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(54) Benævnelse: **Behandlingsindretning og fremgangsmåde til fremstilling af en behandlingsindretning**

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The invention relates to a treatment arrangement for treating a surface, comprising a planar electrode arrangement, to which an electric voltage can be supplied, and a planar shielding layer consisting of an insulating plastic, which at least partially encloses the electrode arrangement, wherein the electrode arrangement consists of a plastic provided with conductive additives.

The invention furthermore relates to a treatment device comprising such a treatment arrangement and a method for producing a treatment arrangement of the mentioned type.

Various treatment arrangements are known, using which a surface can be treated under the action of electrical voltages. These include treatment arrangements in which a current is introduced directly into the surface to be treated. The shielding layer has the function in this case of avoiding touching of the electrode by an operator.

Furthermore, performing inductive heating of the surface to be treated by means of the electrode is known. In this case, the shielding layer is used to insulate the electrode in relation to the surface to be treated, to prevent a direct current introduction and possibly the formation of flashover sparks.

In one preferred embodiment of the treatment arrangement according to the invention, it is designed as a plasma treatment device and is used to build up a high-voltage field by means of the electrode arrangement by ionizing an air space or gas space between the treatment arrangement and the surface to be treated to form a plasma, and therefore a plasma treatment of the surface known per se takes place. In this case, in the scope of the present invention, the electrode arrangement can be connected to a pole of an electric voltage and the surface to be treated can form a counter electrode. However, it is also possible to form the electrode arrangement from at least two electrodes, which are connected to different poles of an electric voltage, and therefore an electric field is built up between the electrodes, using which, for example, air can be ionized to form a plasma.

The surface to be treated can be a material which is prepared on its surface by the treatment, for example, a plasma treatment, for the purpose of being provided with a layer, for example, a protective layer. The treatment of the surface is used for the purpose of improving the adhesion of the layer like a primer treatment. Such treatments come into consideration for materials made of plastic, metal, wood, or the like.

One preferred application in the scope of the invention is the treatment of human or animal skin as the surface to be treated. In particular for the formation of a plasma, advantageous effects on the skin surface have been proven. In particular, the plasma treatment has a disinfecting, i.e., germ-killing effect. Designing a treatment arrangement for a plasma treatment in the form of a wound dressing is therefore known. The layer of the treatment arrangement facing toward the wound can be formed in this case from silicone, which is known to be skin-friendly and skin-compatible and is suitable as an insulating layer. One material coming into consideration is, for example, the silicone gel SILPURAN® from Wacker Chemie AG, Burghausen, Germany. This two-component silicone gel crosslinks to form a soft silicone layer which has a certain stickiness and therefore adheres to the skin.

Forms of such treatment arrangements coming into consideration are known, for example, from DE 10 2014 013 716 A1 and are known for the treatment of skin and/or of wounds using a dielectric barrier plasma. In this case, a metallic electrode is completely embedded in a dielectric material, which can be a silicone. To enable the drainage of wound secretions, the dielectric material can be provided with passage openings, through which wound secretions can pass from the wound side of the treatment arrangement to the distal side, where it can be absorbed by an absorption material, for example. The embedded electrode has to be provided in this case with corresponding passage openings, the diameter of which is larger, however, than the diameter of the passage openings in the dielectric material, and therefore the dielectric material also reliably covers the electrode in the region of the channels formed by the passage openings. The electrode embedded in the dielectric material is formed planar, flexible, and monopolar in this case, and therefore the body associated with the skin surface functions as the counter electrode. The counter electrode can be grounded in this case or act as a “floating electrode”. The construction of the known treatment arrangements has proven itself, since both the dielectric material and also the electrode itself can be formed as flexible and therefore the entire treatment arrangement is suitable for adapting itself to the possibly irregular shape of a body part and thus carrying out the treatment of an intact skin surface or a wound with defined distance relationships and thus reproducible results.

US 2012/0213664 A1 discloses a treatment arrangement for a plasma treatment, with which containers for food or the like designed as foil bags or bottles can be treated. The treatment arrangement has two electrodes, whereby the electrode facing the article to be treated is a flat ground electrode with interruptions through which the plasma field can extend to generate a surface plasma. A flexible dielectric is located between the electrodes. In one example, the dielectric forms a flexible wall with the high-voltage electrode on the inside and the interrupted earth electrode on the outside, which can adapt to the shape of an object such as a bottle. For this purpose, the wall is connected to a base body of the dielectric via a cavity. The electrodes applied to the surfaces of the flexible wall can consist of a conductive silicon polymer. Nothing is disclosed about the connection between the electrodes and the dielectric wall. The treatment arrangement is obviously not intended for the treatment of human or animal skin or wound surfaces.

WO 2012/106735 A2 discloses various designs of treatment arrangements in which a conductive electrode is embedded in a flat flexible dielectric. For an embodiment of a face mask, it is proposed to form a first dielectric layer in a negative form corresponding to the face, to apply a conductive electrode layer there, which is enclosed with a further dielectric layer. Examples for the conductive layer are a conductive ink, a metal foil or a conductive gel. An separate connection of the conductive layer with the dielectric is not disclosed.

To achieve this object, a treatment arrangement of the type mentioned at the outset is characterized according to the invention in that the electrode arrangement consists of a pourable plastic provided with conductive additives, and in that, in the region of a boundary layer between electrode arrangement and shielding layer, the plastics of the electrode arrangement and the shielding layer are connected to one another by material bonding.

To achieve this object, a treatment arrangement of the type mentioned at the outset is characterized in that in the region of the boundary layer between the electrode arrangement and the shielding layer, the plastic of the electrode arrangement and the shielding layer are connected to one another in a material-bonding manner without an additional adhesive layer, the plastics being mixed and/or cross-linked with one another in the region of the boundary layer.

The present invention is based on the object of simplifying the construction of a treatment arrangement of the type mentioned at the outset and making it even more reliable.

In the treatment arrangement according to the invention, an electrode is thus not at least partially enclosed, in particular completely embedded, by the dielectric plastic layer as a metallic electrode, but rather the electrode is itself formed from a suitable plastic, which is made conductive by additives. Such electrodes are known per se. According to the invention, they are used to form the treatment arrangement, in order to thus enable a materially-bonded connection between the electrode arrangement and the shielding layer, which results due to the plastics themselves and does not have an additional adhesive layer at the boundary layer between the electrode arrangement and the shielding layer. Electrode arrangement and shielding layer can thus be formed as a quasi-unified material and thus ensure a high level of security against delamination of the electrode arrangement from the shielding layer. This is significant in particular if the treatment arrangement is advantageously flexible and enables strong bends, to be able to adapt itself even to difficult body parts, i.e., for example, be able to wrap around a wrist.

