

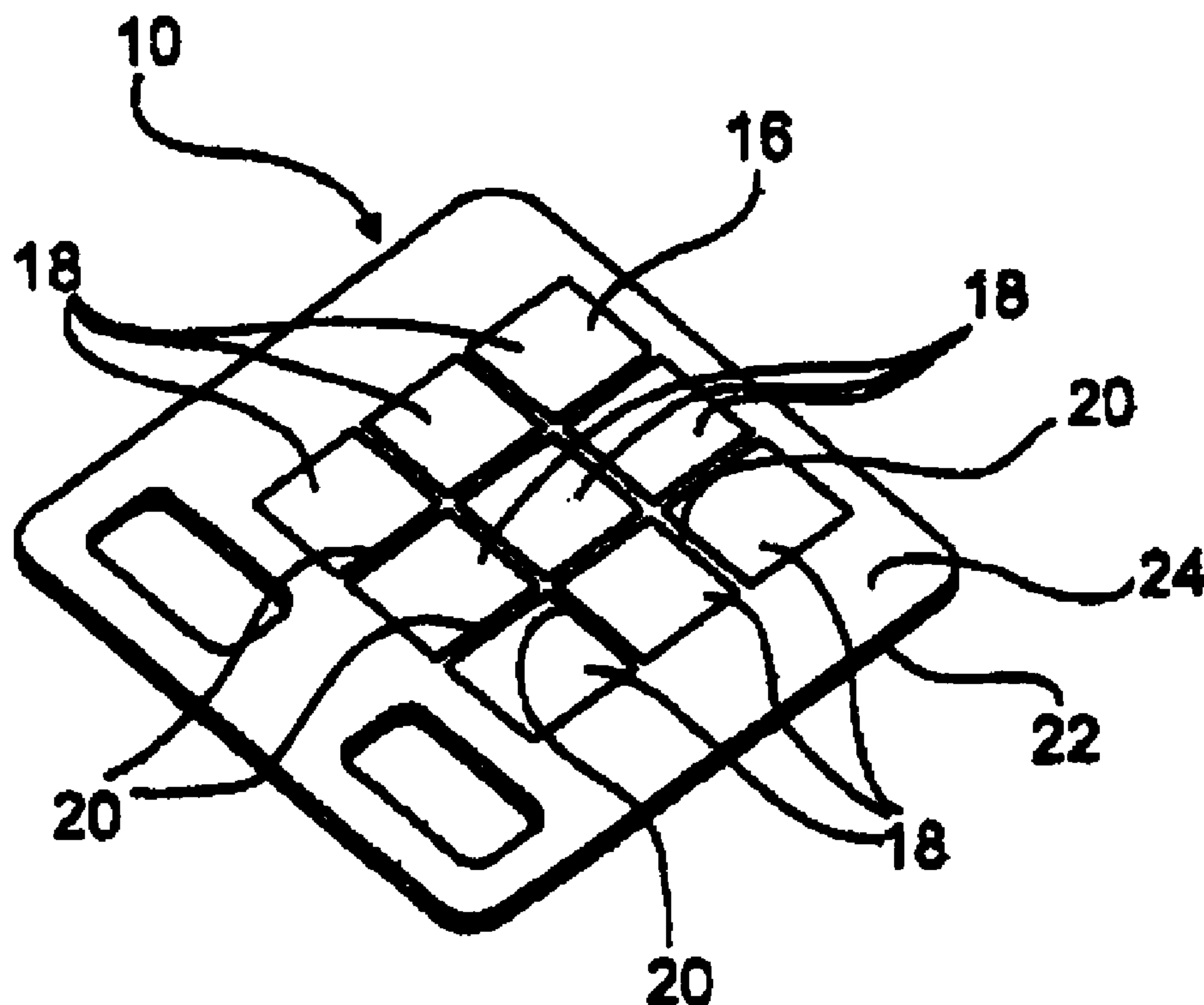


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(54) Titre : PLAQUE POLAIRE, NOTAMMENT PLAQUE D'EXTREMITÉ OU PLAQUE BIPOLAIRE POUR PILE A
COMBUSTIBLE

(54) Title: POLAR PLATE, PARTICULARLY END PLATE OR BIPOLAR PLATE FOR A FUEL CELL



(57) Abrégé/Abstract:

The invention relates to a polar plate (10, 12), particularly an end plate (10) or a bipolar plate (12), for a fuel cell (14), comprising at least one flow field (16) which is accessible from at least one side of the polar plate (10, 12). Said at least one flow field (16) is accessible via a plurality of access holes (18). The invention further relates to a terminal unit and a common unit for a fuel cell stack as well as a fuel cell stack.

ABSTRACT

- 5 The invention relates to a polar plate (10, 12), particularly an end plate (10) or a bipolar plate (12), for a fuel cell (14), comprising at least one flow field (16) which is accessible from at least one side of the polar plate (10, 12). Said at least one flow field (16) is accessible via a plurality of access holes (18). The invention further relates to a terminal unit and a common unit for a fuel cell stack as well as a fuel cell stack.

Polar plate, particularly end plate or bipolar plate for a fuel cell

5 The invention relates to a polar plate, particularly to an end plate or a bipolar plate, for a fuel cell comprising at least one flow field accessible from at least one side of the polar plate. The invention further relates to a termination and a repetitive unit for a fuel cell stack as well as to a fuel cell stack.

10 In SOFC fuel cell systems, for example, the fuel cell stack may consist of repetitive units stacked on top of each other as well as two termination units.

