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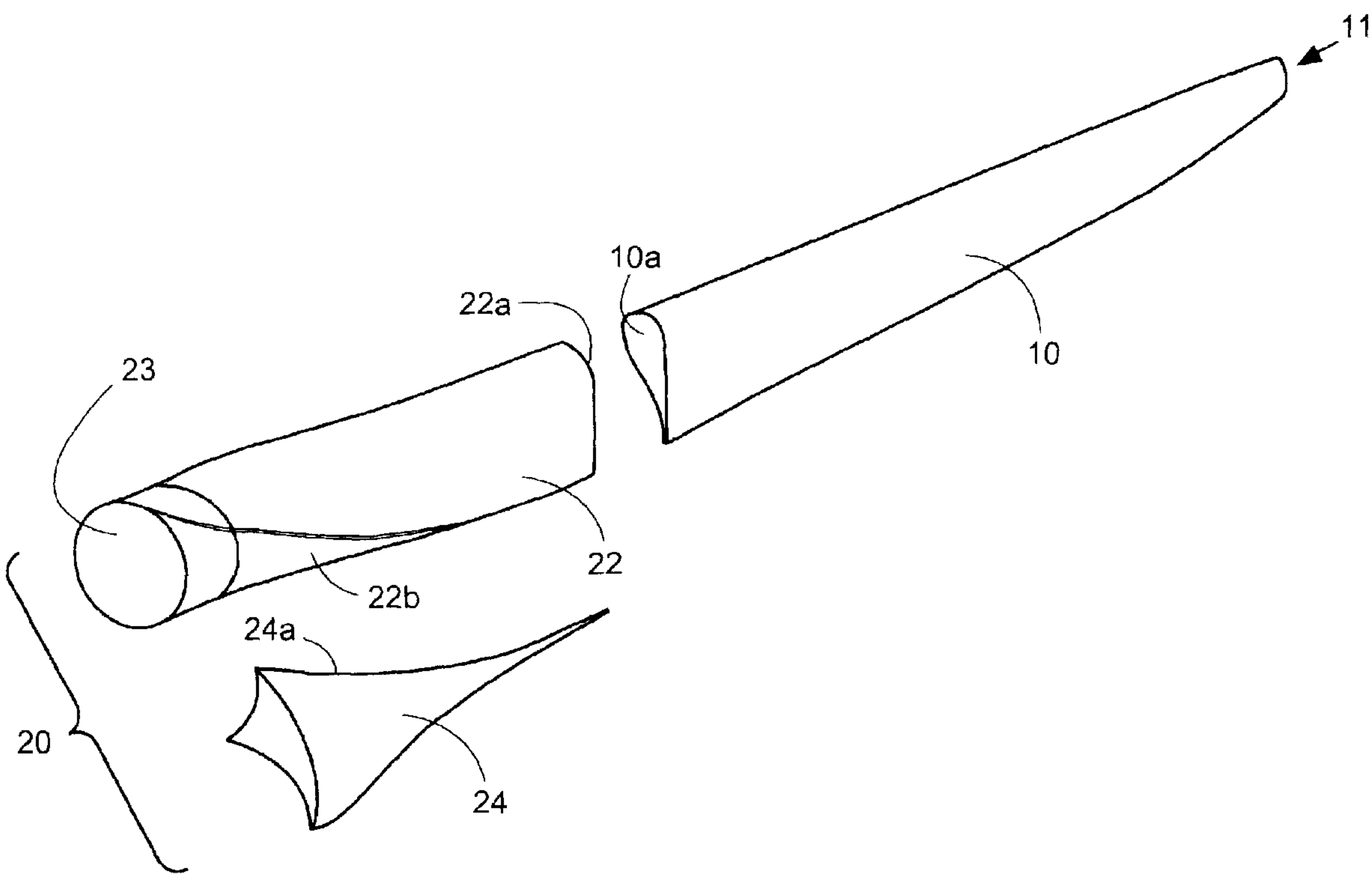

(57) Abrégé/Abstract:
There is provided a rotor blade for a wind power installation, having at least a first and a second component. The first component has the rotor blade tip and the second component has the rotor blade root. The first and second components are in the form of separate parts for jointly forming the rotor blade. The first component is of a first material and the second component is of a second material.

Abstract

There is provided a rotor blade for a wind power installation, having at least a first and a second component. The first component has the rotor blade tip and the second component has the rotor blade root. The first and second components are in the form of separate parts for jointly forming the rotor blade. The first component is of a first material and the second component is of a second material.

(Figure 1)

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Rotor blade for a wind energy installation

The present invention concerns a rotor blade for a wind power installation, wherein the rotor blade has at least a first and a second component, wherein the first component has the rotor blade tip and the second component has the rotor blade root.

A divided rotor blade is known for example from DE 199 62 989 A1. The parts of that known rotor blade are produced and transported separately because of the considerable dimensions in order thereby to limit the demands on the infrastructure both in manufacture and also upon transport.

As general further state of the art attention is directed to DE 101 52 449 A1, DE 203 20 714 U1 and WO 03/078833 A1.

