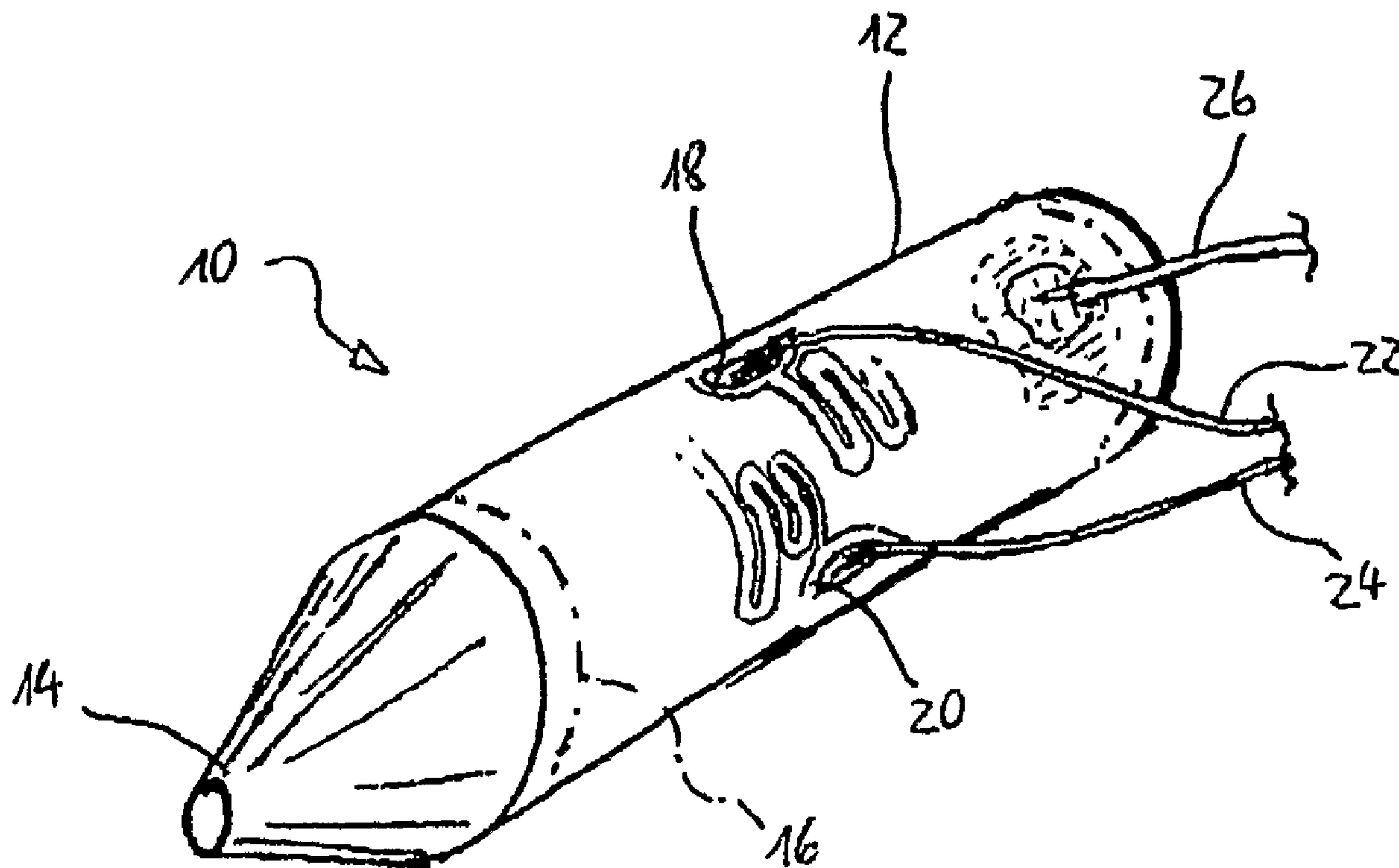




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(54) Titre : PROCEDE POUR FIXER UN FIL DE CONNEXION ELECTRIQUE SUR UN ELEMENT DE SURFACE, ET ELEMENT CHAUFFANT, NOTAMMENT POUR UN SYSTEME DE PULVERISATION DE MATIERE PLASTIQUE
 (54) Title: METHOD FOR THE ATTACHMENT OF AN ELECTRICAL LEAD WIRE ON A SURFACE ELEMENT, AS WELL AS A HEATING ELEMENT, ESPECIALLY FOR A PLASTIC-SPRAYING DEVICE



(57) Abrégé/Abstract:

An apparatus and methods for attaching electrical leads (22, 24) to a heating layer (16) of a heater are provided. An attachment material (50) is thermally sprayed over cords (32) of the electrical leads (22, 24), which are in contact with the heating layer (16) over a contact area (20). The attachment material (50) and the heating layer (16) are further thermally sprayed with a layer (52), which is an isolating material. The thermal sprayed connection between the electrical leads (22, 24) and the heating layer (16) thus provides more intimate contact and an improved electrical connection.

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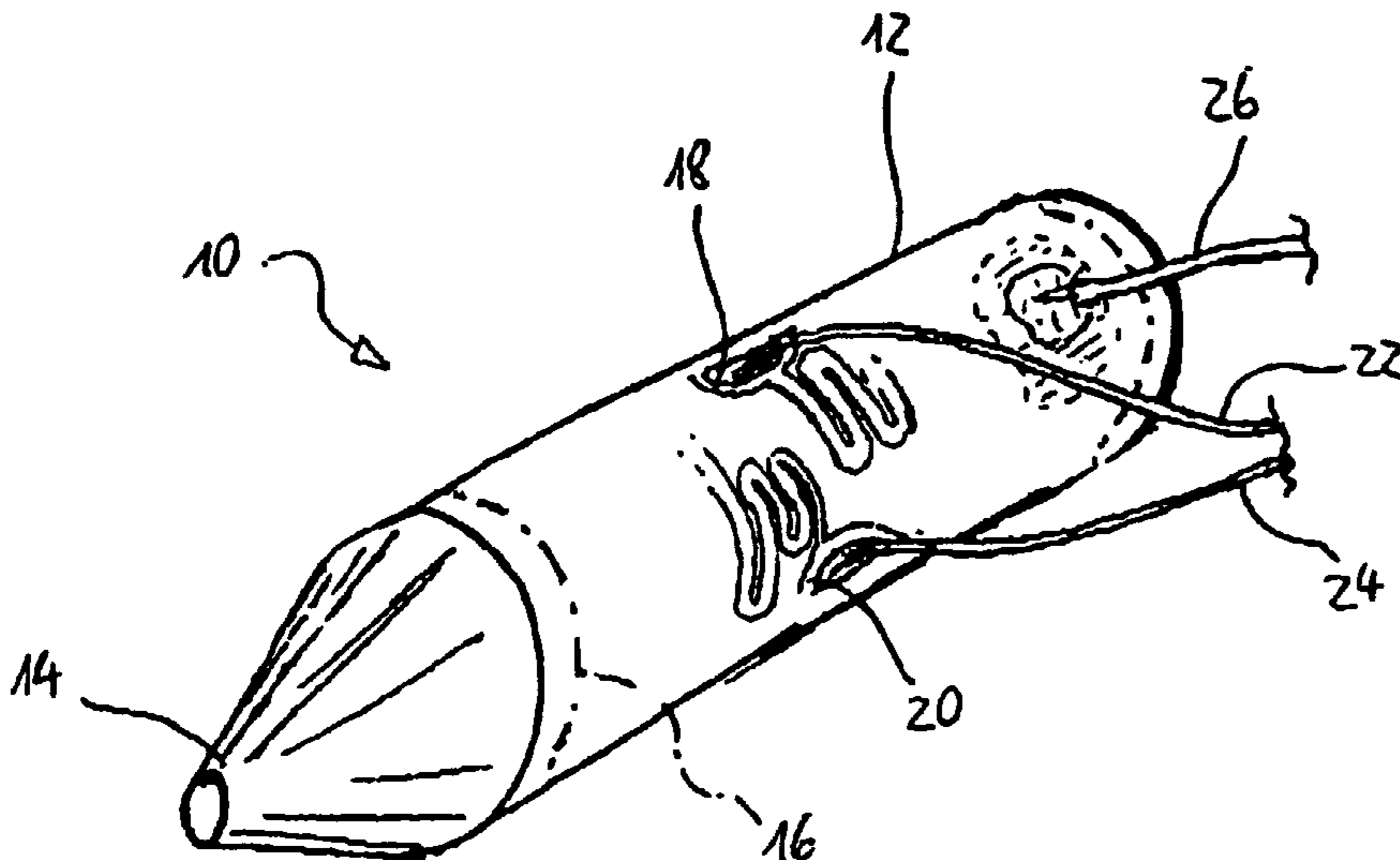
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(54) Title: METHOD FOR THE ATTACHMENT OF AN ELECTRICAL LEAD WIRE ON A SURFACE ELEMENT, AS WELL AS A HEATING ELEMENT, ESPECIALLY FOR A PLASTIC-SPRAYING DEVICE



(57) Abstract: An apparatus and methods for attaching electrical leads (22, 24) to a heating layer (16) of a heater are provided. An attachment material (50) is thermally sprayed over cords (32) of the electrical leads (22, 24), which are in contact with the heating layer (16) over a contact area (20). The attachment material (50) and the heating layer (16) are further thermally sprayed with a layer (52), which is an isolating material. The thermal sprayed connection between the electrical leads (22, 24) and the heating layer (16) thus provides more intimate contact and an improved electrical connection.

