(12) STANDARD PATENT APPLICATION (11) Application No. AU 2012201570 A1
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Replaceable CP anodes

(51) International Patent Classification(s)
C23F 13/06 (2006.01)

(21) Application No: **2012201570** (22) Date of Filing: **2012.03.16**

(30) Priority Data

(31) Number	(32) Date	(33) Country
11158687.1	**2011.03.17**	**EP**

(43) Publication Date: **2012.10.04**
(43) Publication Journal Date: **2012.10.04**

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2012201570 16 Mar 2012

Abstract

An anode for cathodic protection of underwater-located equipment, comprises: a support body; sacrificial material retained by the support body; and attachment means for releasably attaching the anode to the equipment.

Fig. 2

20122201570 16 Mar 2012

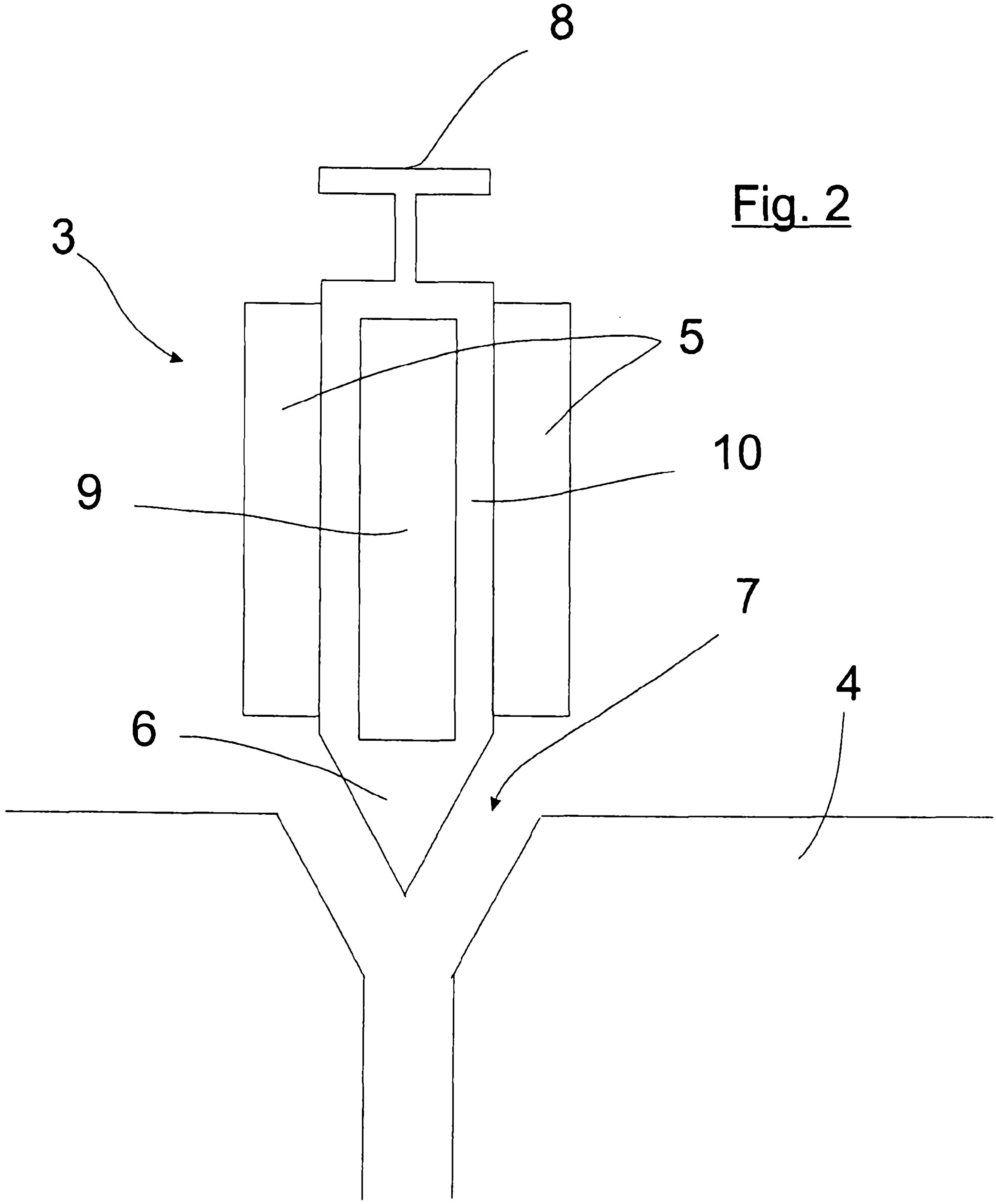

Fig. 2

20122015 70 16 Mar 2012

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COMPLETE SPECIFICATION
(ORIGINAL)

		Class	Int. Class
Application Number:			
Lodged:			

Complete Specification Lodged:
Accepted:
Published:

Priority

Related Art:

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Invention Title:

REPLACEABLE CP ANODES

Our Ref : 937293
POF Code: 88428/505550

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

6006q

Replaceable CP anodes

This application claims priority from European Application No. 11158687.1 filed on 17 March 2011, the contents of which are to be taken as incorporated herein by this reference.

This invention relates to anode for cathodic protection of underwater-located equipment and a method for providing corrosion protection of underwater-located equipment. Suitable underwater-located equipment may comprise a well tree for a subsea hydrocarbon fluid extraction facility for example.

Background

As is well-known, metallic equipment that is to be deployed underwater is at risk of corrosion. To protect the equipment, it is common to provide a galvanic anode (also known as a "sacrificial anode") proximate the equipment, thus providing cathodic protection (CP) for the equipment. Such anodes comprise sacrificial metal materials which have a more negative electrochemical potential than the metal of the equipment, such that when deployed, the sacrificial material of the anode is corroded more readily than the equipment metal. Currently, the most common metal materials used as the sacrificial material for galvanic anodes include alloys of aluminium, magnesium and zinc, with aluminium and zinc being favoured for subsea use.

