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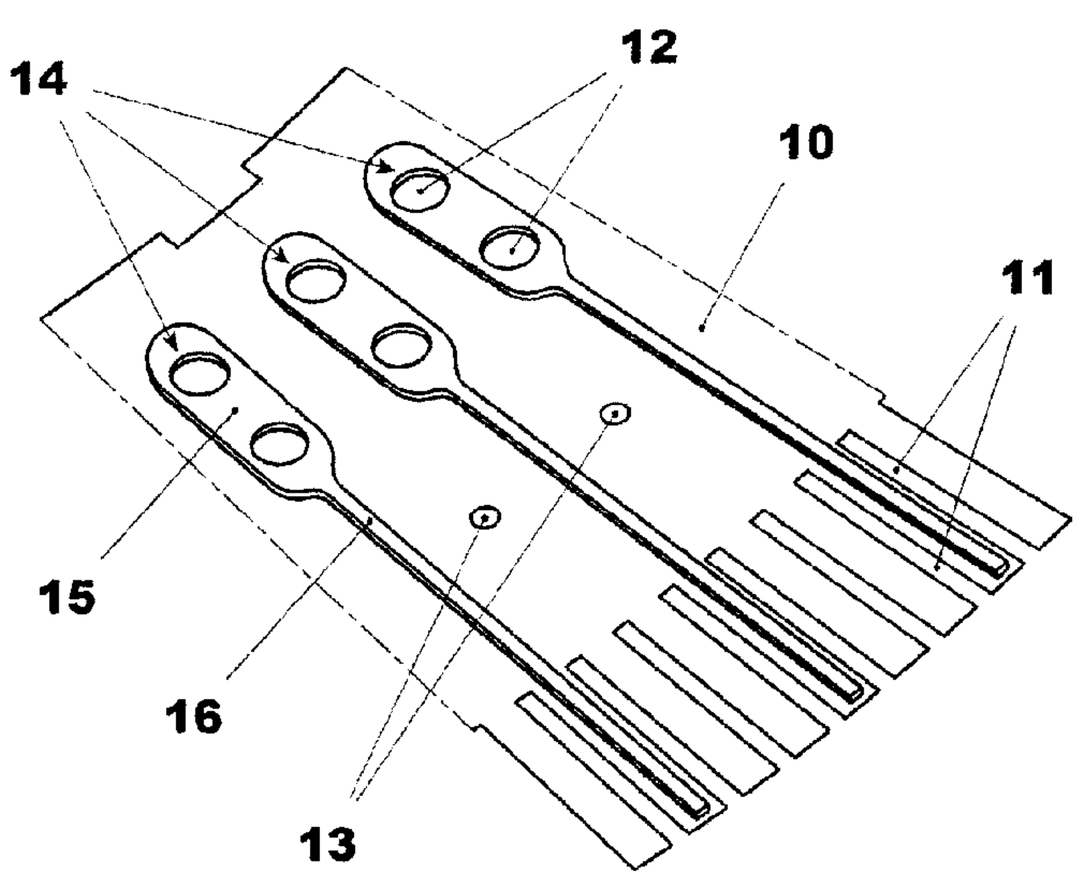


(57) Abrégé/Abstract:
A rotor for an electrodynamic machine, especially a hydrogenerator, comprises a laminated core which is assembled from a number of lamination segments (10) which are arranged in series in the axial direction, wherein for forming cooling ducts duct spacers (14) are inserted between lamination segments (10) which follow each other in the axial direction.

The duct spacers (14), for resisting centrifugal forces which act upon them, are supported on bolts (12) which extend through the laminated core of the rotor in the axial direction.

ABSTRACT

A rotor for an electrodynamic machine, especially a hydrogenerator, comprises a laminated core which is assembled from a number of lamination segments (10) which are arranged in series in the axial direction, wherein for forming cooling ducts duct spacers (14) are inserted between lamination segments (10) which follow each other in the axial direction.

The duct spacers (14), for resisting centrifugal forces which act upon them, are supported on bolts (12) which extend through the laminated core of the rotor in the axial direction.

(Fig. 1)

ROTOR FOR AN ELECTRODYNAMIC MACHINE

TECHNICAL FIELD

The invention relates to the field of electric machines. It refers to a rotor for an electrodynamic machine according to the preamble of claim 1.

BACKGROUND OF THE INVENTION

Stator and rotor cores of electrodynamic machines, such as generators, in most cases are formed as laminated cores which comprise lamination stacks of individual lamination segments, which stacks are held together with bolts. Slots which extend in the axial direction for accommodating the corresponding windings are arranged in the laminated cores on the inner or outer periphery. The rotor of such a machine is described for example in EP-A2-0 736 953.

In the case of high-performance machines, by inserting duct spacers between

adjacent stack sections of the laminated core, radial cooling ducts are formed, through which a suitable cooling medium, for example cooling air, flows in order to dissipate the heat which ensues in the winding or in the laminated core during operation.

Conventional duct spacers for stators, as are known for example from publications EP-A2-0 893 871 or US-A-4,362,960 or US-B2-6,583,526, are normally produced as double-T or rectangular profiles consisting of steel, non-magnetic steel or aluminum and are fastened on the lamination segments by means of spot-welding or adhesive bonding.

For fast-rotating laminated cores of rotors, adhesive bonding or spot-welding of the duct spacers no longer suffices on account of the high centrifugal forces.

SUMMARY OF THE INVENTION

It is therefore the object of the invention to disclose a rotor of the type referred to the introduction, the duct spacers of which are protected in a simple way against a harmful influence of the centrifugal forces which occur during operation.

The object is achieved by means of the entirety of the features of original claim 1. It is essential for the invention that the duct spacers, for resisting centrifugal forces which act upon them, are supported on bolts which extend through the laminated core of the rotor in the axial direction. As a result of this, a fastening of the spacer elements on the laminated core results which safely withstands the largest centrifugal forces which occur.

According to one development of the invention, the duct spacers extend essentially in the radial direction.

Another development of the invention is characterized in that at least some of the

duct spacers are formed in one piece and have a constant thickness, wherein the duct spacers of constant thickness are especially cut out of a metal sheet. The one-piece duct spacers preferably comprise in each case a widened first section which has at least one hole for inserting the axial bolts of the laminated core, and also a narrow second section in the form of a radial finger.

Another development of the invention is characterized in that at least some of duct spacers are assembled in each case from a plurality of individual parts which at least partially lie one above the other, wherein the duct spacers which are assembled from a plurality of individual parts which at least partially lie one above the other preferably have the same thickness in the regions in which the individual parts lie one above the other.

The assembled duct spacers preferably comprise in each case an upper part and a lower part which have in each case a widened first section with a hole for inserting the axial bolts of the laminated core, and also a narrow second section in the form of a radial finger, wherein the two parts with the first section and the hole arranged therein lie one above the other, while the fingers lie next to each other in a spaced apart manner.

For adjusting to the overall thickness of the two first sections which lie one above the other the fingers especially have double thickness compared with the first sections.

