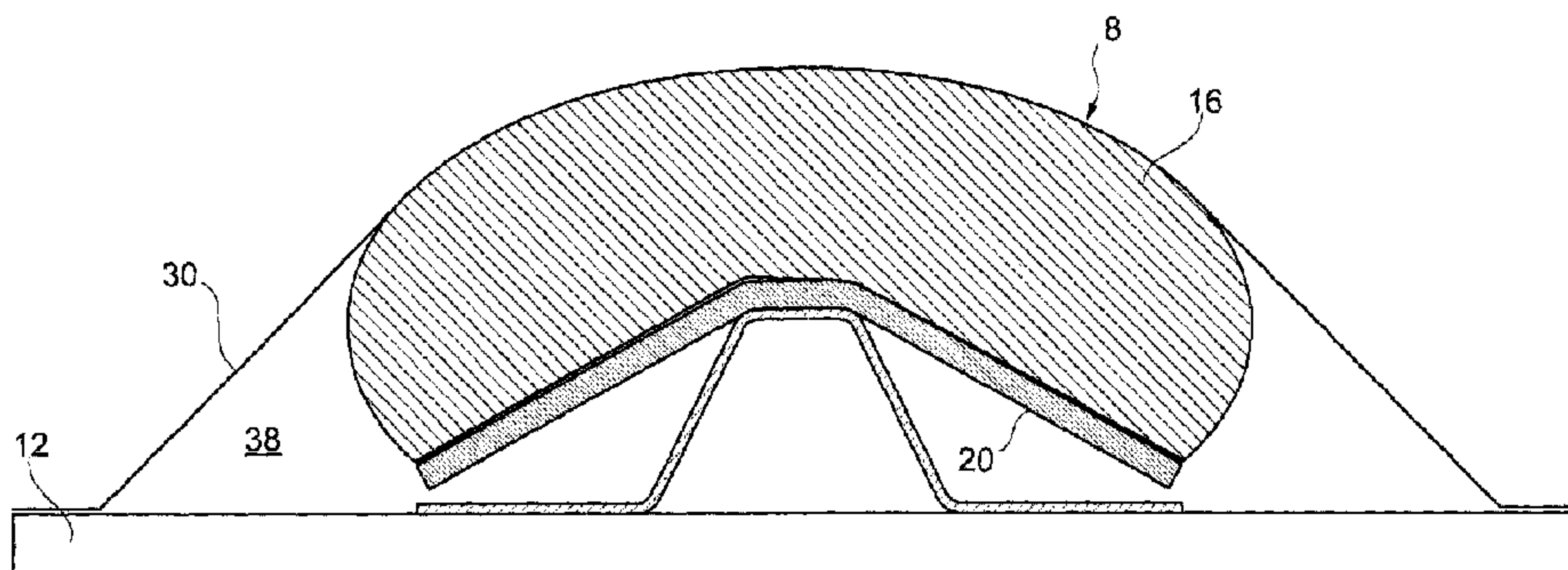




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(54) Titre : **FACONNAGE D'UNE PIECE PROFILEE EN PREIMPREGNE**
(54) Title: **SHAPING DURING THE MANUFACTURE OF A PROFILED COMPONENT**



(57) **Abrégé/Abstract:**

The present application relates to shaping for producing a profiled component. In order to provide a simplified manufacturing of a profiled component having an improved component quality, a shaping device (10) for producing a profiled component is provided, which includes a lay-on unit (12), a press-on unit (14) and a pressure application unit (16). The lay-on unit has a support surface (18) for laying on a semi-finished product (20) to be shaped. The press-on unit is provided for pressing a semi-finished product to be shaped onto the support surface. The pressure application unit has, at least on the side that faces the semi-finished product, a bendable shell (22) for lying on the semi-finished product in an unshaped first state and for lying thereon in a shaped second state, as well as a pressure-transmitting and deformable filling (24). The pressure application unit can be arranged between the press-on unit and a semi-finished product to be shaped. For example, the semi-finished product to be shaped may be a fibre-reinforced composite material (60). As a press-on unit, inter alia a vacuum membrane (30) is proposed.

Abstract

The present application relates to shaping for producing a profiled component. In order to provide a simplified manufacturing of a profiled component having an improved component quality, a shaping device (10) for producing a profiled component is provided, which includes a lay-on unit (12), a press-on unit (14) and a pressure application unit (16). The lay-on unit has a support surface (18) for laying on a semi-finished product (20) to be shaped. The press-on unit is provided for pressing a semi-finished product to be shaped onto the support surface. The pressure application unit has, at least on the side that faces the semi-finished product, a bendable shell (22) for lying on the semi-finished product in an unshaped first state and for lying thereon in a shaped second state, as well as a pressure-transmitting and deformable filling (24). The pressure application unit can be arranged between the press-on unit and a semi-finished product to be shaped. For example, the semi-finished product to be shaped may be a fibre-reinforced composite material (60). As a press-on unit, inter alia a vacuum membrane (30) is proposed.

[Fig. 8]

SHAPING DURING THE MANUFACTURE OF A PROFILED COMPONENT

The present invention relates to a shaping apparatus for manufacturing a profiled component and a method for producing
5 a profiled component.

Profiled components are used for example in vehicle structures, e.g. in load-dissipating structures. Profiled components are used for example as curved structural components in the hull construction of an aircraft, for
10 example an aeroplane, for example as a stringer or a rib. The profiled components are produced for example from a flat semi-finished product by a corresponding shaping process. In line with efforts towards achieving reduced fuel consumption and the concomitant strive towards minimising weight,
15 profiled components are made for example from a fibre-reinforced composite material. To this end, for example fibrous structures, together with a matrix material, are laid onto a template having the corresponding profile and are subsequently cured into the finished profiled component using
20 compression and heating steps. In order to apply the pressure required therefor, for example vacuum films are used which extend over the laid-out semi-finished product in the form of the fibre layers, which may for example be impregnated with a matrix material, so that as a result of the application of a
25 vacuum in the region between a base plate and the vacuum film, a corresponding pressure can be applied onto the semi-finished product. In the course of this, the semi-finished product is made to lie against the underlying template. Apart from laying out individual fibre layers into the given
30 template, also mats prepared as so-called prepregs are used, which are made up from a plurality of layers of fibre mats and a binder or matrix material applied thereto, so that the

mat laid out on the template will initially only approximately adapt to the template and will not lie exactly against it. The exact laying-on process, which to a certain extent is a reshaping, is then carried out using a vacuum
5 film. Therefore, also the term diaphragm shaping is used for this method. When manufacturing profiled components, it is also known to assemble individual profiled segments into a profiled component. For example, flat profiled regions may be combined with a so-called omega profile in order to form a
10 type of hollow profile. The connection is then carried out by bonding, e.g. under the effect of heat and pressure. From EP 2 253 460 A2, for example a connection system for composite and metal components is known, wherein the regions to be connected are pressed against each other by pressure
15 chambers, wherein the pressure chambers are equipped with a stretchable and elastically deformable membrane, so that in the pressure chamber, a pressure may be applied via a fluid so as to act uniformly onto the surfaces to be joined. The surfaces to be joined are preformed, so that the elastic
20 membrane ensures a uniform pressing on. The pressure chambers are accommodated in housing structures which have an elastically deformable membrane only in the region of the joint to be pressed together. However, in order to join a plurality of profile regions, the method known from EP 2 253
25 460 A2 requires the prefabrication of the individual already finish-profiled profile elements. However, it has been shown that the handling of fibre mats, for example prepregs, and the required placing into a template structure is complex and therefore cost-intensive. Moreover, the pressing on of a
30 semi-finished product by way of diaphragm shaping is insufficient in the case of tight internal radii, because in

these regions, only insufficient pressure can be applied by means of the vacuum film.

It is therefore an object of the present invention to provide a simplified way of manufacturing a profiled
5 component having an improved component quality.

This object is achieved by means of a shaping device and a method for producing a profiled component as claimed in any one of the independent claims. Embodiment examples are shown in the dependent claims.

10 According to a first aspect of the invention, a shaping apparatus for manufacturing a profiled component is provided, wherein the shaping apparatus includes a lay-on unit, a press-on unit and a pressure application unit. The lay-on unit includes a support surface for laying on a semi-finished
15 product to be shaped. The press-on unit is provided for pressing a semi-finished product to be shaped against the support surface. The pressure application unit has, at least on the side that faces the semi-finished product, a bendable shell for lying against the semi-finished product in an
20 unshaped first state and for lying on in a shaped second state, as well as a pressure-transmitting and deformable filling. The pressure application unit can be disposed between the press-on unit and a semi-finished product to be shaped.

25 The term "profiled" relates for example to an elongated component that is formed with a profiled cross-section. The term "profiled" also relates to an elongated component that is curved in a longitudinal direction. Moreover, "profiled" also relates to a component that is formed with a cross-
30 sectional profile in the transverse direction and that is moreover formed in a curved manner in the longitudinal direction.

The term "shaping" comprises for example the laying of an initially flat semi-finished product, for example of a more or less flat semi-finished product, on a support surface that is provided as a shape-imparting structure.