Although all sea-deployed equipment is at risk of such corrosion, there are particular problems associated with hydrocarbon fluid extraction facilities deployed on the sea bed, for example well trees. These are relatively large, very expensive structures, often required to be in place for over twenty years, and there may be major safety and environmental issues if corrosion occurs.

Typically, well trees are provided with U-shaped aluminium galvanic anodes, with the "legs" of the U being welded to the tree to ensure good electrical continuity. A typical such anode is schematically shown in Fig. 1. As shown, the anode comprises a block of aluminium 1, with a metallic leg 2 extending from each end. In use, the free ends of legs 2 are welded onto the well tree.

2012201570 16 Mar 2012

Current practice is to weld the anodes to the tree frame (or other structure, manifold, template, flowbase etc) at the manufacturing stage. This gives good electrical continuity for the CP system to work efficiently.

The number of anodes / quantity of aluminium used is a function of the intended field life of the tree. For trees with a long life span, this means that many anodes are required. For example, if calculations show that eight anodes will be required for a field life of twenty years, then all eight anodes will be welded to the tree frame (or other structure) in the workshop. This approach can makes the tree densely populated, and so fitting in many anodes may be difficult, and furthermore can result in anodes having to be closer to vulnerable areas than desired. In addition, placement of the anodes is important - anode positions need to be considered carefully to minimise the dangers of hydrogen embrittlement and to optimise cathodic protection.

A reference herein to a patent document or other matter which is given as prior art is not to be taken as an admission that that document or matter was known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

It is an aspect of the present invention to overcome these problems, and enable effective cathodic protection of underwater equipment, such as well trees, for the duration of the equipment's operational life. Please note that in the following discussion and indeed claims, the term “anode” is used to denote an item which includes sacrificial material, and not the sacrifical material itself.

This aspect is achieved by utilising replaceable galvanic anodes. In a preferred embodiment, these anodes are adapted for insertion and removal by means of a remotely operated vehicle (ROV).