WO 2005/053361 A3

**METHOD FOR THE ATTACHMENT OF AN ELECTRICAL LEAD WIRE
ON A SURFACE ELEMENT, AS WELL AS A HEATING ELEMENT,
ESPECIALLY FOR A PLASTIC-SPRAYING DEVICE.**

5

DESCRIPTION

State of the art

10 **[0001]** The invention deals foremost with a procedure for the attachment of
an electrical conductor to a surface element.

[0002] Such a procedure is for example well-known from DE 198 10 848 A1.
In that publication a heating element is published, this was used for the heating of a rear view
15 mirror of motor vehicles. The heating element consists of a conductive strip, which by means
of arc or plasma spraying procedures is applied on a base surface. At the ends of the
conductive strip contact points are available, to which the connecting leads can be soldered to.
The appropriate soldered connections build, however, relatively thick, so that at least in the
region of the contact points a certain space demand is necessary. Furthermore, the production
20 of such soldered connections is comparatively expensive and the use of ordinary soldering
materials limits the temperature tolerance in the device.

[0003] From DE 195 38 686 A1 an electrical resistance heater is well-known,
where a heating layer is created from a mixture of graphite particles and a bonding agent
25 which is sprayed on a base surface. The connection of the in this manner manufactured
heating layer with a current supply is made by electrodes, which are formed from a metal
band or for a metal foil. Here the disadvantage is, that such metal bands or foils must be build
relatively large in order to make an acceptable transition resistance possible, thus within the
region of the contact points much place is needed.

30

[0004] The invention at hand has therefore the task, to develop the initially
specified art in such a way, that an electrical conductor with as little space demand as possible
and with small cost to can be fastened to a surface element.

35 **[0005]** This task is first solved with a procedure of the initially mentioned art
with a procedure which covers the following steps:

- A. first an attachment region of the conductor is placed at least indirectly
next to the surface element;

- B. then the attachment region which is placed at least indirectly to the surface element of the conductor and a directly next to the attachment region placed region of the surface element is thermally sprayed over with an attachment material.

5

[0006] A further solution consists of one which covers a procedure containing the following steps:

- A. on a region of the surface element a contact material is thermally sprayed on so that a contact point is manufactured;
- 10 B. an attachment region (33) of the conductor (24; 26) is welded onto the contact point by using an attachment material.

Advantages of the invention

15 **[0007]** With the first mentioned procedure according to invention the attachment of the electrical conductor to the surface element takes place by only using a very small amount of material, as is only possible when thermal spraying. With this procedure usually a powder material is sprayed on the surface element first. Thereby a continuous however very thin layer forms, on the attachment region of the conductor and that directly
20 next to it placed surface element. This layer is on the one hand intimately connected with the surface element and on the other hand with the attachment region of the conductor and leads so to the attachment of the conductor at the surface element. Space demand for the attachment is that way essentially determined only by the dimensions of the attachment region of the electrical conductor certainly and can therefore be relatively small.

25

[0008] Depending upon what kind of thermal spray procedure it can additionally lead to melting on the material of its electrical conductor within the attachment region and/or of the material at the exposed surface of the surface element. Thereby a more intimate contact between the electrical conductor and the surface element is creates, which
30 leads to a safe attachment of the electrical conductor at the surface element.

[0009] With the secondly mentioned procedure a higher material demand is necessary, the mechanical connections is however still loadable and exhibits therefore a long life span. The production of the contact points through thermal spraying makes an even
35 material distribution possible and prevents damage at the surface element. Here it is understood, that the term is not meant as point of material in the mathematical sense, but a material collection with comparatively little expansion.

[0010] Favorable developments of the invention are indicated in sub/dependent-claims.

5 **[0011]** First, relative to the second procedure it is suggested, that the attachment region to the contact points ought to be by means of ultrasonic welding. There mechanical oscillations are transmitted to connecting parts. By reflection of the mechanical oscillations at the sound-radiating end-surfaces a Sonotrode, a standing wave, forms the energy transfers into the work pieces, which a causes welding by internal friction. This is
10 inexpensive and can be used also with sensitive materials. Beyond that an additional attachment material can be omitted, which is necessary with ordinary welding methods. In all other respects, it also in the context of the invention at hand, that the attachment region is welded directly, thus without edge contact points before, to the surface element using ultrasound.

15

[0012] Furthermore it is possible, that the surface element covers an electrical conductive layer, preferably a heating layer or a cooling layer and that the attachment region of the electrical conductor is in connection with an electrical layer. These procedures according to the invention lead to a space saving electrical contact with small
20 transfer resistance.

[0013] The electrically conductive layer is preferably also applied by thermal spraying and can afterwards by regionally removed from the layer which at first does not exhibit the desired form. An appropriate procedure is revealed in DE 101 62 276 A1,
25 which's contents are expressly also revealed as part of the present publication.

[0014] In further development for this it is suggested, that the attachment and/or contact material, which is thermally sprayed and/or welded, exhibits relative to the electrically conductive layer a higher, preferably at least fivefold, or even stronger, at least
30 tenfold the electrical conductivity. That way one avoids that if the electrically conductive layer over the conductor has a current, in the region of the contact of the electrical conductor with the electrically conductive layer that it leads to an increased local temperature, which could damage the electrically conductive layer and/or attachment material. In particular then, if the electrically conductive layer serves as a heating layer, one can by this measure keep the
35 temperatures in the region of the attachment of the electrical conductor to the heating layer comparatively low, which extends the life span of the manufactured device. In the procedure

mentioned second the contact material and the attachment mounting material can be identical.

5 [0015] A modified execution form plans, that the surface element an electrically leading layer covers preferably a heating layer and that before step A on the electrically conductive layer an electrically isolating layer is applied, preferably thermal sprayed, and that the conductor is a thermal-element. Through the isolation a short-circuit between the electrically conductive layer and the thermal-element is avoided. with the attachment of the thermal-element by thermal spraying high temperature-utilization (until 600 10 degrees Celsius) is made possible. Because of the isolating layer which is indirect, but ultimately however still comparatively direct placement of the thermo-element on the electrically conductive layer temperature collection exhibits a very good dynamic. If the surface element is a heating layer, nearly no delayed-action of the temperature regulation of the heating layer is present.

15

[0016] In order to be sure, that the attachment and/or contact material only sprays on where the attachment of the leader actually take place, it is suggested that before thermal spraying the attachment and/or the contact material, the region directly next to the attachment region and/or region of the surface element contact point be covered. If the surface 20 element is a tubing element, a two piece pipe clip can be used, which on the to each other turned edges, on which the electrical conductor is to be placed on the surface element, exhibit an appropriate recess.

[0017] The procedure according to invention is suitable particularly well 25 when the attachment region of the electrical conductor covers a cord of an electrical cable, one lug, a vein end sleeve, a connector lug of a plug or pin, or a spot-weld one thermal-element.

[0018] A further favorable embodiment procedure is characterized by that, 30 the thermal spraying procedure comprises plasma spraying. With plasma spraying high temperatures can be reached, which allows the use of high temperature attachment materials. However, still different thermal spraying procedures can be used in addition.

[0019] For the protection of the attachment region of the electrical conductor 35 and the sprayed on attachment material in the above first mentioned procedure it is suggested that after the step b) an electrical isolating layer, which preferably covers ceramic or plastic, is

at least thermal sprayed on the attachment region and the directly adjacent region of the surface element.

5 [0020] Similarly for the above second mentioned procedure suggests, it is suggested that before step b) an electrically isolating layer, which preferably covers ceramic or plastic is thermal sprayed on the surface element and the contact points, and also likewise before step b) the isolating layer at least regionally sprayed on isolation layer on the contact points is removed, preferably sanded off. This permits application of an isolation- and protection layer, as long as no interfering cables are present.

10

[0021] In further development it is also mentioned, that after step b) the contact points and the to it fastened attachment region with an electrically is provided with an isolating material, preferably to be poured. Thus the contact point is likewise completely isolated and protected.

15

[0022] Furthermore certainly one suggests that at least electrically isolating layer of Al₂O₃ covers the surface element with the austenitic nickel based alloy, the attachment region of the electrical conductor's pure nickel, and/or the attachment material's copper.

20

[0023] The invention deals also a hot channel element, especially for a plastic spraying mechanism, with a tubular base piece, one on the base piece sprayed heating layer, and at least an electrical conductor.

25

[0024] It is suggested, that an attachment region of the electrical leader is at least indirectly fastened to the heating layer through, that it and a directly adjacent to attachment region placed region are thermal sprayed with an attachment material.