Figures 1, 2, 4 and 6 show a polar plate according to the state of the art, Figure 1 showing a schematic cross sectional view of a polar plate, Figure 2 the polar plate according to Figure 1
 15 deformed due to stresses, Figure 4 the detail Y of Figure 1 and Figure 6 a perspective illustration of the polar plate. The known polar plate 10' comprises a flow field plate 22' forming a housing bottom part comprising a flow field 16' not shown in any more detail and a blind plate 24' forming an upper housing part. Aside from two operating means supply orifices which are of no particular relevance the blind plate 24' comprises an access
 20 orifice 18' accessible via the flow field 16' as can be best seen in Figure 6. The flow field plate 22' and the blind plate 24' are connected in a gas-tight manner via a welded joint not shown in any more detail. Above and/or inside of the access orifice 18' a membrane-electrode unit 26' is disposed which is, for example, attached to the periphery of the blind plate 24' in a non-positive manner by means of solder glass. Additional seals, contact-
 25 generating layers, etc. which are provided in real embodiments are not shown for reasons of clarity.

The membrane-electrode unit 26' may, for example, be primarily formed of yttrium-stabilised zirconium oxide while the polar plate 10' can be made of ferritic steel. Materials
 30 which are so different have different expansion coefficients which lead to stress during thermal cyclising (in an SFOC fuel cell system, for example, the temperature may vary between the ambient temperature and an operating temperature of 800°C or more). Yttrium-stabilised zirconium oxide as well as ferritic steel are, in principle, capable of endure

tension and pressure stresses without any plastic deformation. The three-dimensional structure of the polar plate 10' which is recognisable particularly in Figure 1 and comprises narrow edges, however, leads to the possible occurrence of bending moments and therefore of a bending of the structure. Furthermore, withdrawal movements may occur due to the mechanical event of buckling. If the membrane-electrode unit 26' is exposed to compressive strain, for example at ambient temperature, while the polar plate 10' consisting of the flow field plate 22' and the blind plate 24' is exposed to tensile stress a bending moment occurs as shown in Figure 4. In this case the force F resulting from the compressive and tensile stresses cooperates with a lever arm L_1 . Said bending moment may lead to a deformation of the polar plate 10' as shown in Figure 2. The deformation shown is a relaxation of the tensions. An equilibrium will result in which lengths change as well. For example, the dimension x_2 shown in Figure 2 is larger than the dimension x_1 shown in Figure 1.

- Deformations of repetitive units or termination units 30' as shown in Figure 2 may lead to a cracking of seals and/or to a breaking or sliding-off of electric contacts.

The invention is therefore based on the object to at least substantially reduce deformations of termination and/or repetitive units for fuel cell stacks during a thermal cyclising.

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- The polar plate according to the invention is based on the generic state of the art in that at least one flow field is accessible via a plurality of access orifices. This solution is based on the finding that the material present between the access orifices results in a stiffening of the construction and, above that, to reduced bending moments when a plurality of small access orifices are provided instead of one large access orifice. In this way, as a result, the deformation of termination and/or repetitive units is at least considerably reduced which results in an enhanced cycle strength. Since the seals will no longer crack the tightness is enhanced. Since a breaking or sliding off of electric contacts is also prevented there is a
- 25

reduced contact degradation in the entire fuel cell stack, i.e. of the contacts of anode and cathode, etc.

5 In preferred embodiments it is contemplated that the plurality of access orifices are separated from each other by at least one or more enforcement struts. It is, for example, possible to subdivide a large rectangular or quadratic access orifice into a plurality of smaller rectangular or quadratic access orifices by means of enforcements struts disposed perpendicular to each other. In this connection it is considered as particularly advantageous that the enforcement struts are formed by the material of a so-called blind plate as discussed
10 later in more detail.

Furthermore, it is preferable that the polar plate according to the invention comprises a flow field plate comprising the at least one flow field and a blind plate comprising the plurality of access orifices. Similar to the state of the art the flow field plate and the blind
15 plate are connected to each other in a gas-tight manner, for example by welding.

In preferred embodiments of the polar plate according to the invention it is contemplated that it consists, at least in portions, of steel, particularly of ferritic steel. Ferritic steel is, for example, capable of withstanding temperatures as they are encountered during the operation of SOFC fuel cell systems.
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Furthermore, it is preferable that for the polar plate according to the invention at least one flow field for supplying a hydrogenous working gas to a membrane-electrode unit is provided. Similar to the state of the art the membrane-electrode unit may, for example, be
25 primarily manufactured of yttrium-stabilised zirconium oxide.

In certain embodiments of the polar plate according to the invention it is contemplated that it is an end plate. For one of the end plates of a fuel cell stack it is sufficient that it comprises a flow field for distributing the hydrogenous working gas.
30

In other embodiments of the polar plate according to the invention it is contemplated that it is a bipolar plate and that distributor means for supplying an oxygenic gas to another membrane-electrode unit are provided on the side of the bipolar plate opposing the access

orifices. The distributor means may, for example, be formed like a channel and attached to the side of the flow field plate opposing the flow field or formed integrally with the same.

The termination unit according to the invention for a fuel cell stack may, in particular,
5 comprise:

- a polar plate in the form of an end plate for a fuel cell stack comprising at least one flow field accessible from at least one side of the end plate via a plurality of access orifices, and

10

- a membrane-electrode unit covering the plurality of access orifices,

the at least one flow field being provided for supplying a hydrogenous working gas to the membrane-electrode unit.

15

The repetitive unit according to the invention for a fuel cell stack may, in particular, comprise:

- a polar plate in the form of a bipolar plate for a fuel cell stack comprising at least
20 one flow field accessible from at least one side of the end plate via a plurality of access orifices, and

- a membrane-electrode unit covering the plurality of access orifices,

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the at least one flow field being provided for supplying a hydrogenous working gas to the membrane-electrode unit and distributor means for supplying an oxygenic gas to a further membrane-electrode unit allocated to another termination or repetitive unit being provided on the side of the bipolar plate opposing the access orifices.