The materially-bonded connection according to the invention between the plastic of the electrode arrangement and the plastic of the shielding layer takes place after mixing of these plastics at least in the region of the boundary layer in a simple manner when the plastics jointly cure and/or crosslink – at least in this region. In a further preferred embodiment, chemically identical plastics are used for the electrode arrangement and the shielding layer, which may thus be mixed well. For the electrode arrangement, the plastic is solely provided with the conductive additives in this case, which can be metallic particles, for example, microparticles or nanoparticles, graphite powder, *inter alia*.

Alternatively, it is possible to dispense with the mixing of the plastics and to produce the materially-bonded connection in that the plastics of electrode arrangement and shielding layer, which abut one another in the boundary layer, crosslink with one another. This can take place in that a first of the plastics is initially only partially crosslinked and is further crosslinked with the second of the plastics during the crosslinking thereof in the meaning of the original crosslinking. In another embodiment, the first of the plastics can also be completely crosslinked if it has functionally crosslinkable peripheral groups, which, upon the supply of the non-crosslinked second of the plastics, during the crosslinking thereof, result in secondary crosslinking between the first plastic and the second plastic.

In one preferred embodiment of the invention, the electrode arrangement is enclosed on all sides by the shielding layer. This is advantageous in particular if a high voltage is supplied to the electrode, as is the case for the treatment using a dielectric barrier plasma in one preferred embodiment of the invention.

In this configuration, it is possible to lead an electrically conductive terminal of the electrode arrangement out of the shielding layer. Alternatively, it is possible to form the electrode arrangement, for example, having a terminal tongue, which is also enclosed by the shielding layer, and to supply the electric voltage using a contact arrangement, which pierces the shielding layer and thus establishes the contact to the electrode arrangement. Such contacting using a self-cutting contact is known, for example, from EP 2 723 447 B1.

It can also be expedient for the treatment arrangement according to the invention if the shielding layer is profiled on the treatment side to form application faces, between which the air intermediate spaces exist to form the plasma upon application of the treatment arrangement to the surface to be treated. In this case, the profile can be irregular or regular. A profile in the form of round nubs is known from EP 2 515 997 A1; also a profile in the form of chambers open on one side is known from DE 10 2013 019 057 A1, which are formed on the treatment side of the shielding layer and can optionally be filled with conditioning or healing substances.

For the application as a wound treatment arrangement, it is expedient if a wound dressing surface is formed on the treatment side. This can be formed by the suitable material of the shielding layer itself or can be additionally applied on the treatment side of the shielding layer.

In particular silicones in any form, preferably in the form of silicone gels, are suitable for the shielding layer and the electrode arrangement.

In particular for the purpose of wound care, an embodiment of the treatment arrangement according to the invention is suitable in which the shielding layer has sections protruding beyond the area of the electrode, which are formed as adhesive toward the surface to be treated. The adhesive property of a silicone gel itself can possibly be utilized for this purpose. In this case, the silicone layer can already cause the fastening of the entire arrangement on the skin in the surroundings of the wound, and therefore possibly a secondary bandage in addition to the treatment arrangement can be omitted.

A monopolar electrode can be used as the electrode arrangement of a treatment arrangement according to the invention if the surface to be treated or the body located behind it functions as the counter electrode. Alternatively, the electrode arrangement can be formed as at least bipolar, wherein the two poles are connected to the poles of a voltage supply. The electrodes are then expediently formed and positioned such that the electrode of one pole extends close and parallel to the electrode of the other pole over the area of the treatment arrangement in many regions, and therefore a spatial electrical field suitable for plasma formation arises between these two poles. In order that the electric field is distributed over the area and is not only locally present, the two electrode poles are preferably formed in strips and led parallel or antiparallel over the area of the treatment arrangement. Meandering shapes, spiral courses, comb-shaped structures, etc. are suitable for this purpose.

Using a treatment arrangement according to the invention, a treatment device is preferably formed, which is formed and positioned to change a direct contact of the electrode arrangement and the surface to be treated. As already explained, in particular for a dielectric barrier plasma treatment, embedding the electrode arrangement completely in the electrical shielding layer can suggest itself.

The production of the material bond according to the invention between the plastic of the electrode arrangement and the plastic of the shielding layer is achieved in that, at least in the region of a boundary surface between the electrode arrangement and the shielding layer, the plastics are mixed with one another in a liquid state and jointly cured and/or crosslinked. In this manner, the material bond is caused by a uniform matrix structure or a gradual transition from one matrix structure to the other matrix structure.

It is entirely possible to prefinish the electrode arrangement and/or the shielding layer and partially or entirely crosslink or cure them and subsequently liquefy or at least swell them in the region of a boundary surface, to thus achieve common curing and/or crosslinking in this region.

However, it is preferable for at least one layer of the shielding layer and then the plastic of the electrode arrangement provided with the conductive additives, each in the liquid state, to initially be introduced into a casting mold, such that mixing results in the boundary region between the plastics, and subsequently the plastics are jointly cured and/or crosslinked by cooling. In this case, the possible crosslinking, for example, in the case of a silicone gel, can be carried out by a crosslinking component, which results in the crosslinking in a temperature-dependent or temperature-independent manner.

The mixing of the plastics in the boundary region can be dispensed with in the case of the crosslinking of the plastics with one another. For this purpose, it can be provided that the electrode arrangement or the shielding layer is firstly molded and partially crosslinked using the plastic. The other plastic can then be injected into a mold, for example, an injection mold, and caused to crosslink, wherein the second plastic is selected such that the first plastic, which is initially only partially crosslinked, is further crosslinked at the same time.

Alternatively thereto, it is possible to crosslink the first plastic practically completely and at the same time to provide it with functional, crosslinkable groups. In this case, the first plastic can be laid as a pre-molded part in an injection mold, using which the molding of the second plastic is carried out, which is supplied in the non-crosslinked liquid state. The second plastic is selected in this case such that it produces a secondary crosslinking with the crosslinkable groups of the first plastic part. In particular in the case of silicones, this is possible by OH groups, which enable a polycondensation reaction with cleavage of water. Another example results with remaining reactive SiH groups, which enable additive crosslinking with reactive vinyl groups of the other silicone plastic. However, all other polymerization reactions are also suitable for the secondary crosslinking.