The object of the present invention is to further optimise a rotor blade for a wind power installation.

In a rotor blade of the kind set forth in the opening part of this specification that object is attained by the use of a first material for the first component and a second material for the second component.

Thus there is provided a rotor blade for a wind power installation having at least a first and a second component. The first component has the rotor blade tip and the second component has the rotor blade root. The first and the second components are in the form of separate parts in order jointly to form the rotor blade. The first component has a first material and the second component has a second material.

In that respect the invention is based on the realisation that dividing the rotor blade admittedly makes it possible to reduce the dimensions of the parts to be handled but a choice of suitable materials and production processes linked thereto also advantageously influence economy and that this is to be attributed to a number of factors. The reduction in the dimensions of the individual parts also reduce the demands imposed on infrastructure and logistics in manufacture, handling and transport of the rotor blades to the point of assembly on the wind power installation. The infrastructure however is also dependent on the material to be processed, for pre-processing and post-processing steps are required prior to and after the pure shaping operation, depending on the respective material involved. These are for example cutting it to size and burr removal in metal machining. When processing fibre-reinforced plastic materials such steps include complying with predetermined thermal demands, for example in heat treatment operations and so forth.

While the state of the art admittedly already describes multi-part rotor blades, the shaping parts of which, over the entire rotor blade length, are always made from the same material, the invention proposes the use of different materials which can be advantageously matched to the primary function of the component. That specifically targeted choice of material leads for example to a material with a comparatively high modulus of elasticity for a region which is subjected to the effect of high loads, and a material of low inherent weight for rotor blade parts where those loads do not occur.

In accordance with the state of the art, light material with a comparatively low modulus of elasticity would otherwise be used for example even where it is necessary to ensure a high level of load transfer. A correspondingly large amount of material has to be installed there; considerably more than is required solely for achieving accuracy in respect of shape, in order to guarantee secure load transfer. That considerable amount of material can be saved by a selection in accordance with the invention of another material with a higher modulus of elasticity.

In a preferred embodiment of the rotor blade the second component is in turn divided into at least two parts which jointly form the second component. The second component is particularly preferably divided in that fashion into a load-bearing part and a blade trailing edge box. Handling of large rotor blade components can be further facilitated by that division and in particular on-road transport is in that way simplified quite a bit for rotor blades are of the greatest depth in the region of the second component and can there easily attain dimensions of more than 6 m. Accordingly any tight highway curve and any bridge represents a potential obstacle with corresponding problems which can be reduced, if not even avoided, by dividing that second component into two.

In that respect in a particularly preferred feature different materials are in turn used for the two parts which jointly form the second component.

In order to still further facilitate the implementation of transport tasks, the blade trailing edge box is if necessary divided once again into a plurality of parts so that it is possible in that way to manufacture and transport rotor blades of any dimensions.

In order to arrive at a particularly advantageous division of the rotor blade into the two components the first component is preferably of a length of about 5/6 to 1/2 of the length of the total rotor blade while the length of the second component preferably corresponds to 1/6 to 1/2 of the rotor blade length.

The blade trailing edge box or the parts thereof can be made for example from aluminium. That material is light, it can be well shaped, and it involves a temperature characteristic which comes close to that of steel. Therefore, with a combination of an aluminium trailing edge box and a load-bearing part of steel, the expectation is for a blade which can be relatively inexpensively manufactured, with adequate accuracy in respect of shape. In addition the modulus of elasticity of aluminium is smaller approximately by a factor of 5 than that of steel. That provides inter alia that loads to which the second component is subjected are not carried by the softer material of the trailing edge box. The dimensioning of the parts of the trailing edge box can in turn be effected in a correspondingly more advantageous fashion.

In order to facilitate fitment of the blade by assembly of the individual parts and also in subsequent operation inspection of the blade and in particular checking of the transition between the first and second components, in a particularly preferred feature the load-bearing part of the second component is adapted to be negotiable on foot. That signifies on the one hand that the interior affords sufficient space and furthermore the material is sufficiently capable of bearing a load that at least no (permanent) deformation occurs.

The connection between the first and second components of the rotor blade is particularly preferably effected with a butt joint, wherein the connecting elements for bridging over the gap of the joint are arranged exclusively within the rotor blade. That imparts an aerodynamically clean external contour to the blade.

In that respect the connection is preferably such that the connecting elements include cross-bolts, tie elements and on the second component an L-flange directed inwardly of the rotor blade, wherein the cross-bolts are accommodated in openings in the first component. In a preferred embodiment those openings are in the form of through holes. To provide an aerodynamically smooth rotor blade surface the holes are appropriately covered over. That can be effected by means of prefabricated covers with which the hole is covered over from the exterior. It will be appreciated that that function can also be implemented when processing the blade surface by the application of a filling material or the like.

In an alternative embodiment of the present invention the openings are in the form of blind holes from the inside of the first component, in which case independently of the manner of implementation of the openings, the tie elements are connected to the cross-bolts, extend through the L-flange and are secured there.

