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(54) **Connection assembly, method of manufacturing a connection assembly, and tool for manufacturing a connection assembly**

Verbindungsanordnung, Verfahren zur Herstellung einer Verbindungsanordnung und Werkzeug zur Herstellung einer Verbindungsanordnung

Ensemble de connexion, procédé de fabrication d'un ensemble de connexion et outil de fabrication d'un ensemble de connexion

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(73) Proprietor: **Tyco Electronics France SAS
95300 Pontoise (FR)**

(72) Inventor: **Bednarek, Alain
95640 Neuilly en Vexin (FR)**

(74) Representative: **Grünecker Patent- und
Rechtsanwälte
PartG mbB
Leopoldstraße 4
80802 München (DE)**

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Description

[0001] The invention relates to a method of manufacturing a connection assembly and to a tool for manufacturing said connection assembly, wherein the connection assembly comprises at least one conductor and at least one connection device which is plastically deformed about the conductor to form two faces which face each other.

A connection assembly can, for example, comprise a conductor of a cable and a crimp terminal. These connection assemblies usually provide a good connection in terms of a low resistance and a good long term stability. However, for example, when it comes to small wire sizes and/or when aluminum is used, such connections can be problematic.

It is known in the prior art, e.g. from US 2014/0144016, US 2004/042607 A1 and DE 10 2012 007846 A1 to use laser beam welding for effecting a material bond between the two opposing faces.

In WO 2011/125348 A1, the connection assembly is heated during deformation to strengthen the connection to the conductor by thermal contraction.

WO 2014/021336 A1 uses a sealing material to seal a gap of the crimped terminal.

US 5,808,260 A is regarded as the most closely related prior art and uses two electrodes that are spaced from each other in the direction of the conductor. The electrodes may be located on the same side or on diametrically opposing sides of the connection assembly.

The object of the invention is to simplify the production. This object is achieved when the two electrodes are located on the same deformation part of the deformation unit.

[0002] The solution presented by this invention is presented in the method of manufacturing of independent claim 1, and in the tool of independent claim 7. This solution simplifies production.

The solution can be further improved by the following advantageous developments and embodiments.

The conductor can be part of a cable. The cable can further comprise an insulation around the conductor. The conductor can be a single wire or comprise more than one wire. It can be a bundle of wires.

[0003] When the connection device is plastically deformed about the conductor, the conductor can also be plastically deformed. For example, a single wire or more than one wire of a cable can be squeezed and the cross section can change.

[0004] The connection device can comprise one or more deformation sections that are adapted for being plastically deformed about the conductor. Such a deformation section can be flap-like or wing-like or it can have one or more legs so that it can be deformed easily. Free ends of a deformation section can protrude into a volume of the conductor to achieve a high contact area and thus a good contact.

[0005] The faces can face in a circumferential direction

of the conductor. This can give a good gripping of the conductor. The faces can be parallel to an axial direction or to an extension direction of the conductor. This allows an easy manufacturing and gives a good gripping. The faces can be part of a surface that continues on the outside of the connection device and/or the connection assembly. The faces can be part of an outer surface or a back surface of the connection device in order to allow an easy manufacturing. The faces can be located on portions that are bent inwards. By this method, a good gripping performance and a larger contact area between the connection device and the conductor can be achieved.

[0006] The conductor and the connection device can be made from a variety of different conductive materials. Preferred materials are aluminum, copper, or alloys containing these materials, for example, CuSn0.15 or CuSn4. In particular, high electrical conductivity materials having low mechanical properties, for example little elasticity at operation temperature or at elevated temperatures, can be used. Due to the inventive solution, the risk of a relaxation during the life time of the connection assembly, in particular if the connection assembly is subjected to higher temperatures, is reduced. The connection device can have one material in a base or a support section and a coating or a layer of a different material. The coating can in particular comprise tin or zinc. This can be advantageous, for example, when the connection is made by melting a layer, as tin and zinc and alloys containing these materials melt more easily than other materials.

[0007] In the inventive method, faces can be materially bonded by at least partially melting and joining the faces. This can, for example, be done by melting a coating or a top layer that can, for example, contain tin or zinc and by then joining the faces. After cooling down, the faces are then joined by a material bond, in this case a material bond that can be called a solder bond, as the joining process resembles a soldering operation. However, it is in most cases not necessary to add additional solder material from outside, as the coating can already contain tin or zinc or other solderable/meltable material. Nevertheless, a flux can be added, for example as a liquid, a grease, or a meltable solid. The flux can also be present in an additional layer.

[0008] In another advantageous embodiment, the faces are welded to each other. In such a welding operation, it is not just a coating, if such a coating is present, but also part of a base or a support of the conductor device that melts in the area of the faces. Such a welding connection can provide a more rigid and stable connection. However, usually higher temperatures are necessary for melting the base material.

[0009] In the finished connection assembly, such molten und joined faces can for example be seen by a microscopic inspection of a cut and ground cross section of the connection assembly. Due to the melting, the faces can be deformed relative to their original shape. The faces can be at least partially intermixed. Parts of one face

can be located in the other face. The faces can be united to form a single molten and subsequently cooled and solidified area.

[0010] In particular if the two faces are soldered to each other, this can also help to improve the resistance of the connection assembly against salt spray or other climatic phenomena. The soldering seals a possible entrance channel for substances that can damage the connection assembly, for example by corrosion.

[0011] The energy for heating and melting can come from different sources. In a first advantageous embodiment, a current can be used to generate heat and thus melt the faces. Due to the resistance in the material, the current creates heat. The area in which the current flows can advantageously be limited to essentially the area of the faces.

[0012] The current can run from one face to the other. The faces can be the section of a current path with the highest resistance so that the highest amount of heat is generated in the faces and the faces melt while other regions stay solid. The resistance can for example be adjusted by the choice of materials and the cross section of the current path. For example, the resistance can be increased by making the cross section of the current path smaller at the faces.

[0013] In another advantageous embodiment, the current runs along an extension direction of the conductor. The extension direction of the conductor is the direction in which the conductor extends through the loop formed by the plastically deformed connection device. This extension direction is thus usually perpendicular to directions in which the faces face, that means to the normals of the faces. If a wire or a cable is used, the extension direction is the longitudinal direction of the wire or a cable. If the current runs along the extension direction of the conductor, the current also runs along the faces so that heat can be generated in the face. In order to avoid unnecessary heating of other regions which could, for example, melt or insulate the outer cable, the current can be limited to the region of the faces.

As a further measure to avoid unnecessary heating of further elements like an insulator, the connection device or the conductor can be cooled while the faces are heated and molten. The tool can therefore comprise a cooling unit.

In a preferred embodiment, the steps of plastically deforming the connection device about the conductor and the material bonding of the faces to each other take place at substantially the same time. The material bonding can take place at the end of the plastic deformation step in which the two faces are brought into an abutting or adjacent position. In particular, the forces that are used for plastically deforming can also be used to push the two faces together and thus, join them. However, as the heating of the faces might take some time, it can start before the two faces come into contact so that the faces are already molten when they start to touch each other.

[0014] According to the invention, a tool for manufac-

turing a connection assembly, said tool being according to claim 7, is herein presented. In an advantageous development, the bonding unit is adapted for materially bonding the two faces to each other while the connection device is being deformed about the conductor. By this, time can be saved and forces that are used for deforming can also be used for materially bonding the two faces to each other.

The deformation unit can comprise two deformation parts that are adapted for deforming the connection device about the conductor when they are being moved toward each other. One of the deformation parts can be static or stationary, while the other can be movable. The static part can be seen as an anvil, the other part can be seen as a punch or hammer. In an alternative, both deformation parts can be movable.

One of the deformation parts can be adapted for holding the conductor and/or the connection device. To this end, one deformation part can comprise holding means.

The bonding unit can be adapted for melting the faces. The bonding unit can, in particular, comprise a laser, for example, a laser diode. The laser can be directed to the area of the faces for heating the faces. Depending on the intensity and duration of the laser treatment, the laser can melt only a coating or a top layer of the connection device in the area of the faces so that a soldering bond can be achieved. In an alternative, higher intensities and longer durations can lead to more profound melting of the connection device in the area of the faces so that a welding of the faces to each other can be achieved.

In an alternative, currents can be used for heating and melting the face. This can for example, be achieved by running a current through the connection device and/or the conductor. The current can be induced by a magnetic field. In a preferred embodiment, the current is applied electrically, that means by applying a voltage between two contact points on the connection device.

[0015] In order to apply such a current, the bonding unit comprises two electrodes that are adapted for contacting the connection device. In particular, the construction can be such that the connection device connects the two electrodes when it is inserted or when it touches the two electrodes, while an insulating gap is present between the two electrodes when the connection device is not present. For example, in case two deformation parts are used, the two electrodes can be located on one deformation part. The two electrodes can be located on a deformation part with holding means so that the heating of the connection device can start before the other deformation unit starts to deform the connection device. By this, time can be saved. In an alternative, the electrodes can be located on the deformation unit that does not have the holding means. Such a design can be safer, as the heating of the connection device only takes place when the tool is in operation. An unnecessary and possible dangerous heating of the connection device during a non operation interval is thus avoided. Further, as the time interval, in which the current is applied, is defined accu-

rately, more accurate and reliable connections can be made.

In a further alternative, one electrode can be located on one deformation unit and the other electrode can be located on the other deformation unit so that a current can only flow when the two are in contact and deform the connection device and/or the conductor.

[0016] The two electrodes are located on the same deformation part, and as such it is advantageous if the two electrodes are arranged behind each other in an extension direction of the conductor on one deformation part. In particular, the electrodes can be part of the deformation part and take an active role in the deformation itself. They can have shapes that are adapted for deforming the connection device about the conductor. As the deformation takes place around the extension direction of the conductor, the electrodes and/or the deformation parts are more stable because they do not have to be split in the center to achieve an insulation. Rather, every electrode can be integral and surround the conductor and/or the connection device at least partially.

[0017] In an alternative, the two electrodes can be adapted to be behind each other in a direction that is perpendicular to the extension direction of the conductor. The current can thus flow in a direction perpendicular to the extension direction and thus through the two faces subsequently.

[0018] In order to avoid heating of other elements, the tool can comprise a cooling unit for cooling the connection device and/or the conductor. By this, for example a melting of an insulator of a cable can be avoided and/or higher temperatures can be used on the faces so that a tighter connection can be achieved.