30

[0025] Alternatively one suggests, that it covers a thermal sprayed contact point, which is thicker than the surface element and to which an attachment region of the electrical conductor is welded onto.

35

[0026] With a hot channel element for one plastic spraying device those above in relation to the invention specific procedures become especially effective, because particularly a plastic spraying device usually only little space is available for the spraying nozzles. thanks to this procedure according to invention only little space is needed for the attachment of the electrical conductor at the thermal sprayed heating layer. An additional

isolation from plastic or silicone is not needed. Furthermore, high temperature-application (up to 600 degrees Celsius) is possible, and due to thermal spraying the electrical conductor clings well on the surface element, which benefits its life span.

5 **[0027]** One suggests that the electrical conductor covers a connection element of the current supply of the heating layer, and that its attachment region is connected electrically with the heating layer. That way the embodiment of the hot channel element according to invention reaches a very good efficiency, since due to the thermal spraying a small transfer resistance can be obtained between the connection element and the electrical
10 heating layer.

[0028] Furthermore, the electrical conductor may cover a thermal-element, whereby between the thermal-element and heating layer an electrically isolating layer is present. The indirect, however, nevertheless relatively direct contact of the thermal-element
15 with the electrical heating layer of the thermal-element the temperature of the heating layer is captured very well and with a very high dynamic, which facilitates the set-up of the desired temperature of the heating layer.

[0029] Furthermore, the hot channel element may cover a strain relief
20 element and the electrical conductor can be clamped between the strain relief element and surface element. This relieves the actual junction point and increases that way the reliability of the hot channel element.

Drawings

25

[0030] In the following particularly preferential embodiments of the present invention is described in more detail with respect to the attached drawings. The drawings show:

30 **[0031]** Figure 1: a simplified perspective representation of a first execution of a as a plastic spray nozzle developed hot channel element with a surface heating layer, which is contacted by two electrical connection leads and a thermal-element;

[0032] Figure 2: the region of the plastic spraying nozzle of figure 1, in that
35 the connecting leads contact the heating layer;

[0033] Figure 3: a cut through a contact point of a connecting lead with a heating layer from figure 2;

5 [0034] Figure 4: a cut through a contact point of the thermal-elements with the heating layer;

[0035] Figure 5: a perspective representation of a pipe clip, which is used in the production of the plastic spray nozzle of figure 1;

10 [0036] Figure 6: a partial cut side view of a second execution of a hot channel element, which is contacted by two electrical connecting leads;

[0037] Figure 7: a perspective representation of the hot channel element of figure 6;

15

[0038] Figure 8: an increased top view of a region of the hot channel element of figure 6;

20

[0039] Figure 9: a partial cut side view along the IX-IX line of figure 8; and

[0040] Figure 10: a partial cut front view along the X-X line of figure 8.

Description of the execution examples

25 [0041] In figure 1 a first hot channel element carries altogether the description mark 10. There we have a plastic spraying nozzle with a cylindrical pipe section 12 and a nozzle section 14. On pipe section 12 is a heating layer 16 which is thermal sprayed, its axial edges are suggested in figure 1 by dotted lines. It is meander shaped, whereby the individual meander 17 of the heating layer 16 are shown for the sake of simplicity only in an axial middle region of the heating layer 16. Since the heating layer 16 relative to its width is much thinner, it can also be designated as a surface element.

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[0042] The heating layer 16 is applied on the pipe section 12 by first thermal spraying an electrically conductive material on a laminar isolating intermediate layer 19. From this the created material layer still shows no desired shape and/or structure. Only thereafter is the material layer partially removed in such a manner, for example by means of

35

lasers, that the electrically conductive resistance layer is created, which has the meander shape shown. An applicable procedure is described in DE 101 62 276 A1 publication of the applicant, to which's content is hereby expressly referred to.

5 **[0043]** At the two ends of the meander shaped heating layer 16 in each case contact areas 18 and 20 are developed. On these there are, as described below in more detail, Connecting leads 22 and 24 attached, which serve as the current supply for the heating layer 16. On the heating layer, which is likewise described in further detail below, the thermal-
10 element 26 is indirectly fastened, which serves for the collection of the actual operating temperature of the heating layer 16.

[0044] The production of the contact between the lower connection lead 24 and the electrical heating layer 16 is described in greater detail with reference to the figures 2 and 3 as well as 5 .

15 **[0045]** First, at the end of the connecting leads 24 an isolation 30 is removed (preferably from mineral fiber or glass-silk), whereby cords 32 become free. These are then fanned out and are brought in as large of a contact area 20 as possible (the regions of the cords 32 which are at least approximate to the contact area 20 therefore create the attachment area 33).

20 **[0046]** The adjustment of the connecting leads 24 and the adjacent cords 32 can take place for example by means of the pipe clips 34 shown in figure 5. This exhibit's the two halves of 36 and 38, which cannot be illustrated interconnected any closer if drawn as in figure 5. The inside diameter of the pipe clip 34 is about the same for instance as the outside
25 diameter of the pipe section 12 of the hot channel element 10.

[0047] The two halves of 36 and 38 point in each case at a free longitudinal edge 40 and/or 42 which is a semicircular recess 44 and/or 46. These are so dimensioned, that if the pipe clip 34 on the tubing section 12 is put on, the circular recess just leaves the contact
30 area 20 formed by the two recesses 44 und 46 uncovered, a remaining region 47 of the heating layer 16, however, is covered by the pipe clip 34.

[0048] The in figure 5 to the right rear regions of the longitudinal edges 40 and 42 pointing regions are displayed somewhat radial outward. Thereby it becomes that, if
35 the two halves of 36 and 38 of the pipe clip 34 on the tubing section 12 are placed together, a clamping section 48 is created, through which the connecting leads 24 and the thereby also

attachment area 33 of the cords 32 are fixed during assembly of the hot channel element 10.

5 **[0049]** The rest of the attachment regions 33 of the cords 32 are placed by the contact surfaces 20 and the connecting lead 24 is fixed through the pipe clip 34, the attachment material 50 is thermal sprayed to attachment regions 33 of the cords 32 and the directly adjacent to the attachment area placed contact area 20.

10 **[0050]** With the mounting material 50 it deals with a metal powder, which is molten by thermal spraying and sprayed on the attachment regions 33 of the cords 32 and the contact area 20. It exhibits a higher, preferably an approximately 10 times better electrical conductivity than the material of the heating layer.

15 **[0051]** After solidifying of the attachment material 50 the attachment regions 33 of the cords 32 are enclosed with attachment material 50. Thereby they are attached in intimate contact with the contact area 20. When thermal spraying the surfaces of the cords 32 facing each other and the contact area 20 can easily melt, which ensures an additional anchorage of the attachment section 33 of the cords 32 to the contact surface 20.

20 **[0052]** After the attachment of the connecting lead 24 to contact surface 20 the heating layer 16 the pipe clip 34 is removed. Then the attachment material 50 and the heating layer 16 are thermal sprayed with a layer 52 from an isolating material. This way heating layer 16 as well as the region, in which the connection lead 24 is fastened to the contact area 20 of the heating layer 16, is covered and protected. Also a malfunctioning of the heating layer 16, for example due to a short-circuit, is avoided.

25 **[0053]** The thermal-element 26 is intended for the collection of the temperature of the heating layer 16, as mentioned initially. The procedure for its attachment is the same as the procedure for the attachment of the connection lead 24 at the contact area 20 of the heating layer 16, which is described in great detail above. That attachment region 33 forms through the spot-weld of the thermal-elements 26 and a directly connecting short section of the two element wires.

30 **[0054]** As follows from figure 4, the thermal-element 26 is however not in direct contact with the heating layer 16, since the thermal-element 26 is made by definition of an electrically conductive material, which would lead to short-circuit with the heating layer 16 if in direct contact. In order to avoid such a short-circuit, the thermal-element 26 is only

fastened after the production of the isolating layer 52. If necessary a non-metallic material can also be used as an attachment material as long as it resembles the material of the isolating layer 52 (reference symbol 54 in figure 4). As a material for thermal-element 26 iron-constantan or nickel- chrome-nickel is preferably used.

5

[0055] In the figures 6 to 10 a second execution form of a hot channel element 10 is shown. Such elements and regions carry, which exhibit equivalent functions to elements and regions as described in the previous execution examples, the same description marks. They are again not described in the greater detail. Furthermore, it shall be noted that for simplification purposes the representation of the heating layer in the figures 6 to 10 are not shown in the detail.

[0056] With in the hot channel element 10 shown in figures 6 to 10 the two connecting leads 22 and 24 are fastened in another way to the heating layer 16 than with the preceding execution example: First a covering element not shown in the figures is placed upon on the heating layer 16, which exhibits two circular to oval cut-outs, which arranged to the heating layer 16 in the region of the two contact surfaces (not shown in the figures 6 to 10 in great detail).