5 The term "bendable shell" relates to an enveloping material that may be bent or deformed like a film and which can therefore be adapted to various profiles, however which is not stretchable or elastic in its longitudinal direction, i.e. in the direction of the enveloping surface. The bendable
10 shell must in any case be capable of maintaining the enclosed volume, i.e. it must be possible for an applied pressure to be also transmitted.

According to one embodiment example, the semi-finished product to be shaped is a fibre-reinforced composite
15 material.

For example, the fibre-reinforced composite material includes a composite laminate. The term "composite laminate" refers to a material that may include, apart from a fibre-reinforced composite material, also further material layers
20 and/or material inserts, such as e.g. a metal fabric, a metal foil and the like. The shaped semi-finished product will then for example be used, upon passing through further operating steps, as a stringer or a rib on an aircraft. The further operating steps may include for example curing the profiled
25 semi-finished product shaped.

The support surface includes for example concave or recessed regions, e.g. regions with interior edges and/or interior corners.

The support surface forms a template counter-piece for
30 shaping the semi-finished product to be shaped.

The semi-finished product to be shaped is provided e.g. as an inherently stable plate, i.e. as a self-supporting

plate which after having been laid onto the support surface will not, or only to a very minor extent, adapt to the structure of the support surface underneath it.

According to a further embodiment, the pressure
5 application unit is provided all around with a bendable shell.

For example, the pressure application unit forms a bladder filled with a fluid.

According to a further embodiment, the press-on unit is a
10 vacuum membrane, with a vacuum unit for generating a negative pressure being provided in a region between the vacuum membrane and the support surface. The negative pressure can be generated in such a way that air pressure acting from the outside on the vacuum membrane effects a shaping of the semi-
15 finished product by laying, or intimately laying, the semi-finished product onto the support surface.

The vacuum membrane is for example a vacuum film. The vacuum unit is for example a vacuum pump that is in communication with the region between the vacuum membrane and
20 the support surface.

According to a further embodiment, the pressure application unit is integrated into the vacuum membrane.

For example, the vacuum membrane is designed in multiple layers and includes, at least partly, a cavity that is
25 provided with the pressure-transmitting and deformable filling.

According to a further embodiment, the pressure application unit has as a filling at least one member of the group of fluids, liquids, gels and loose bulk solids.

30 For example, the pressure-transmitting and deformable filling includes a fluid medium. According to one example, the liquid is stable under pressure. The filling may e.g. be

a highly viscous filling.

According to a further embodiment, the filling of the pressure application unit may have a dynamic viscosity of at least 100 Pa·s.

5 According to a further embodiment example, the pressure application unit has such a volume that, when the pressure application unit lies on the support surface, all of the recesses of the support surface are filled by the pressure application unit, so that the vacuum membrane forms a convex
10 enveloping surface.

The recesses form for example concave shape regions.

The forming of a convex enveloping surface in a maximally compressed state offers for example the advantage that whilst vacuum is applied, the vacuum membrane is at no point
15 stretched again in relation to the underlying pressure application unit, or is as it were relaxed, as would be the case if the vacuum membrane initially formed a convex enveloping surface and would, during further shaping, form an enveloping surface with concave regions.

20 According to one embodiment example, the pressure application unit includes a replaceable pressure application element.

According to a further embodiment example, the pressure application unit includes a plurality of pressure application
25 elements, which may for example also be designed to be replaceable.

For example, several pressure application elements are provided next to each other, one after the other and/or on top of each other (in the direction of the applied pressure).

30 It is also possible to combine a number of pressure application elements to form one pressure application unit.

For example, a pressure application unit, or a pressure

application element, may also be designed with a plurality of chambers, e.g. by means of inserted partitions, which at least reduce, or even completely stop, the flow or movement of the filling from one chamber to the next.

5 According to a further embodiment it is provided that the pressure application unit can be tempered and that the pressure application unit can be used to supply thermal energy to a semi-finished product to be shaped, and/or can also be discharged therefrom.

10 According to a further embodiment, the support surface is replaceable and various surface profiles may be inserted.

 According to a further embodiment example, the press-on unit is a rigid press-on shape with a replaceable shape profile.

15 This shaped profile may for example be adapted to a profile shape of the support surface.

 According to a second aspect of the invention, a method for producing a profiled component is provided, which comprises the following steps:

- 20 a) disposing a semi-finished product to be shaped on a support surface of a lay-on unit;
- b) disposing a pressure application unit on the semi-finished product that includes, at least on the side that faces the semi-finished product, a bendable shell to lie
- 25 against the semi-finished product in an unshaped first state and to lie on in a shaped second state, and a pressure-transmitting and deformable filling;
- c) disposing a press-on unit on the pressure application unit;
- 30 d) pressing the semi-finished product to be shaped against the support surface by means of the press-on unit via the pressure application unit and shaping it at the same time.

According to an exemplary embodiment, the press-on unit is a vacuum membrane, and in step (d) a negative pressure is generated in a region between the vacuum membrane at the support surface by means of a vacuum unit, so that air
5 pressure acting from the outside on the vacuum membrane acts via the pressure application unit and effects shaping by laying the semi-finished product onto the support surface.

According to a further embodiment example, in order to soften the semi-finished product, the latter is tempered by
10 the pressure application unit prior to step (d).

According to the present invention, also the use of the apparatus described above is provided for producing a profiled component.

According to one aspect of the invention, a flexible
15 element is used for shaping a semi-finished product, which due to its capability of lying intimately against it, effects an improved shaping of the semi-finished product by way of an improved pressing on of the semi-finished product especially on internal radii. The pressure-transmitting and deformable
20 filling may for example also be used as a heat transfer medium, in order to heat for example a semi-finished product provided as a laminate and also to soften it in order to support the shaping operation. By using a medium with a higher viscosity, such as e.g. a gel, the pressure-
25 transmitting intermediate body may also be used in regions where, for example due to gravity, an unfavourable flowing off or migrating of the filling might occur. For example, compared to a rigid compression die, the deformable element provided according to the invention may be used to achieve a
30 good degree of shaping during the shaping of the semi-finished product and also in the case of slightly deviating shapes, in particular in the case of varying internal radii

or internal edges or internal corners. Unlike rigid shaping dies, the shaping apparatus can be used, as a result of the flexibility of the pressure element, without setting up time for various sub-templates. The flexible intermediate element
5 effects an improved pressing against the shaped structure underneath it.

It is to be pointed out that the features of the embodiment examples and the aspects of the apparatus also apply to the embodiments of the method as well as to the use
10 of the apparatus, and vice versa. Moreover, also those features may be freely combined where this has not been explicitly mentioned.

Embodiment examples of the invention will be explained in more detail below by means of the attached drawings, wherein:

15 **Fig. 1** shows an embodiment example of a shaping apparatus for producing a profiled component according to the present invention;

Fig. 2 shows a further embodiment example of a shaping apparatus according to the present invention;

20 **Fig. 3a+b** show a further embodiment example of a shaping apparatus according to the present invention in two states during the shaping operation;

Fig. 4 shows a further embodiment example of a shaping apparatus according to the present invention;

25 **Fig. 5a+b** show further embodiment examples of a pressure application unit according to the invention;

Fig. 6 shows steps of a method for producing a profiled component according to an embodiment example of the invention;

30 **Fig. 7 - 9** show schematic views of states during an embodiment example of a method according to the present invention.

Figure 1 shows a shaping device 10 for producing a profiled component. To this end, a lay-on unit 12, a press-on unit 14 and a pressure application unit 16 are shown.

5 The lay-on unit has a support surface 18 for supporting a semi-finished product to be shaped, which is indicated by a dotted line 20.

The press-on unit 14 is provided for pressing a semi-finished product to be shaped onto the support surface 18.

10 The pressure application unit 16 includes, at least on the side that faces the semi-finished product, a bendable shell 22 and a pressure-transmitting and deformable filling 24. Moreover, the pressure application unit 16 may be disposed between the press-on unit 14 and a semi-finished product to be shaped.

15 For example, the pressure application unit 16 may be formed to run around with the bendable shell 22 and may form a bladder that is filled with a fluid.

20 It is pointed out that the shaping device 10 is only shown in a schematic form and that in particular the press-on unit 14, the pressure application unit 16 and the lay-on unit 12 also may have other shapes or profiles, which will also be shown below.

25 The press-on unit 14 is for example formed as a rigid press-on shape 26 and may be designed, on the side that faces the pressure application unit 16, with a replaceable shape profile 28 which is shown in Figure 1 as a flat lay-on profile.

30 Figure 2 shows an alternative embodiment, wherein the press-on unit 14 is a vacuum membrane 30. Moreover, a vacuum unit 32, for example a vacuum pump, is provided for generating a negative pressure in a region between the vacuum membrane and the support surface in such a way that air

pressure acting from the outside onto the vacuum membrane effects shaping by pressing the semi-finished product onto the support surface. Figure 2 shows a schematic view of a connection 34 of the vacuum unit 32 with the region between the vacuum membrane 30 and the support surface 18. It is pointed out that any connections and seals of the vacuum membrane 30 in relation to the support surface 18 as may be necessary for generating a vacuum in the intermediate region are not shown in Figure 2.