The invention will be explained in greater detail hereafter on the basis of exemplary embodiments illustrated in the drawing. In the figures:

Figure 1 - shows a top view of a first exemplary embodiment of a treatment arrangement according to the invention, which is connected to a voltage supply device;

Figure 2 - shows a section through the treatment arrangement according to Figure 1 along line A-A;

Figure 3 - shows the exemplary embodiment according to Figure 1 of a treatment arrangement, which is connected to a modified voltage supply device;

Figure 4 - shows the arrangement according to Figure 3 in an illustration to show the electrode arrangement;

Figure 5 - shows a top view of a second exemplary embodiment of a treatment arrangement according to the invention;

Figure 6 - shows a section through the treatment arrangement according to Figure 5 along line B-B;

Figure 7 - shows a top view of a third embodiment of a treatment arrangement according to the invention, which is connected to a pole of a high-voltage supply device;

Figure 8 - shows a section through the treatment arrangement according to Figure 7;

Figure 9 - shows a view from below of the treatment arrangement according to Figure 7.

Figures 1 and 2 illustrate a treatment arrangement, in which a dielectric shielding layer 1, in which an electrode arrangement 2 is embedded such that the shielding layer 1 encloses the electrode arrangement 2 on all sides. For this purpose, the shielding layer 1 is formed having a thickness such that the electrode arrangement 2 is enclosed on all sides with a sufficiently thick dielectric shield, which prevents a noticeable current flow. The shielding layer 1 forms a lateral terminal tongue 3, into which the electrode arrangement 2 extends.

As may be seen from Figure 4 in particular, the electrode arrangement 2 has two electrode strips 4, which extend parallel to one another as strip-shaped conductors and are wound in spirals in an oval shape, wherein inner ends 5 are terminated in linear pieces pointing antiparallel in one loop of the other electrode strip in each case. The two electrode strips extend parallel to one another in the terminal tongue 3 and end in contact surfaces 6, which are each connected via connecting lines 7 to one pole 8 of a high-voltage supply device 9. Figure 1 schematically shows that an AC voltage is applied to one pole, which oscillates around a ground potential, while the other pole 8 is at the ground potential. The electrode arrangement 2 is thus supplied with an alternating AC high voltage. The two electrode strips 4 are arranged such that they always alternate sections extending in parallel with one another, and therefore the alternating high voltage of the high-voltage supply device 9 is always applied between the sections of the electrode strips lying parallel to one another and generates local electrical fields there, which are suitable for forming a dielectric barrier plasma.

The dielectric shielding layer 1 is provided in one piece with sections 10, which extend on all sides – with the exception of the terminal tongue 3 – beyond the electrode arrangement 2 and the shielding layer 1 embedding the electrode arrangement 2 and are formed adhesive on the lower side 11 thereof, such that the treatment arrangement can be fastened on the skin of a body part like a self-adhesive bandage using the sections 10 which are adhesive on the lower side 11.

Figure 2 illustrates the lesser thickness of the sections 10 in relation to the remaining shielding section 1, which embeds the electrode arrangement 2 in the form of the electrode strips 4 on all sides.

It may also be seen from Figures 1 and 2 that the dielectric shielding layer 1 is provided outside the electrode strips 4 with passage openings 12, via which air can reach a wound surface, on the one hand, and wound secretions are transportable from a wound surface from the lower side of the shielding layer 1 forming a treatment side 13 to the distally located upper side 14, on the other hand.

As Figure 1 illustrates, the passage openings are located in the intermediate spaces between the electrode strips 4, and therefore the insulation of the electrode arrangement 2 is not endangered by the passage openings.

It may additionally be seen from Figure 2 that the electrode arrangement 2 is a planar arrangement having a low height extension, which is formed in this embodiment of the invention by the planar electrode strips. These are preferably formed from a silicone which is electrically conductive due to conductive additives, which corresponds to the silicone of which the dielectric shielding layer 1 consists.

Figure 3 merely shows that the two poles 8 of the high-voltage supply device can both be connected to alternating AC voltages, which have a phase shift of 180° in relation to one another, and therefore the resulting voltage difference for forming the local electrical fields between the electrode strips 4 has a double amplitude.

The second exemplary embodiment illustrated in Figures 5 and 6 differs from the first exemplary embodiment according to Figures 1 to 4 solely in that the treatment side 13 of the dielectric shielding layer 1 is not formed smooth, but rather has a profile 15 in the form of hemispherical protrusions, with the upper sides of which the treatment arrangement can rest on the surface to be treated, i.e., in particular on the skin of a body part. Air intermediate spaces 17 are located between the application faces 16', in which air intermediate spaces a plasma can form due to the electrical fields built up between the electrode strips 4 when the treatment arrangement rests on the skin of a body part.

The exemplary embodiment illustrated in Figures 7 to 9 has a substantially square surface of the dielectric shielding layer 1, which is adjoined by integral sections 10' in a cloverleaf shape. The electrode arrangement 2' is formed by a continuous electrically conductive surface, in which circular passage openings 18 are located. The electrically conductive surface of the electrode arrangement 2' is embedded on all sides in the dielectric shielding layer 1. Passage openings 12 of the dielectric shielding layer, the diameter of which is significantly smaller than the diameter of the passage openings 18 in the electrode arrangement 2', however, extend concentrically with the passage openings 18. It is thus ensured that even in the region of the passage openings 12, which ensure a ventilation of the wound surface and a removal of wound secretions, a sufficient insulation in relation to the electrode arrangement 2' is always provided. The dielectric shielding layer 1 according to this exemplary embodiment also has a terminal tongue 3', into which a corresponding attachment of the electrode arrangement 2' extends, wherein the electrode arrangement 2' is also completely shielded on all sides by the dielectric shielding layer 1 in the region of the terminal tongue 3'. Contacting takes place via a contact point 19, via which a high-voltage potential of the high-voltage supply device 9 is conducted to the electrode arrangement 2'. In this embodiment, the body of the surface to be treated forms a counter electrode for the AC high voltage of the high-voltage supply device 9.

The view from below according to Figure 9 illustrates a profile 15‘ of the treatment side 13 of the dielectric shielding layer 1. The profile 15' is formed with walls 20 aligned in a grid, which form chambers 21 (Figure 8) open to the surface to be treated around the passage openings 12, 18, in which, as in the air intermediate spaces 17 of the preceding embodiments, a plasma can form when the treatment arrangement rests on the skin or wound surface of a body.