[0057] Subsequently, an electrically conductive contact material is thermally sprayed on the contact areas of the heating layer 16, whereby two approximately 0,5 mm thick contact points 56a and 56b are created. Now a layer 52 from an isolating material is sprayed on the heating layer 16 and the two contact points 56a is and 56b, which is shown only for representation purposes in figure 9. Thereafter, the region of the contact points 56a and 56b and the layer 52 is again sanded off.

[0058] The attachment regions 33 of the two connection leads 22 and 24 are implemented as lugs 57a and 57b. They were welded by point welding 58a and/or 58b with a contact point 56a and/or 56b. For this an ordinary welding method can be used, whereby a separate attachment material can be used, or welding can take place by means of ultrasonic welding. There the two connection leads 22 and 24 are held by clamp-rings 60, which are organized in the art as a shell around the hot channel element 10. So that the appropriate lugs' 33 neighboring end of the connection lead 22 to 24 is clamped between the clamping ring 60 and the hot channel element 10. After the welding the lugs 57a and 57b with the contact point 56a and 56b the lugs 57a and 57b and their surroundings are poured with an electrically isolating material 62.

What is claimed is:

1. A method for the attachment of an electrical lead wire to a surface element comprising the following steps:
 - a. placing an attachment area of the lead wire adjacent to the surface element; and
 - b. attaching the lead wire to the surface element by thermally spraying an attachment material over the attachment area and over a region of the surface element immediately next to the attachment area.
2. A method according to claim 1 wherein the surface element, being an electrically conductive layer, which preferably encompasses a heating layer and that before step a, an electrically isolating layer is applied to the electrically conductive layer, which is preferably sprayed on thermally and the lead wire consists of a thermal element.
3. A method according to claim 1 wherein the attachment area consists of an electrical lead wire, a cord of an electrical cable, a cable lug, an end splice, and a connection banner of a plug or pins or a welding point of a thermal element.
4. A method according to claim 1, wherein the thermal spray step encompasses plasma spraying.
5. A method according to claim 1 wherein after step (b), an electrically isolating layer, which is preferably a ceramic or a plastic layer, is sprayed on thermally on the attachment area and at least on the immediately adjacent area of the surface element.

6. A method for the attachment of an electrical lead wire to a surface element, wherein a contact material is thermally sprayed onto a surface of the surface element, the method comprising the following steps:
 - a. thermally spraying the contact material onto the surface of the surface element such that a contact point is created; and
 - b. welding an attachment area of the lead wire to the contact point.
7. A method according to claim 6, wherein the lead wire is welded to the contact point using ultrasound.
8. A method according to claim 6 wherein the surface element being an electrically conductive layer, preferably encompasses a heating layer or a cooling layer and that the attachment area of the electrical lead wire is electrically connected with the electrically conductive layer.
9. A method according to claim 8 wherein the attachment and contact materials which are thermally sprayed or welded opposite of the electrically conductive layer and have a higher or at least five to preferably ten times the electrical conductivity.
10. A method according to claim 6 wherein before the thermal spraying of the contact material, an area not immediately adjacent to the attachment area or contact point of the surface element is covered such that the area is prevented from being sprayed on.
11. A method according to claim 6 wherein before step (b), an electrically isolating layer, which is preferably a ceramic or a plastic layer, is thermally sprayed on the surface element and the contact point and that also before step (b), the isolating layer that was sprayed on the contact point is at least partially removed, preferably through polishing.

12. A method according to claim 11, wherein after step (b), the contact point and the attached attachment area are provided with an electrical isolating material, preferably through casting.
13. A method according to claim 11, wherein at least the electrically isolating layer is Al_2O_3 , and covers the surface element having an austenitic nickel base layer, the attachment area of the electrical lead wire of pure nickel, or the attachment material consisting of copper.
14. A method according to claim 6, wherein the surface element is an electrically conductive layer selected from a group consisting of a heating layer and a cooling layer, and the contact point is electrically connected with the electrically conductive layer.
15. A method according to claim 6, wherein an electrically isolating layer is applied over the contact point and the lead wire.
16. A heating channel element for a plastic spray device, with a pipe-like base piece, a heating layer that is thermally sprayed on to the base piece and at least one electrical lead wire having an attachment area wherein the attachment area of the electrical lead wire that is at least immediately adjacent to the heating layer is attached via an attachment material, that is thermally sprayed on the attachment area.
17. A heating channel element for a plastic spray device, with a pipe-like base piece, a heating layer that is thermally sprayed on the base piece and at least one electrical lead wire having an attachment area wherein the channel element comprises a thermally sprayed on contact point which is thicker than the heating layer and is welded to the attachment area of the electrical lead wire.

18. A heating channel element according to claims 16 or 17 wherein the electrical lead wire provides the power supply to the heating layer and that the attachment area is electrically connected to the heating layer.
19. A heating channel element according to claims 16 or 17 wherein the electrical lead wire includes a thermal element and that between the thermal element and the heating layer, an electrically isolating layer exists.
20. A heating channel element according to claim 19 wherein the channel element includes a strain relief ring and that the electrical lead wire is clamped between the strain relief ring and the heating layer.
21. A method for attachment of an electrical lead wire to a surface element comprising:
 - fanning out cord of the electrical lead wire;
 - preparing an attachment area for the cords of the lead wire at least on the surface element; and
 - thermally spraying the lead wire to the attachment area with an attachment material.
22. The method according to Claim 21, wherein the surface element is an electrically conductive layer selected from a group consisting of a heating layer and a cooling layer, and the attachment area is electrically connected with the electrically conductive layer.
23. The method according to Claim 22, wherein the attachment material comprises an electrical conductivity from five to ten times higher than an electrical conductivity of the electrically conductive layer.
24. The method according to Claim 22 further comprising an electrically isolating layer applied to the electrically conductive layer by thermal spraying.

25. The method according to Claim 24, wherein the thermal spraying comprises plasma spraying.
26. The method according to Claim 21, wherein an electrically isolating layer is applied over the attachment area and the lead wire.
27. A heating device comprising a heating layer and an electrical lead wire connected at an attachment area, the electrical lead wire comprising fanned out cords that are secured to the attachment area by thermal sprayed attachment material.
28. The heating device according to Claim 27 further comprising an electrically isolating layer applied to the heating layer and the attachment area.
29. The heating device according to Claim 27 further comprising a clamping ring, wherein the electrical lead wire is clamped between the clamping ring and the heating layer.

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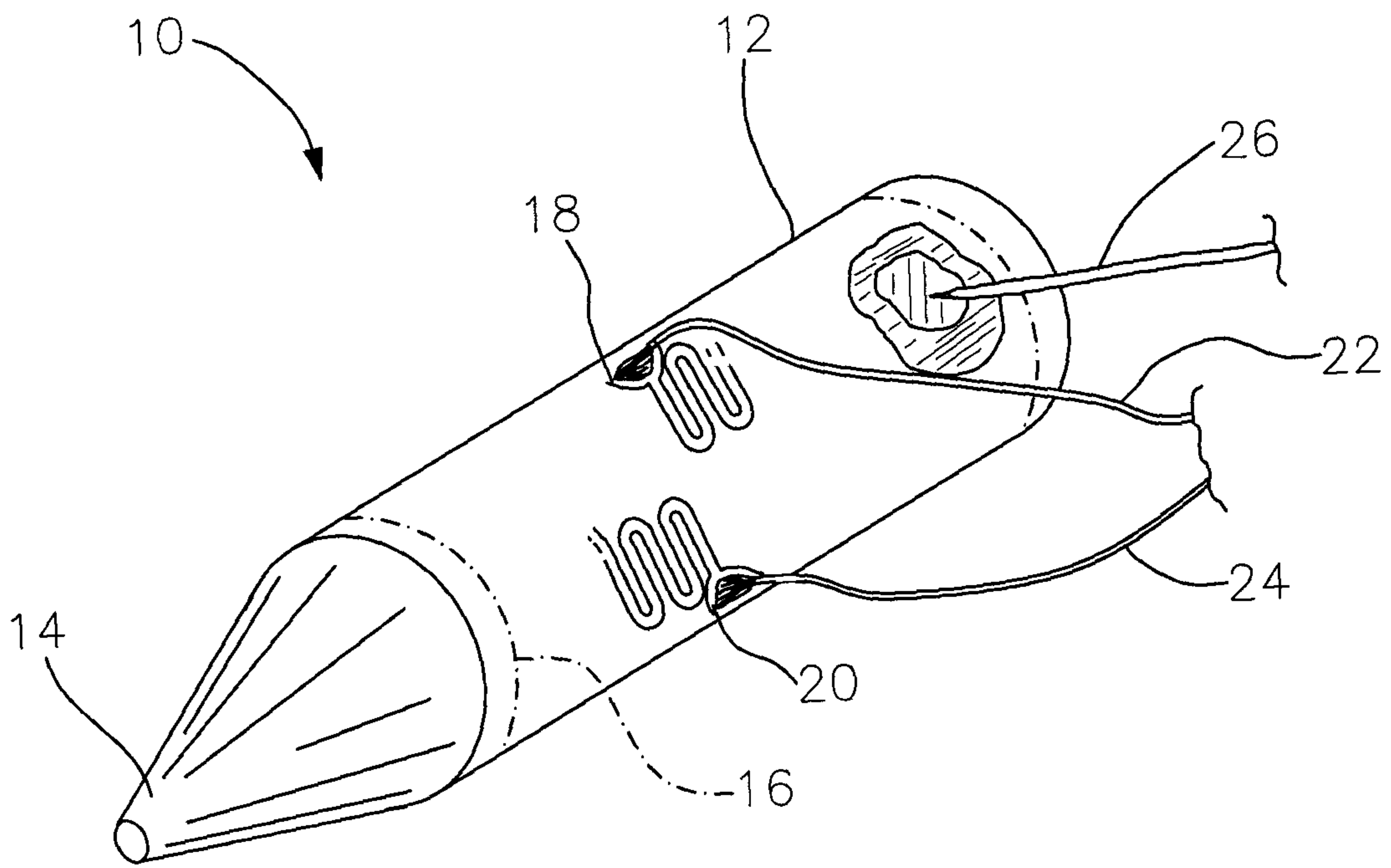