The material thickness of the first component in the region of the opening is crucial for the way in which the openings are made. To provide for reliable load transfer a predetermined minimum contact area is required for the cross-bolts, and that area determines the necessary depth of the opening. If the material is not thicker, the arrangement involves a through hole which then has to be covered over at the rotor blade surface. If the material is thicker a blind hole is sufficient so that there is no need for the rotor blade surface to be subsequently processed.

To make use of that economically advantageous blade there is provided a wind power installation having at least one such rotor blade.

A preferred embodiment by way of example of the present invention is described more fully with reference to the accompanying Figures in which:

Figure 1 shows an exploded view of a rotor blade according to the invention,

Figure 2 shows a view of a rotor blade according to the invention in the assembled condition,

Figure 3 shows a simplified side view of the connection between the first and second components,

Figure 4 shows a plan view of the connection between the first and second components, and

Figure 5 shows an alternative embodiment of the connection shown in Figure 3.

The exploded view in Figure 1 shows the first component 10 which includes the rotor blade tip 11. The second component 20 is formed from two parts, namely a load-bearing part 22 which also includes the rotor blade root 23 for fixing the rotor blade to the rotor hub (not shown), and a blade trailing edge box 24. The load-bearing part 22 has a first connecting face 22a and a second connecting face 22b. The first connecting face 22a serves to connect the load-bearing part 22 to the first component or the connecting face 10a of the first component. The second connecting or contact face 22b serves to connect the load-bearing part 22 to the blade trailing edge box 24. In that respect the corresponding contact faces, that is to say on the one hand the contact or connecting face 22a and on the other hand the contact or connecting face 10a are so adapted to each other that the load-bearing part and the first component can be substantially seamlessly fixed together. A corresponding consideration applies for the connecting or contact faces 22b and 24a.

Figure 2 shows the rotor blade 1 according to the invention in the assembled condition. In this case the first component 10 and the second component 20 assembled from the parts 22 and 24 form the rotor blade which is identified generally by reference 1.

Account is taken of the different demands on the components and the parts thereof, by the choice of different materials. Thus preferably fibre-reinforced synthetic resin is used for the first component (blade tip) while steel is used for the load-bearing part of the second component (blade root) and aluminium is used for the part or parts of the blade trailing edge box. Thus the required strength can be imparted to the load-bearing part by working processes which have long been known and which are reliably managed in steel processing. As the second component is that which includes the rotor blade root which thus in the assembled rotor blade forms the inner region near the rotor hub, no particularly high demands are placed on the aspect of accuracy of shape. The relatively high modulus of elasticity of steel also means that there is no need for additional material for transmission of the loads which occur, from the rotor blade. The situation was different for example with glass fibre-reinforced plastic material (GRP) as material for the second component. Here, it would be necessary to use more material than is actually required to provide a structure that is stable in respect of shape, to achieve the flexural stiffness required for load transfer. As however steel has a modulus of elasticity which is about 5 times higher than GRP, that reinforcement and the complication and expenditure that is inevitably involved therewith is not required.

The first component (blade tip) forming the outer part of the rotor blade must in contrast be produced with a high level of accuracy in respect of shape as that component quite predominantly determines the aerodynamic properties of the rotor blade. Production processes using fibre-reinforced synthetic resins have been known for that purpose for many years so that components with a high level of accuracy in respect of shape and at the same time low weight, but in return at higher material costs than for steel, can also be produced in mass production. It will be appreciated that it is also possible to use a different material of comparatively low weight like aluminium for the first component. The low weight of the first component results in correspondingly low loads which act overall on the second component and the wind power installation. By way of example mention may be made here of the rotationally cyclical loads due to the effect of gravity.

Figure 3 shows how a connection between the first component 10 and the second component 20 or the contact face 10a and the contact face 22b can be made.

Provided in the first component 10 are what are referred to as blind holes, that is to say openings which do not pass completely through the material. A cross-bolt 12 is fitted into such an opening. A tie element 14, for example a screwthreaded rod, is connected to that cross-bolt 12, the length of the tie element 14 being such that it protrudes from the first component 10 to such an extent that the second component 20 can be fitted thereon and a screw connection is possible.

As the second component 20 has an L-flange 26 directed inwardly of the rotor blade, it can be seen from Figure 3 that the cross-bolt 12 is also fitted into the opening from the interior of the rotor blade. As a result the outside of the rotor blade remains intact and thus aerodynamically clean.

As can further be seen from this Figure the two components 10, 20 of the rotor blade are joined together by a nut 16 being fitted on to the screwthread on the tie element 14, that protrudes from the L-flange 26 of the second component 20.

To provide for more advantageous load transfer from the L-flange 26 to the second component 20, knee gusset plates 48 can be provided at predetermined spacings.

Figure 4 shows a plan view of the connection between the first component 10 and the second component 20. Shown here once again are the cross-bolts 12 to which there are connected tie elements 14 which engage through the L-flange 26 of the second component 20 and are tightened with nuts 16 so as to afford a firm and fixed connection between the two components 10, 20.