As Figures 6 and 8 illustrate, a boundary layer 22, via which the materials of the electrode arrangements 2, 2' and the shielding layers 1 are connected to one another by material bonding according to the invention, exists in each case between the electrode arrangements 2, 2' and the dielectric shielding layers 1 enclosing them. It can be advantageous if the electrode arrangements 2, 2' and the shielding layers 1 consist of plastics which are substantially chemically equivalent, such as so-called liquid silicone rubbers or silicone gels. These plastic materials are insulating as a plastic matrix. For the electrode arrangements 2, 2', conductive additives are admixed to the insulating plastic material, and therefore the required conductive formation of the electrode arrangements 2, 2' is enabled in spite of the use of the insulating plastic matrix. In this manner, a bond which is secure against delamination even in the event of strong deformations of the flexible treatment arrangement is achieved between the electrode arrangement 2, 2' and the dielectric shielding layer 1.

However, it is also possible to use various plastics for the electrode arrangements 2, 2' and the shielding layers 1 in the scope of the invention, which may be cross-linked with one another either directly with one another or via a secondary cross-linking in the region of the boundary layer 22.

PATENTKRAV

1. Behandlingsindretning til behandling af en overflade, med en plan elektrodeindretning (2, 2'), som kan tilføres en elektrisk spænding, og et plant afskærmningslag (1), som består af et isolerende kunststof, og som i det mindste delvis omgiver elektrodeindretningen (2, 2'), hvor elektrodeindretningen (2, 2') består af et kunststof, som er forsynet med ledende tilsætningsstoffer, **kendetegnet ved, at** kunststofferne i elektrodeindretningen (2, 2') og afskærmningslaget (1) i området af grænselaget (22) mellem elektrodeindretning (2, 2') og afskærmningslag (1) er forbundet materialesluttende med hinanden uden et yderligere klæbelag ved, at kunststofferne er blandet med hinanden og/eller er tværbundet med hinanden i området af grænselaget (22).

2. Behandlingsindretning ifølge krav 1, **kendetegnet ved, at** elektrodeindretningen (2, 2') på alle sider er omsluttet af afskærmningslaget (1).

3. Behandlingsindretning ifølge krav 1 eller 2, **kendetegnet ved, at** en elektrisk ledende terminal i elektrodeindretningen (2, 2') er ført ud af afskærmningslaget (1).

4. Behandlingsindretning ifølge et af kravene 1 til 3, **kendetegnet ved, at** en kontaktindretning til tilførsel af den elektriske spænding kan føres gennem afskærmningslaget (1) til elektrodeindretningen (2, 2').

5. Behandlingsindretning ifølge et af kravene 1 til 4, **kendetegnet ved, at** afskærmningslaget (1) er profileret på behandlingssiden (13) til dannelse af anlægsflader (16'), mellem hvilke der ved anlæg af behandlingsindretningen mod overfladen, som skal behandles, består luftmellemrum (17) til dannelse af plasmaet.

6. Behandlingsindretning ifølge et af kravene 1 til 5, **kendetegnet ved** en på behandlingssiden (13) udformet sårkompresflade.

7. Behandlingsindretning ifølge et af kravene 1 til 6, **kendetegnet ved, at** kunststofferne i elektrodeindretningen (2, 2') og afskærmningslaget (1) er kemisk identiske.

8. Behandlingsindretning ifølge et af kravene 1 til 7, **kendetegnet ved, at** kunststofferne i elektrodeindretningen (2, 2') og afskærmningslaget (1) er silikone.

9. Behandlingsindretning ifølge et af kravene 1 til 8, **kendetegnet ved, at** afskærmningslaget (1) omfatter afsnit (10), som rager ud over fladen af elektrodeindretningen (2, 2'), og som er udformet klæbende hen mod overfladen, som skal behandles.

10. Behandlingsindretning ifølge et af kravene 1 til 9, **kendetegnet ved, at** elektrodeindretningen (2, 2') kan forbindes med en pol i den elektriske spænding og er udformet således, at overfladen, som skal behandles, kan danne en modelektrode.

11. Behandlingsindretning ifølge et af kravene 1 til 10, **kendetegnet ved, at** elektrodeindretningen (2) omfatter to elektrodestrimler (4), som kan forbindes med to spændingsførende poler (8) i den elektriske spænding.

12. Behandlingsindretning ifølge et af kravene 1 til 11, **kendetegnet ved** en højspændingsforsyningsindretning (9), som er forbundet med elektrodeindretningen (2, 2') til dannelse af et plasma mellem en plan behandlingsside (13) på behandlingsindretningen og overfladen, som skal behandles.

13. Fremgangsmåde til fremstilling af en behandlingsindretning ifølge et af kravene 1 til 12, **kendetegnet ved, at** kunststofferne mindst i området af en

grænseflade (22) mellem elektrodeindretning (2, 2') og afskærmningslag (1) blandes med hinanden i en flydende tilstand og hærdes og/eller tværbindes i fællesskab.

14. Fremgangsmåde ifølge krav 13, **kendetegnet ved, at** først indføres mindst et lag af afskærmningslaget (1), dernæst kunststof i elektrodeindretningen (2, 2'), som er forsynet med de ledende tilsætningsstoffer, i flydende tilstand i en støbeform, således at der i grænseområdet (22) mellem kunststofferne opstår en sammenblanding, og at kunststofferne efterfølgende hærdes og/eller tværbindes i fællesskab.

15. Fremgangsmåde ifølge krav 13, **kendetegnet ved, at** et første af kunststofferne delvis tværbindes, og et andet af kunststofferne dernæst i ikke-tværbundet tilstand ledes over på det delvis tværbundne første kunststof, og der med tværbindingen af det andet kunststof gennemføres en yderligere tværbinding af det delvis tværbundne første kunststof.

16. Fremgangsmåde ifølge krav 13, **kendetegnet ved, at** et første af kunststofferne i tværbundet tilstand omfatter funktionelle grupper, som kan tværbindes, og at der med et andet af kunststofferne fremstilles en materialesluttende forbindelse ved hjælp af en sekundær tværbinding af det andet kunststof med grupperne i det første kunststof, som kan tværbindes.