FIG. 1

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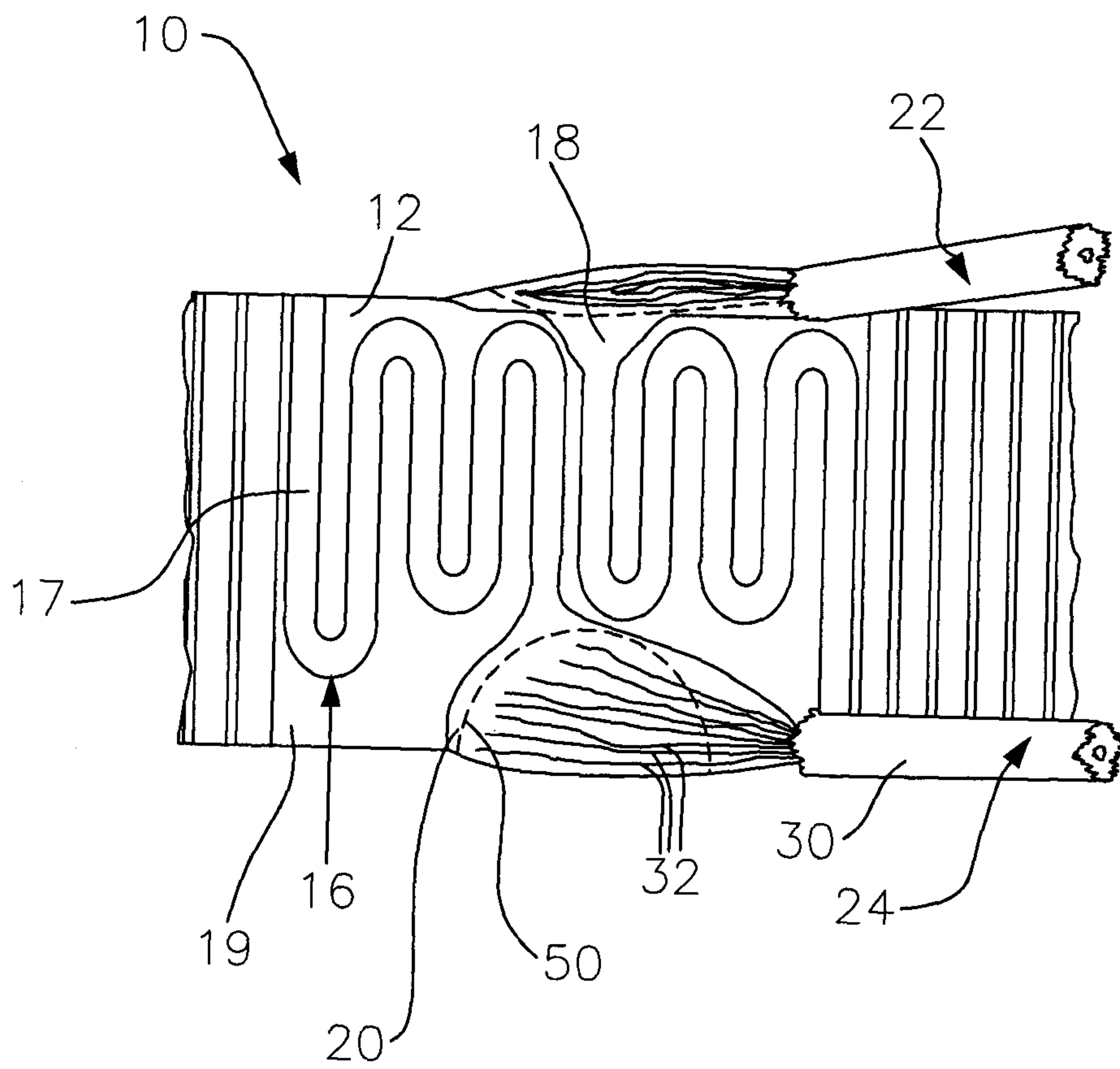


FIG. 2

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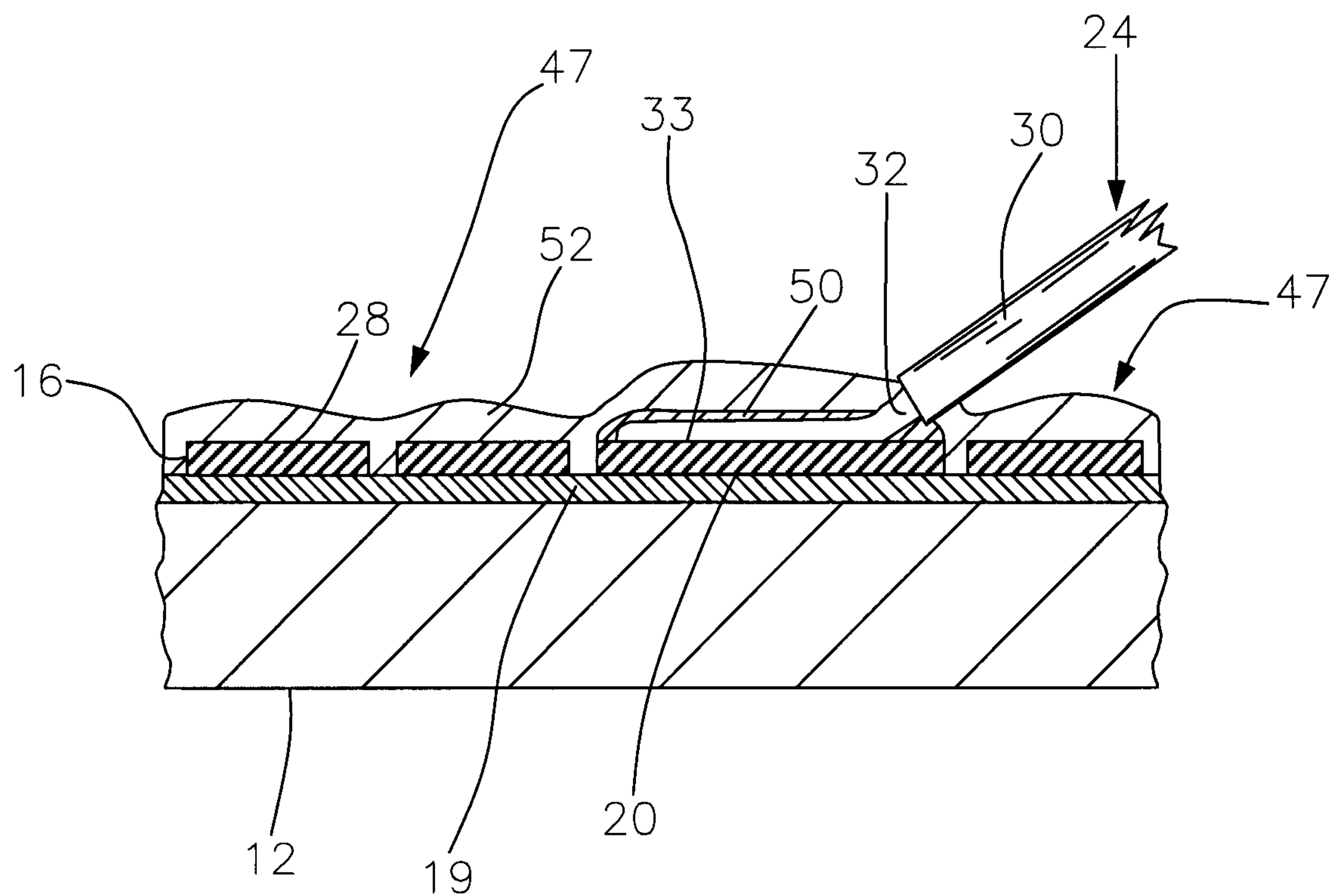