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Furthermore the fuel cell stack according to the invention comprises:

- at least one termination unit according to the invention, and

- a plurality of the repetitive units according to the invention.

Preferred embodiments of the invention will be described by way of example in more detail with reference to the allocated drawings in which:

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Figure 1 shows a cross sectional view of a termination unit according to the state of the art already explained in the introduction;

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Figure 2 shows the termination unit of Figure 1 also already explained in the introduction in a deformed state;

Figure 3 shows a schematic cross sectional view of an embodiment of the termination unit according to the invention;

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Figure 4 shows the detail Y of Figure 1 already explained in the introduction;

Figure 5 shows the detail Z of Figure 5;

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Figure 6 shows a perspective view of a polar plate according to the state of the art already explained in the introduction;

Figure 7 shows a perspective illustration of an embodiment of the polar plate according to the invention;

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Figure 8 shows a schematic cross sectional view of an embodiment of the repetitive unit according to the invention; and

Figure 9 shows a schematic cross sectional view of an embodiment of the fuel cell stack according to the invention.

30

In the Figures the same or similar reference numerals designate the same or similar elements which will, for the avoidance of repetitions, at least partly only be explained once.

As is best recognisable by means of a comparison of Figures 6 and 7 the polar plate 10 according to the invention is provided with a plurality of access orifices 18 as shown in Figure 7 instead of a single large access orifice 18' (see Figure 6). The plurality of access orifices 18 are, in this case, separated from each other by a plurality of enforcement struts 20 which are formed by the material of a blind plate 24. A flow field 16 formed or accommodated by a flow field plate 22 is accessible through the plurality of access orifices 18. The flow field plate 22 as well as the blind plate 24 may advantageously be formed of ferritic steel.

10 In Figures 3 and 5 the portion of the blind plate 24 forming the plurality of access orifices 18 is illustrated in broken lines. A comparison of Figures 4 and 5 will show that the lever arm L_2 is clearly shortened by the enforcement struts 20 as compared to the lever arm L_1 . In this way a reduced bending moment acts on a structure which is, in addition, even stiffer due to the enforcement struts 20. The deformation of the termination unit 30 according to the invention (see Figure 3) as well as the deformation of the repetitive unit according to the invention (see Figure 8) is thus at least significantly reduced as compared to the state of the art. The repetitive unit 34 shown in Figure 8 differs from the termination unit 30 shown in Figure 3 in that distributor means 28 for supplying an oxygenic gas to another membrane-electrode unit are provided on the side of the flow field plate 22 opposing the flow field. Said distributor means 28 may be formed in any way well known to those skilled in the art, for example in a bridge-like manner.

The cooperation of a termination unit 30 according to the invention and two repetitive units 34 according to the invention as well as another termination unit of another design which is not of particular relevance here can be seen in Figure 9 illustrating an embodiment of the fuel cell stack according to the invention. Here each membrane-electrode unit can be supplied with a hydrogenous working gas via a respective flow field 16 on the one side and with an oxygenic gas via respective distributor units 28 on the other side as per se known. Even though the individual components of the fuel cell stack 32 are designed asymmetrically like in the state of the art there are all in all reduced bending moments and a stiffer structure which is deformed clearly less in case of stresses caused by temperature variations as compared to the state of the art.

The features of the invention disclosed in the above description, in the drawings as well as in the claims may be important for the realisation of the invention individually as well as in any combination.

List of Reference Numerals

	10, 10'	polar plate
	12	polar plate
5	14	fuel cell
	16, 16'	flow field
	18, 18'	access orifice(s)
	20	enforcement struts
	22, 22'	flow field plate
10	24, 24'	blind plate
	26, 26'	membrane-electrode unit
	28	distributor means
	30, 30'	termination unit
	32	fuel cell stack
15	34	repetitive unit
	36	termination unit of a different design

CLAIMS

1. A polar plate (10, 12) for a fuel cell stack (14) comprising a flow field plate (22) comprising at least one flow field (16) and a blind plate (24) comprising a plurality of access orifices (18) wherein the at least one flow field (16) is accessible from at least one side of the polar plate (10, 12), via the plurality of access orifices (18) **characterised in that** the plurality of access orifices (18) are separated from each other by at least one or more enforcement struts (20).
2. The polar plate (10, 12) according to claim 1, wherein the polar plate is a bipolar plate (12).
3. The polar plate (10, 12) according to any one of claims 1 or 2, **characterised in that** it consists, at least in portions, of steel or ferritic steel.
4. The polar plate (10, 12) according to any one of claims 1, 2 or 3, **characterised in that** the at least one flow field (16) is provided for supplying a hydrogenous working gas to a membrane-electrode unit (26).
5. The polar plate (10, 12) according to claim 4, **characterised in that** it is an end plate (10).
6. The polar plate (10, 12) according to claim 4, **characterised in that** it is a bipolar plate (12) and in that distributor means (28) for supplying oxygenic gas to another membrane-electrode unit (26) are provided on the side of the bipolar plate (12) opposing the access orifices (18).
7. A termination unit (30) for a fuel cell stack (32), comprising:
 - a polar plate (10) according to claim 5, and
 - a membrane-electrode unit (26) covering the plurality of access orifices (18).

8. A repetitive unit (34) for a fuel cell stack (32) comprising:
 - a polar plate (12) according to claim 6, and
 - a membrane-electrode unit (26) covering the plurality of access orifices (18).
9. A fuel cell stack (32) comprising:
 - at least one termination unit (30) according to claim 7, and
 - a plurality of repetitive units (34) according to claim 8.