Figure 3A shows the device 10 in a state in which the semi-finished product 20, here indicated by a continuous line, is laid on the support surface 18 of the lay-on unit 12, and moreover the pressure application unit 16 already lies on the semi-finished product 20. Moreover, the vacuum membrane 30 is positioned above the pressure application unit 16 in such a way that the membrane 30 is connected to the lay-on unit 12 in lateral edge regions 36. On the right-hand edge region 36, the connection 34 of the vacuum unit 32 is schematically shown. Moreover, the letters P as well as associated arrows indicate how air pressure acts on the vacuum membrane 30, but this has no effect in the initial state, because the same air pressure is also prevalent in the region that encloses the vacuum membrane 30, identified with reference numeral 38. An effect of the air pressure P is not achieved until a negative pressure is applied through the vacuum unit 32.

Figure 3B shows a state in which the semi-finished product 20 has been completely shaped and lies against the support surface 18. As a result of this it is achieved that the membrane 30 acts on the pressure application unit 16 and the pressure application unit 16 in turn acts on the semi-finished product 20.

As is also shown in Figure 3B, the pressure application unit has for example such a volume 40 that, when the pressure application unit lies on the support surface 18 or on the semi-finished product 20 that lies fully thereon, all of the
5 recesses of the support surface, as identified in Figure 3A with reference numeral 42, are filled by the pressure application unit 16, so that the vacuum membrane forms a convex enveloping surface 44.

The pressure application unit 16 has for example a
10 replaceable pressure application element 46, as is shown in Figure 4.

Moreover, a plurality 48 of pressure application elements 50 may be provided. This is also shown in Figure 4, however it is pointed out that whilst the figure shows the
15 replaceability of the pressure application element 46 and the presence of the plurality 48 in combination, they do not necessarily have to be present in this combination. In other words, these two features may also be provided independently from each other and may be combined with other features shown
20 in other figures.

For example, as shown in Figure 4, a plurality of pressure application elements may be provided above each other in the direction of the applied pressure. Moreover it is possible to provide a plurality of pressure application
25 elements next to each other or one after the other, which however is not shown in any more detail.

For example, a larger pressure application element, for example the pressure application element 46 from Figure 4, may be combined with two smaller pressure application
30 elements, for example the two pressure application elements 50 in Figure 4, in order to still effect, in the case of a strong profiling of the support surface 18, for example in

the form of a central region 52 that protrudes very far, a corresponding shaping or laying on of the semi-finished product 20.

At this point it should be explicitly mentioned that in the figures, the support surface 18 is formed with a central protruding region, for example for producing a profile with a so-called hat-shaped cross-section, but in addition, other profiles of the support surface 18 are of course also possible, but this is not shown in any more detail. The fact that the figures always refer to a similar profiling of the substrate surface 18 is merely done in order to simplify the explanation and does by no means mean that this is a central feature of the present invention. Rather, the profiles of the support surface 18 are freely selectable.

In particular, according to the invention also profiles with an undercut, at least to a certain extent, may be provided, because due to the flexible pressure application unit, a clean shaping may be achieved also in the case of such shapes as a result of the fact that the semi-finished product contacts the support surface 18 in a uniform manner throughout (however this is not shown in more detail).

Figure 5A shows a further embodiment example wherein the pressure application unit 16 is integrated in the vacuum membrane 30, for example as a cavity 54 provided with a pressure-transmitting and deformable filling, which is achieved by way of a double-wall design of the vacuum membrane 30.

According to a further embodiment example, the pressure application unit 16 is formed with a plurality of chambers 56 which are separated from each other by a partition 58. The partition 58 can for example prevent the filling 24 from moving out of the one segment or the one chamber 56 into the

adjacent chamber 56 or can get into the adjacent chamber only at a reduced rate or decelerated. As a result, it may for example be avoided that in the case of highly profiled support surfaces, the filling 24 flows off or sinks down in the pressure application unit 16 before the pressure can act on the semi-finished product via the press-on unit 14 in order to shape it.

The filling 24 of the pressure application unit 16 includes for example a fluid, a liquid, a gel and/or loose bulk solids.

The use of a liquid provides a pressure-stable filling.

For example, the filling may be a highly viscous filling in order to reduce flowing of the filling 24 in the pressure application unit 16 at least to some degree.

For example, the filling has a dynamic viscosity of at least 100 Pa·s.

For example, the filling may include small spheres which are provided to bulk in the pressure application unit, and these spheres are pressure resistant.

Steps of a method 100 for producing a profiled component will be described below initially with regard to Figure 6. In a first arrangement step 110, a semi-finished product to be shaped is arranged on a support surface of a lay-on unit. Subsequently, a pressure application unit, which has at least on the side facing the semi-finished product a flexible shell and a pressure-transmitting and deformable filling, is arranged in a second arrangement step 112, which arrangement is carried out on a semi-finished product. In a third arrangement step 114, a press-on unit is arranged on the pressure application unit. Subsequently, the semi-finished product to be shaped is pressed, in a press-on operation 116, against the support surface by means of the press-on unit via

the pressure application unit, and the semi-finished product is shaped in correspondence with the profiling predetermined by the profile of the support surface.

5 The first arrangement step 110 is also referred to as step (a), the second arrangement step 112 as step (b), the third arrangement step 114 as step (c) and the press-on operation 116 is referred to as step (d).

For example, the press-on unit in the process is a rigid press-on shape 26 as has already been mentioned above.

10 According to an alternative example of the method, the press-on unit is a vacuum membrane also as described above. In step (d), a negative pressure is generated in a region between the vacuum membrane and the support surface by a vacuum unit, so that air pressure acting from the outside on
15 the vacuum membrane acts via the pressure application unit and shaping is effected by laying the semi-finished product onto the support surface. The generation of a negative pressure is indicated in Figure 6 with an additional box 118, but it is explicitly pointed out that this step 118
20 constitutes a possible option to steps (a) to (d), which is also indicated by a dotted connection line 120 between box 118 and the press-on operation 116.

As a further option it may for example be provided to soften the semi-finished product prior to step (d) by
25 tempering it by means of the pressure application unit, which is indicated in Figure 6 in an exemplary manner with a further box 122, which is connected, by means of a further dotted connection arrow 124, with steps (a) to (d), wherein the position of the connection arrow 124 indicates that this
30 tempering process is carried out prior to step (d), but it is pointed out that the tempering process may also be provided in connection with step (b), indicated by a further box 126

with a corresponding dotted connection line, or subsequent to step (d) (see further box 128). Since the tempering of the semi-finished product is carried out by means of the pressure application unit 16, the tempering process will always be
5 started with the arrangement in step 112 up to just prior to the press-on operation or to certain extent also during the press-on operation 116.

However, it is to be pointed out that whilst the tempering process 122 is shown in combination with the
10 features of steps (a) to (d) as well as in combination with the generation of a vacuum, however, the other features may also be provided without tempering. Also, the tempering may be provided without the generation of a vacuum, for example when the press-on unit has a rigid press-on shape.

15 Figure 7 shows a schematic view of the state of an embodiment example wherein the semi-finished product to be shaped, which may for example be a fibre-reinforced composite material 60, has been laid on top of the support surface 18 of the lay-on unit 12. A profile segment may for example be
20 provided as the support surface 18, which profile segment forms a template counter-piece for shaping the semi-finished product 20 to be shaped. As shown in Figure 7, the profile, or the support surface 18, has two lateral, flat regions 62 as well as a central raised, flat region 64, wherein in each
25 case an inclined transitional region 66 is provided between the flat, lateral region 62 and the central, raised, flat region 64. Accordingly, this profile shape has interior edge regions 68 which may also be referred to as concave shape regions.

30 Above the semi-finished product 20, the pressure application unit 16 with the bendable shell 22 and the pressure-transmitting and deformable filling 24 is indicated

by an elliptic shape. Due to the bendable shell 22, the shell 22 will come to lie, e.g. due to gravity, on the semi-finished product 20, so that the semi-finished product can already be heated, for example if the pressure application
5 unit has been tempered, in order to supply or dissipate in this way thermal energy, indicated by an arrow 70 and the letter E, for example in order to cool the semi-finished product 20 by means of a pre-cooled pressure application unit 16, for example in order to reach a certain degree of
10 rigidity of the semi-finished product 20.

Subsequently, the vacuum membrane 30 is for example laid over the pressure application unit 16 and is connected to the lay-on unit 12 or the support surface 18 or the extension thereof, as is schematically shown in Figure 8. In Figure 8,
15 the semi-finished product 20 has already been partially deformed, as is shown by it being, as it were, laterally folded down. In other words, the state shown in Figure 8 already indicates that a negative pressure has been generated in the region 38 between the membrane 30 and the lay-on unit
20 12 in such a way that the air pressure acting from the outside, which is only schematically indicated with an arrow P, effects that the semi-finished product is shaped.

If further negative pressure is now generated, the pressure application unit 16 will be caused to lie intimately
25 fully against the semi-finished product 20 and will cause the semi-finished product 20 to lie against the support surface 18, so that the semi-finished product 20, as shown in Figure 9, is completely shaped. In particular, the semi-finished product 20 will here be uniformly pressed against the
30 internal radii of the recesses 68.