[0019] In order to improve the bonding strength, additional bonding material can be added. For example, additional material can be added when the material bond has already been made. It can for instance be added on the outside next to the faces. In an advantageous embodiment, the additional bonding material could be added during the manufacturing just before the connection device is deformed, for example by a micro-metering device that can inject the additional material onto or into the conductor and/or into or onto the connection device. Further, additional bonding material might be already be added to the conductor during the manufacturing of the conductor. For example, the conductor could be coated or additional material could be added between strands of a multi-stranded conductor. The additional bonding material can in particular be a material that melts when the faces are heated during the manufacturing. It could for example be solder or hot melt glue.

[0020] In order to improve the sealing performance, additional sealing material can be added. For example, additional material can be added when the material bond has already been made. It can for instance be added on the outside next to the faces. In an advantageous embodiment, the additional bonding material could be added during the manufacturing just before the connection de-

vice is deformed, for example by a micro-metering device that can inject the additional material onto or into the conductor and/or into or onto the connection device. Further, additional sealing material might be already be added to the conductor during the manufacturing of the conductor. For example, the conductor could be coated or additional material could be added between strands of a multi-stranded conductor. The additional sealing material material can in particular be a material that melts when the faces are heated during the manufacturing. It could for example be solder or hot melt glue. It can especially by a material that gives additional bonding and sealing performance at the same time.

[0021] If additional bonding or sealing material is present that is to be molten during the manufacturing, the deformation parts can have additional gaps or recesses in the area where the two faces should touch each other so that the additional material can exit through the gap between the faces just before this gap is closed.

[0022] The invention will now be described in greater detail and in an exemplary manner using advantageous embodiments and with reference to the drawings. The described embodiments are only possible configurations in which, however, the individual features as described above can be provided independently of one another or can be omitted.

[0023] In the drawings:

- Fig. 1 shows a schematic perspective view of an inventive connection assembly;
- Fig. 2 shows a schematic cross-sectional view of a connection assembly during manufacture;
- Fig. 3 shows a schematic perspective view of an advantageous method of manufacturing;
- Fig. 4 shows a schematic longitudinal cross-sectional view of the step of the method of manufacturing of fig. 3;
- Fig. 5 shows a schematic transverse cross-sectional view of the step of the method of manufacturing of figures 3 and 4;
- Fig. 6 shows a schematic cross-sectional view through an inventive connection assembly.
- Fig. 7 shows a schematic perspective view of a second method of manufacturing;
- Fig. 8 shows a schematic cross-section through the step shown in fig. 7;
- Fig. 9 shows a detail of the cross-section of fig. 8;
- Fig. 10 shows a schematic perspective view of a third advantageous method of manufacturing;
- Fig. 11 shows a schematic perspective close-up view of an inventive connection assembly;
- Fig. 12 shows a schematic cross-sectional view of a further advantageous embodiment of a connection assembly.

[0024] In figure 1 a connection assembly 1 is depicted. The connection assembly 1 comprises a conductor 2 (hidden in figure 1) and a connection device 3. The con-

ductor 2 is part of a cable 4 and is surrounded by the insulation 5 of the cable 4. In a connection area 6, the insulation 5 is removed from the conductor and the conductor 2 is connected to the connection device 3. The connection device 3 is in this case a terminal that can for example be used in a connector or plug in order to make contact to a counter connector or a counter plug. The connection device 3 comprises a deformation section 31 in which the connection device 3 is plastically deformed about the conductor 2 to form two faces 7 which face each other. The faces 7 are connected to each other by a material bond 15. Such a material bond can for example be a solder or a weld bond. Due to the material bond 15, the connection device 3 exerts a compressive force onto the conductor 2. The compressive force is longtime stable and does not decrease over time.

[0025] The deformation section 31 in figure 1 is embodied as a crimp barrel 32 which has wing-like sections 33 that can be wound or wrapped about or around the conductor 2.

[0026] The connection device 3 further comprises an insulation crimp section 8 that is adapted for being crimped onto the insulation 5 of the cable 4. It thus helps to relieve the strain applied to the cable 4. Further, grease 9 is present in order to seal the conductor 2 from the environment and to avoid oxidation of the conductor and ingress of dirt or water.

[0027] In figure 2 a cross-sectional view of a step of the manufacturing method is shown. A tool 10 is used for manufacturing the connection assembly 1. The tool 10 comprises a first deformation part 11 and a second deformation part 12. The first deformation part 11 is static and immovable, whereas the second deformation part 12 is movable.

[0028] In the manufacturing method, the conductor 2 and the connection device 3 are placed on the first deformation part 11. The first deformation part 11 can comprise holding means for holding the conductor 2 and/or the connection device 3 in its place. In this stage, the wing-like sections 33 or legs of the crimp barrel 32 are not yet fully wrapped around the conductor 2.

[0029] The second deformation part 12 is then moved along the actuation direction A towards the first deformation part 11 and onto and around the conductor 2 and the connection device 3. The wing-like sections 33 of the crimp barrel 32 and thus the deformation section 31 of the connection device 3 are bent inwards towards the conductor 2 and wrapped around the conductor 2. Free ends or tips 34 of the wing-like section 33 are pressed into the conductor 2 which in this case comprises several strands of wire. The tips 34 are located in a volume of the conductor 2. The volume is surrounded and limited by the wing-like sections 33 of the connection device 3. By this, a large contact area can be achieved. Two faces 7 of the deformation section 31 are moved into a position adjacent to each other. This is done by exerting forces F onto the connection device 3 and the conductor 2 that act in an inwards direction. The two faces 7 are materially

bonded to each other. To achieve this, the tool 10 comprises a bonding unit 14. The bonding unit 14 can for example comprise the second deformation part 12 which could for example be heated in order to heat the connection device 3 and thus the faces 7 so that the coating on the connection device 3 melts in the area of the faces 7. After cooling, a material bond 15, for example in the form of a solder bond is thus achieved.

[0030] The bonding unit 14 could also be adapted to run a current through the conductor 2 and/or the connection device 3. The current can heat and at least partially melt the faces 7. If the connection device 3 comprises a coating comprising for example tin or zinc, this coating can melt in the area of the faces 7 and produce a material bond 15 in the form of a soldering bond. If no such coating is present or if high currents and temperatures are used, the base material of the connection device 3 in the area of the deformation section 31, in particular in the area of the faces 7 can melt and thus lead to a welding bond as a material bond 15.

[0031] The faces 7 in figure 2 are faces of an outside or back side of the connection device 3 and the connection assembly 1. In other words, the faces 7 continue outside the area in which they touch each other to be an outside of the connection device 3. Due to this, the coating which can already be present on the outside of the connection device 3, for example for protection purposes, can also be used for making the material bond 15.

[0032] The faces 7 face in a circumferential direction C of the conductor 2. The faces 7 are parallel to an axial direction or an extension direction E of the conductor.

[0033] In the example of figure 2, it is not only the connection device 3 that is deformed plastically during manufacturing. The conductor 2 is also deformed plastically.

[0034] Due to the material bond 15, the connection device 3 surrounds the conductor 2 around 360°, which is indicated by the continuous line 16. No gap is present between the faces 7. Due to this, the connection device 3 can permanently exert high forces onto the conductor 2. It compresses the conductor 2. Thus, a good electrical contact is made between the two, the electrical contact being longtime stable. In particular, movements of the conductor 2 within the connection device 3 are minimized and cannot lead to a loosening of the connection between the two.

[0035] In figures 3, 4 and 5 a method of manufacturing a connection assembly 2 is depicted. In the method shown therein, a current is used to establish the material bond 15. The tool 10 for making the connection comprises a deformation unit 13 which comprises the first deformation part 11 and the second deformation part 12. The first deformation part 11 is again static or stationary and thus could be designated as an anvil. The second deformation part 12 is movable and can thus be designated as a hammer or a punch. The two deformation parts 11, 12 are relatively movable to each other and are adapted to deform the connection device 3 around the conductor 2 when they are moved toward each other. The second

deformation part 12 is also part of a bonding unit 14 that makes the material bond 15 between the faces 7.

[0036] In the case shown in figures 3 to 5, the material bond 15 is made by melting parts of the faces 7 with a current I. The current I only runs through the upper side of the connection assembly 1. The second deformation part 12 comprises a first electrode 121 and a second electrode 122 which are located behind each other in an extension direction E of the conductor 2 and are separated by an insulating part 123. Voltage can be applied between the first electrode 121 and the second electrode 122. When the second deformation part 12 is in contact with the connection device 3 and the conductor 2, the current I can thus flow between the first electrode 121 and a second electrode 122 through the connection device 3 and the conductor 2. This can lead to a heating of the connection device 3 and/or the conductor 2 and thus the faces 7 so that the faces 7 can melt at least partially. Thus, when the faces 7 are in the position adjacent to each other and the faces 7 are molten, the faces 7 can make a material bond 15. To support this, the faces 7 can be pushed towards each other. The faces 7 can be molten right before they come into the position adjacent to each other or when they are already in this position adjacent to each other. In order to cool the material bond 15 and thus to solidify the liquid parts, the tool 10 comprises a cooling unit 17 which, in this case, comprises the first deformation part 11.

[0037] The voltage between the first electrode 121 and the second electrode 122 can be present at all times. For example, the conductor 2 and the connection device 3 can be held in the first deformation part 11 and the second deformation part 12 can be moved onto the conductor 2 and the connection device 3. During the time interval in which the second deformation part 12 touches the conductor 2 and the connection device 3, the current I flows. When the second deformation part 12 moves away again, the current I is automatically interrupted.

[0038] In another advantageous embodiment, the flow of the current I can be controlled by an external source. For example, the second deformation part 12 can first come into contact with the conductor 2 and the connection device 3 with no voltage applied. When the second deformation part 12 is already in contact with the conductor 2 and the connection device 3, the flow of the current I can be activated and deactivated after a certain time. The material bond can then cool down with no current flow while the second deformation part 12 is still in contact with the conductor 2 and the connection device 3. Subsequently, the second deformation part 12 can be moved away so that a material bond 15 is already solid when the second deformation part 12 moves away. Anyway, the material bond 15 is made at substantially the same time as the plastic deformation takes place and the two faces 7 are brought into a position adjacent to each other.