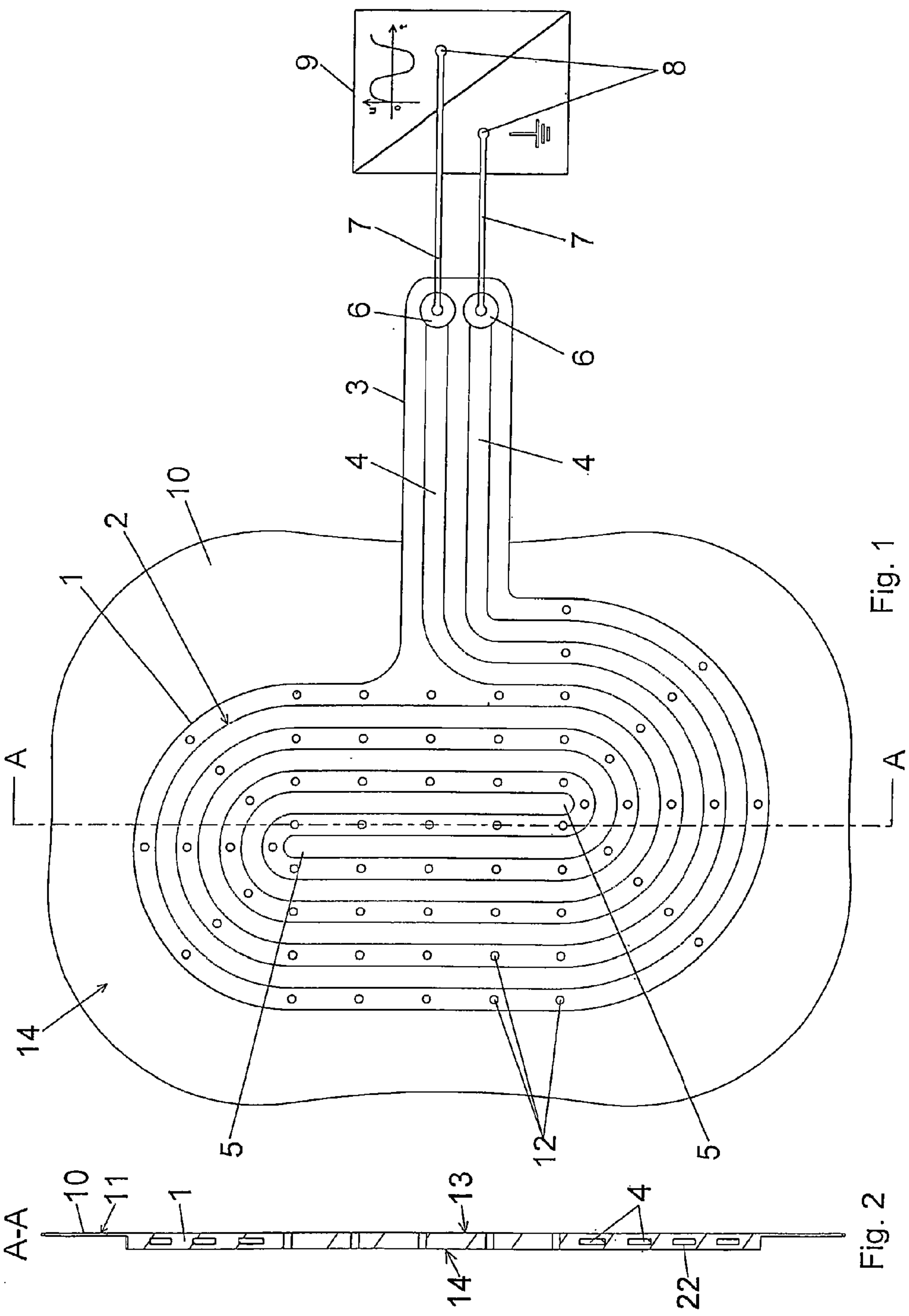

Fig. 1

Fig. 2

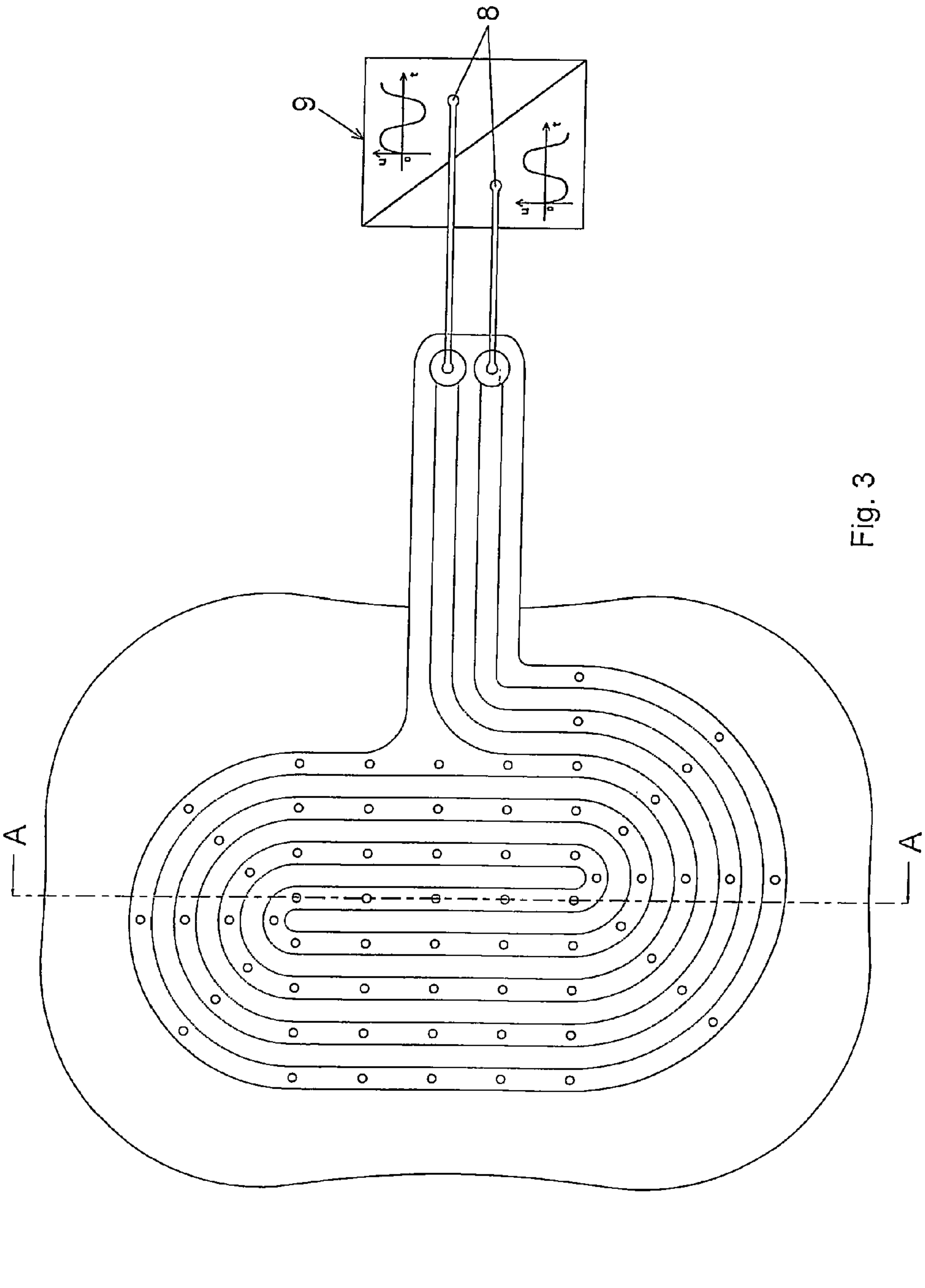