It is to be pointed out that the illustrations of Figures 7 to 9 are schematic and that in particular the shape of the

pressure application unit 16 may also deviate therefrom, in particular in connection with Figure 9, where the application unit 16 runs into the lateral interstices. Of course, also another transition from the vacuum membrane, which rests on the lay-on unit 12 and subsequently covers the pressure application elements or the pressure application unit 16, may also be provided here or may develop.

Once the semi-finished product 20 has been completely shaped, cooling may be provided by means of the heat-controllable pressure application unit 16, for example by means of cooling or heating elements introduced into the pressure application unit 16, which cool the semi-finished product in order to ensure that the semi-finished product keeps its contour.

Thus, for example, semi-finished products may be shaped which are stable in shape at normal processing temperatures and will be heated and softened by the shaping process by the pressure application unit 16 only to such a degree that the shaping process can take place. The subsequent cooling will then result in a shaped semi-finished product that can be supplied to further operating steps, for example a further processing step, for example a curing process.

The semi-finished product 20 to be shaped may in particular be a composite laminate.

By means of the pressure application unit 16 according to the invention, a simple and yet precise shaping of the semi-finished product may be achieved for example with the use of a vacuum membrane, so that not only time is saved, but the product can also be adapted to the predetermined contour in a more precise manner. The use of a flexible pressure application unit also provides the advantage that even in the case of a not absolutely exact positioning of the pressure

application unit on the semi-finished product, the shaping process will still be precise. If a tempered pressure application unit is provided, for example by using a gel with a heat storage capacity as high as possible, any additional
5 heat input devices, for example through radiation input, may be dispensed with which means a further simplification during the shaping process for producing a profiled component.

The embodiment examples described above may be combined in various ways. In particular, aspects of the method may
10 also be used for embodiments of the devices as well as the use of the devices, and vice versa.

In addition it is to be pointed out that "comprising" does not exclude any other elements or steps, and "a/an" does not exclude a plurality. It is further to be pointed out that
15 features or steps which have been described with reference to one of the above embodiment examples and aspects, can also be used in combination with other features or steps of other embodiment examples and aspects as described above. Reference signs in the claims are not to be regarded in a limiting
20 sense.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A shaping device for producing a profiled component, comprising:

- a lay-on unit;
- a press-on unit; and
- a pressure application unit;

wherein the lay-on unit has a support surface for laying on a semi-finished product to be shaped;

wherein the press-on unit is provided for pressing the semi-finished product to be shaped onto the support surface;

wherein the pressure application unit has, at least on a side facing the semi-finished product, a flexible shell that lies against the semi-finished product in an unshaped first state and that lies on in a shaped second state;

wherein the pressure application unit is arranged between the press-on unit and the semi-finished product to be shaped,

wherein the press-on unit has a flexible surface that lies against the pressure application unit, wherein the flexible surface transmits a shaping force onto the pressure application unit; and

wherein the pressure application unit further has a pressure-transmitting and deformable filling, and the flexible shell is designed to hold a volume of the filling enclosed in the pressure application unit.

2. The device as claimed in claim 1, wherein the semi-finished product to be shaped is a fibre-reinforced composite material.

3. The device as claimed in claim 1 or 2, wherein:
the flexible surface of the press-on unit lies on one side on the pressure application unit, and on another side a pressure is applied via a fluid that transmits the shaping force, wherein for pressurizing:

i) the flexible surface forms a volume onto which pressure can be applied; or

ii) the press-on unit is a vacuum membrane, wherein a vacuum unit is provided to generate a negative pressure in a region between the vacuum membrane and the support surface such that ambient air pressure acting from outside on the vacuum membrane effects a shaping by pressing the semi-finished product onto the support surface.

4. The device as claimed in claim 3, wherein the pressure application unit has such a volume that when the pressure application unit lies on the support surface, all recesses of the support surface are filled by the pressure application unit, so that the vacuum membrane forms a convex enveloping surface.

5. The device as claimed in claim 1 or 2, wherein the flexible surface of the press-on unit is held by holding points such that the flexible surface forms a convex contour both in the unshaped first state and in the shaped

second state, wherein a tensile stress is applied onto the flexible surface for transmitting the shaping force.

6. The device as claimed in any one of claims 1 to 5, wherein the pressure application unit is peripherally provided with a flexible shell.

7. The device as claimed in any one of claims 1 to 6, wherein the filling of the pressure application unit comprises:

- gaseous fluids;
- liquids;
- gels; and/or
- loose bulk solids.

8. The device as claimed in claim 7, wherein the filling of the pressure application unit has a dynamic viscosity of at least 100 Pa·s.

9. The device as claimed in any one of claims 1 to 8, wherein the pressure application unit has a replaceable pressure application element or a plurality of pressure application elements.

10. The device as claimed in any one of claims 1 to 9, wherein the semi-finished product is tempered by the pressure application unit; and wherein the pressure application unit supplies and dissipates thermal energy to/from the semi-finished product to be shaped.

11. The device as claimed in any one of claims 1 to 10, wherein the support surface is replaceable and various surface profiles can be inserted.

12. A method for producing a profiled component, the method comprising the steps of:

a) arranging a semi-finished product to be shaped on a support surface of a lay-on unit;

b) arranging a pressure application unit on the semi-finished product to lie on the semi-finished product in an unshaped first state and to lie on the semi-finished product in a shaped second state, wherein the pressure application unit has a flexible shell at least on a side facing the semi-finished product;

c) arranging a press-on unit on the pressure application unit, wherein the press-on has a flexible surface lying on the pressure application unit, wherein the flexible surface transmits a shaping force onto the pressure application unit;

d) pressing the semi-finished product to be shaped onto the support surface using the press-on unit via the pressure application unit while shaping the semi-finished product;

wherein the pressure application unit has a pressure-transmitting and deformable filling, and the flexible shell is designed to hold a volume of the filling enclosed in the application unit.

13. The method as claimed in claim 12, wherein:

the flexible surface of the press-on unit lies on one side on the pressure application unit, and on another side a pressure is applied via a fluid that transmits the shaping force, wherein for pressurizing:

i) the flexible surface forms a volume onto which pressure can be applied; or

ii) the flexible surface is a vacuum membrane; wherein in step d) a vacuum unit is provided to generate negative pressure in a region between the vacuum membrane and the support surface such that ambient air pressure acting from outside on the vacuum membrane effects a shaping by pressing the semi-finished product onto the support surface.

14. The method as claimed in claim 12 or 13, wherein the flexible surface of the press-on unit is held by holding points such that the flexible surface forms a convex contour both in the unshaped first state and in the shaped second state, wherein a tensile stress is applied onto the flexible surface for transmitting the shaping force.

15. The method as claimed in any one of claims 12 to 14, wherein the pressure application unit tempers the semi-finished product prior to step d) so as to soften the semi-finished product.

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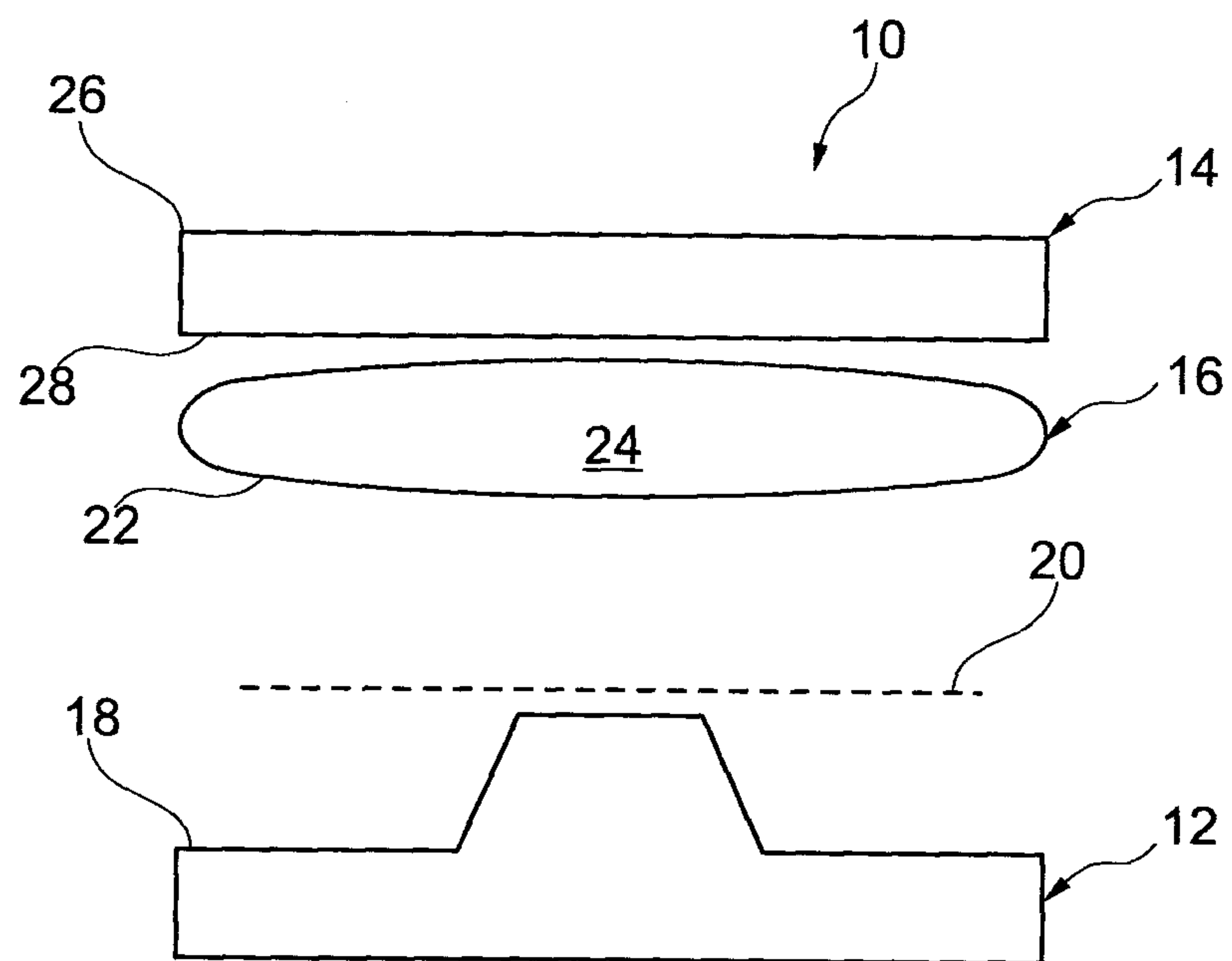