[0039] In figure 6 a cross-section through a connection assembly 1 according to the invention is depicted. No

gap is visible between the faces 7. Rather, the material bond 15 makes a seamless connection between the two faces 7. In this example, the two faces 7 are still clearly visible in a cross section of the connection assembly 1, as only coatings of the faces 7 were molten and joined. Thus, at least the base section or support section has not been deformed substantially. If higher temperatures are used, for example by using higher intensities or longer time intervals, the base section can also be molten, at least partially. In this case, the cross section of the connection assembly 1 would be slightly different. The shape of the faces 7 after the manufacturing process might be different from the shape of the faces 7 before the manufacturing process. Parts of one face 7 could have flown into the other face 7. The faces 7 could be united and form a single molten and solidified region.

[0040] In figures 7, 8, and 9, a second advantageous embodiment of a manufacturing method is shown. The tool 10 comprises a deformation unit 13 with a first deformation part 11 at the bottom and a second deformation part 12 above the first deformation part 11. The conductor 2 and the connection device 3 are again located between the first and the second deformation part 11, 12. Faces 7 are brought into contact with each other in the upper region of the connection assembly 1. In order to establish the material bond 15, the tool 10 comprises a bonding unit 14. In this case the bonding unit 14 comprises a laser 140 for example a laser diode, that emits a laser beam 141 that is directed onto the area of the faces 7. The laser beam 141 is at least partially absorbed by the material of the faces 7 and melts the faces 7 at least partially. The laser beam 141 can then be turned off and the material bond 15 between the two faces can then cool down so that a tight connection between the two faces is established.

[0041] The laser beam 141 can only melt a coating on the faces 7 so that a soldering bond between the faces 7 is made. If higher intensities and/or longer time intervals are used, the laser beam 141 can also melt a base material so that a welding connection between the faces 7 can be made.

[0042] In figure 10 a third advantageous embodiment of the method of manufacturing is depicted. Again a current I is used for heating and melting. However, in this embodiment the current I flows from the second deformation part 12 to the first deformation part 11. To achieve this, a voltage can be applied between a first and a second deformation part 11, 12.

[0043] In figure 11 a connection assembly 1 can be seen in detail. Due to the soldered joint the resistance of the connection assembly 1 against salt spray or other climatic phenomena is improved. The soldered material bond 15 seals a possible entrance channel for substances like water, oxygen or other material that can damage the connection assembly, for example by corrosion. Further, it can be seen that the three parts of the second deformation unit 14 that have been used for deforming and for running a current I along the extension direction

E have left marks on the connection device 3.

[0044] In figure 12 a cross section of a connection assembly 1 with additional bonding material 41 and/or additional sealing material 42 is depicted. This could have been added after the material bond 15 has been made. It can also be that the additional bonding and/or sealing material 41, 42 had already been present in the area of the conductor 2 before the connection device 3 was wrapped around it. It could for example have been molten during the heating of the faces 7 and then have, at least partially, exited through the still existing gap between the faces 7 before the gap was closed during the deformation step.

Reference Signs

[0045]

1	connection assembly
2	conductor
3	connection device
4	cable
5	insulation
6	connection area
7	face
8	insulation crimp section
9	grease
10	tool
11	first deformation part
12	second deformation part
13	deformation unit
14	bonding unit
15	material bond
16	continuous line
17	cooling unit
31	deformation section
32	crimp barrel
33	wing-like section
34	tip
41	additional bonding material
42	additional sealing material
121	first electrode
122	second electrode
123	insulating part
140	laser
141	laser beam
A	actuation direction
C	circumferential direction
E	extension direction
F	force
I	current

Claims

1. Method of manufacturing a connection assembly (1) using the tool (10) of any of the claims 7 to 14, said

method plastically deforming a connection device (3) about a conductor (2) and thus moving two faces (7) of the connection device (3) into a position adjacent to each other, and by materially bonding the two adjacent faces (7) to each other using electric current (I), **characterized in that** the current (I) runs from a first electrode (121) on a deformation part (12) of a deformation unit (13) to a second electrode (122) on the same deformation part (12), wherein the first electrode (121) and the second electrode (122) are separated by an insulating part (123).

2. Method according to claim 1, **characterized in that** the faces (7) are materially bonded by at least partially melting and joining the faces (7).

3. Method according to claim 2, **characterized in that** a current (I) is used for melting the faces (7).

4. Method according to one of claims 1 to 3, **characterized in that** the current (I) runs along an extension direction (E) of the conductor (2).

5. Method according to one of claims 1 to 3, **characterized in that** the current runs from one face (7) to the other.

6. Method according to one of claims 3 to 5, **characterized in that** the connection device (3) and/or the conductor (2) are cooled while the faces (7) are molten.

7. Tool (10) for manufacturing a connection assembly (1) comprising at least one conductor (2) and at least one connection device (3) which is plastically deformed about the conductor (2), wherein the tool (10) comprises at least one deformation unit (13) for deforming the connection device (3) about the conductor (2), wherein the deformation unit (13) moves two faces (7) of the connection device (3) into a position adjacent to each other, and wherein the tool (10) further comprises a bonding unit (14) for materially bonding the two faces (7) of the connection device (3) to each other, the bonding unit (14) comprising two electrodes (121, 122) that are separated by an insulating part (123), wherein the deformation unit (13) comprises a first deformation part (11) and a second deformation part (12), **characterized in that** the second deformation part (12) comprises the first electrode (121) and the second electrode (122).

8. Tool (10) according to claim 7, **characterized in that** the bonding unit (14) is adapted for materially bonding the two faces (7) to each other while the connection device (3) is being deformed about the conductor (2).

9. Tool (10) according to one of claims 7 or 8, **characterized in that**

terized in that the deformation unit (13) comprises two deformation parts (11, 12) that are adapted for deforming the connection device (3) about the conductor (2) when they are being moved towards each other.

10. Tool (10) according to one of claims 7 to 9, **characterized in that** the bonding unit (14) is adapted for melting the faces (7).
11. Tool (10) according to one of claims 7 to 10, **characterized in that** the bonding unit (14) comprises two electrodes (121, 122) adapted for contacting the connection device (3).
12. Tool (10) according to one of claims 7 to 11, **characterized in that** the two electrodes (121, 122) are arranged behind each other in an extension direction (E) of the conductor (2) on one deformation part (11).
13. Tool (10) according to one of claims 7 to 11, **characterized in that** the electrodes (121, 122) are located behind each other in a direction that is perpendicular to the extension direction (E) of the conductor (2).
14. Tool (10) according to one of claims 7 to 13, **characterized in that** the tool (10) comprises a cooling unit for cooling the connection device (3) and/or the conductor (2).

Patentansprüche

1. Verfahren zum Herstellen einer Verbindungsanordnung (1) unter Verwendung des Werkzeugs (10) nach einem der Ansprüche 7 bis 14, wobei mit dem Verfahren eine Verbindungsvorrichtung (3) um einen Leiter (2) herum plastisch verformt wird und so zwei Flächen (7) der Verbindungsvorrichtung (3) an eine aneinandergrenzende Position bewegt werden, und die zwei aneinandergrenzenden Flächen (7) unter Verwendung von elektrischem Strom (I) in Stoffbindung miteinander gebracht werden, **dadurch gekennzeichnet, dass** der Strom (I) von einer ersten Elektrode (121) an einem Verformungs-Teil (12) einer Verformungs-Einheit (13) zu einer zweiten Elektrode (122) an dem gleichen Verformungs-Teil (12) fließt, wobei die erste Elektrode (121) und die zweite Elektrode (122) durch einen isolierenden Teil (123) getrennt sind.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Flächen (7) in Stoffbindung gebracht werden, in dem die Flächen (7) wenigstens teilweise zum Schmelzen gebracht und zusammengefügt werden.

3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** ein Strom (I) eingesetzt wird, um die Flächen (7) zum Schmelzen zu bringen.

4. Verfahren nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** der Strom (I) in einer Verlaufsrichtung (E) des Leiters (2) fließt.

5. Verfahren nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** der Strom (I) von einer Fläche (7) zu der anderen fließt.

6. Verfahren nach einem der Ansprüche 3 bis 5, **dadurch gekennzeichnet, dass** die Verbindungsvorrichtung (3) und/oder der Leiter (2) gekühlt werden, wenn die Flächen (7) geschmolzen sind.

7. Werkzeug (10) zum Herstellen einer Verbindungsanordnung (1), die wenigstens einen Leiter (2) und wenigstens eine Verbindungsvorrichtung (3) umfasst, die plastisch um den Leiter (2) herum verformt wird, wobei das Werkzeug (10) wenigstens eine Verformungs-Einheit (13) zum Verformen der Verbindungsvorrichtung (3) um den Leiter (2) herum umfasst und die Verformungs-Einheit (13) zwei Flächen (7) der Verbindungsvorrichtung (3) an eine aneinandergrenzende Position bewegt, und wobei das Werkzeug (10) des Weiteren eine Bindungs-Einheit (14) zum Herstellen von Stoffbindung der zwei Flächen (7) der Verbindungsvorrichtung (3) miteinander umfasst, die Bindungs-Einheit (14) zwei Elektroden (121, 122) umfasst, die durch einen isolierenden Teil (123) getrennt sind, die Verformungs-Einheit (13) einen ersten Verformungs-Teil (11) und einen zweiten Verformungs-Teil (12) umfasst, **dadurch gekennzeichnet, dass** der zweite Verformungs-Teil (12) die erste Elektrode (121) und die zweite Elektrode (122) umfasst.

8. Werkzeug (10) nach Anspruch 7, **dadurch gekennzeichnet, dass** die Bindungs-Einheit (14) so eingerichtet ist, dass sie Stoffbindung der zwei Flächen (7) miteinander herstellt, wenn die Verbindungsvorrichtung (3) um den Leiter (2) herum verformt ist.

9. Werkzeug (10) nach einem der Ansprüche 7 oder 8, **dadurch gekennzeichnet, dass** die Verformungs-Einheit (13) zwei Verformungs-Teile (11, 12) umfasst, die so eingerichtet sind, dass sie die Verbindungsvorrichtung (3) um den Leiter (2) herum verformen, wenn sie aufeinander zu bewegt werden.

10. Werkzeug (10) nach einem der Ansprüche 7 bis 9, **dadurch gekennzeichnet, dass** die Bindungs-Einheit (14) so eingerichtet ist, dass sie die Flächen (7) zum Schmelzen bringt.