FIG. 3

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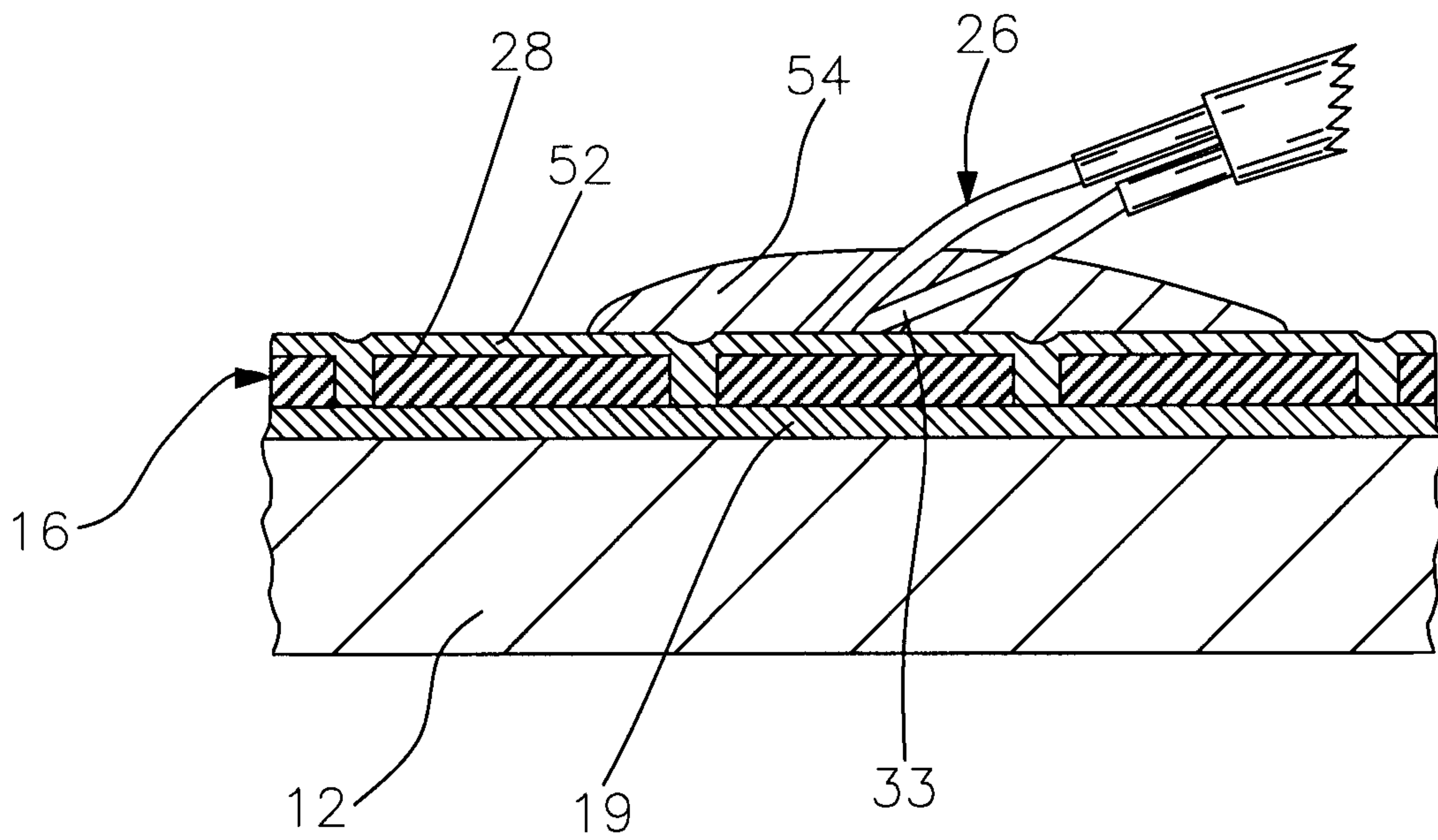


FIG. 4

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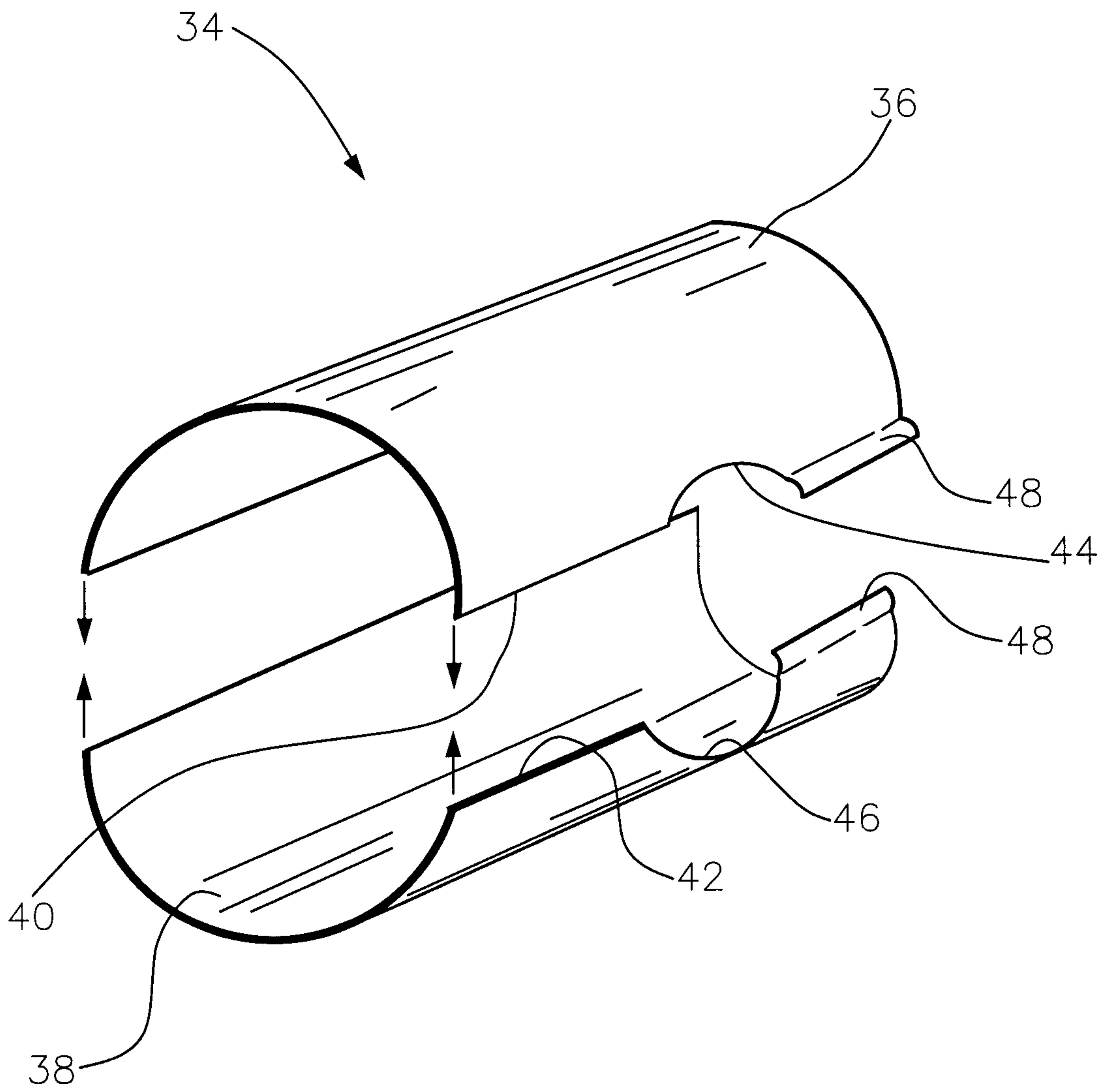