It can further be seen from this Figure that a respective knee gusset plate 28 is provided between two adjacent tie elements so that those knee plates 28 are distributed over the entire inside periphery of the rotor blade and thus promote uniform load transfer.

Figure 5 shows an alternative embodiment of the connection shown in Figure 3. The difference between the two Figures is substantially that Figure 5 shows through holes in place of the blind holes shown in Figure 3. The other parts are identical and are denoted by the same references as in Figure 3. The description is therefore not repeated here and in that respect attention is directed to the description relating to Figure 3.

The above-described rotor blades are preferably used as rotor blades of a wind power installation, the wind power installation preferably having three of those rotor blades.

In accordance with a further embodiment by way of example of the invention the rotor blade trailing edge boxes 24 and the rotor blade tip can be of different dimensions. In this respect however care should be taken to note that the connecting faces 10a of the rotor blade tip 24a and the blade trailing edge box 24 remain the same, even with different dimensions for the rotor blade tip and the trailing edge box, so that the respective and the different rotor blade tips and blade trailing edge boxes can be fixed to the load-bearing part 22. It is possible to ensure in that way that a rotor blade for a wind power installation can be constructed in a modular structure based on the load-bearing part 22 and with rotor blade tips and rotor blade trailing edge boxes 24 of differing configurations. The respective rotor blade can thus be easily adapted to the operating conditions to be expected. It is thus possible to produce rotor blades of differing length and width and of different geometrical dimensions, wherein the load-bearing part 22 remains unchanged and only the rotor blade tip and the blade trailing edge box have to be appropriately adapted.

It is thus possible to achieve inexpensive production of the load-bearing part as that part is of an identical configuration for a multiplicity of different rotor blades.

WHAT IS CLAIMED IS:

1. A rotor blade for a wind power installation having

at least a first and a second component, wherein the first component has a rotor blade tip and the second component has a rotor blade root, and the first and the second components are separate parts which jointly form the rotor blade, wherein the first component (10) has a first material and the second component (20) has a second material,

wherein the second component (20) has at least a first and a second part (22, 24) which are in the form of separate parts and jointly form the second component (20),

wherein the first part represents a load-bearing part (22) and the second part represents a blade trailing edge box (24),

wherein the first part (22) comprises a second material and the second part a third material,

wherein there are provided fibre-reinforced synthetic resin as the first material, steel as the second material for the load-bearing part (22) of the second component (20) and aluminium as the third material for the part or parts of the blade trailing edge box (24).

2. A rotor blade according to claim 1 characterised by the blade trailing edge box (24) being divided into a plurality of parts.

3. A rotor blade according to claim 1 or claim 2 characterised in that the length of the first component (10) corresponds to approximately from 5/6 to 1/2 of the length of the overall rotor blade and the length of the second component (20) corresponds to approximately from 1/6 to 1/2 of the overall rotor blade (1).

4. A rotor blade according to any one of claims 1 to 3 characterised in that at least the load-bearing part (22) of the second component (20) is adapted to being negotiable on foot by a person walking thereon.

5. A rotor blade according to any one of claims 1 to 4 characterised by a connection between the first and second components (10, 20) of the rotor blade (1) with a butt joint, wherein the connecting elements for bridging over a joint gap are arranged exclusively within the rotor blade (1).

6. A rotor blade according to claim 5 characterised in that the connecting elements have cross-bolts (12), tie elements (14) and an L-flange (26) directed inwardly of the rotor blade on the second component (20), wherein the cross-bolts (12) are received in openings in the first component (10) and wherein the tie elements (14) are connected to the cross-bolts (12), extend through the L-flange (26) and are fixed there.

7. A rotor blade according to claim 6 characterised in that the openings in the first component (10) for receiving the cross-bolts (12) are in the form of blind holes from the inside of the first component (10).

8. A rotor blade for a wind power installation according to any one of claims 1 to 7, further comprising

a first component having the rotor blade tip,

a second component having the rotor blade root,

wherein the first and second components are in the form of separate parts and jointly form the rotor blade,

wherein the second component has at least a first load-bearing part (22) and at least a second part which represents the blade trailing edge box (24),

wherein the rotor blade is of a modular structure and wherein rotor blade tips of different dimensions can be fixed to the load-bearing part (22) and/or blade trailing edge boxes (24) of differing dimensions on the load-bearing part (22).

9. A rotor blade according to claim 8 wherein the rotor blade tips (10) have a previously defined contact face (10a) even in relation to different geometrical configurations,

wherein the rotor blade trailing edge boxes (24) have a previously defined contact face (24a) even with different dimensions.

10. A rotor blade according to claim 7 or claim 8

wherein the connecting face (10a) of the rotor blade tip (10) is adapted to a first connecting face (22a) of the load-bearing part (22), and

wherein the contact face (24a) of the blade trailing edge box (24) is adapted to a second connecting face (22b) of the load-bearing part (22).