For doubling the thickness, in this case strip-like layers can be arranged on the fingers.

Another development is characterized in that the assembled duct spacers comprise in each case an upper part and a lower part, in that one of the two parts has a widened first section with a hole for inserting the axial bolts of the laminated core, and also two narrow second sections in the form of radial fingers which lie next to each other in a spaced manner, in that the other of the two parts is formed

as a perforated disk, and in that the perforated disk and the first section with the hole arranged therein lie one above the other, wherein for adjusting to the overall thickness of the first section and perforated disk which lies upon it the fingers have double thickness compared with the first section.

For doubling the thickness, strip-like layers can especially be arranged on the fingers.

A further development of the invention is characterized in that radial slot-like cut-outs are arranged on the outer periphery of the lamination segments, which in the case of laminated cores form the winding slots, and in that the duct spacers extend in the radial direction up to and between the slot-like cut-outs.

Furthermore, it is advantageous if the duct spacers, for the support on the bolts, are additionally connected to the lamination segment by means of welding, spot-welding or pinning.

According to an aspect of the present disclosure, there is provided a rotor for an electrodynamic machine, especially a hydrogenerator, which rotor comprises: a laminated core which is assembled from a number of lamination segments which are arranged in series in an axial direction, wherein for forming cooling ducts duct spacers are inserted between lamination segments which follow each other in the axial direction, wherein for resisting centrifugal forces which act upon them, the duct spacers are supported on axial bolts which extend through the laminated core of the rotor in the axial direction, wherein at least some of the duct spacers are each assembled from a plurality of individual parts, which parts at least partially lie one above the other in the axial direction, wherein each of the assembled duct spacers comprises first part and a second part, each of which has a widened first section with a hole for inserting the axial bolts of the laminated core, and also a narrow second section in the form of a radial finger, wherein the first part and the second part with the first section and the hole arranged therein lie one above the other in the axial direction, while the radial fingers lie next to each other in a spaced apart manner.

There is also provided a rotor for an electrodynamic machine, especially a hydrogenerator, which rotor comprises: a laminated core which is assembled from a number of lamination segments which are arranged in series in an axial direction, wherein for forming cooling ducts duct spacers are inserted between lamination segments which follow each other in the axial direction, wherein for resisting centrifugal forces which act upon them, the duct spacers are supported on axial bolts which extend through the laminated core of the rotor in the axial direction, wherein at least some of the duct spacers are each assembled from a plurality of individual parts, which parts at least partially lie one above the other in the axial direction, wherein each of the assembled duct spacers comprises first apart and a second part, wherein one of the first part and the second part has a widened first section with a hole for inserting the axial bolts of the laminated core, and also two narrow second sections in the form of radial fingers which lie next to each other in a spaced apart manner, wherein the other of the first part and the second part is formed as a perforated disk, and wherein the perforated disk and the first section with the hole arranged therein lie one above the other in the axial direction.

BRIEF EXPLANATION OF THE FIGURES

The invention is to be subsequently explained in more detail based on exemplary embodiments in conjunction with the drawing. In the drawing

Fig. 1 shows in a perspective view a rotor lamination segment with single-finger duct spacers supported on bolts, according to a first exemplary embodiment of the invention;

Fig. 2 shows in two sub-figures 2(a) and 2(b) in perspective view an individual double-finger duct spacer of a first type (Fig. 2a), and also a corresponding rotor lamination segment with single-finger and double-finger duct spacers (Fig. 2b) supported on bolts, according to a second exemplary embodiment of the invention;

Fig. 3 shows in two sub-figures 3(a) und 3(b) in perspective view an individual double-finger duct spacer of a second type (Fig. 3a), and also a corresponding rotor lamination segment with single-finger and double-finger duct spacers (Fig. 3b) supported on bolts, according to a third exemplary embodiment of the invention;

Fig. 4 shows in two sub-figures 4(a) und 4(b) in perspective view an individual double-finger duct spacer of a third type (Fig. 4a), and also a corresponding rotor lamination segment with single-finger and double-finger duct spacers (Fig. 4b) supported on bolts, according to a fourth exemplary embodiment of the invention; and

Fig. 5 shows in two sub-figures 5(a) und 5(b) in perspective view an individual double-finger duct spacer of a first type (Fig. 5a), and also a corresponding rotor lamination segment with single-finger and double-finger duct spacers (Fig. 2b) supported on bolts, according to a second exemplary embodiment of the invention.

WAYS OF IMPLEMENTING THE INVENTION

In Fig. 1, in a perspective view, a rotor lamination segment 10 with single-finger duct spacers 14 supported on bolts according to a first exemplary embodiment of the invention is shown. The lamination segment 10 has the shape of a circle segment and on the outer periphery has a number of radial slot-like cutouts 11 which, when the rotor laminated core is complete, form the axial slots for accommodating the rotor winding. Furthermore, bolt-holes 12 and 13 are provided in the lamination segments 10 on a plurality of concentric diameter circles, which serve in the laminated core for inserting corresponding bolts, as is shown in publication EP-A2-0 736 953 which is referred to in the introduction. The large bolt-holes 12 are provided for so-called rim bolts, the small bolt-holes 13 being

provided for clamping bolts.

A plurality of duct spacers 14, three in the example of Fig. 1, are attached in radial alignment on the upper side of the lamination segment 10 and constructed in one piece, and for example are cut out from a metal sheet by means of a laser. The duct spacers 14 are formed so that both axial clamping and optimum air guiding are ensured. The duct spacers 14 are supported against the (radial) centrifugal forces, which occur during operation, on the rim bolts which are inserted in the bolt-holes 12. This is achieved by the duct spacers 14 comprising a widened first section 15 on the inner end in each case, which has two holes in series in the radial direction which correspond to the bolt-holes 12 of the lamination segment 10. In the laminated core the rim bolts therefore extend through the holes in the section 15 of the duct spacers 14 and securely fix them.

Oriented outwards in the radial direction, the first or hole section 15 merges into a narrow radial finger 16 which extends between adjacent slot-like cut-outs 11 up to the outer edge of the lamination segment 10. Between adjacent duct spacers 14 or fingers 16 radial ducts are thus formed in the laminated core, through which cooling air or another cooling medium can flow. The duct spacers 14 in this example have the same thickness overall. They are preferably lasered or else otherwise solidly machined from steel, antimagnetic steel, or aluminum.

In the example of Fig. 1, the duct spacers 14 have a relatively large distance from each other in the region of the slot-like cutouts 11: only every third tooth (region between adjacent slot-like cutouts 11) of the lamination segment 10 supports the finger 16 of a duct spacer 14. In order to achieve here a much finer division of the cooling ducts, additional duct spacers can be inserted, as are reproduced in detail in Figs. 2 to 5 in the respective sub-figure (a).