FIG. 5

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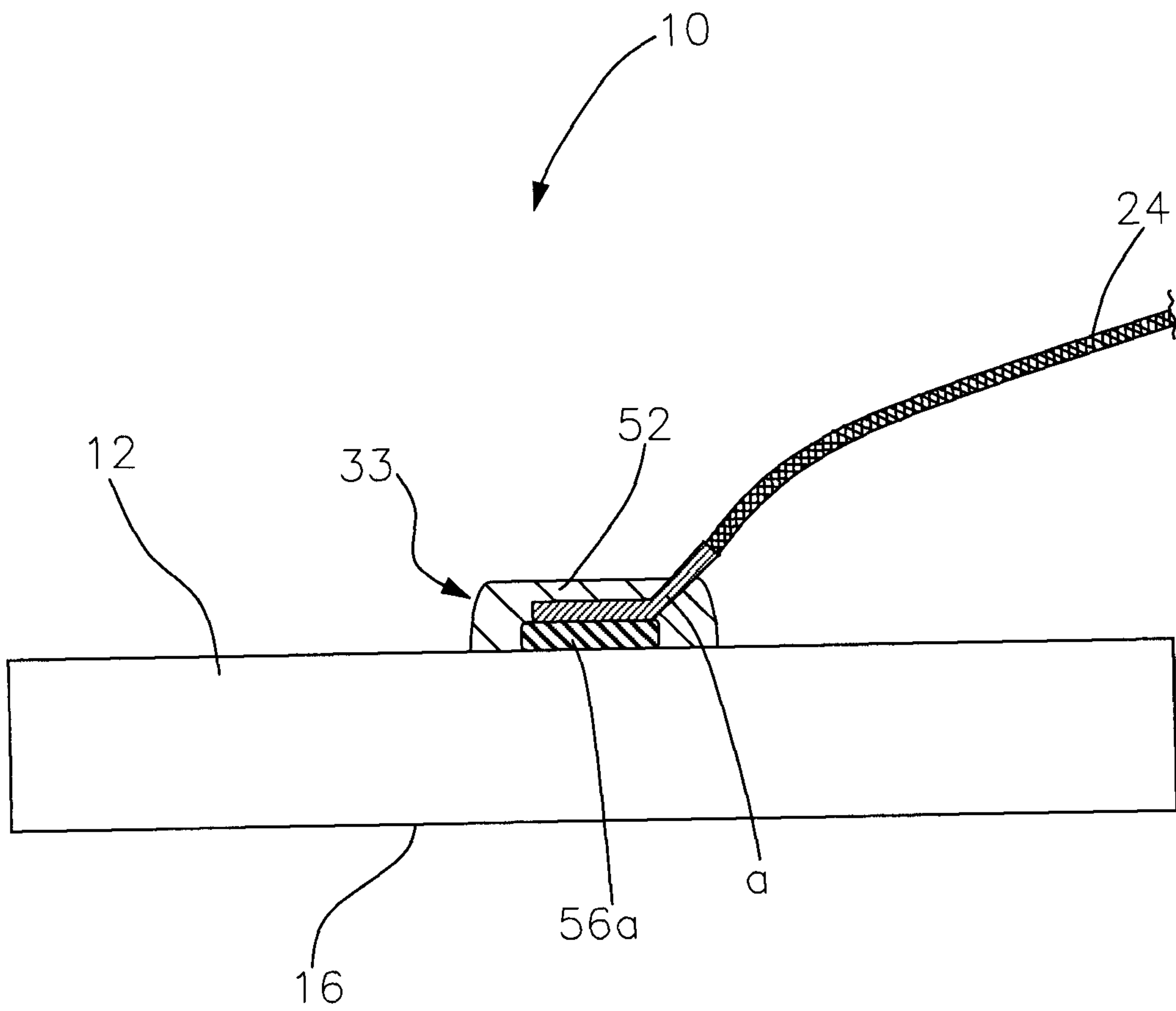


FIG. 6

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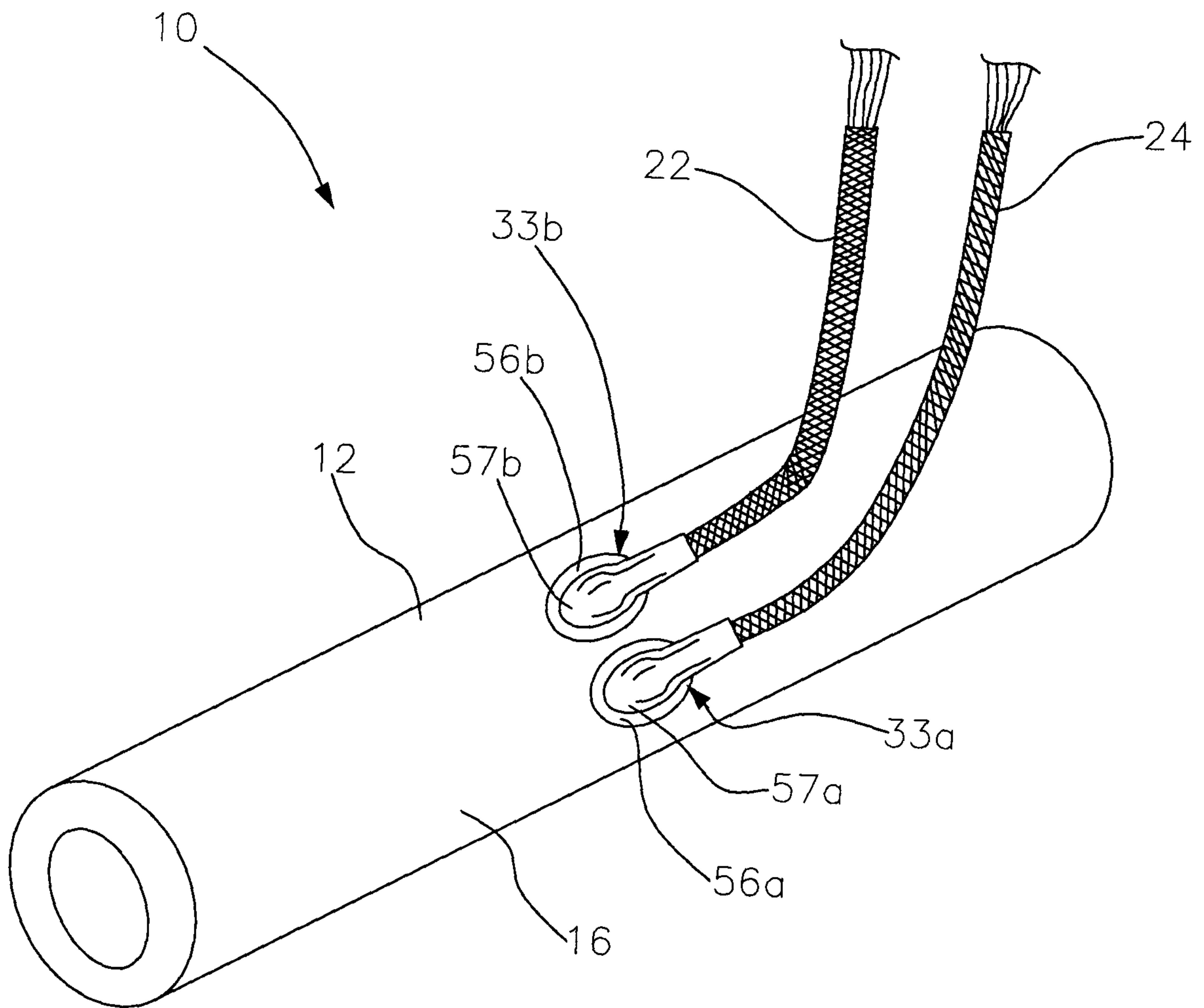


FIG. 7

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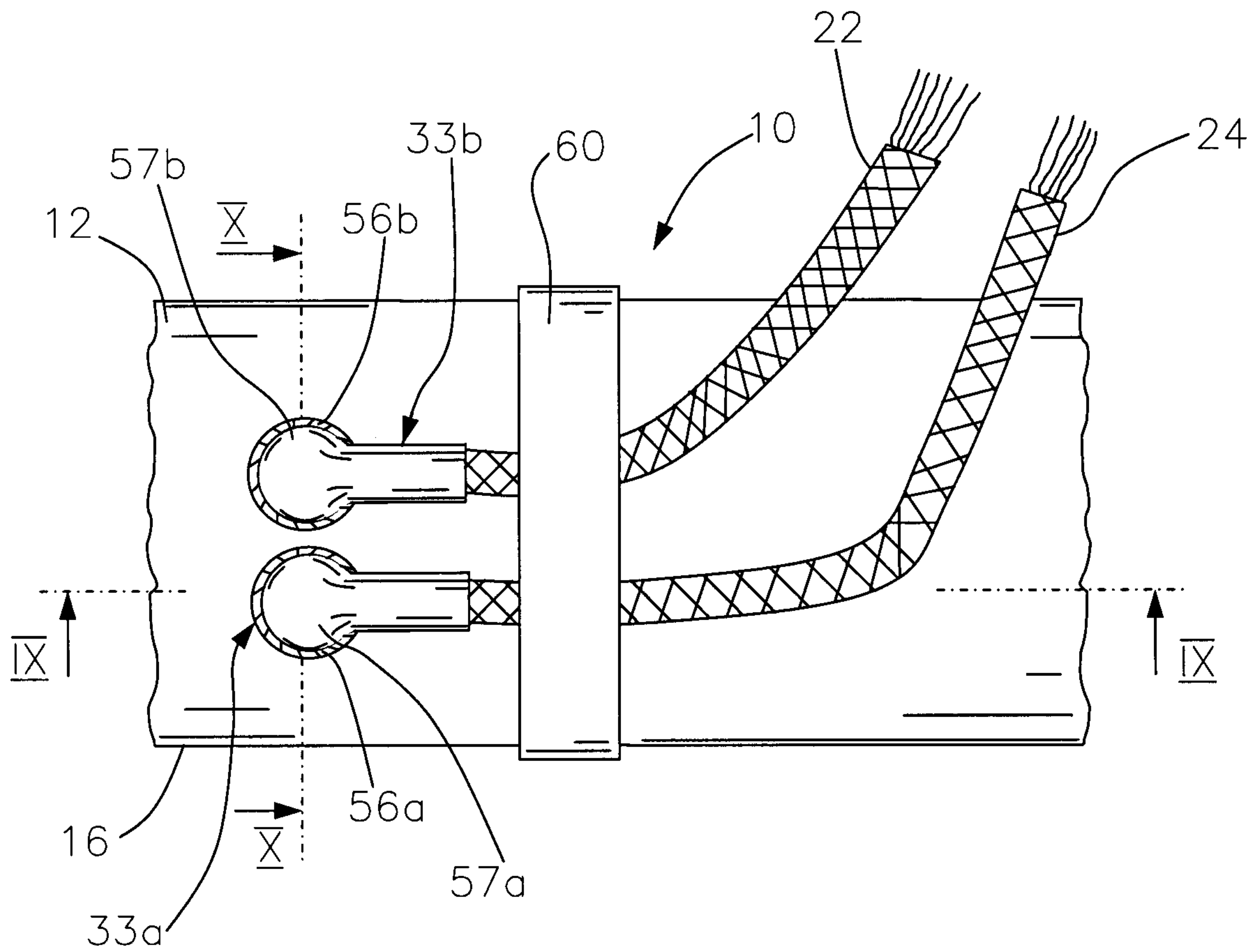