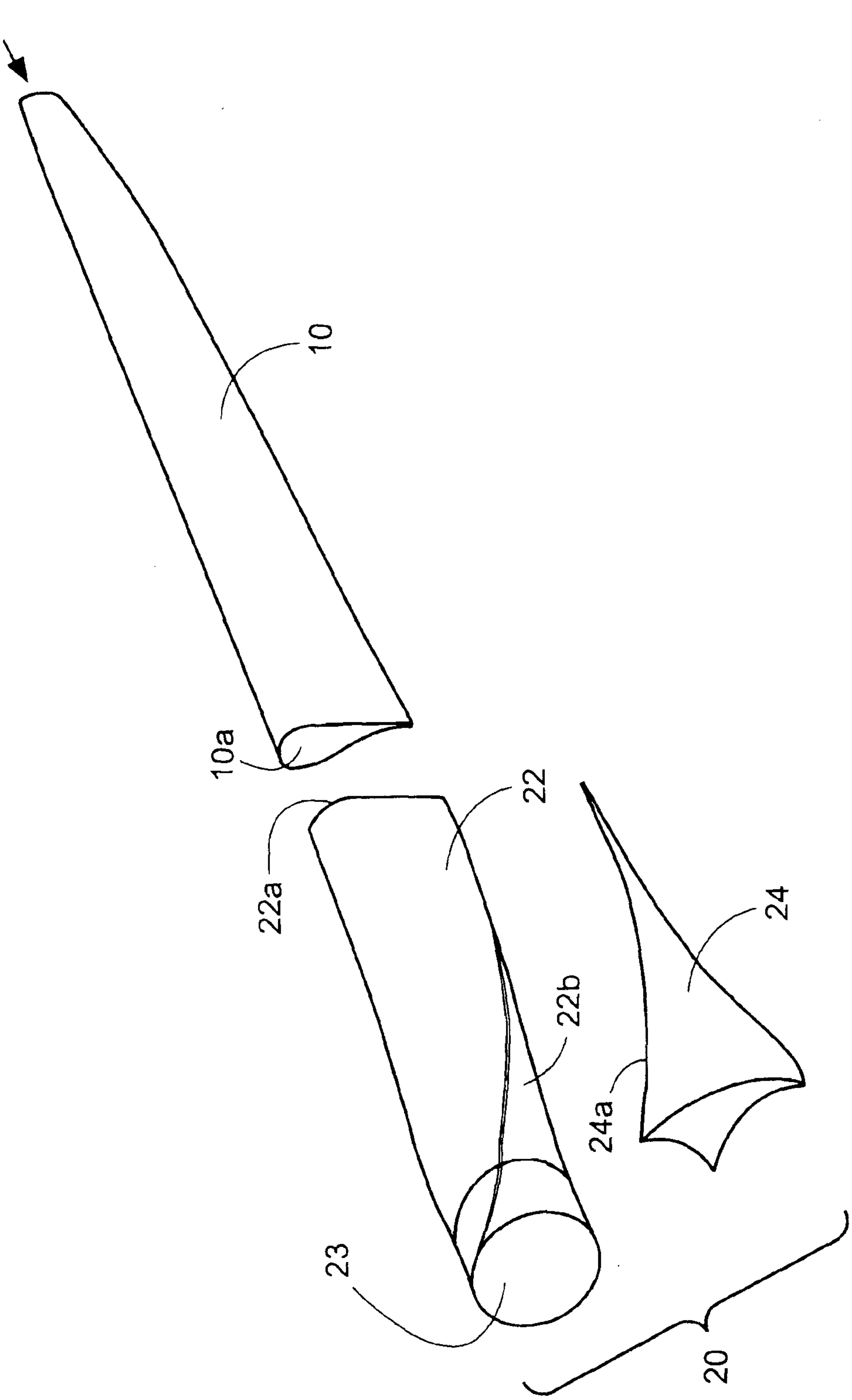


Fig.1

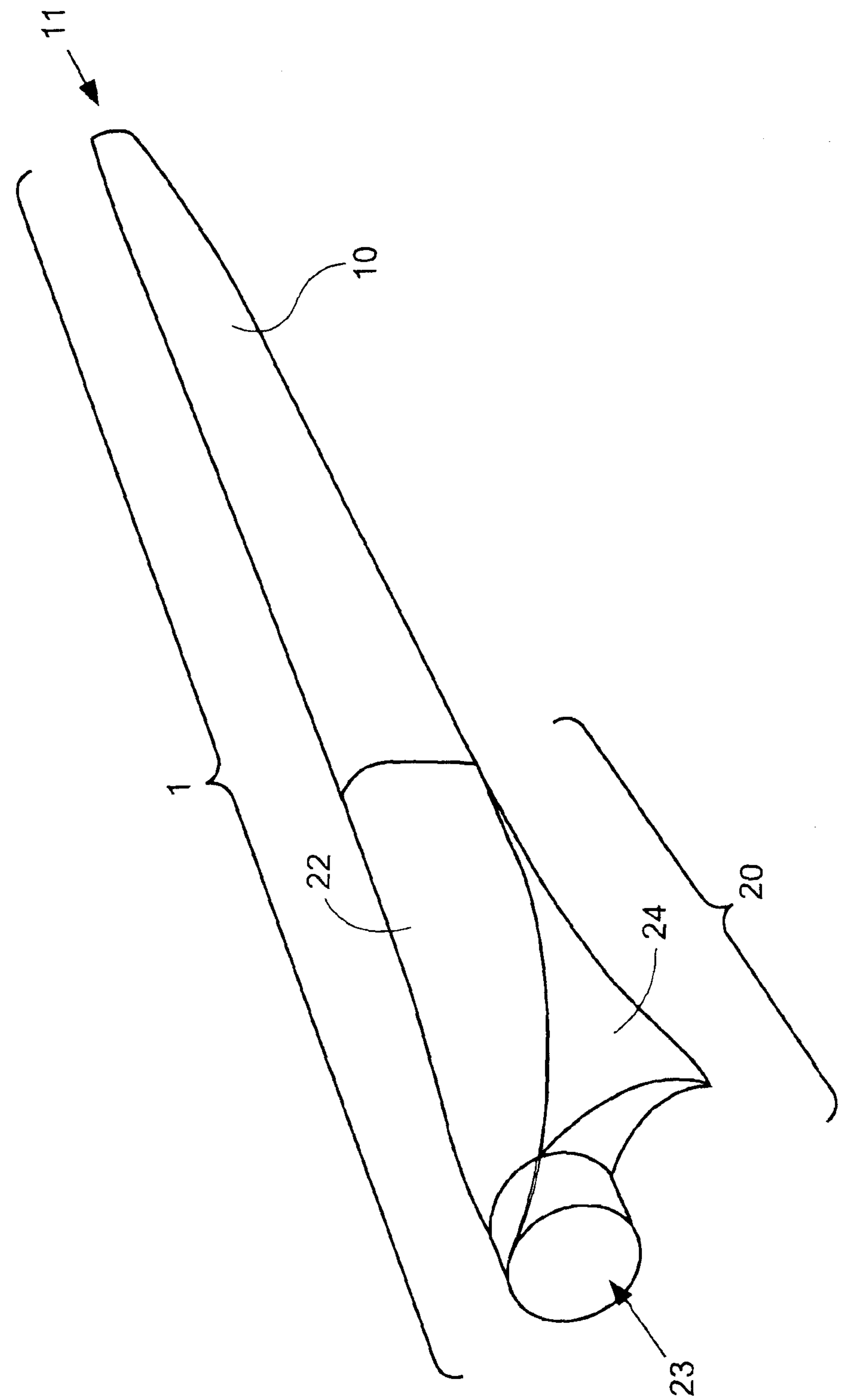


Fig.2