The additional duct spacers 17, 24, 27, 32 all have the same pincer-like basic shape, that is to say a widened inner section 20, 20' in which a bolt-hole 21 is provided which corresponds to the bolt-hole 13, and also two spaced-apart fingers

22, 23 which extend from this section 20, 20' in the radial direction. As is apparent from the sub-figures (b) of Figs. 2 – 5, the two fingers 22, 23 of the additional duct spacers 17, 24, 27, 32 also extend through between adjacent slot-like cutouts 11 up to the outer edge of the lamination segment 10. In this way each slot-like cutout 11 is bordered on its two longitudinal sides by a finger in each case.

The additional duct spacers 17, 24, 27, 32 are assembled in each case from a plurality of individual parts 18, 19 (Fig. 2) or 18, 19, 25, 26 (Fig. 3) or 28, 29; 30, 31 (Figs. 4 and 5) which at least partially lie one above the other. The duct spacers 17, 24, 27, 32 which are assembled from a plurality of individual parts 18, 19; 25, 26; 28, 29; 30, 31 which at least partially lie one above the other have the same thickness in the regions in which the individual parts 18, 19; 25, 26; 28, 29; 30, 31 lie one upon the other, which corresponds to the thickness of the other duct spacers 14.

In the case of the exemplary embodiments of Figs. 2(a) and 3(a), the assembled duct spacers 17 or 24 comprise in each case an upper part 18 and a lower part 19 which have in each case a widened first section 20 or 20' with a hole 21 for inserting the axial bolts of the laminated core, and also a narrow second section in the form of a radial finger 22 or 23. Upper part and lower part 18 or 19 are arranged in relation to each other like the legs of dividers, wherein the bolt-holes 21 of the two parts lie one above the other and form the axis of the dividers. The fingers 22, 23 are constructed with double thickness compared with the first sections 20, 20' for adjusting to the overall thickness of the two first sections 20, 20' which lie one above the other.

In the case of the embodiment which is shown in Fig. 2, the height of the fingers 22, 23 is altered in addition, which in the case of the upper part 18 increases downwards and in the case of the lower part 19 increases upwards. As a result of this, the height offset between the two fingers 22, 23 is compensated.

In the case of the embodiment which is shown in Fig. 3, for doubling the thickness

strip-like layers 25, 26 are arranged on the fingers 22, 23, wherein the layer 25 is applied on the lower side in the case of the upper part 18 and the layer 26 is applied on the upper side in the case of the lower part 19.

In the case of the exemplary embodiments of Figs. 4 and 5, the assembled duct spacers 27 or 32 comprise in each case an upper part 28 and a lower part 29. The lower part 29 has a widened first section with a hole 21 for inserting the axial bolts of the laminated core, and also two narrow second sections in the form of radial fingers 22, 23 which lie next to each other in a spaced apart manner. The upper part 28 is formed as a perforated disk. The perforated disk 28 and the first section 20 with the hole 21 arranged therein lie one above the other. Upper and lower section can also swap places.

For adjusting to the overall thickness of first section 20 and perforated disk 28 which lies above it, the fingers 22, 23 here are also constructed with double thickness compared with the first section 20, which is achieved by means of strip-like layers 30, 31 on the fingers 22, 23. The strips 30, 31 can be applied on the two fingers 22, 23 on the top (Fig. 4a). However, according to the example from Fig. 5(a) the strips can also be attached on the one finger 22 on the upper side and on the other finger 23 on the lower side if one of the fingers (23) is correspondingly vertically offset as a result of an S-shaped bend 33.

The duct spacers 14, 17, 24, 27, 32 in addition to the support on the bolts can be connected to the lamination segment 10 by means of welding, spot-welding or pinning.

LIST OF DESIGNATIONS

10	Lamination segment (rotor)
11	Slot-like cut-out
12	Bolt-hole (rim bolt)
13	Bolt-hole (clamping bolt)

14, 17, 24, 27, 32	Duct spacer
15	Hole section
16	Finger (radial)
18	Upper part
19	Lower part
20, 20'	Hole section
21	Bolt-hole
22, 23	Finger (radial)
25, 26	Layer (strip-like)
28	Upper part
29	Lower part
30, 31	Layer (strip-like)
33	Bend (S-shaped)

CLAIMS:

1. A rotor for an electrodynamic machine, especially a hydrogenerator, which rotor comprises:

a laminated core which is assembled from a number of lamination segments which are arranged in series in an axial direction, wherein for forming cooling ducts duct spacers are inserted between lamination segments which follow each other in the axial direction, wherein for resisting centrifugal forces which act upon them, the duct spacers are supported on axial bolts which extend through the laminated core of the rotor in the axial direction,

wherein at least some of the duct spacers are each assembled from a plurality of individual parts, which parts at least partially lie one above the other in the axial direction,

wherein each of the assembled duct spacers comprises first part and a second part, each of which has a widened first section with a hole for inserting the axial bolts of the laminated core, and also a narrow second section in the form of a radial finger, wherein the first part and the second part with the first section and the hole arranged therein lie one above the other in the axial direction, while the radial fingers lie next to each other in a spaced apart manner.

2. The rotor as claimed in claim 1, wherein the duct spacers extend essentially in a radial direction.

3. The rotor as claimed in claim 1 or 2, wherein at least some of the duct spacers are formed in one piece and have a constant thickness.

4. The rotor as claimed in claim 3 wherein the duct spacers of constant thickness are cut out of a metal sheet.

5. The rotor as claimed in claim 1, wherein the duct spacers which are assembled from a plurality of individual parts which at least partially lie one above the

other in the axial direction have the same thickness in regions in which the individual parts lie one above the other in the axial direction.

6. The rotor as claimed in claim 3 or 4, wherein each of the one-piece duct spacers comprises a widened first section, which has at least one hole for inserting the axial bolts of the laminated core, and also a narrow second section in the form of a radial finger.

7. The rotor as claimed in claim 1, wherein for adjusting to overall thickness of the two first sections which lie one above the other in the axial direction, the fingers have double thickness compared with the first sections.

8. The rotor as claimed in claim 7, wherein for doubling the thickness of the fingers strip-like layers are arranged on the fingers.

9. A rotor for an electrodynamic machine, especially a hydrogenerator, which rotor comprises:

a laminated core which is assembled from a number of lamination segments which are arranged in series in an axial direction, wherein for forming cooling ducts duct spacers are inserted between lamination segments which follow each other in the axial direction, wherein for resisting centrifugal forces which act upon them, the duct spacers are supported on axial bolts which extend through the laminated core of the rotor in the axial direction,

wherein at least some of the duct spacers are each assembled from a plurality of individual parts, which parts at least partially lie one above the other in the axial direction,

wherein each of the assembled duct spacers comprises first apart and a second part, wherein one of the first part and the second part has a widened first section with a hole for inserting the axial bolts of the laminated core, and also two narrow second sections in the form of radial fingers which lie next to each other in a

spaced apart manner, wherein the other of the first part and the second part is formed as a perforated disk, and wherein the perforated disk and the first section with the hole arranged therein lie one above the other in the axial direction.