Fig. 3

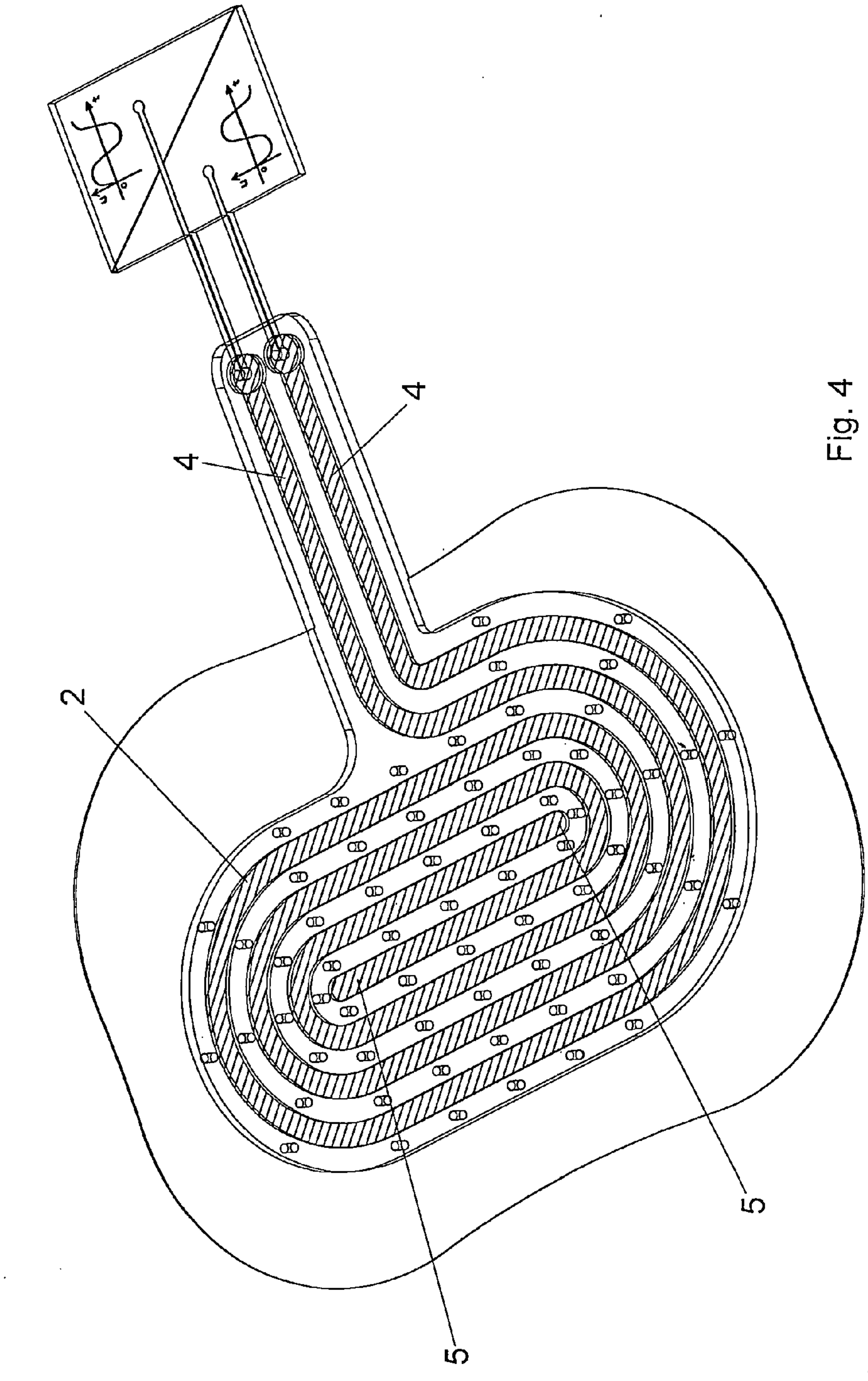

Fig. 4

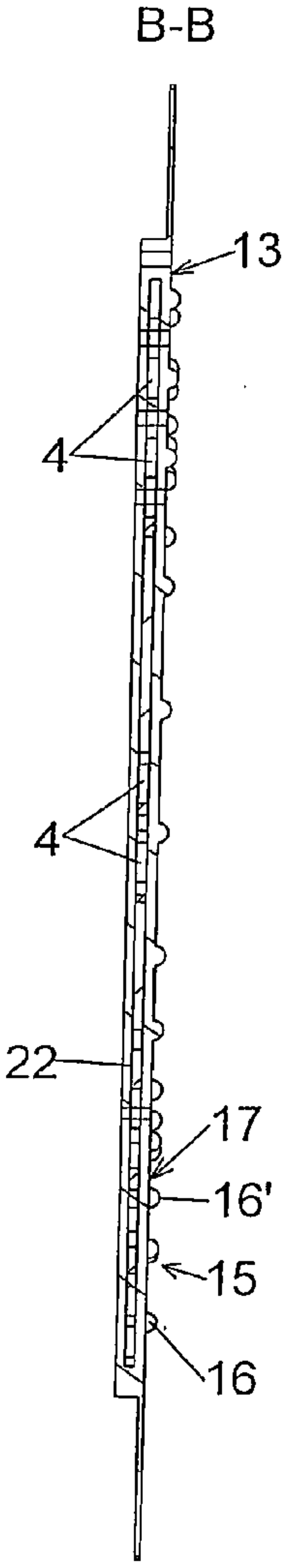