11. Werkzeug (10) nach einem der Ansprüche 7 bis 10,

dadurch gekennzeichnet, dass die Bindungs-Einheit (14) zwei Elektroden (121, 122) umfasst, die so eingerichtet sind, dass sie mit der Verbindungsvorrichtung (3) in Kontakt kommen.

12. Werkzeug (10) nach einem der Ansprüche 7 bis 11, **dadurch gekennzeichnet, dass** die zwei Elektroden (121, 122) in einer Verlaufsrichtung (E) des Leiters (2) an einem Verformungs-Teil (11) hintereinander angeordnet sind.

13. Werkzeug (10) nach einem der Ansprüche 7 bis 11, **dadurch gekennzeichnet, dass** die Elektroden (121, 122) in einer Richtung, die senkrecht zu der Verlaufsrichtung (E) des Leiters (2) ist, hintereinander angeordnet sind.

14. Werkzeug (10) nach einem der Ansprüche 7 bis 13, **dadurch gekennzeichnet, dass** das Werkzeug (10) eine Kühl-Einheit zum Kühlen der Verbindungsvorrichtung (3) und/oder des Leiters (2) umfasst.

Revendications

1. Procédé de fabrication d'un ensemble de connexion (1) en utilisant l'outil (10) décrit dans l'une quelconque des revendications 7 à 14, ledit procédé déformant plastiquement un dispositif de connexion (3) autour d'un conducteur (2) et déplaçant ainsi deux faces (7) du dispositif de connexion (3) dans une position où elles sont adjacentes l'une à l'autre, et en reliant matériellement les deux faces (7) l'une à l'autre en utilisant du courant électrique (I), **caractérisé en ce que** le courant (I) s'écoule d'une première électrode (121) sur un composant de déformation (12) appartenant à une unité de déformation (13) jusqu'à une seconde électrode (122) sur le même composant de déformation (12), la première électrode (121) et la seconde électrode (122) étant séparées par une pièce isolante (123).

2. Procédé selon la revendication 1, **caractérisé en ce que** les faces (7) sont reliées matériellement en faisant fondre partiellement et en réunissant les faces (7).

3. Procédé selon la revendication 2, **caractérisé en ce que** le courant (I) est utilisée pour faire fondre les faces (7) .

4. Procédé selon l'une des revendications 1 à 3, **caractérisé en ce que** le courant (I) s'écoule le long de la direction d'extension (E) du conducteur (2).

5. Procédé selon l'une des revendications 1 à 3, **caractérisé en ce que** le courant s'écoule d'une face (7) à l'autre.

6. Procédé selon l'une des revendications 3 à 5, **caractérisé en ce que** le dispositif de connexion (3) et/ou le conducteur (2) sont refroidis alors que les faces (7) sont fondues.

7. Outil (10) destiné à fabriquer un ensemble de connexion (1) comprenant au moins un conducteur (2) et au moins un dispositif de connexion (3) qui est déformé plastiquement autour du conducteur (2), l'outil (10) comprenant au moins une unité de déformation (13) destinée à déformer le dispositif de connexion (3) autour du conducteur (2), l'unité de déformation (13) déplaçant deux faces (7) du dispositif de connexion (3) dans une position où elles sont adjacentes l'une à l'autre, et l'outil (10) comprenant en outre une unité de liaison (14) destinée à relier les deux faces (7) du dispositif de connexion (3) l'une à l'autre, l'unité de liaison (14) comprenant deux électrodes (121, 122) qui sont séparées par une pièce isolante (123), l'unité de déformation (13) comprenant un premier composant de déformation (11) et un second composant de déformation (12), **caractérisé en ce que** le second composant de déformation (12) comprend la première électrode (121) et la seconde électrode (122).

8. Outil (10) selon la revendication 7, **caractérisé en ce que** l'unité de liaison (14) est conçue pour relier matériellement les deux faces (7) l'une à l'autre alors que le dispositif de connexion (3) est déformé autour du conducteur (2).

9. Outil (10) selon l'une des revendications 7 à 8, **caractérisé en ce que** l'unité de déformation (13) comprend deux composants de déformation (11, 12) qui sont conçus pour déformer le dispositif de connexion (3) autour du conducteur (2) lorsqu'ils sont déplacés l'un vers l'autre.

10. Outil (10) selon l'une des revendications 7 à 9, **caractérisé en ce que** l'unité de liaison (14) est conçue pour faire fondre les faces (7).

11. Outil (10) selon l'une des revendications 7 à 10, **caractérisé en ce que** l'unité de liaison (14) comprend deux électrodes (121, 122) conçues pour entrer en contact avec le dispositif de connexion (3).

12. Outil (10) selon l'une des revendications 7 à 11, **caractérisé en ce que** les deux électrodes (121, 122) sont disposées l'une derrière l'autre dans la direction d'extension (E) du conducteur (2) sur un composant de déformation (11).

13. Outil (10) selon l'une des revendications 7 à 11, **caractérisé en ce que** les électrodes (121, 122) sont situées l'une derrière l'autre dans une direction qui est perpendiculaire à la direction d'extension (E) du

conducteur (2) .

14. Outil (10) selon l'une des revendications 7 à 13,
caractérisé en ce que l'outil (10) comprend une uni-
té de refroidissement destinée à refroidir le dispositif 5
de connexion (3) et/ou le conducteur (2).

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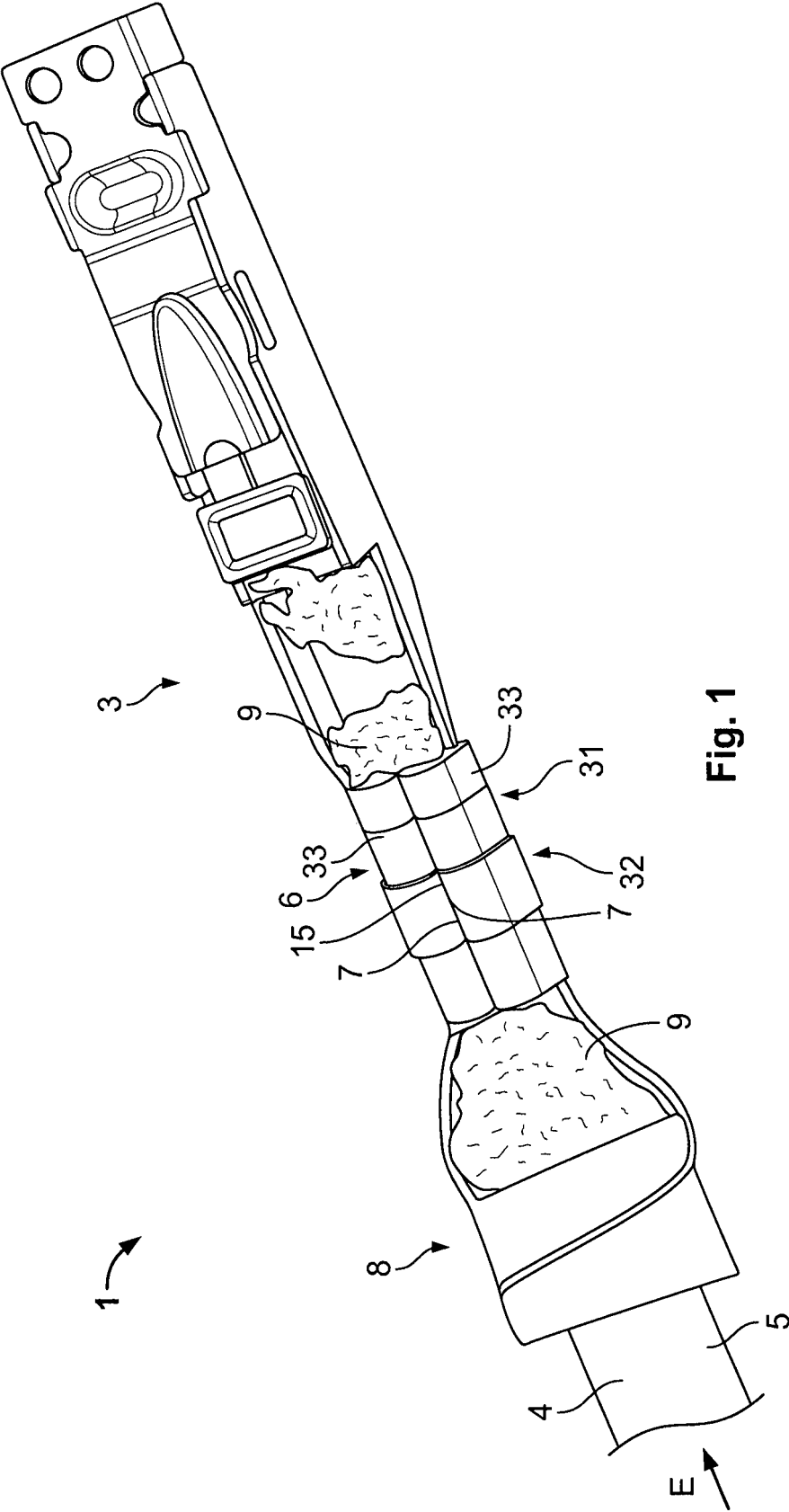