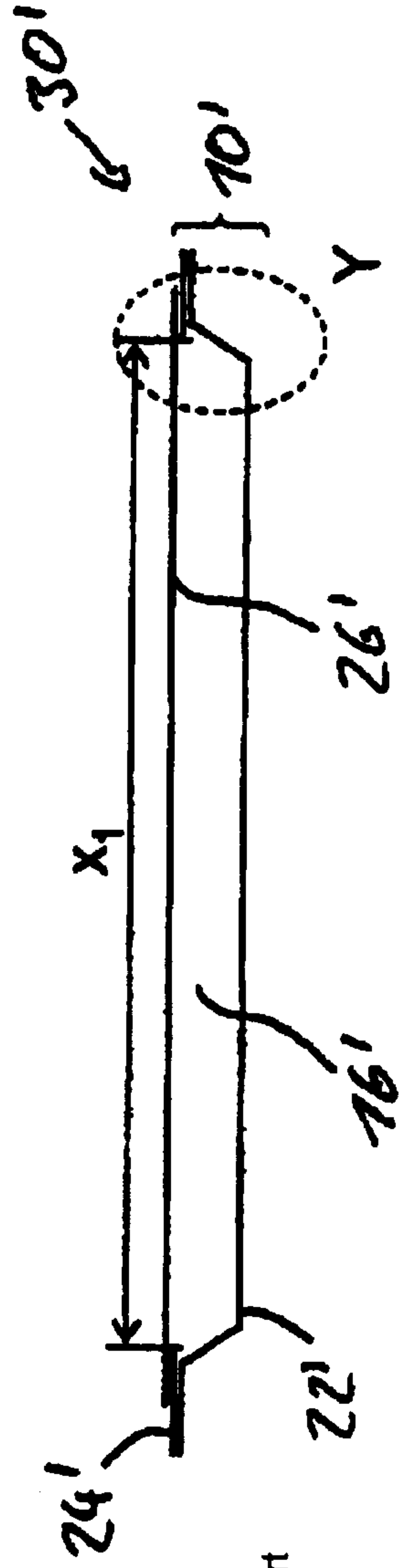


FIG. 1
State of the Art

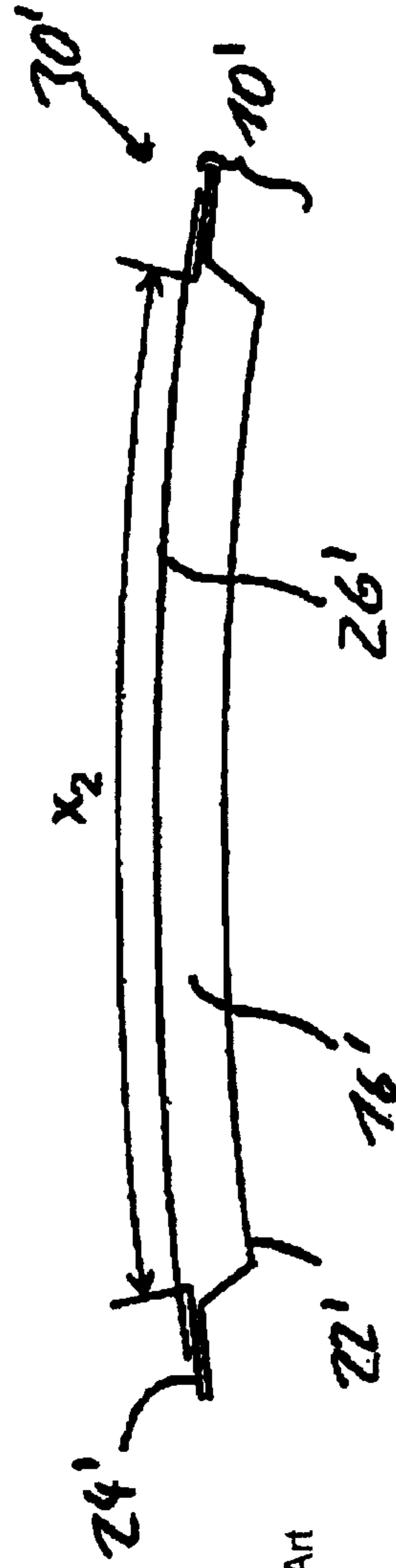


FIG. 2
State of the Art