10. The rotor as claimed in claim 9, wherein for adjusting to overall thickness, the fingers have double thickness compared with the first section.

11. The rotor as claimed in claim 10, wherein for doubling the thickness of the fingers strip-like layers are arranged on the fingers.

12. The rotor as claimed in any one of claims 9 to 11, wherein the duct spacers extend essentially in a radial direction.

13. The rotor as claimed in any one of claims 9 to 12, wherein the duct spacers which are assembled from a plurality of individual parts which at least partially lie one above the other in the axial direction have the same thickness in regions in which the individual parts lie one above the other in the axial direction.

14. The rotor as claimed in any one of claims 1 to 13, wherein on an outer periphery of the lamination segments radial slot-like cutouts are arranged which form winding slots in the laminated core, and wherein the duct spacers extend in the radial direction up to and between the slot-like cutouts.

15. The rotor as claimed in any one of claims 1 to 14, wherein the duct spacers, for support on the axial bolts, are additionally connected to the lamination segment by means of welding, spot-welding, or pinning.

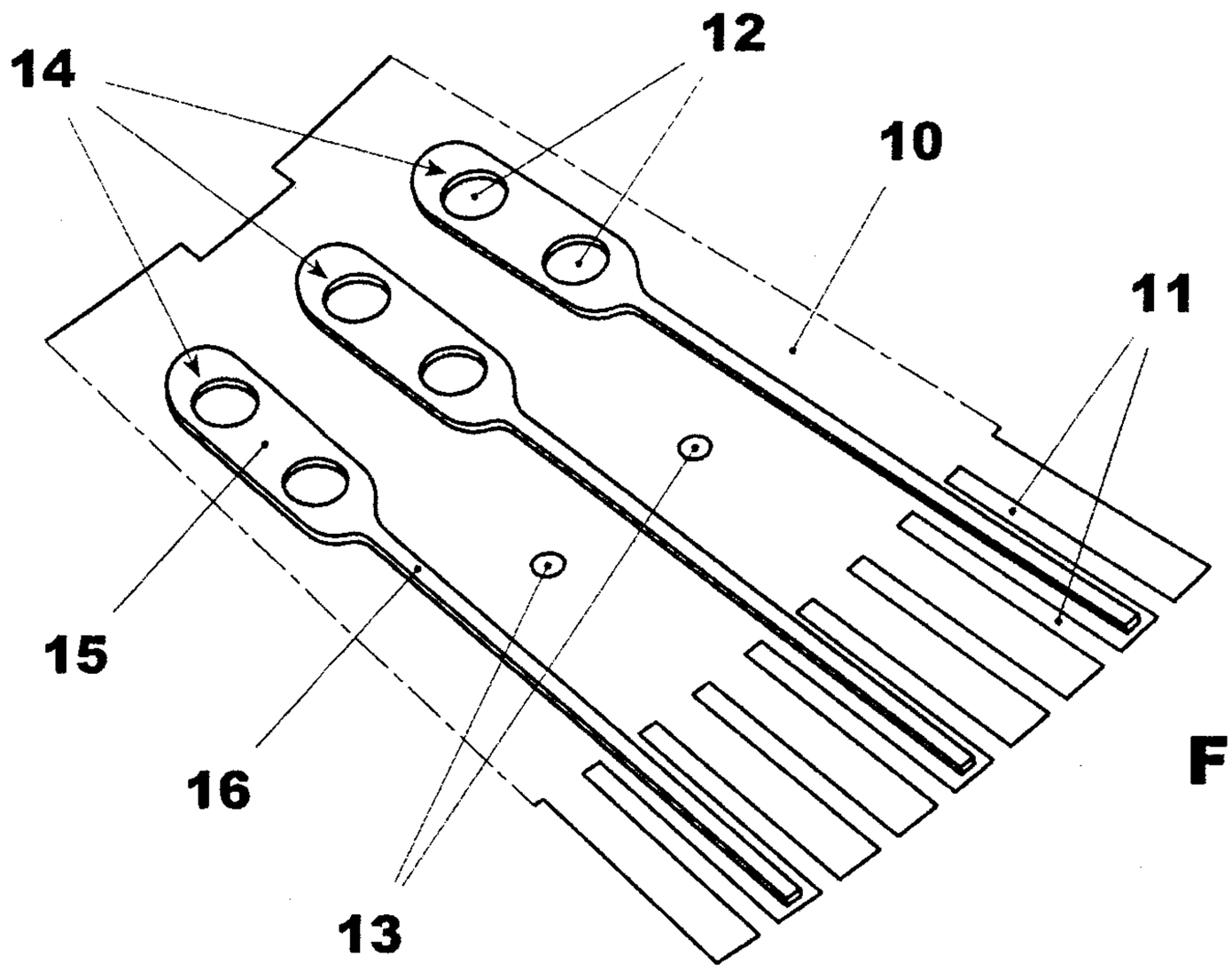


FIG. 1

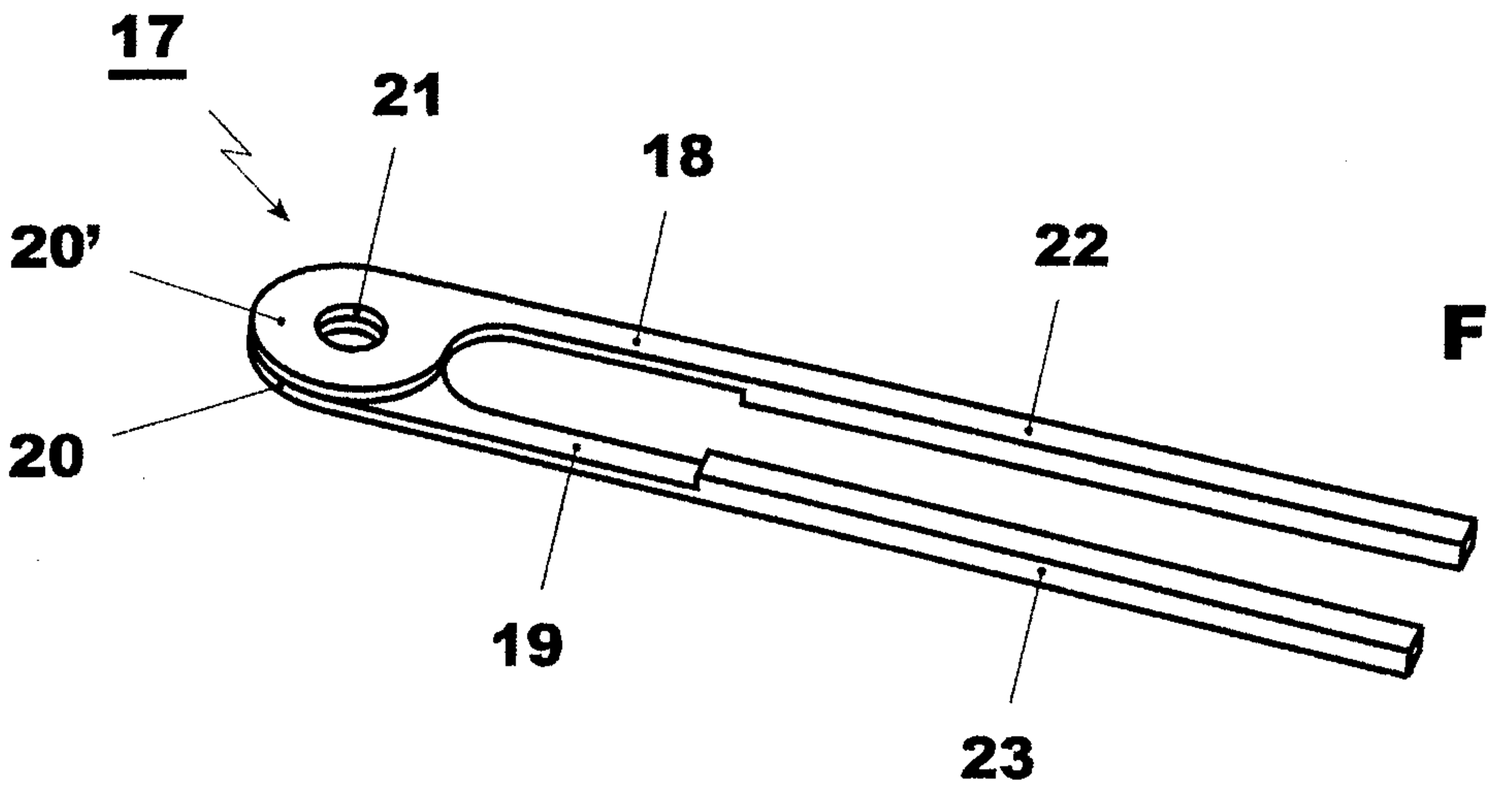


FIG. 2a

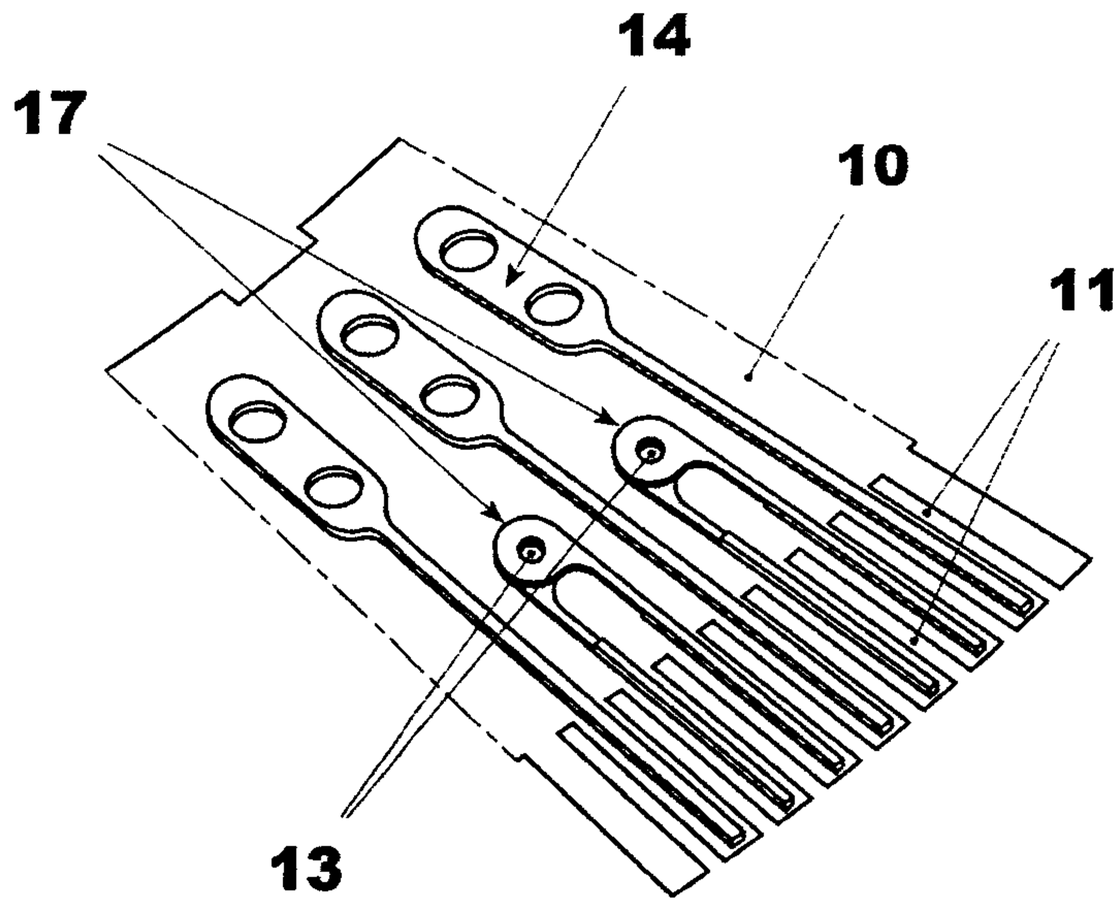


FIG. 2b

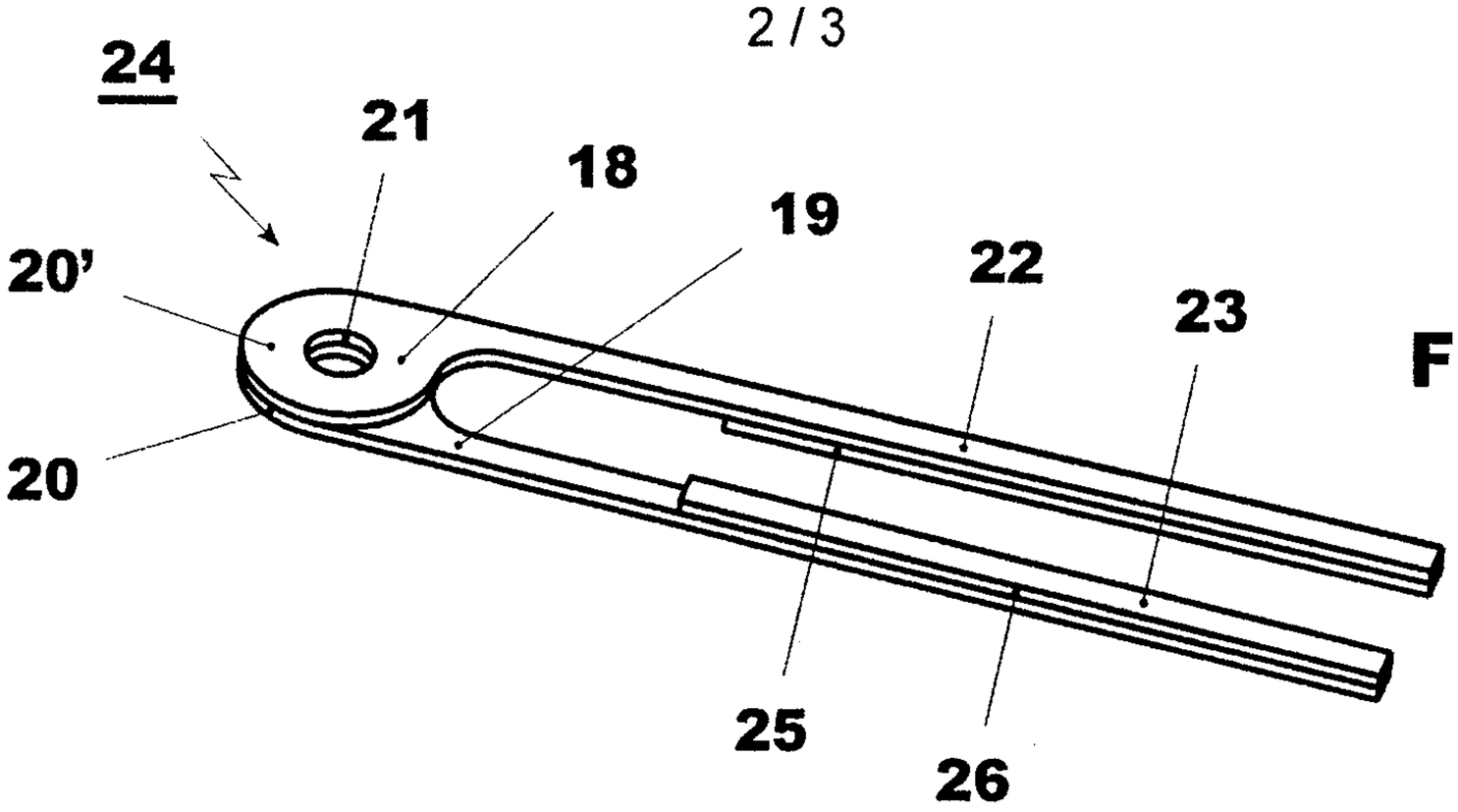