Fig. 1

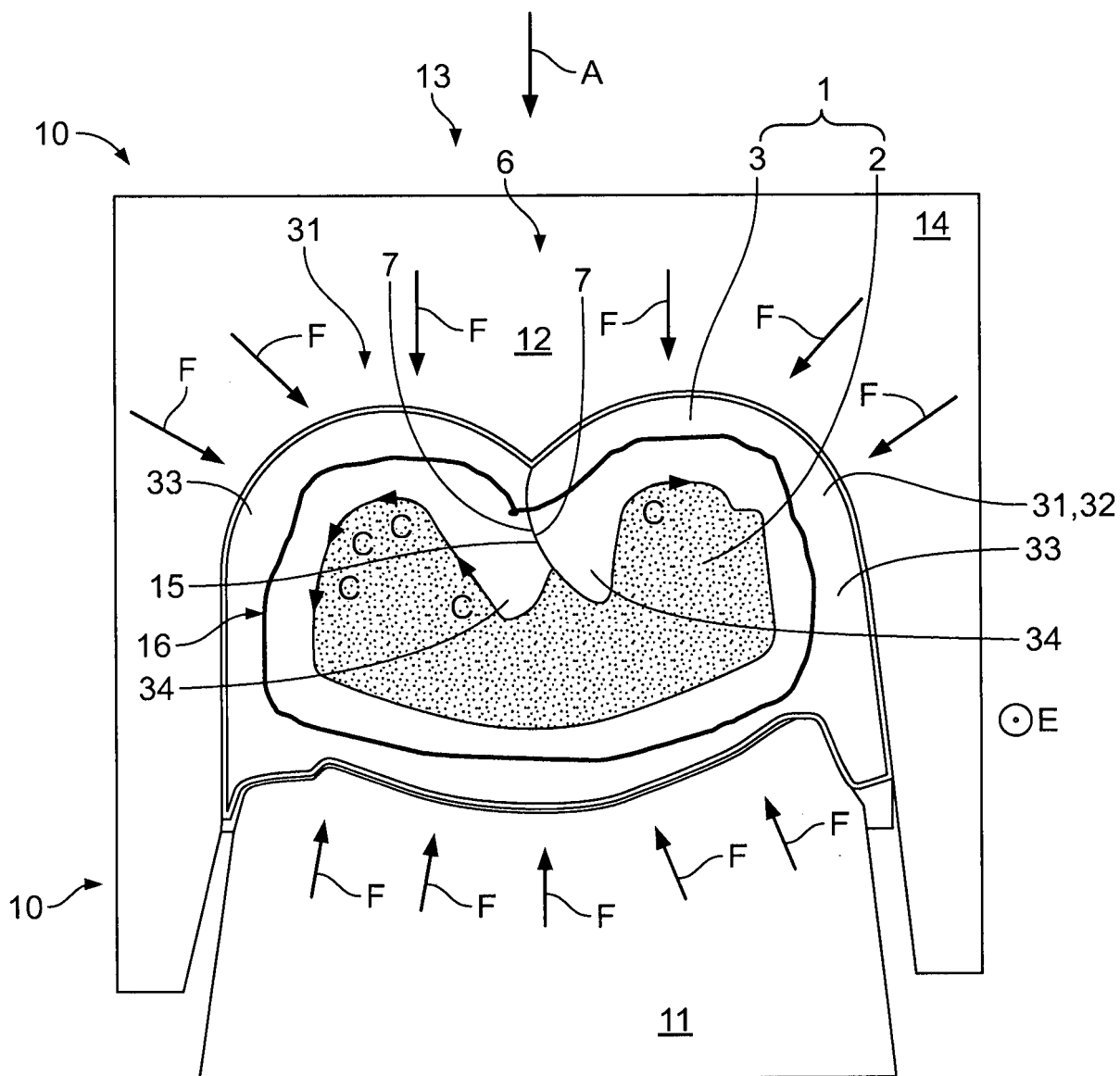


Fig. 2

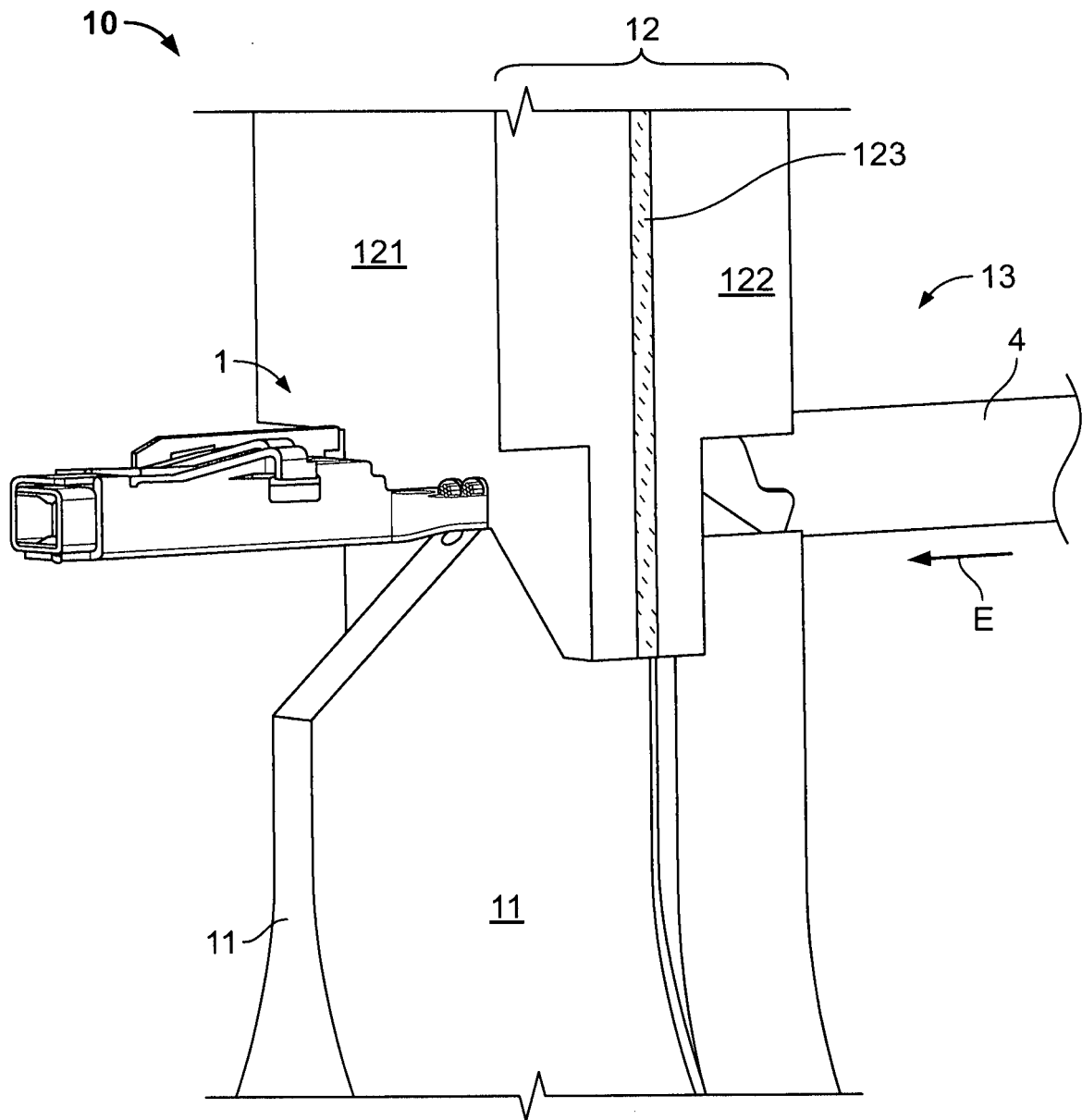


Fig. 3

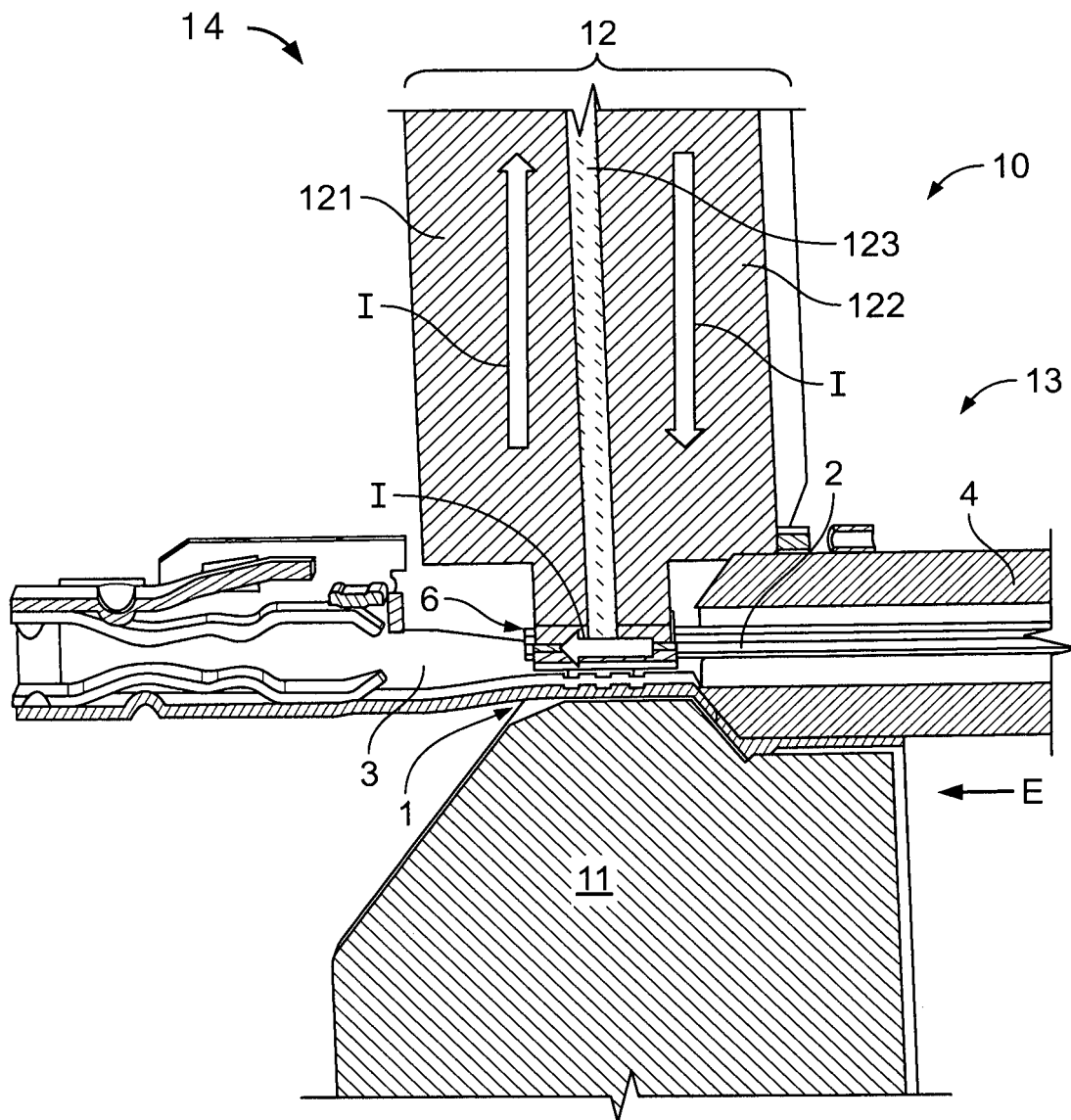


Fig. 4