Fig. 1

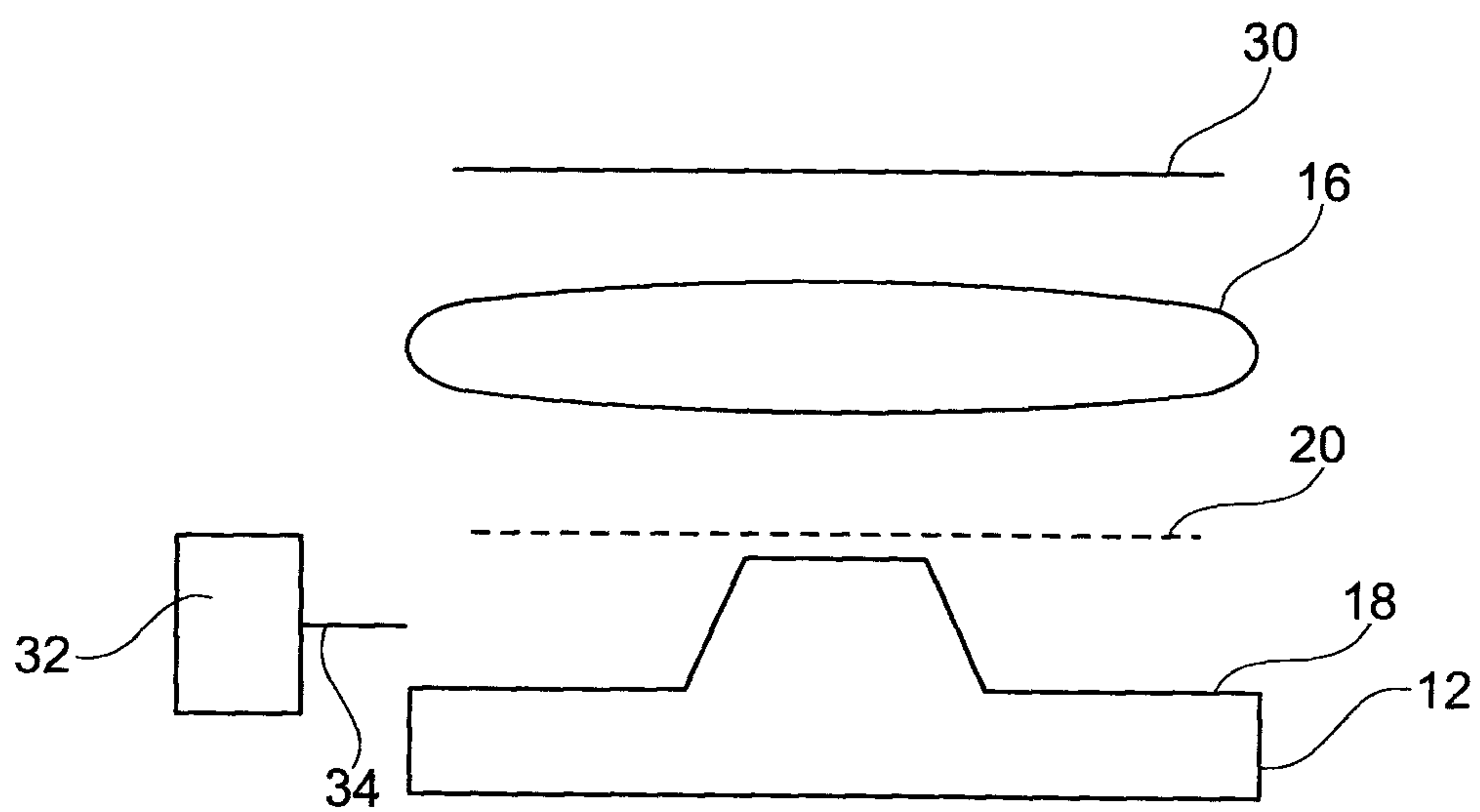


Fig. 2

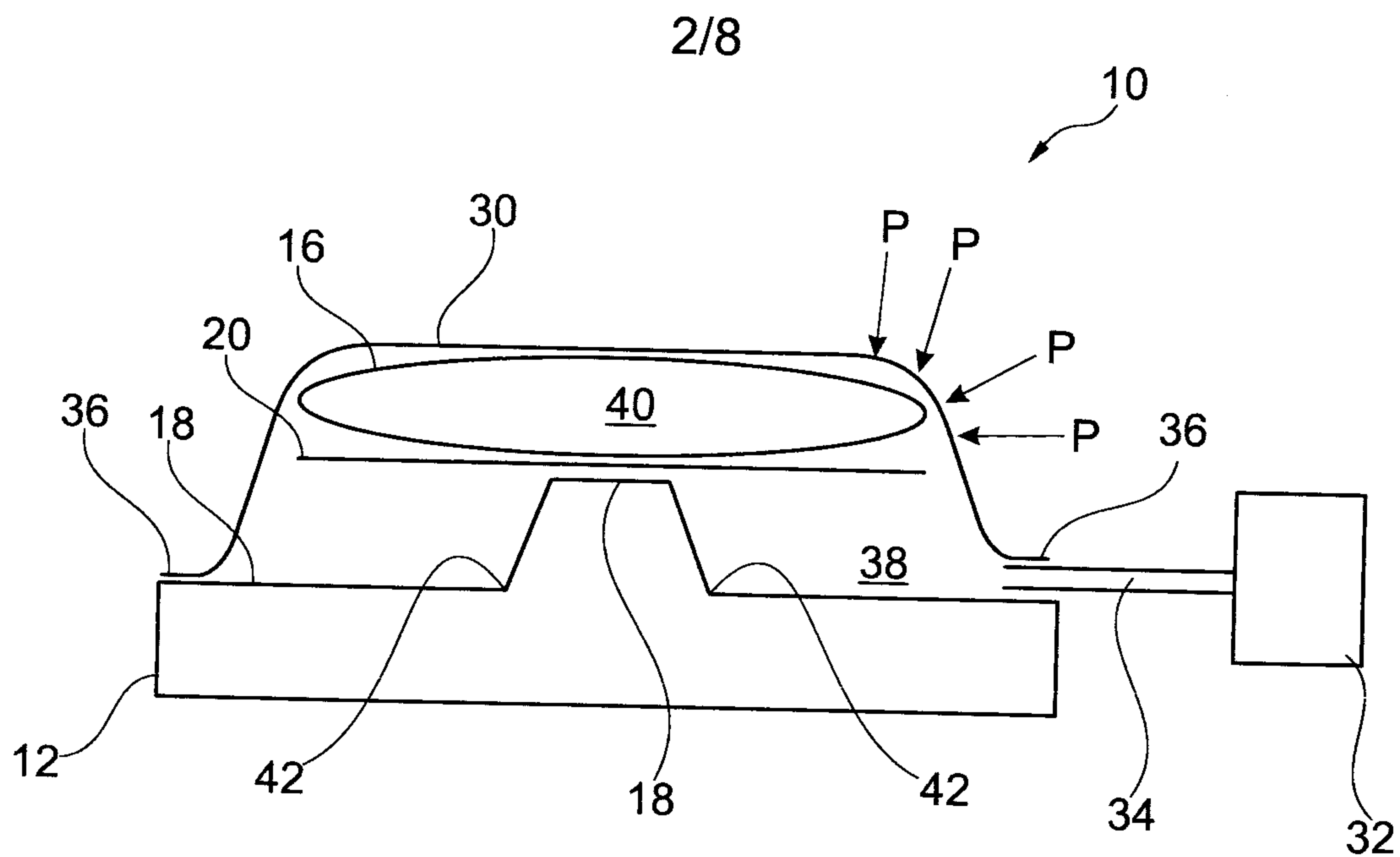


Fig. 3a

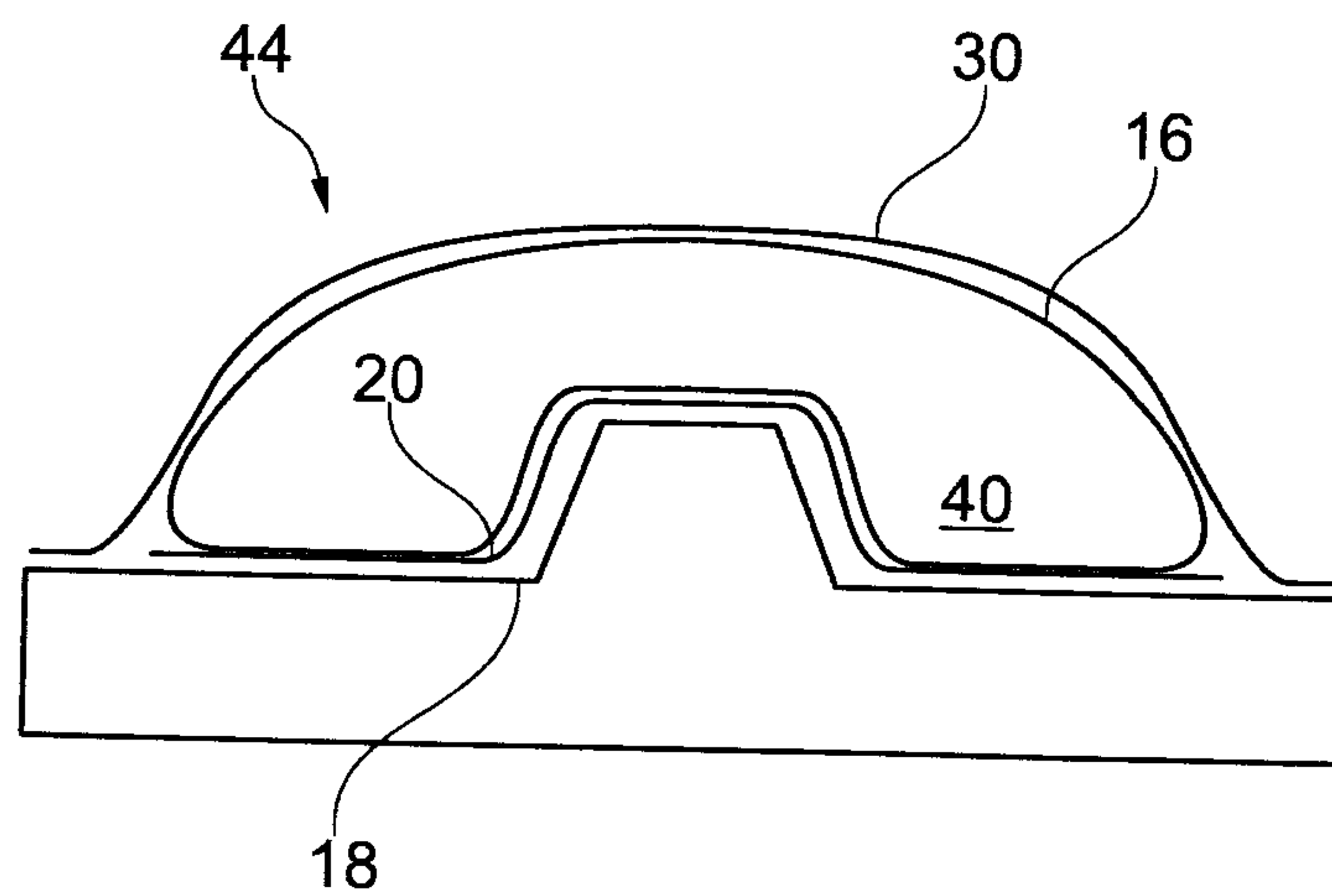


Fig. 3b

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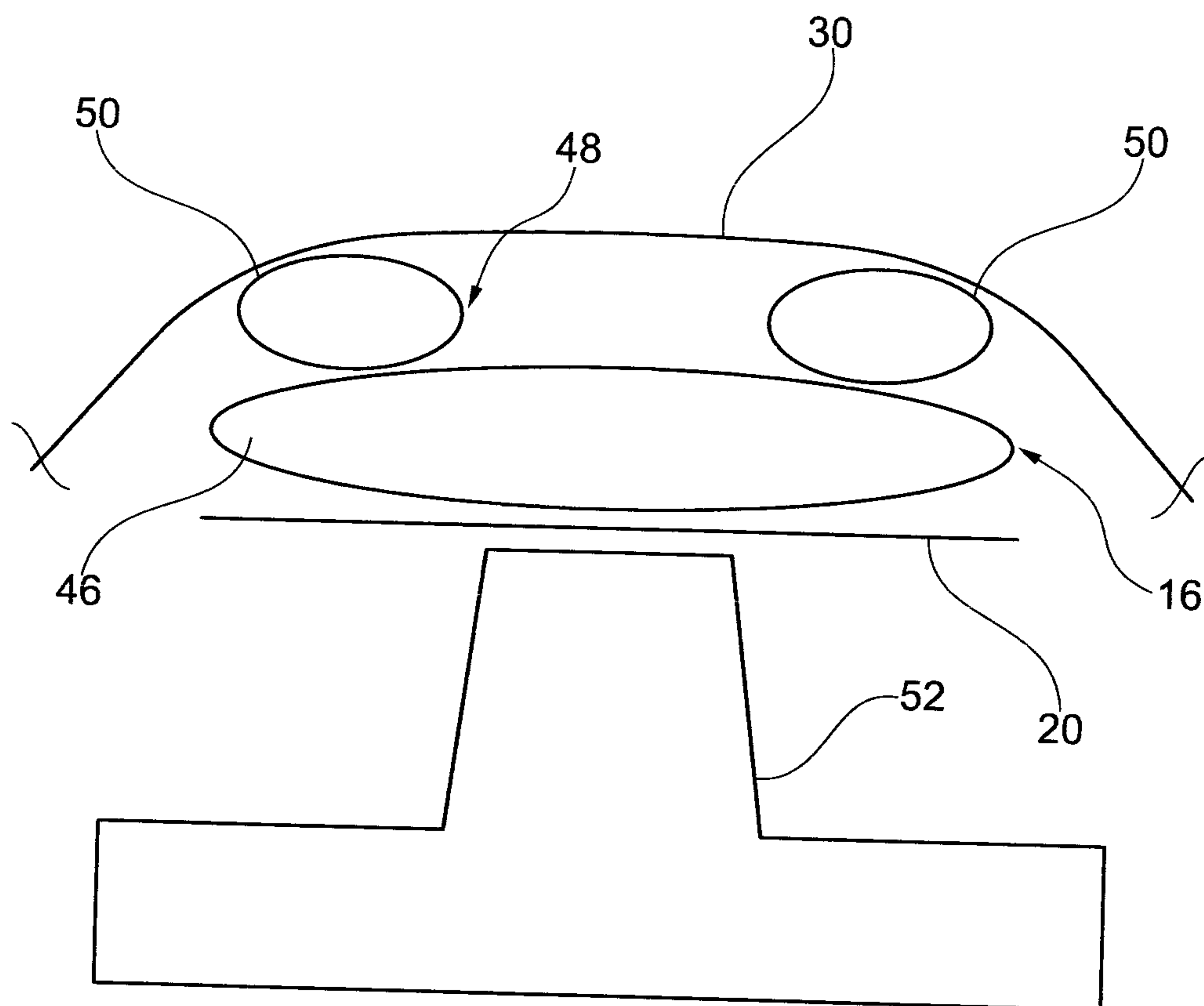