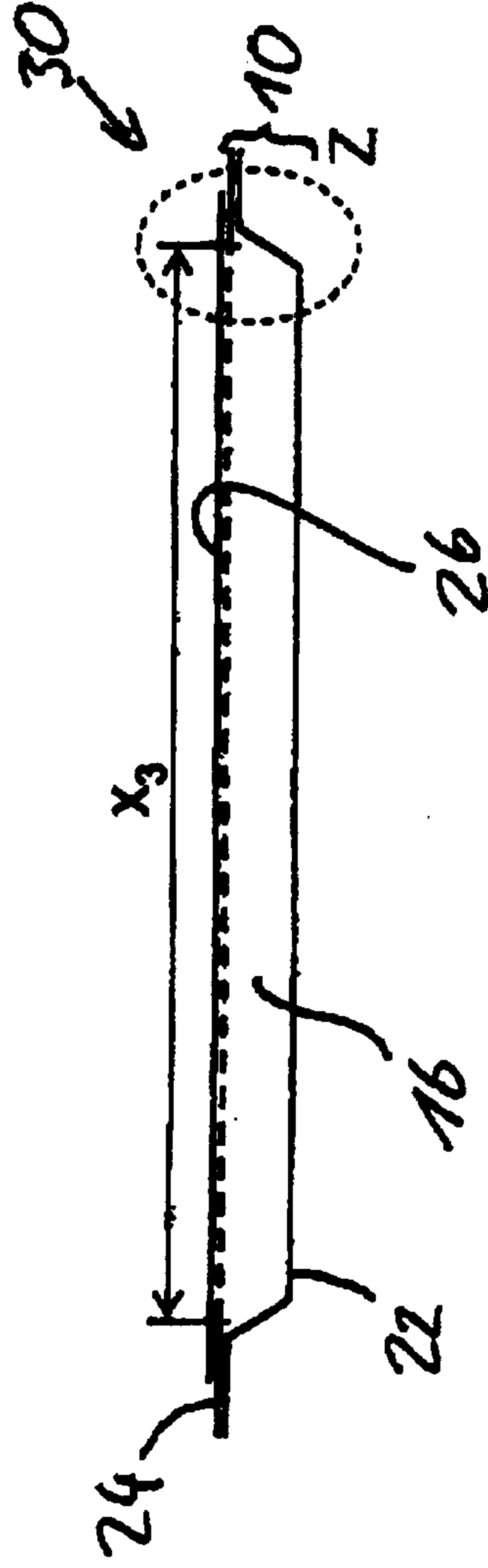


FIG. 3

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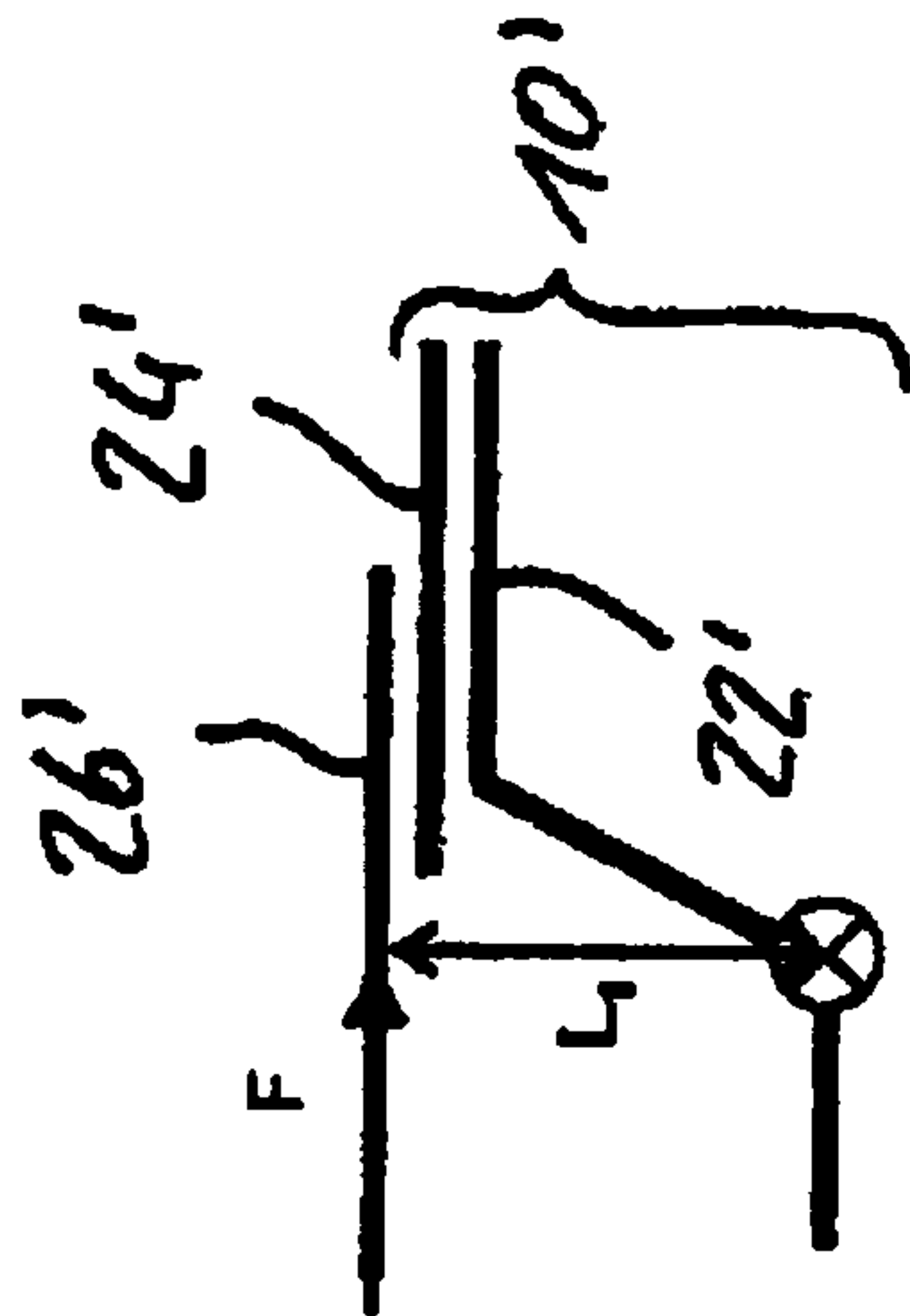