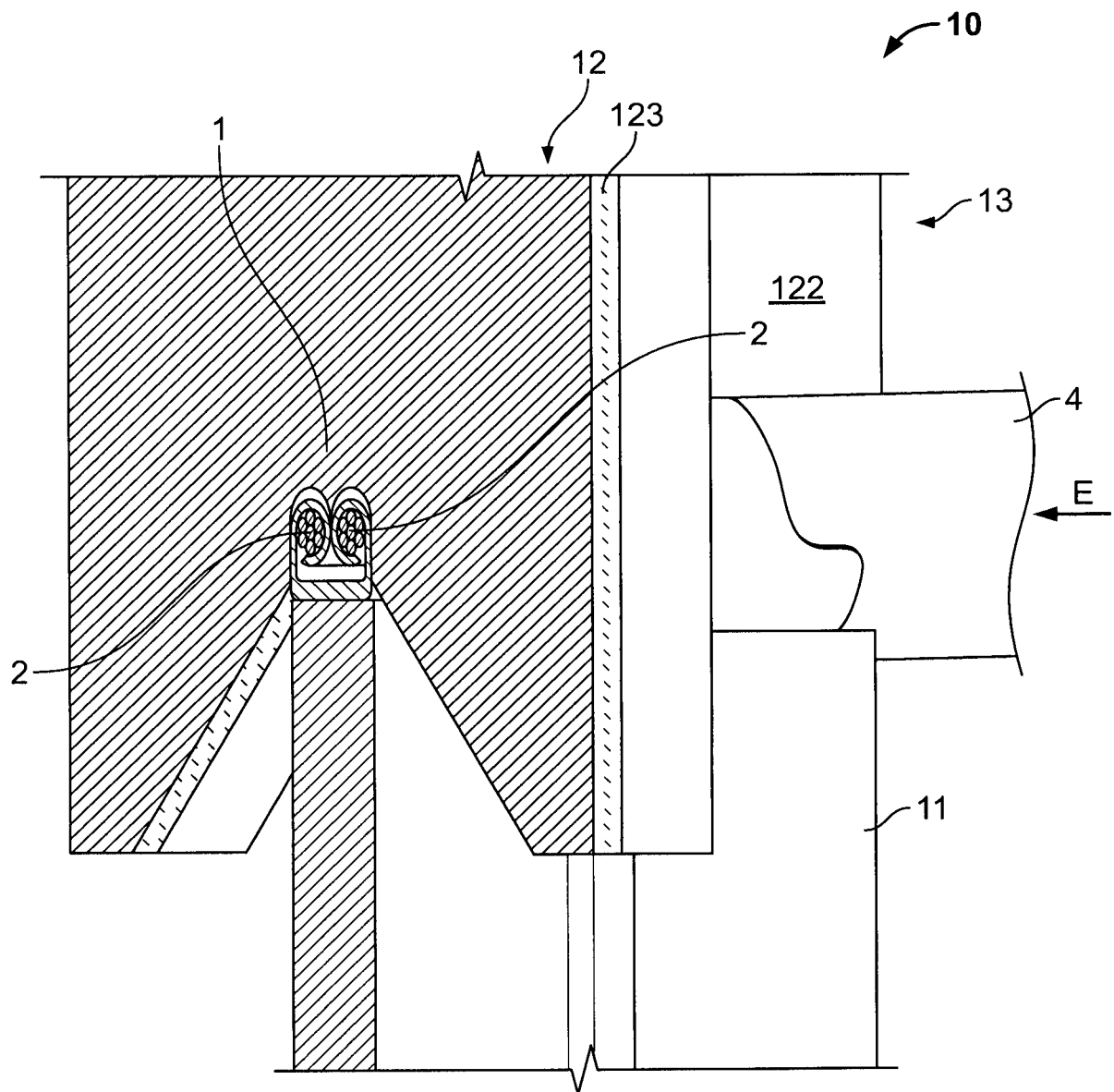


Fig. 5

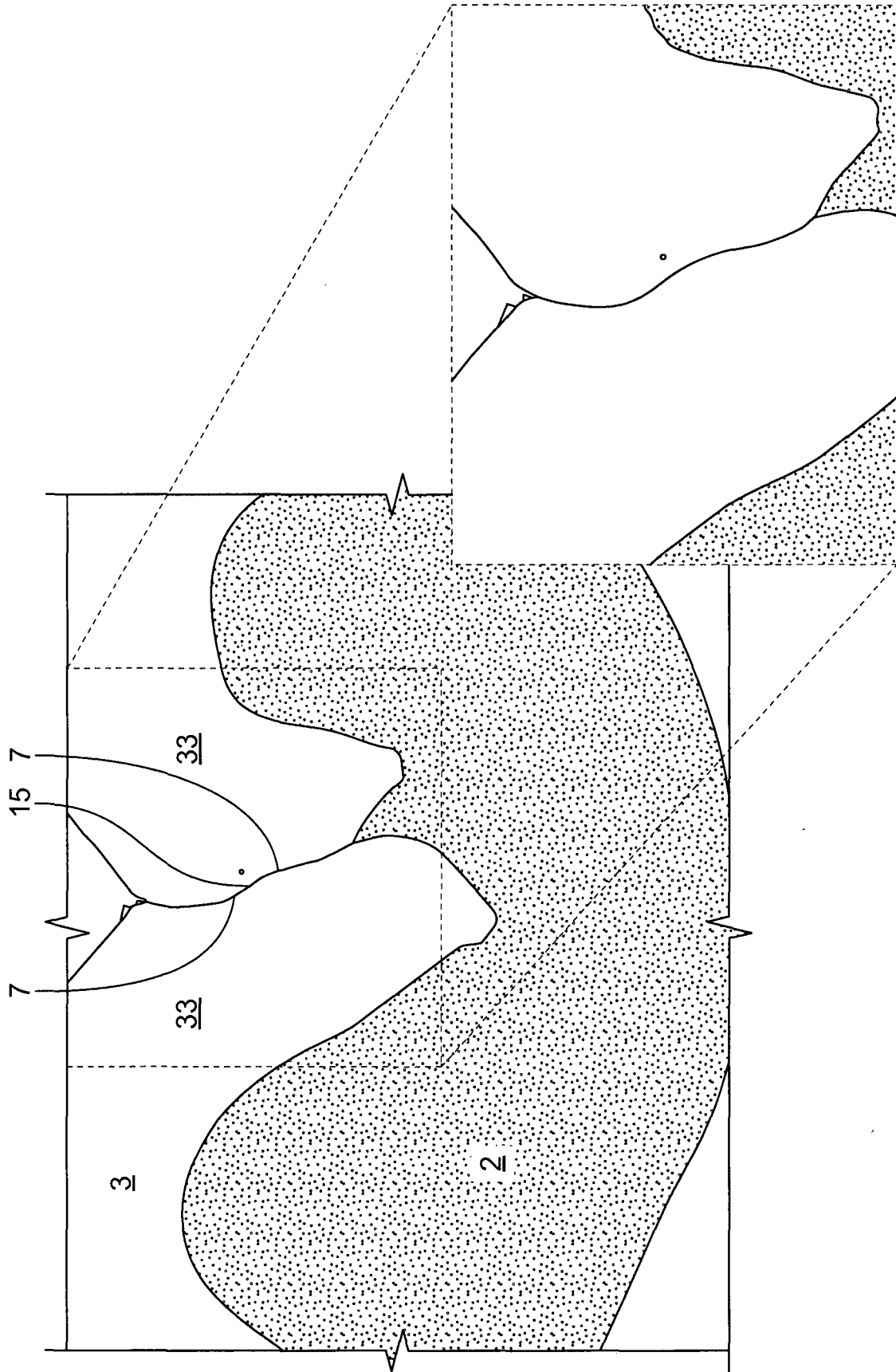


Fig. 6

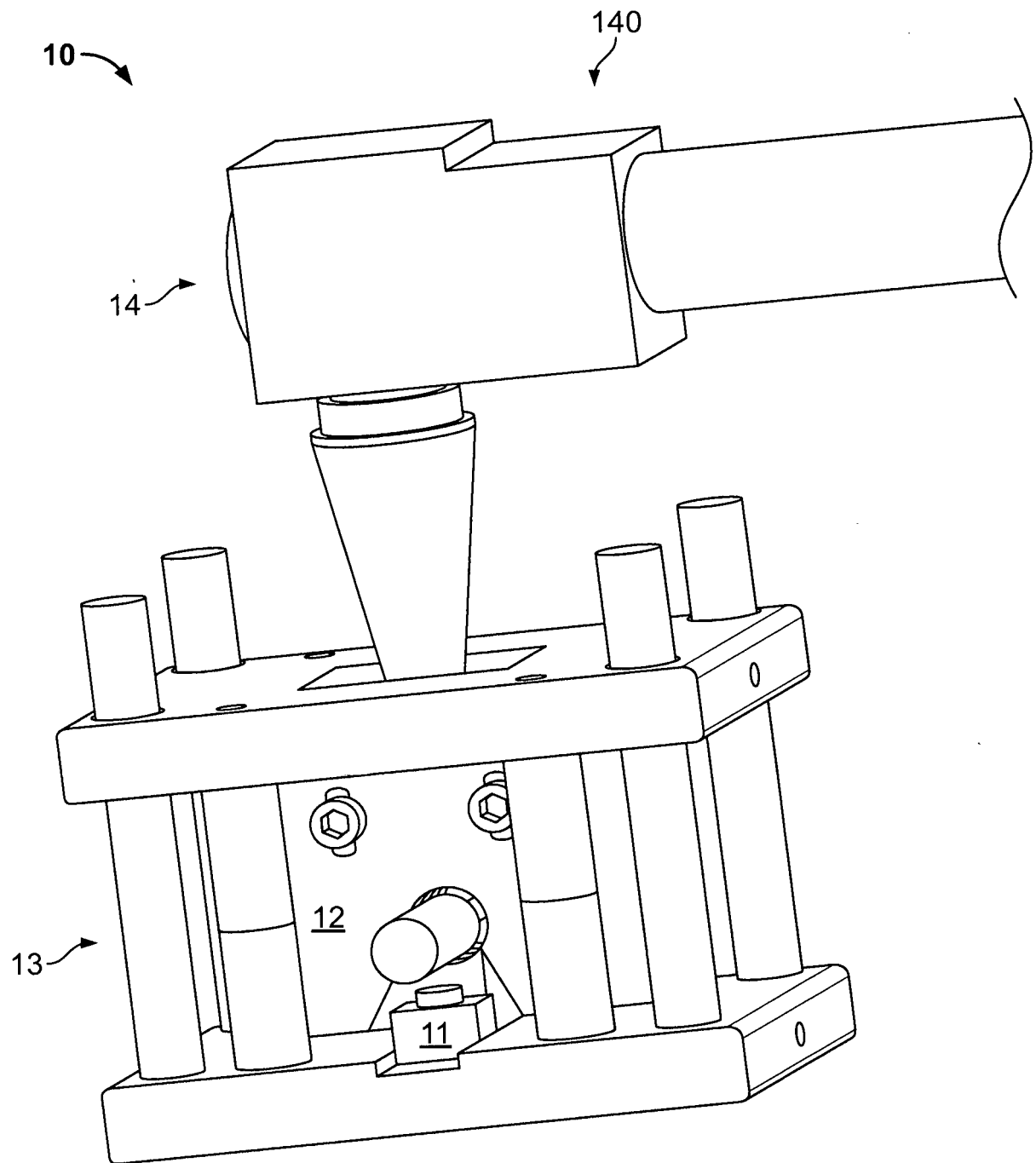


Fig. 7