Fig. 4

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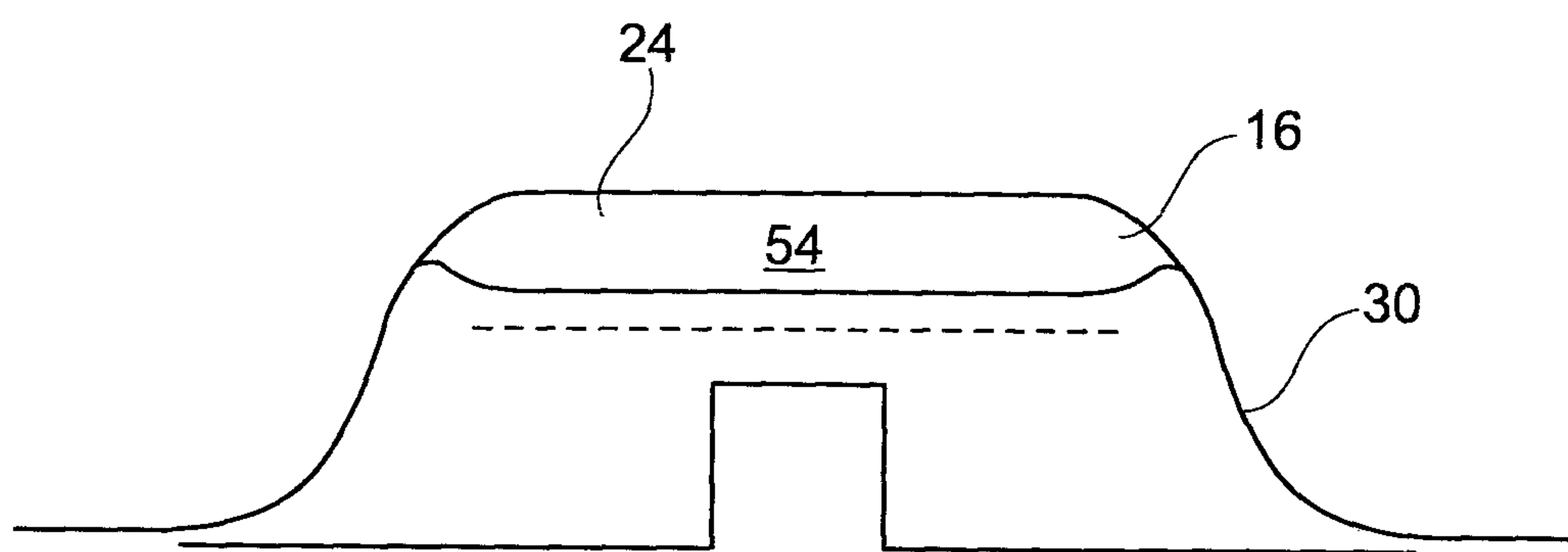