FIG. 4
State of the Art

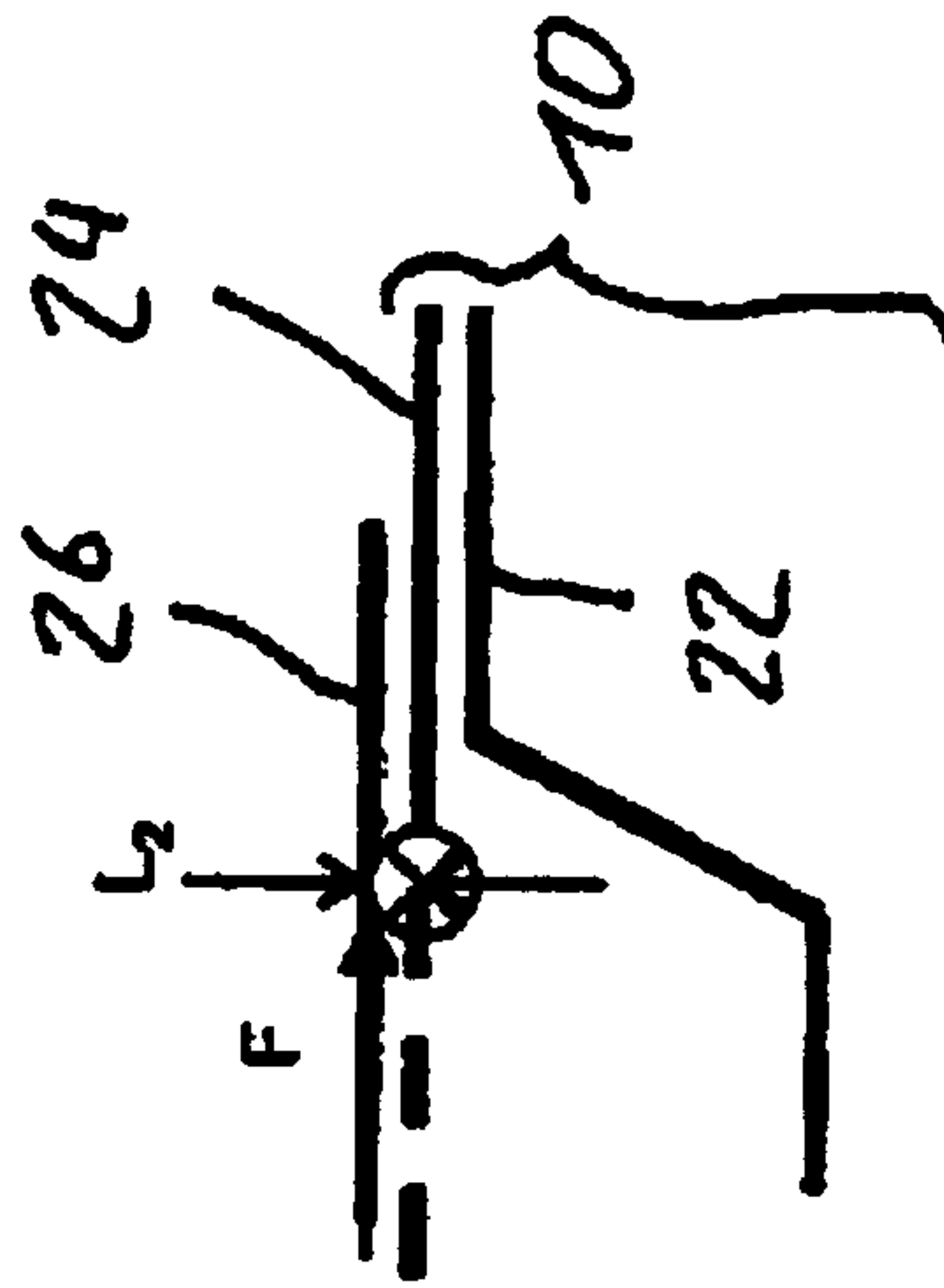


FIG. 5

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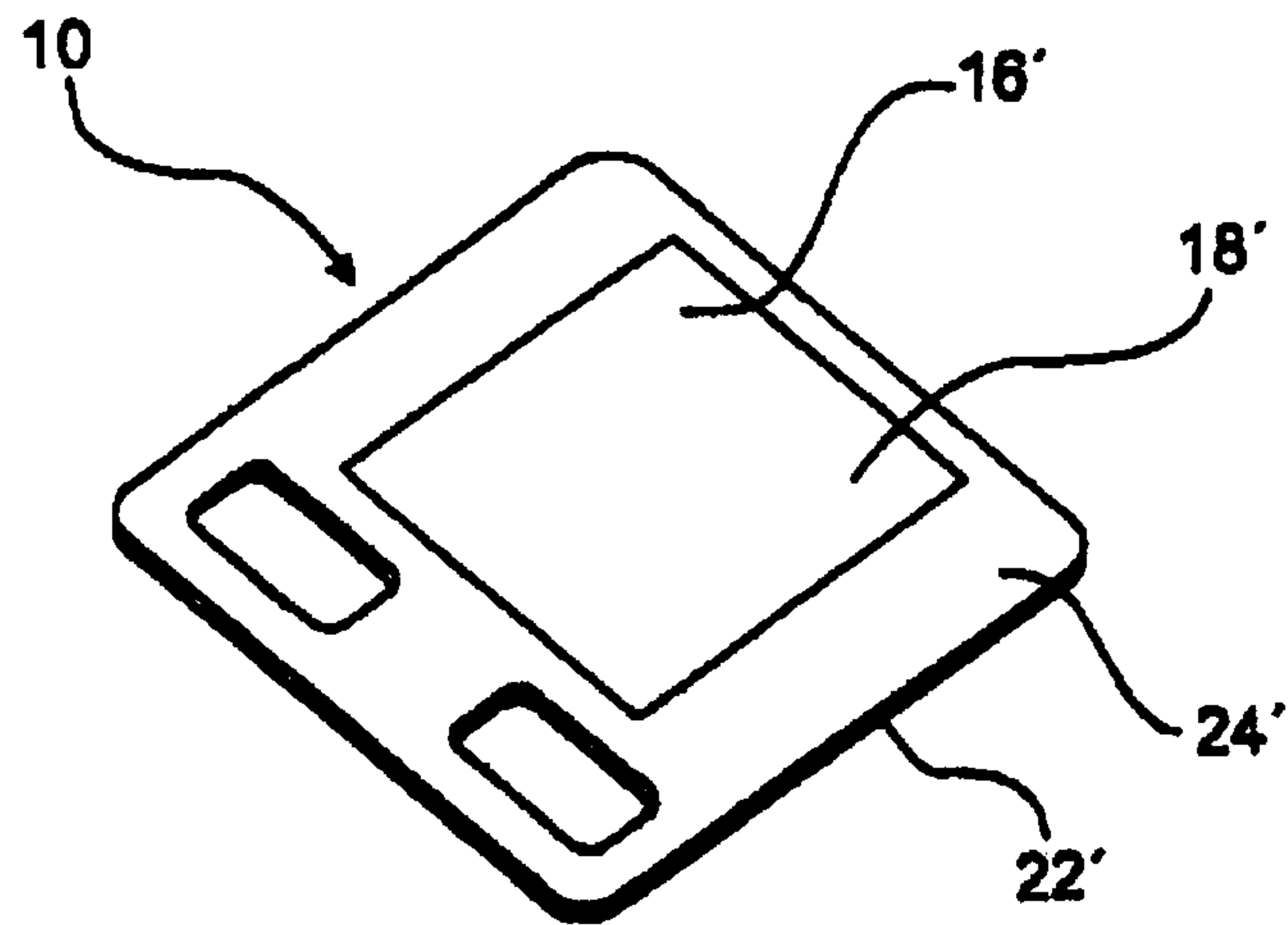