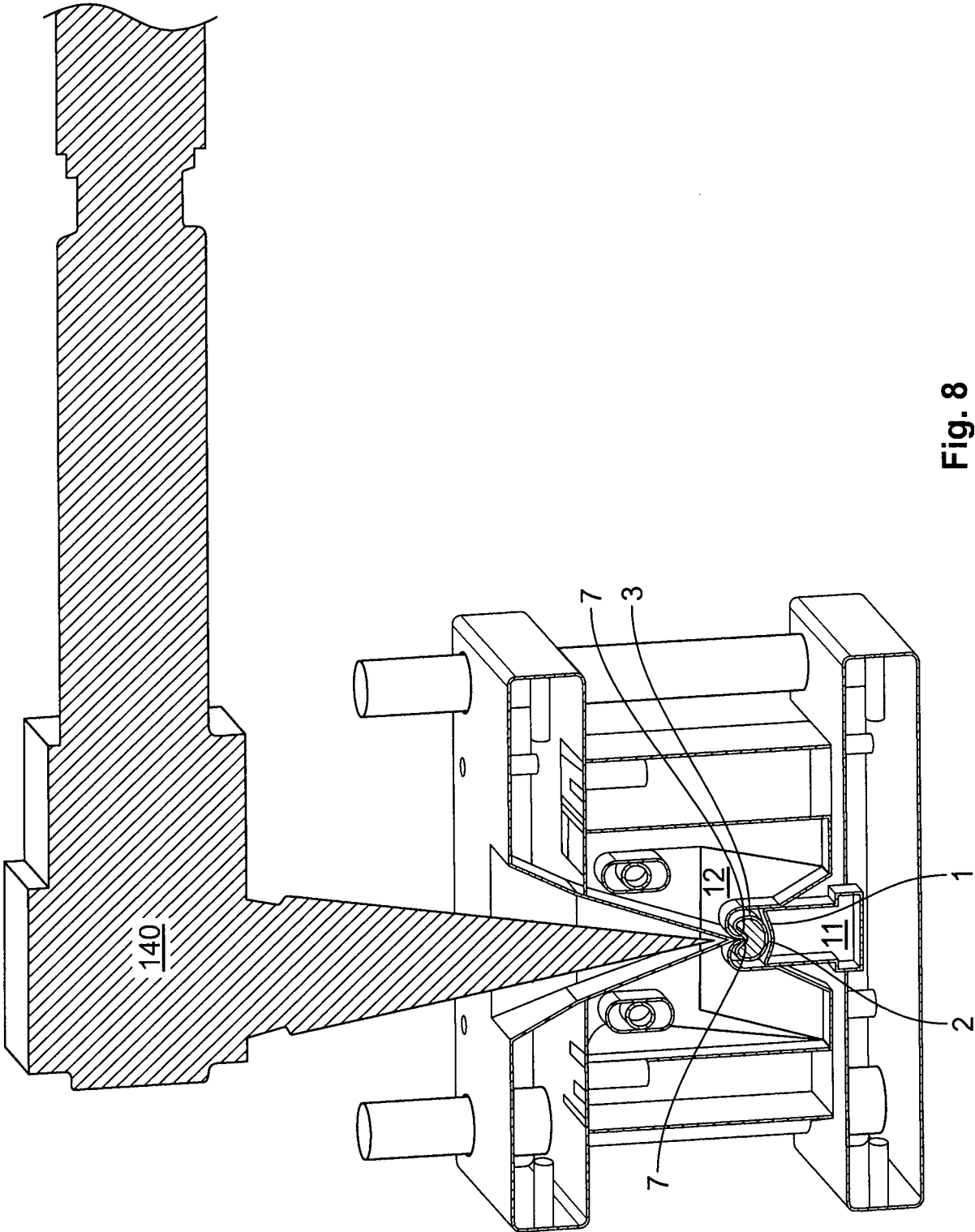


Fig. 8

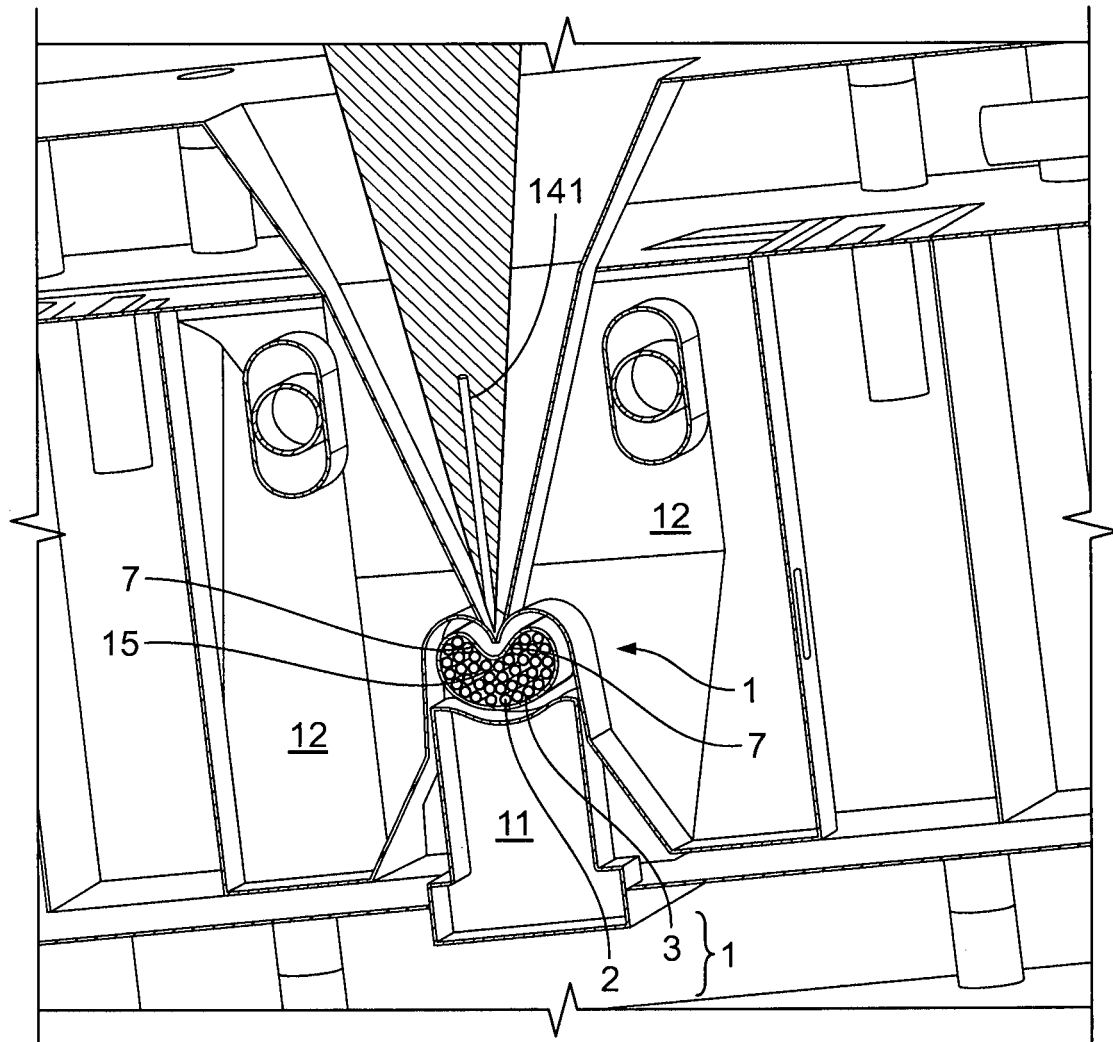


Fig. 9

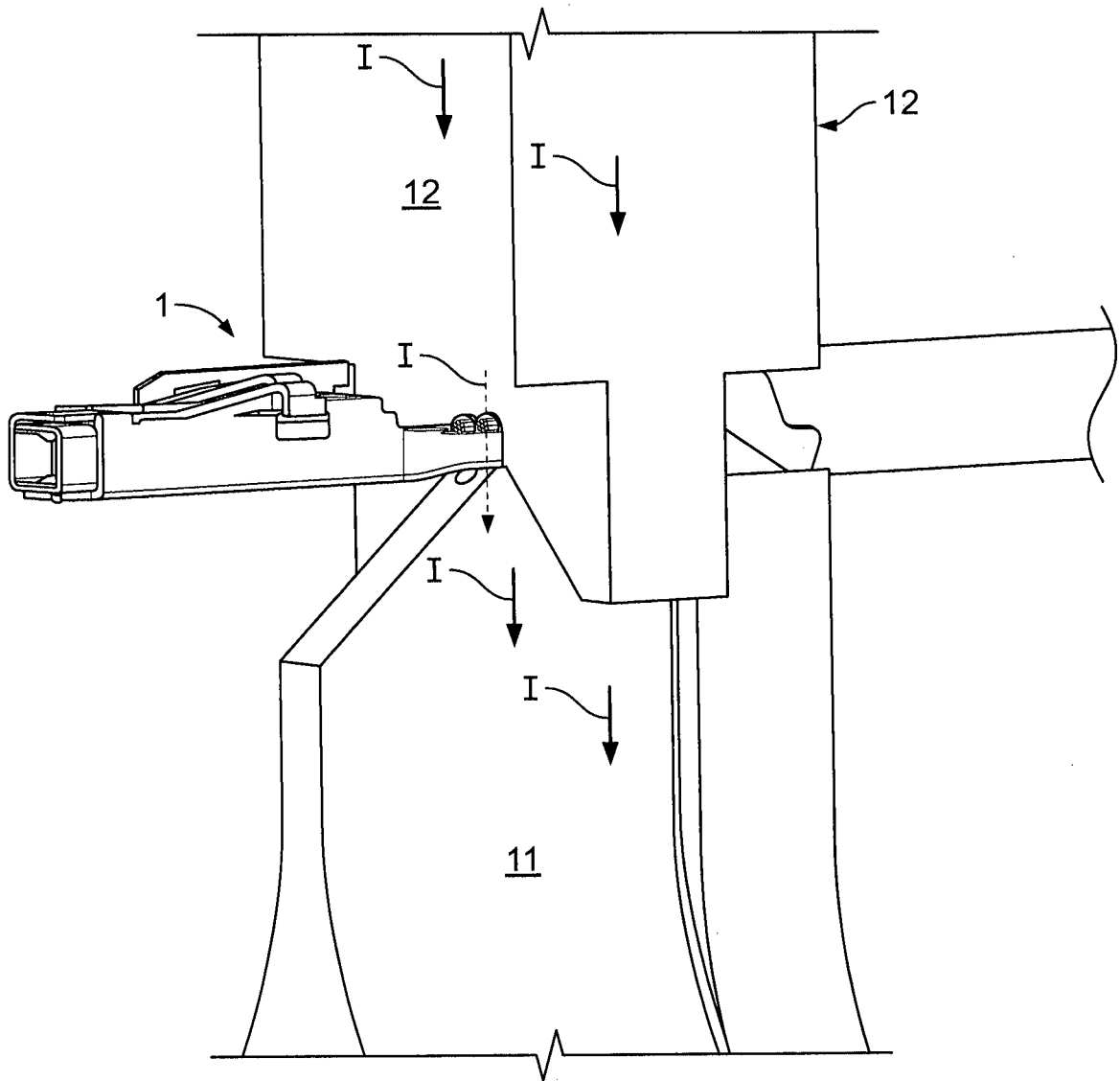


Fig. 10

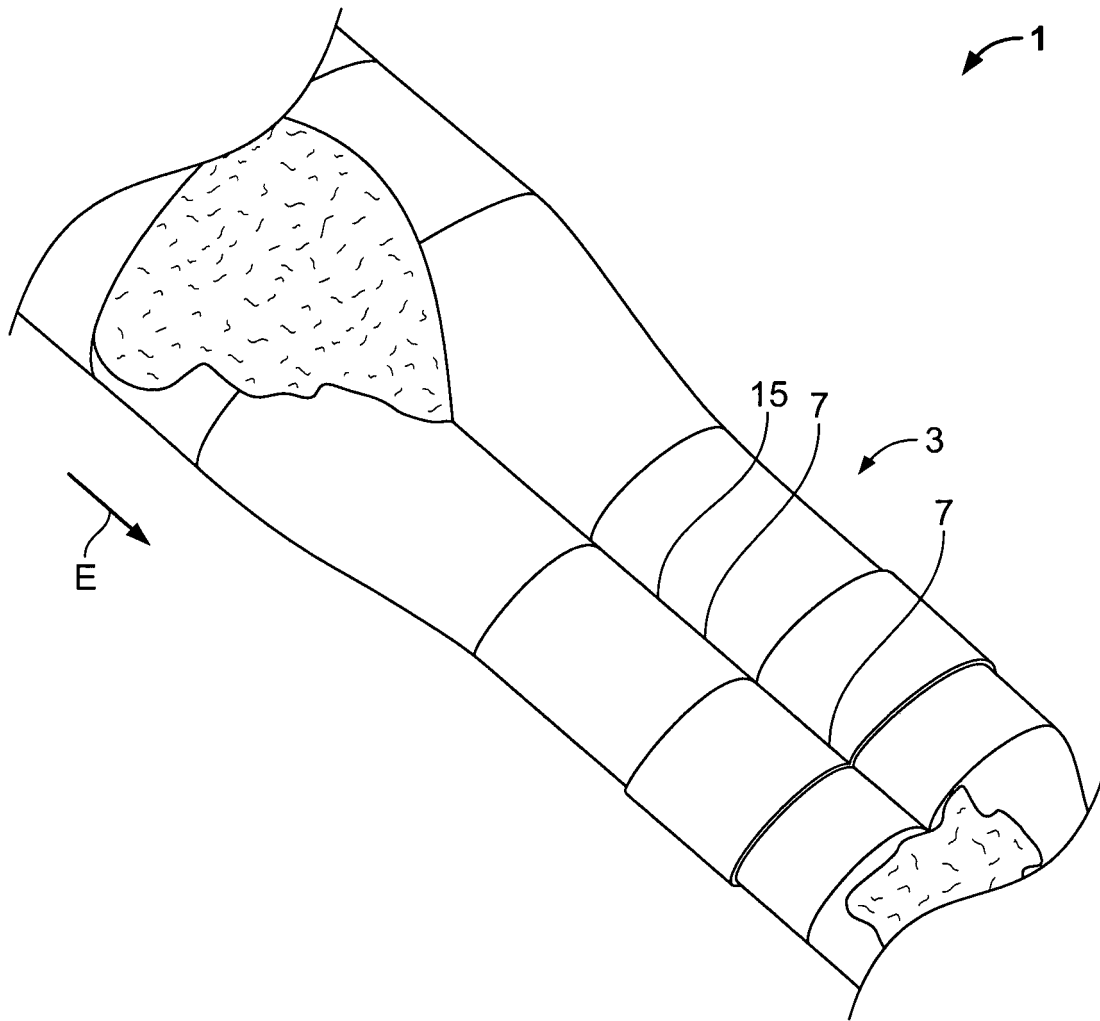