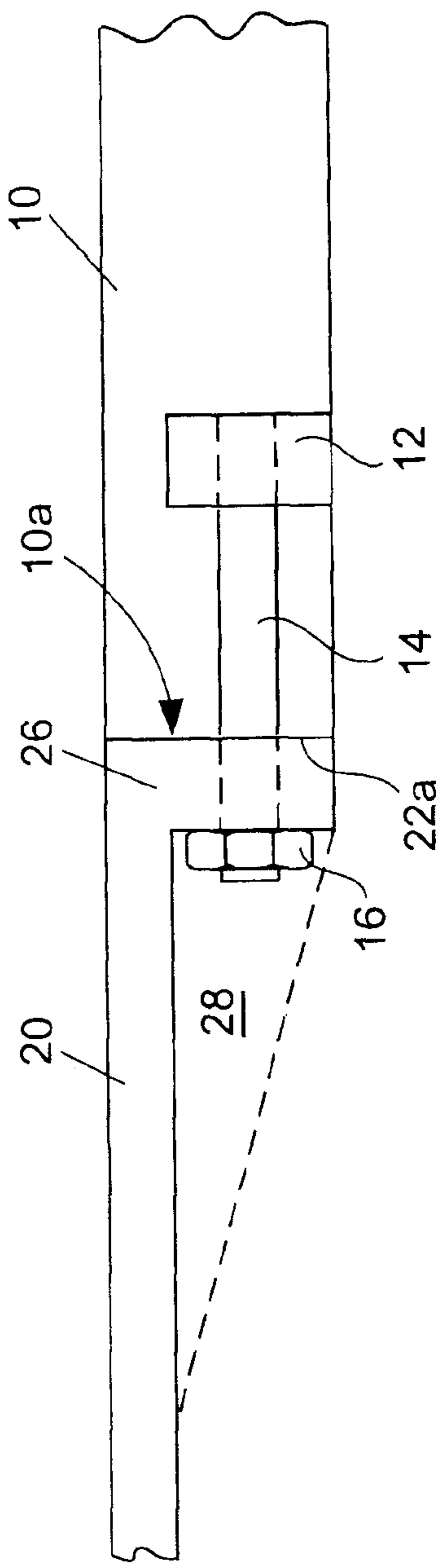


Fig.3

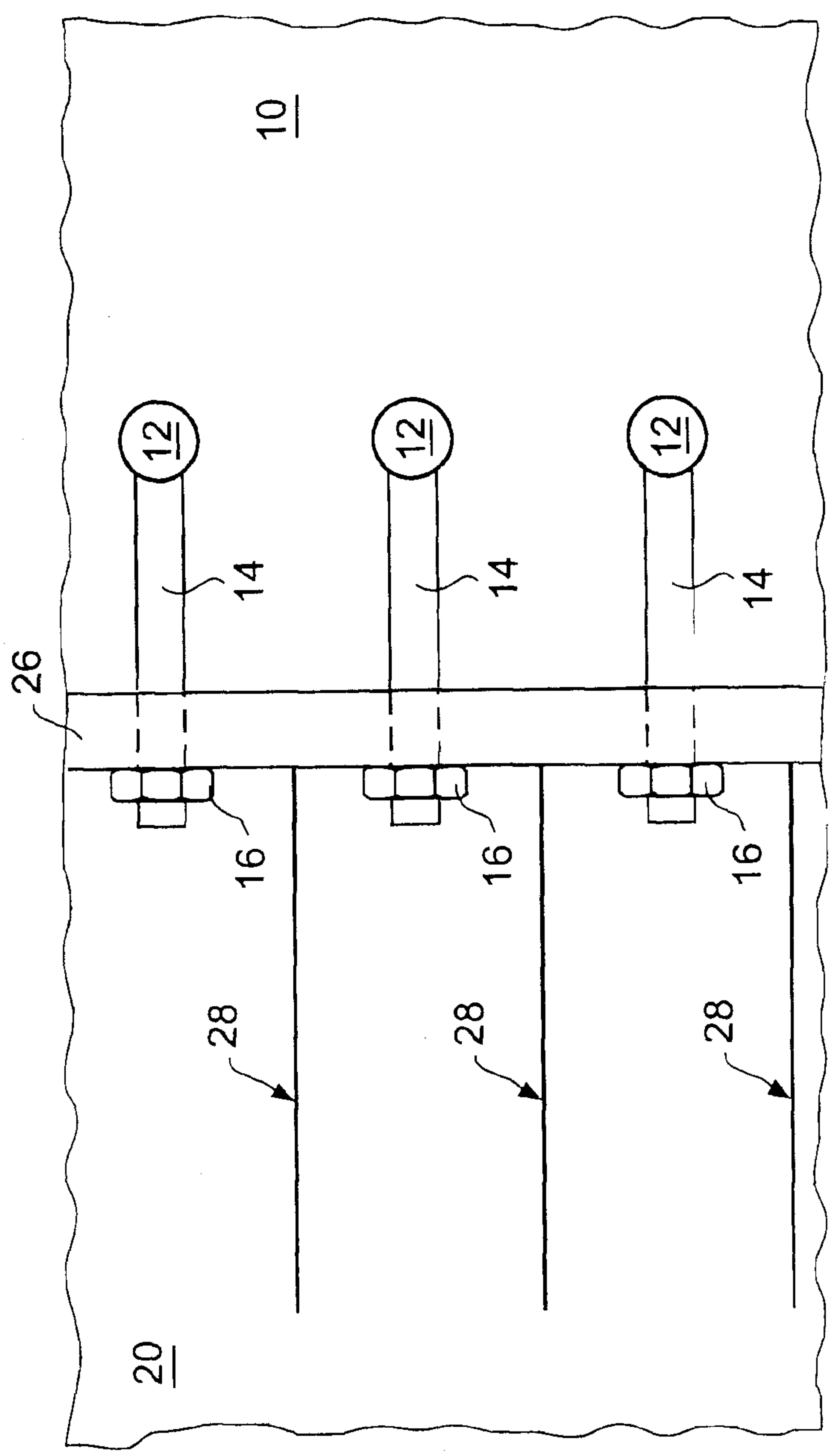


Fig.4

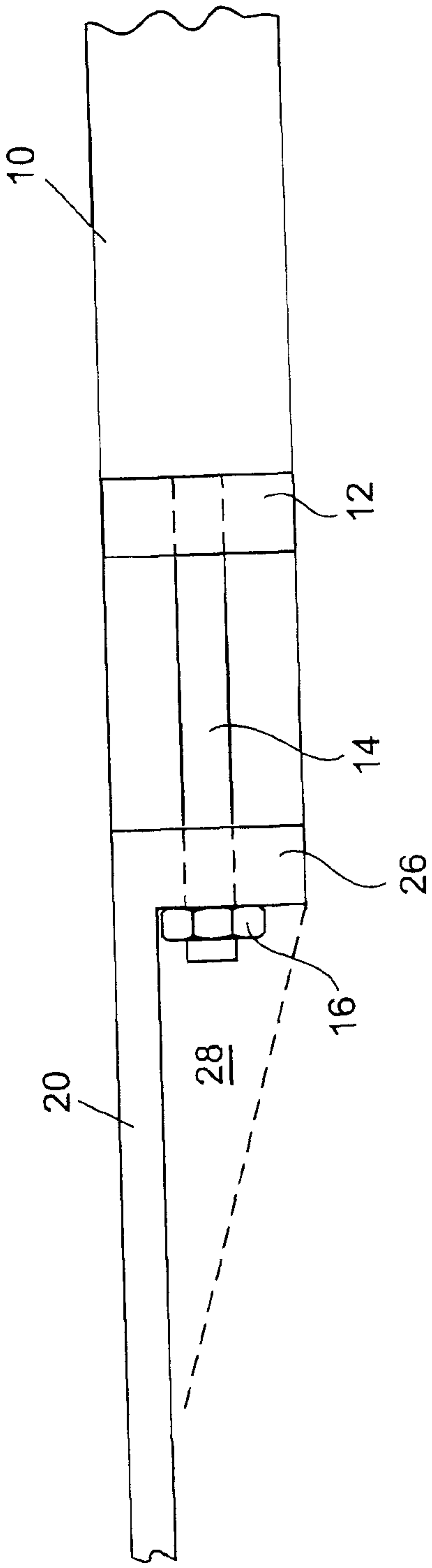