Fig. 5a

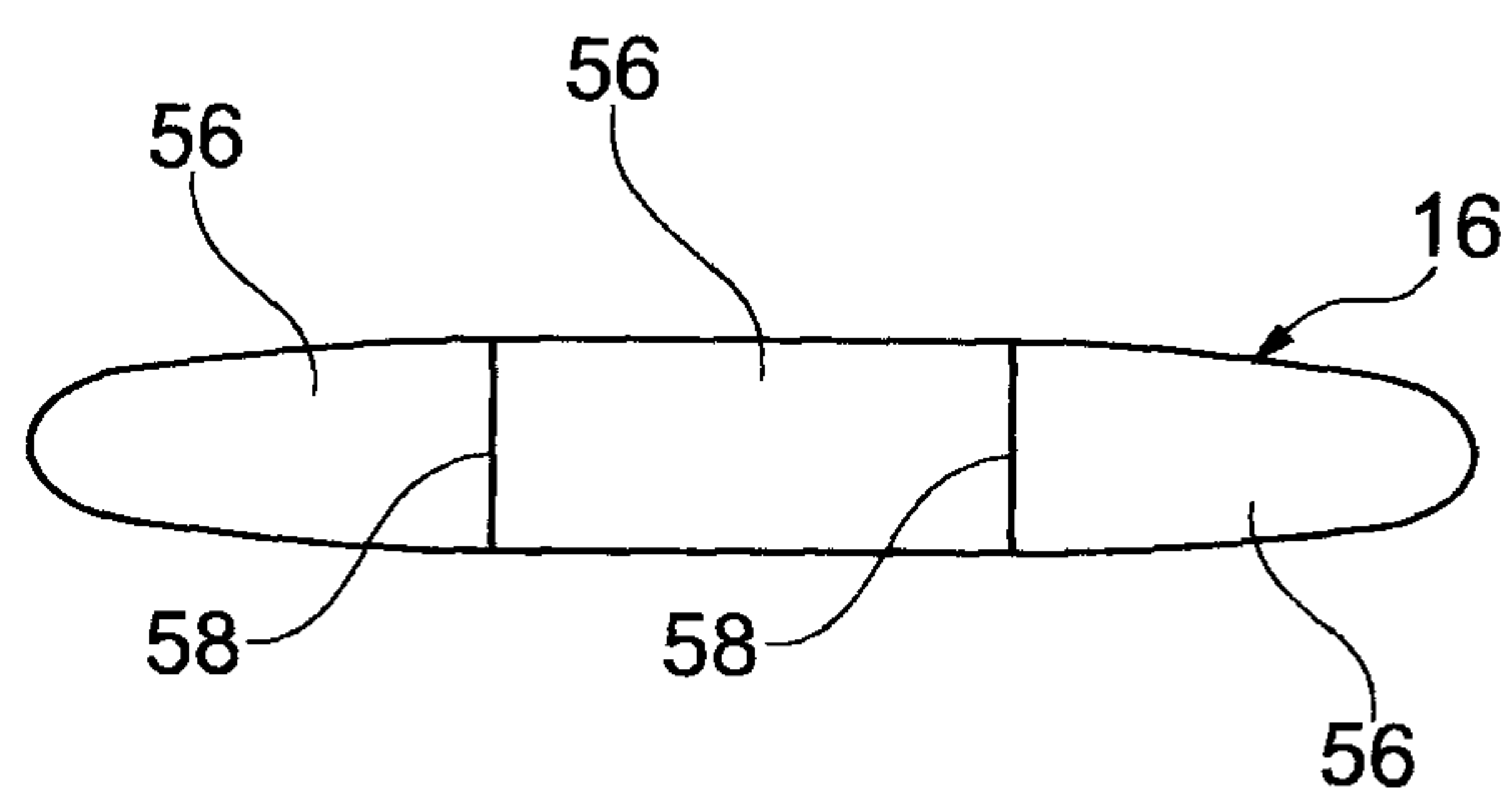


Fig. 5b

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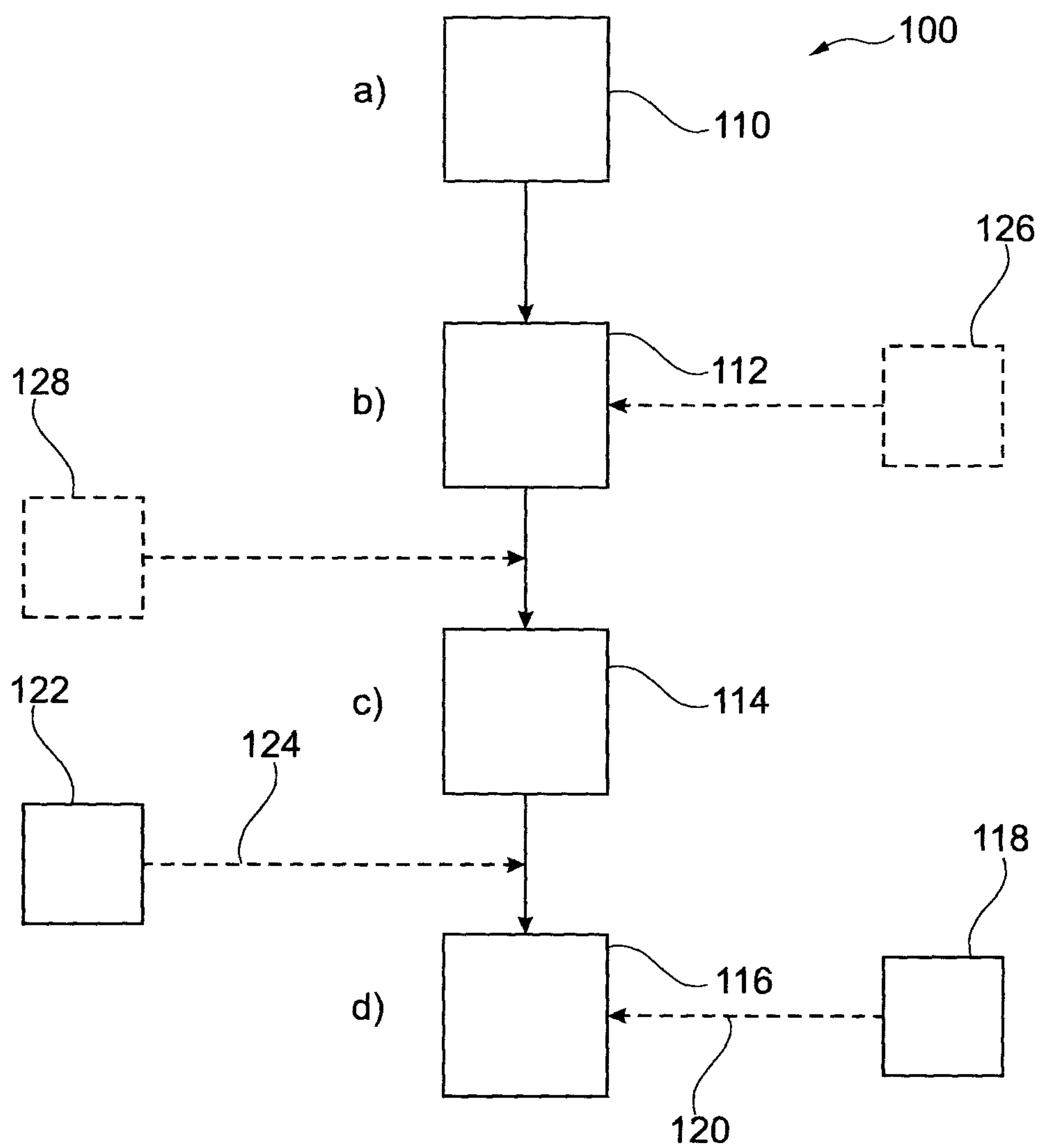
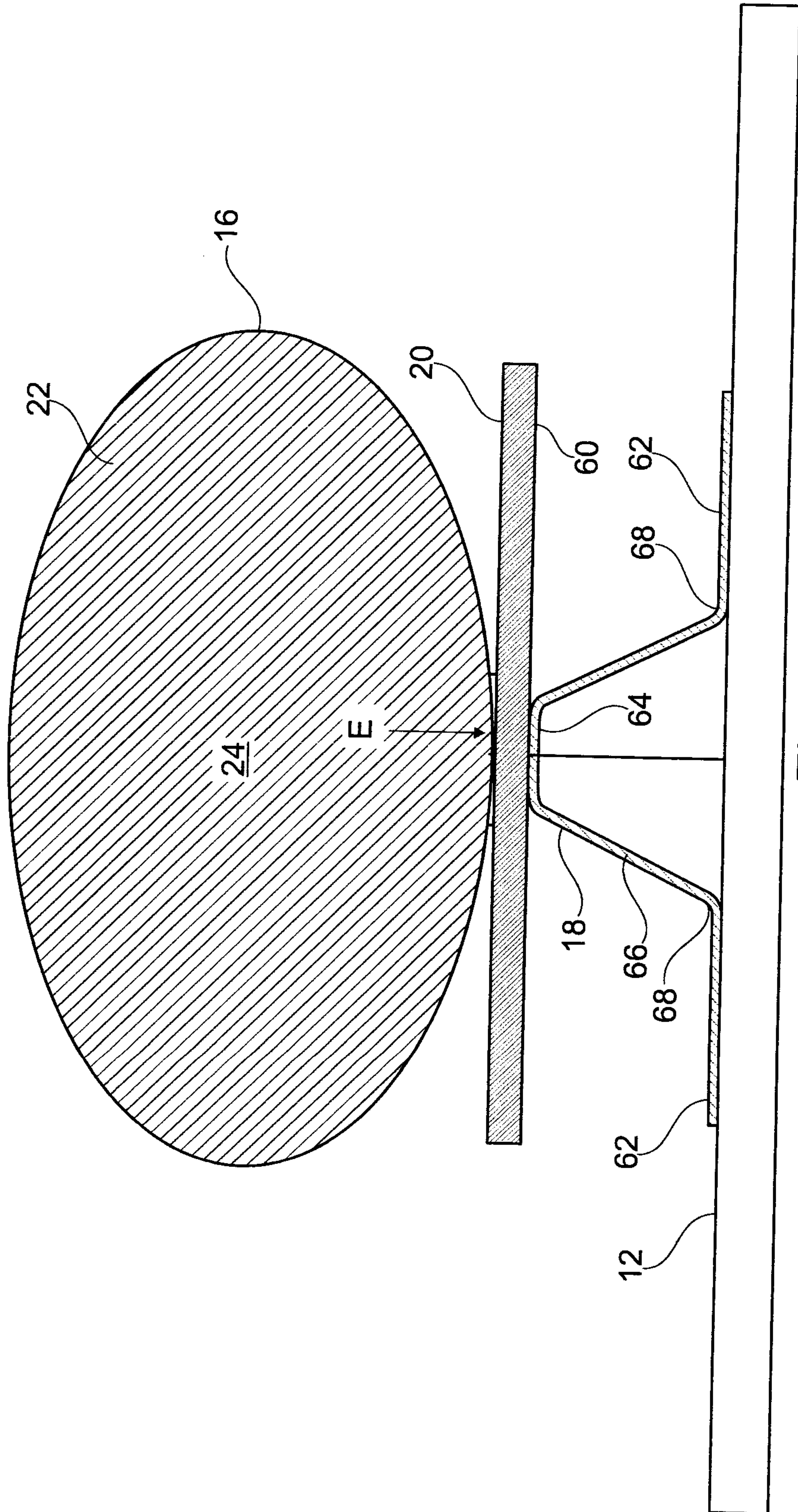


Fig. 6