FIG. 6

(State of the Art)

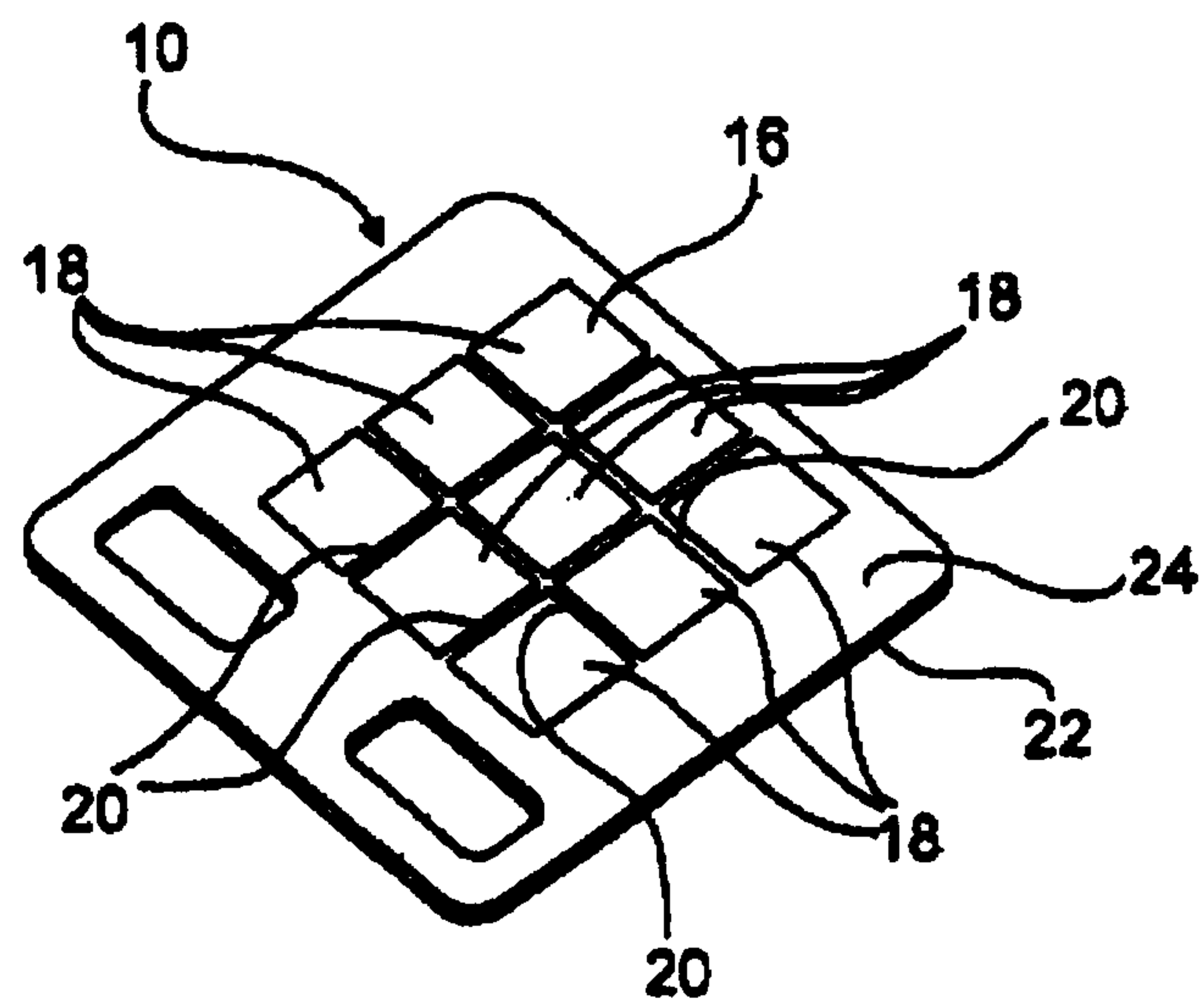


FIG. 7