Fig. 6

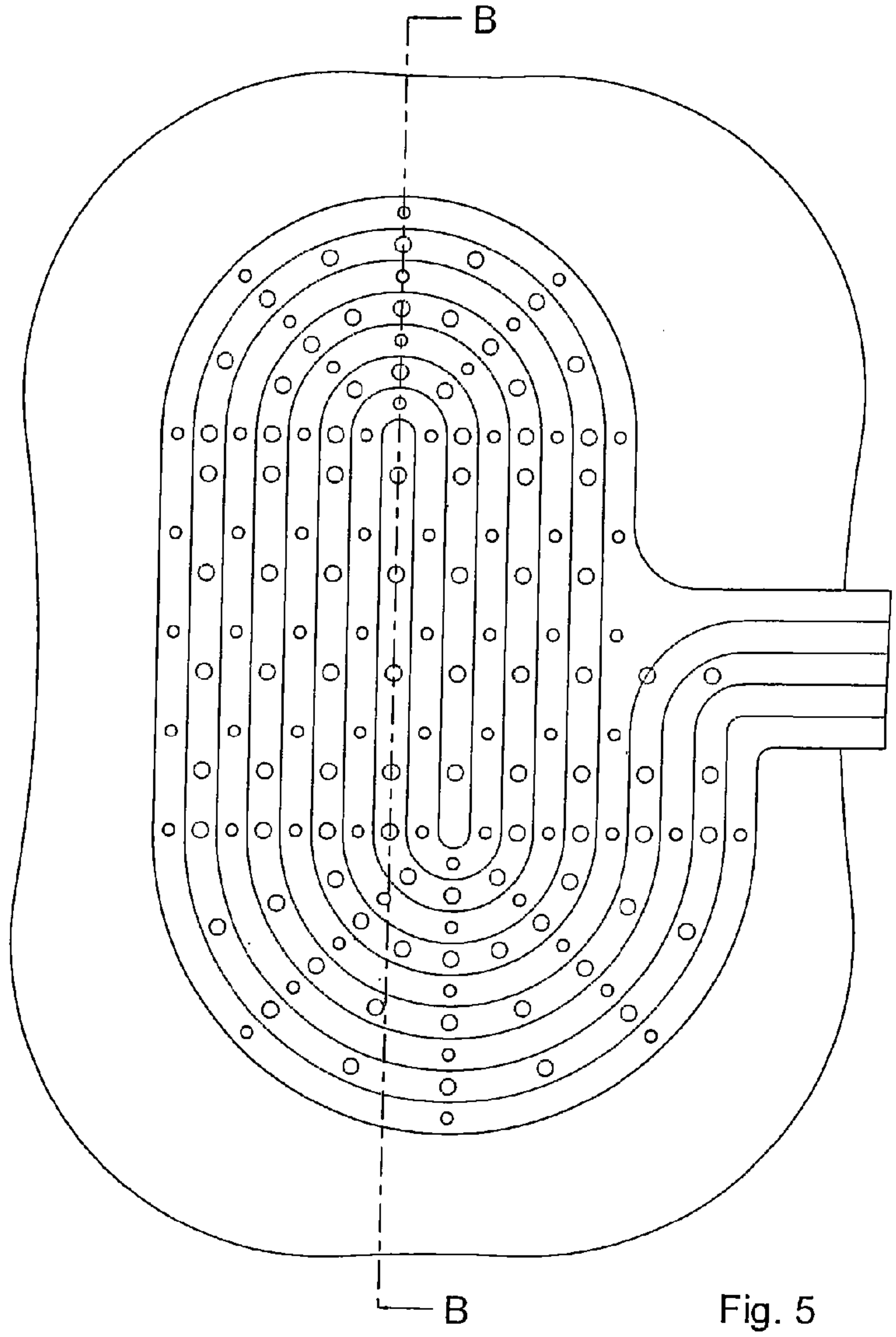

Fig. 5

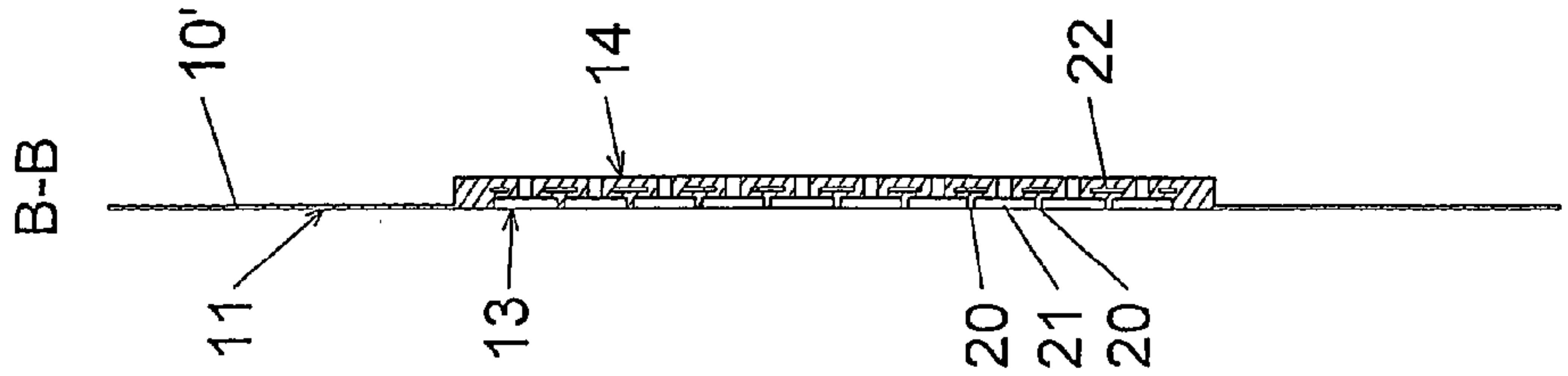

Fig. 8