Fig. 11

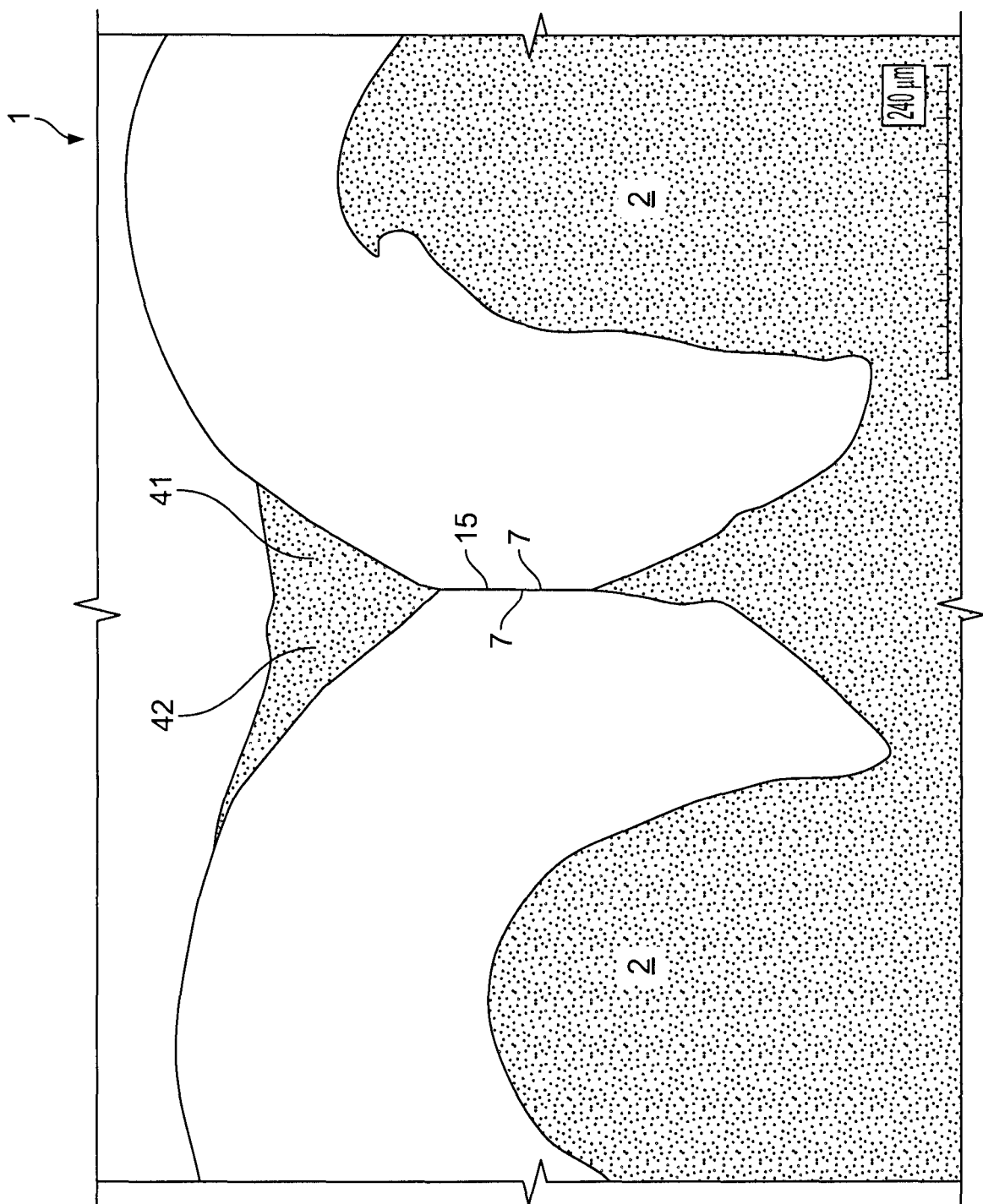


Fig. 12

REFERENCES CITED IN THE DESCRIPTION

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