FIG. 8

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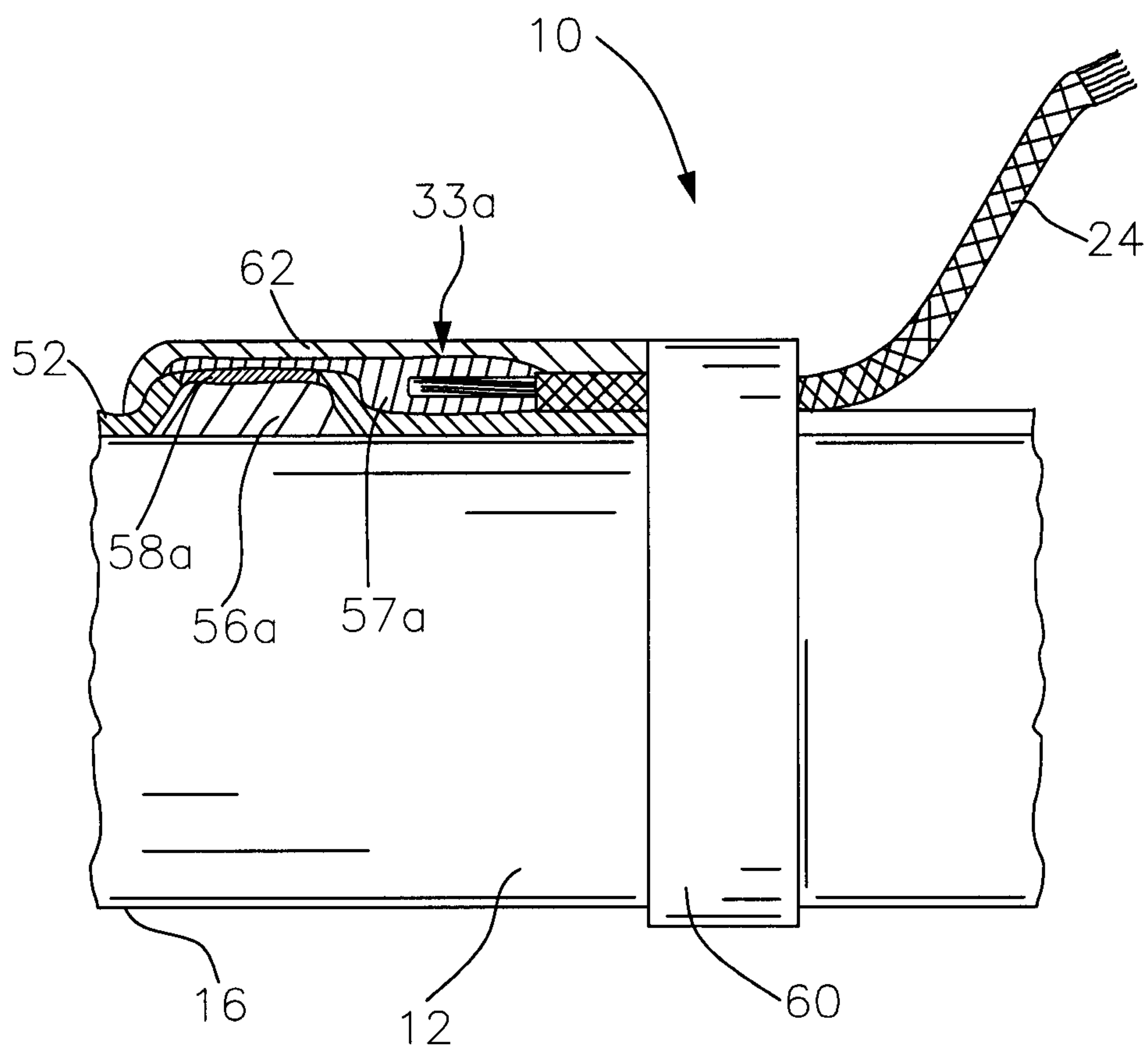


FIG. 9

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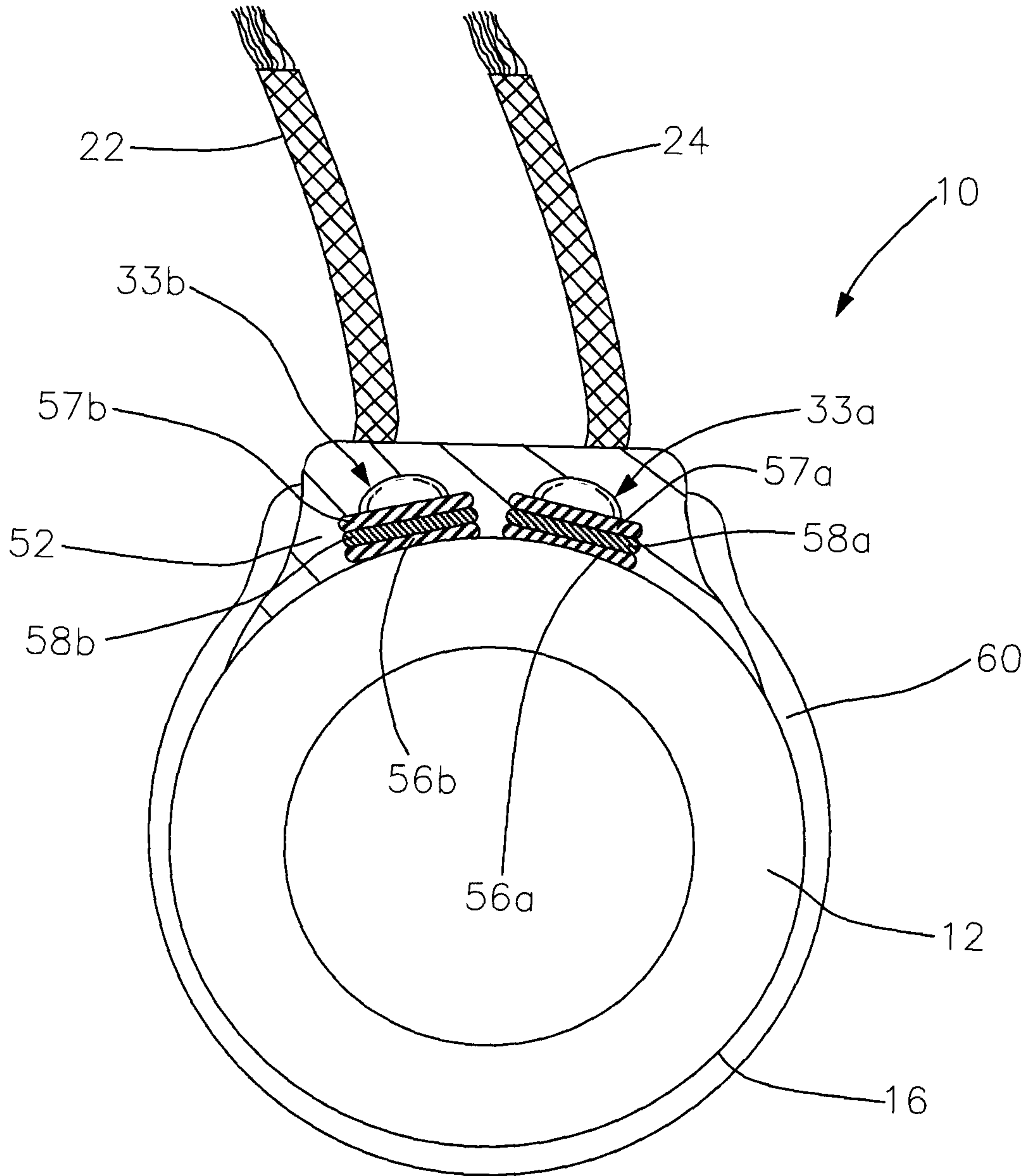


FIG. 10