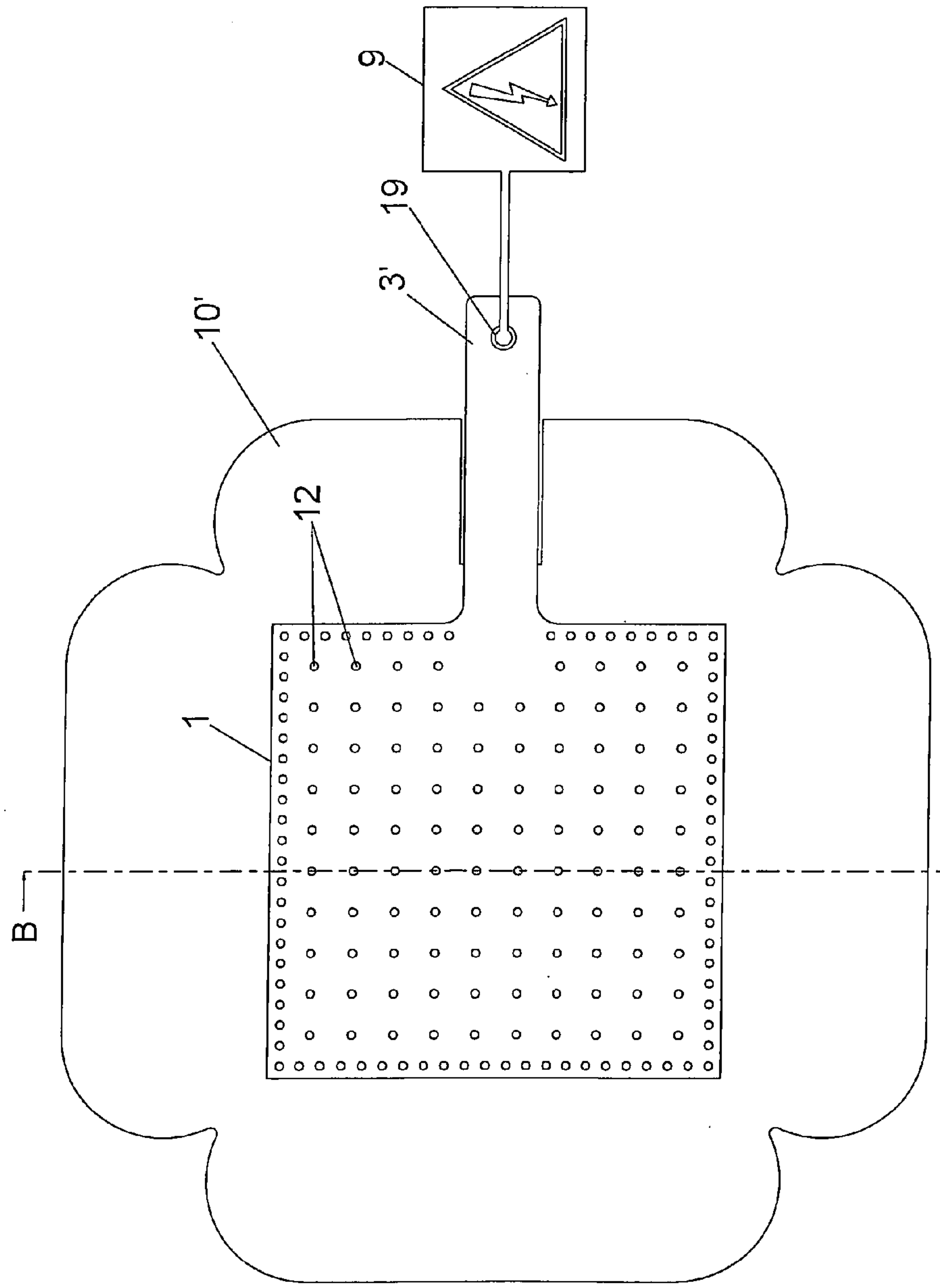

Fig. 7

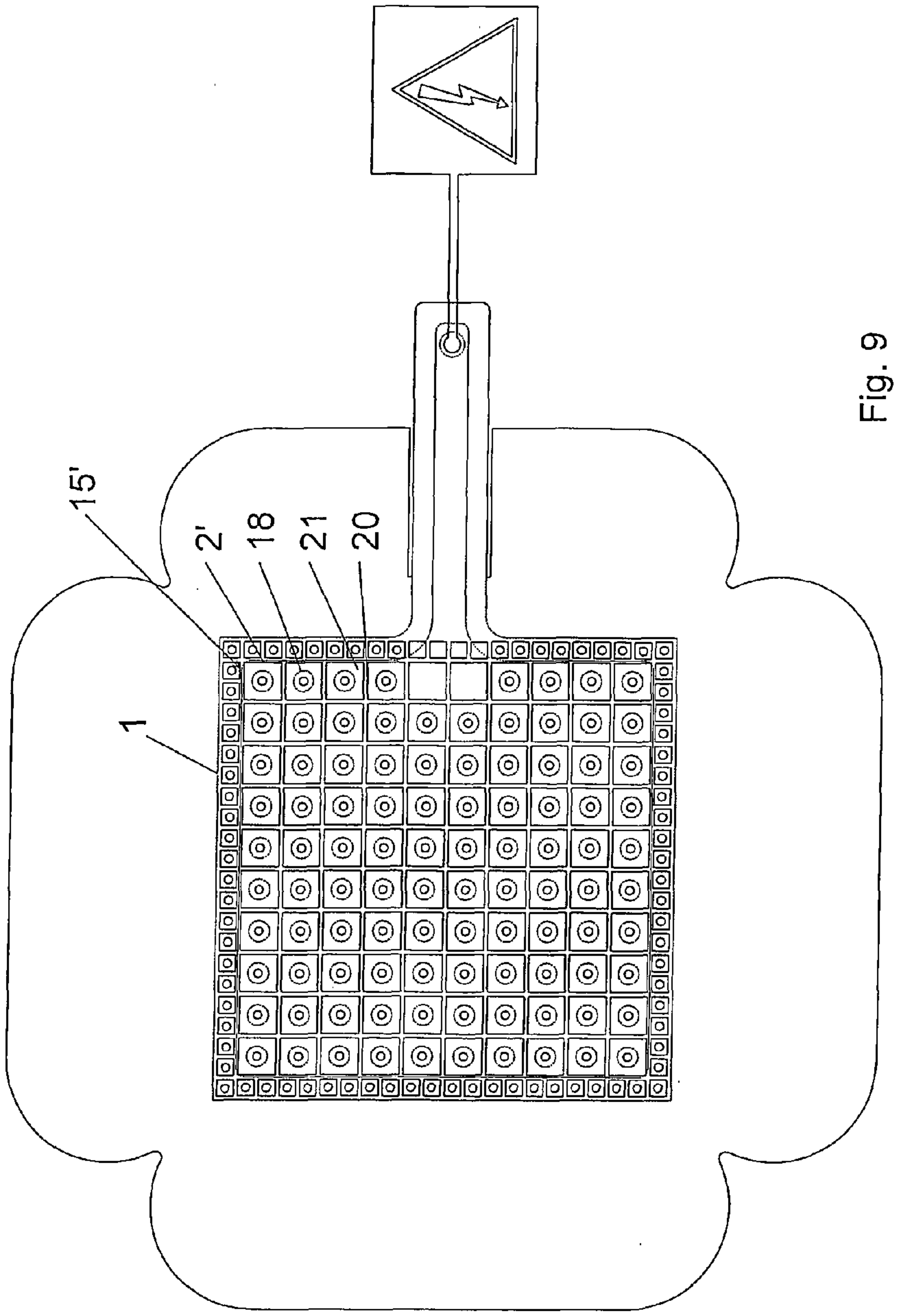

Fig. 9