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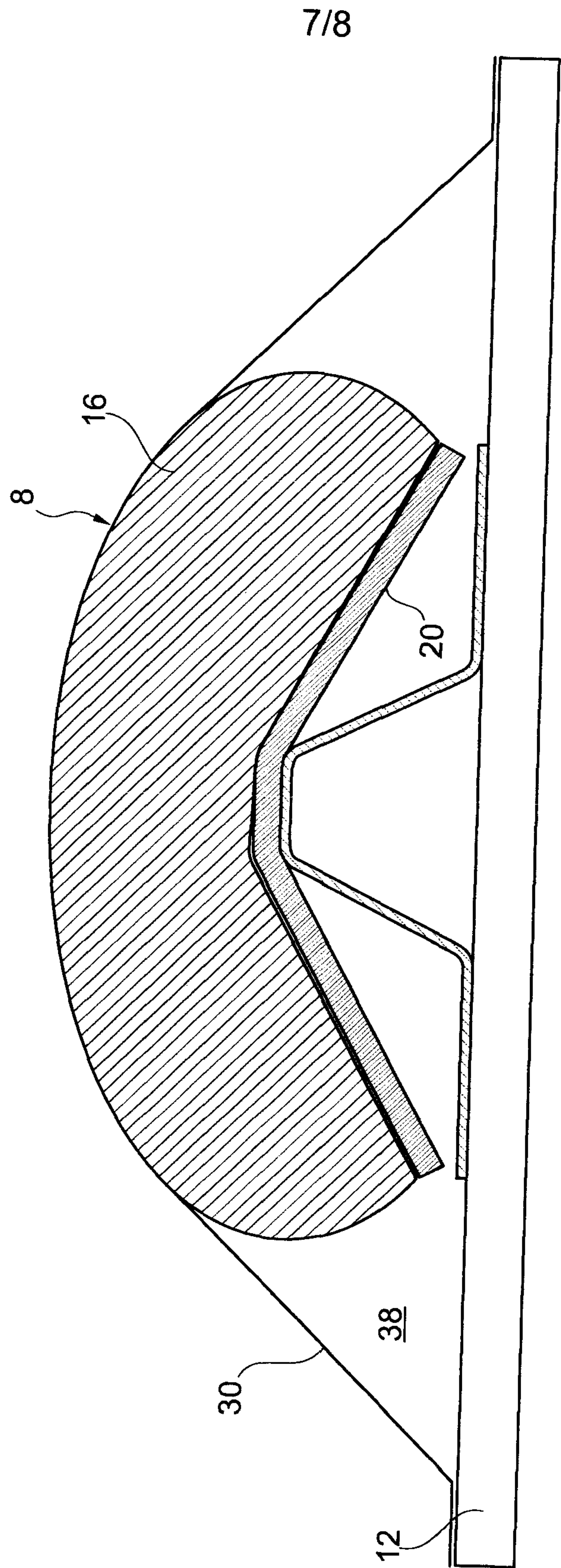
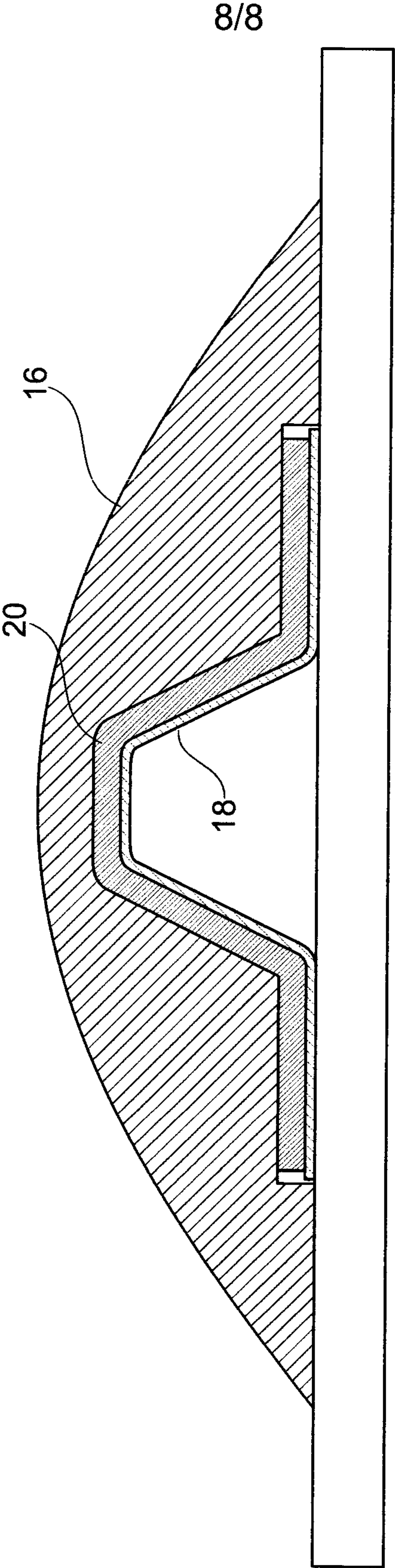


Fig. 8



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Fig. 9