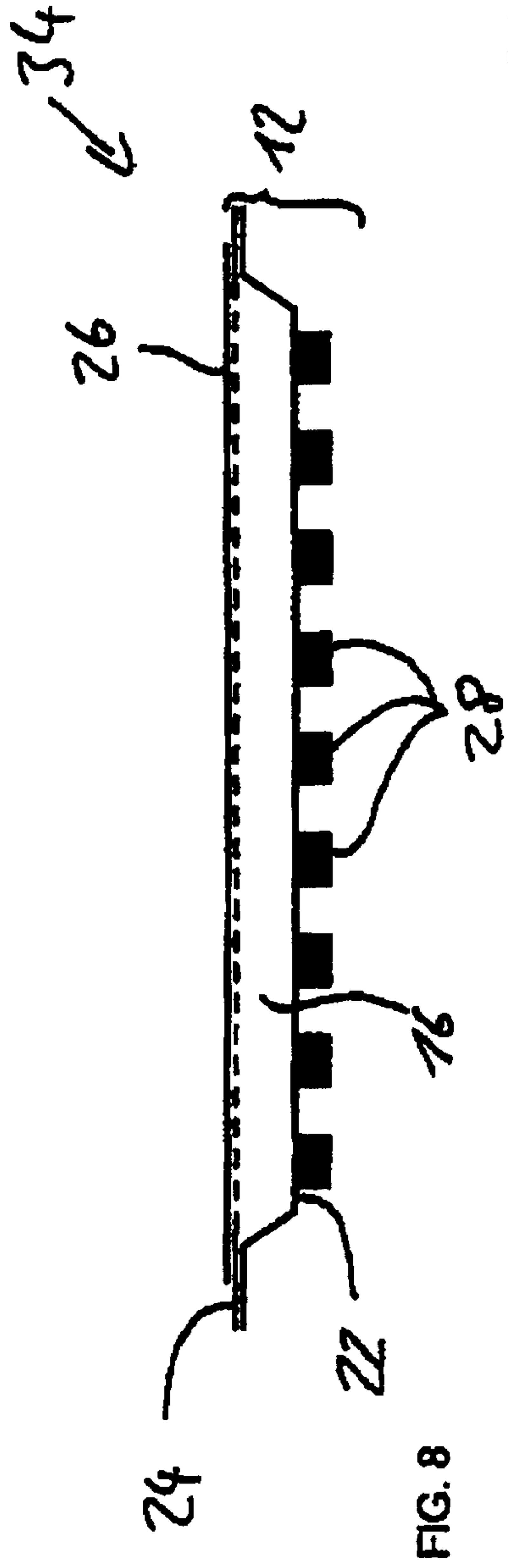


FIG. 8

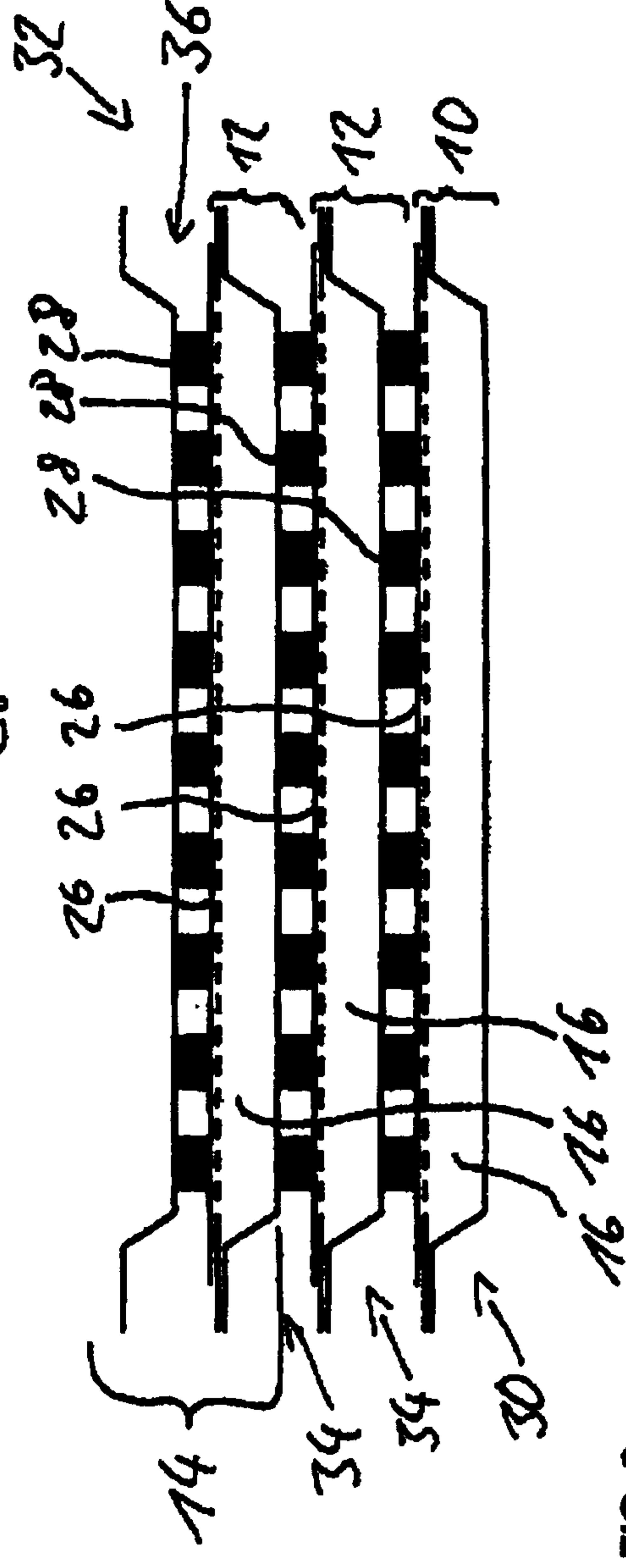


FIG. 9