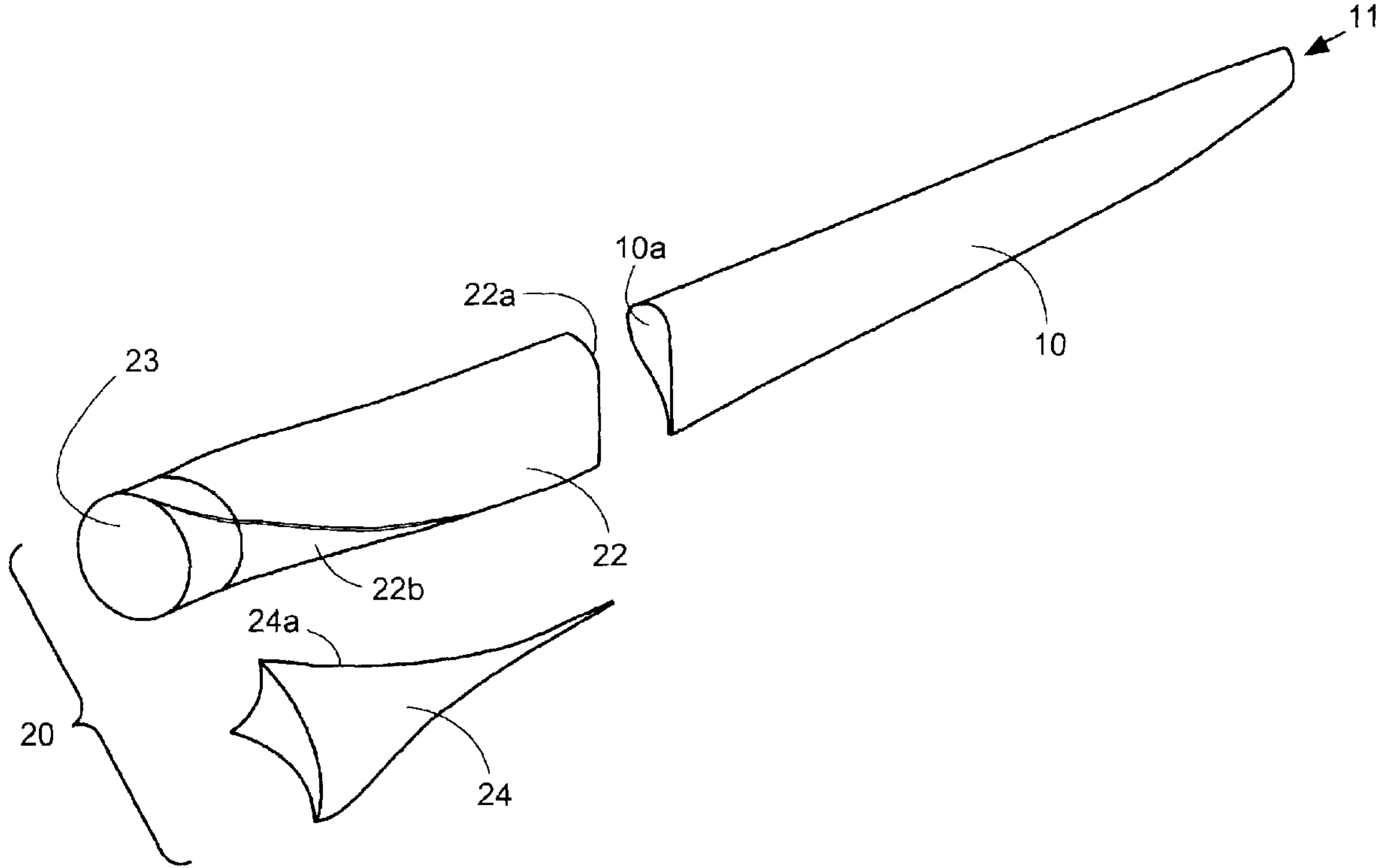


Fig.5



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22a
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22b
24a
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