FIG. 3a

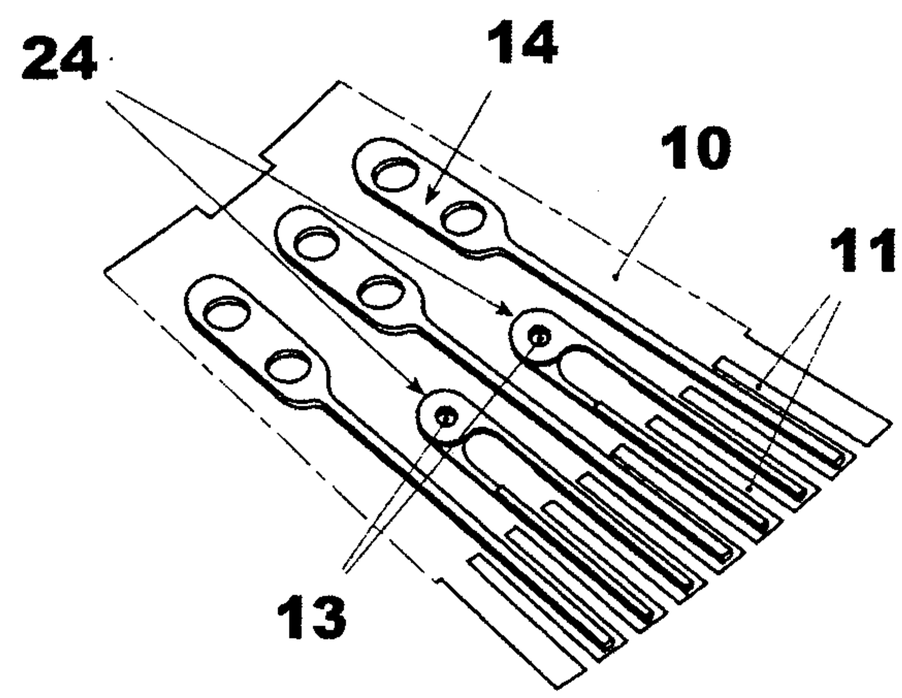


FIG. 3b

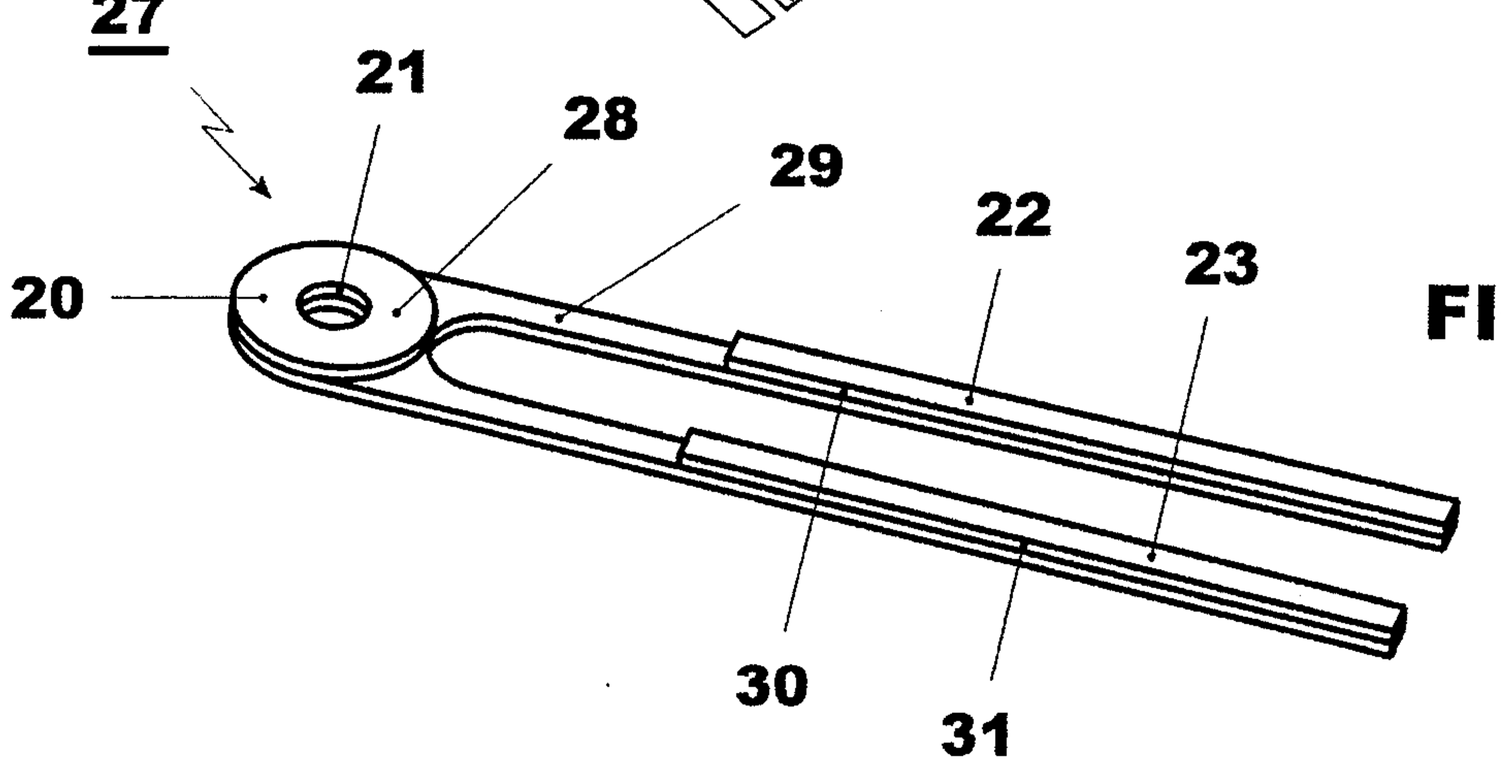


FIG. 4a

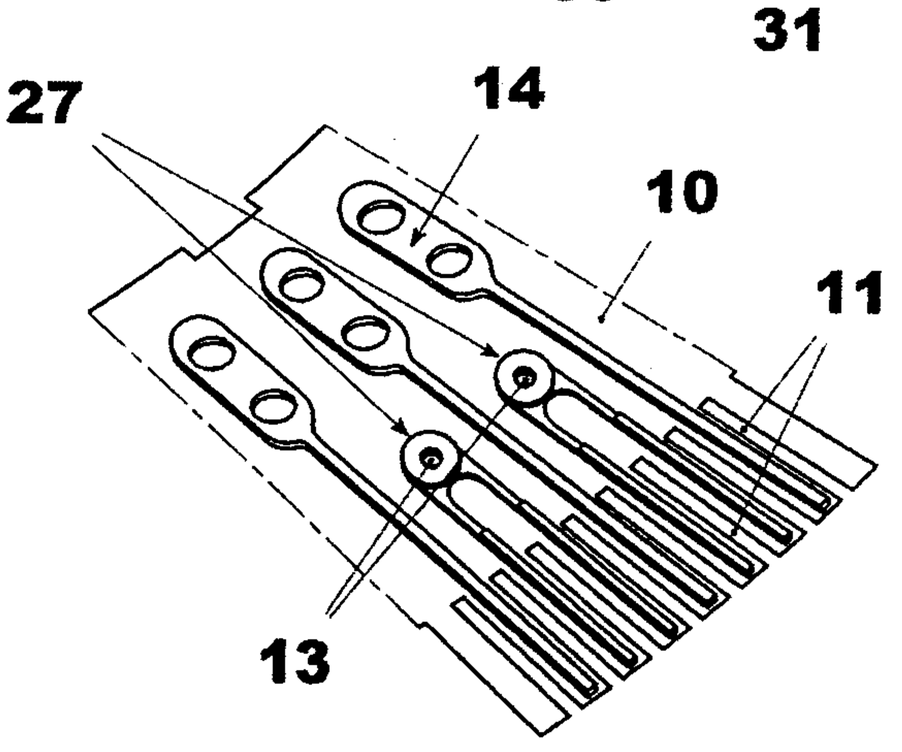


FIG. 4b

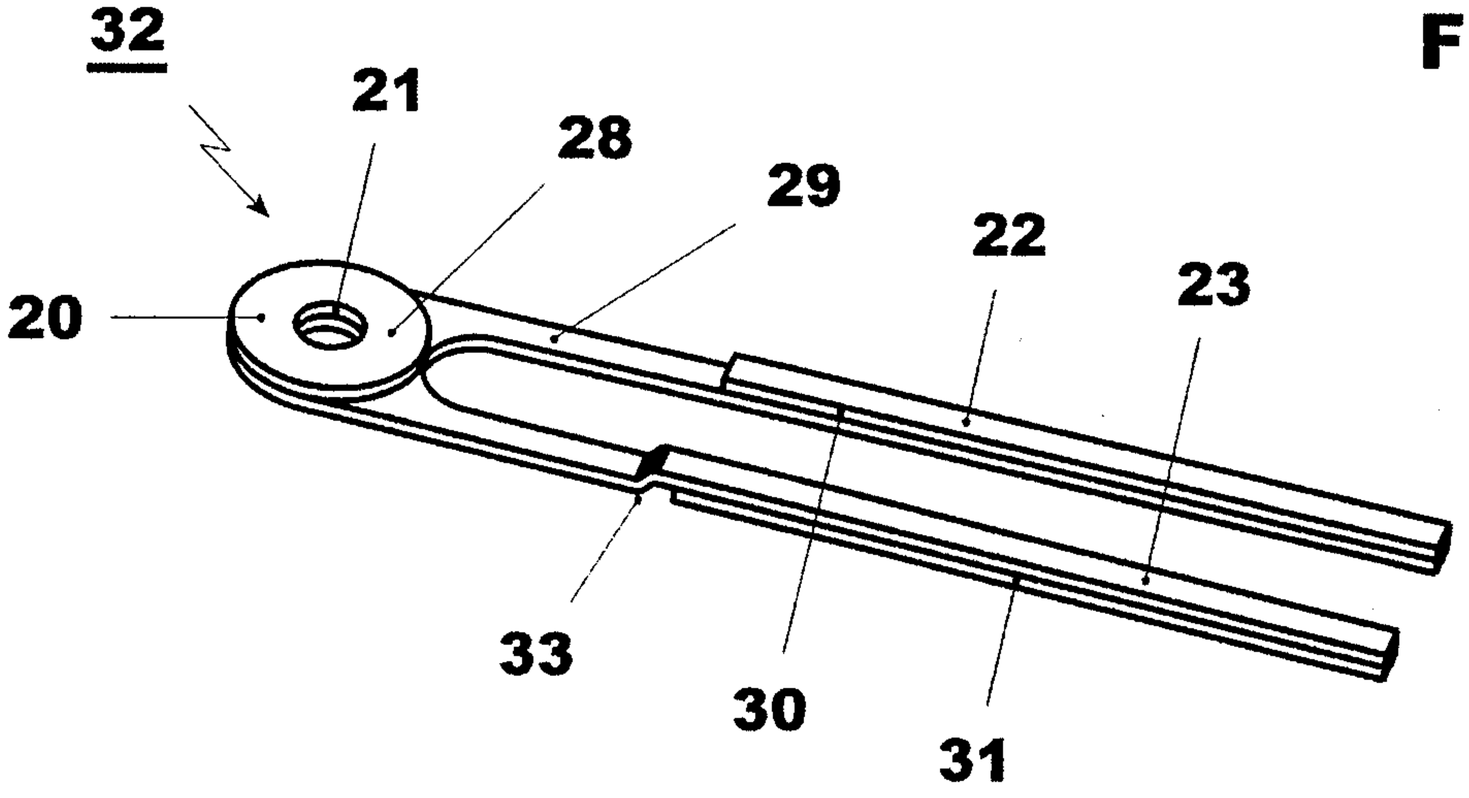


FIG. 5a

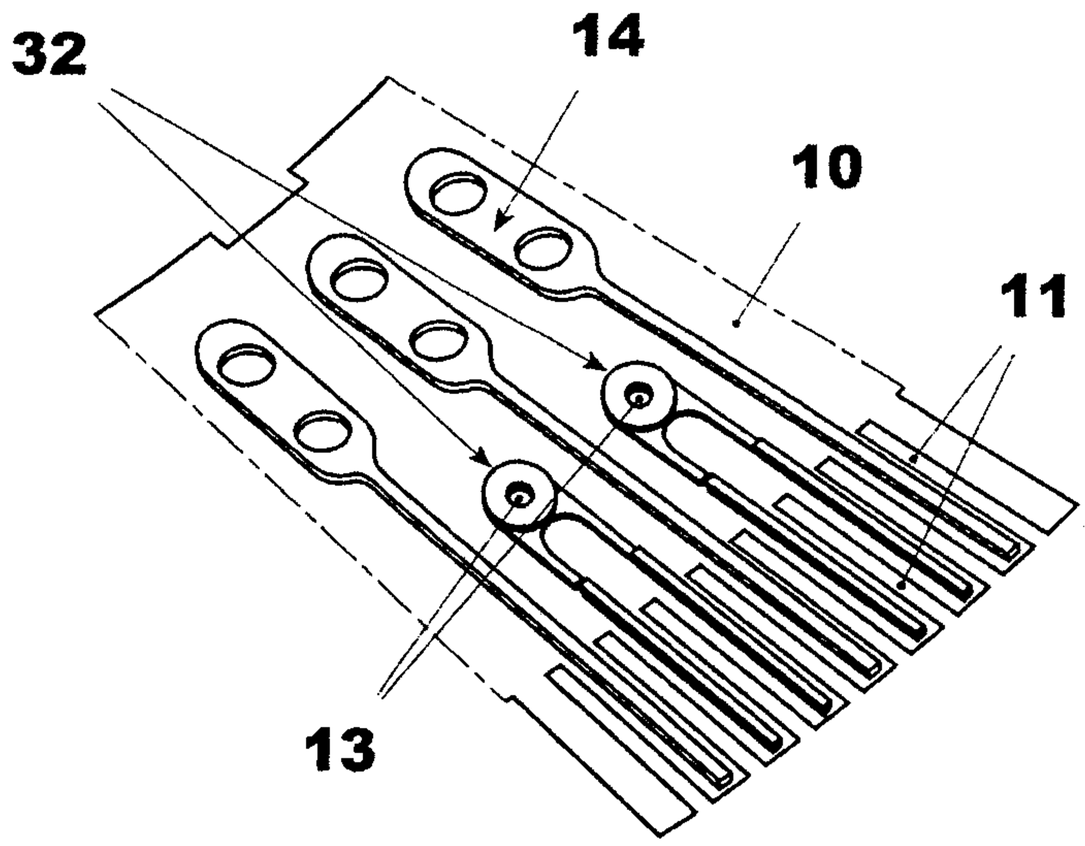
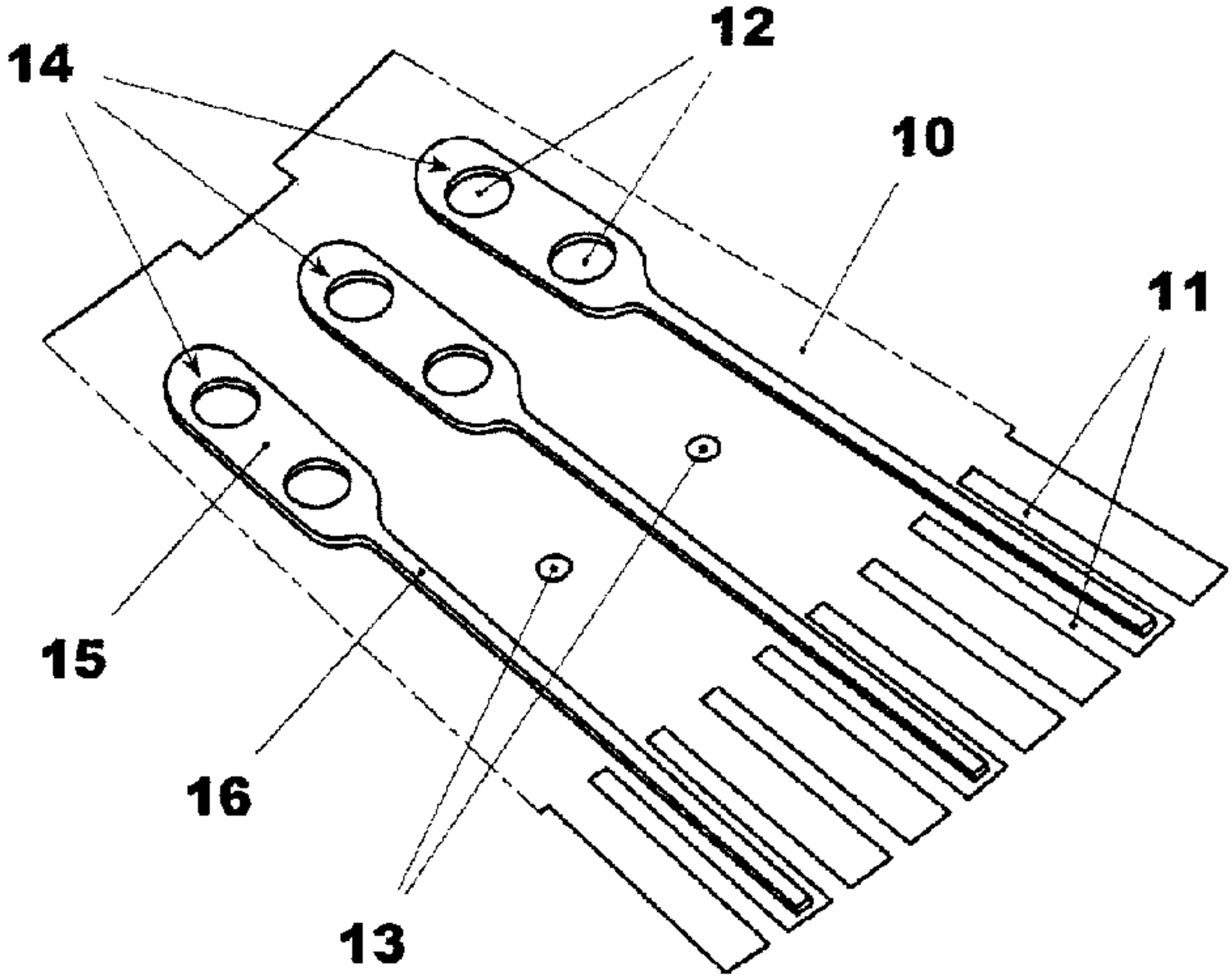


FIG. 5b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