In accordance with a first aspect of the present invention there is provided an anode for cathodic protection of underwater-located equipment, comprising:
a support body;

2012201570 16 Mar 2012

sacrificial material retained by the support body; and
attachment means for releasably attaching the anode to the equipment.

In accordance with a second aspect of the invention there is provided a method for providing corrosion protection of underwater-located equipment, comprising the steps of:
providing an anode for cathodic protection of the equipment, the anode comprising: a support body, sacrificial material retained by the support body, and attachment means for releasably attaching the anode to the equipment; and
attaching the anode to the equipment.

<u>Advantages of using the invention</u>

The present invention provides various advantages over the prior art, including, but not limited to:

i) each anode may take up less space on a tree than a conventional anode;

ii) instead of requiring many anodes at a tree, relatively few need be used, these being replaced as required;

iii) in view of i) and ii) above there is more surface space available on the tree for other purposes;

iv) since anodes are replaced as required, there is the potential for trees to have very long lives;

v) no welding is required;

vi) since anodes are modular, the overall weight of the tree is reduced;

vii) there is no need to run each anode from the surface to the tree. Since use of replaceable anodes means that a stock of anodes may be run to the sea bed by ROV deployment. The ROV may then pick up each anode in turn to place it in position as required. This simplifies the activity by having only one deployment trip that could cover all equipment, e.g. trees and manifolds for example, in the local area; and

viii) all operations may be carried out by ROV with no surface operations, i.e. replacement can be carried out in bad weather. Replacement may be performed for example during a tree inspection visit.

Description of the specific embodiments of the invention

The invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 schematically shows a known aluminium galvanic anode for use at a subsea well tree;

Fig. 2 schematically shows a cross-sectional view of an anode in accordance with an embodiment of the present invention.

A first embodiment of the invention is schematically shown in Fig. 2. Here, an anode 3 in accordance with an embodiment of the invention is shown just prior to deployment at a well tree 4. The anode 3 is designed for manipulation by an ROV, however for clarity the ROV is not shown.

Anode 3 comprises an elongate support body 10, which supports and retains a mass of sacrificial material 5. As shown, the sacrificial material 5 is circumferentially moulded around the support body 10. The material 5 may for example comprise a material selected from the group consisting of aluminium, zinc and magnesium, although other materials may be used.

One end of support body 10 comprises a member formed as a tapered projection 6. This is shaped so as to enable frictional engagement with the well tree 4, this frictional engagement causing the anode 3 in use to be retained at the tree. More particularly, the projection 6 is tapered so as to be inserted ("stabbed") and retained within a substantially correspondingly shaped receptacle 7 provided at the well tree 4. The taper helps to ensure that electrical continuity is maintained between the anode 6 and tree 4.

Receptacle 7 is a new device, specifically adapted for retaining anodes 3, which must be located at the tree prior to anode deployment, e.g. during manufacture. Receptacles 7 are placed at suitable locations on the tree frame that allow relatively simple deployment by ROV. Generally, receptacles would be positioned at the exterior of the tree 4, but in other embodiments receptacles could be placed in the body of the tree 4, such that, for example, anode 3 may be inserted into the

2012201570 16 Mar 2012

receptacle in the body of the tree from above (e.g. through a hole in the roof) or below (e.g. using horizontal tracks).

Friction is needed to force the surfaces of the projection 6 and receptacle 7 to merge and ensure good electrical contact. Once frictionally-engaged, a locking mechanism (not shown) such as a holding latch acts to retain the anode 3 within the receptacle. Preferably this locking mechanism would also be actuable by ROV. The latch may have various designs, as would be appreciable to those skilled in the art, such as a screw thread arrangement, or a lock bar / pin, latch, which is relatively simple relatively immune to crustacean damage.

As mentioned above, the anode 3 is designed for manipulation by an ROV. To this end, the anode comprises an ROV-friendly grab handle 8 . As shown, the handle is mounted on the support body, at the distal end to the projection 6.

Anode 3 also includes buoyancy means for enabling the density of the anode to be selected, in this case comprising an air-filled cavity 9 located within the support body 10. In effect therefore, the support body 10 could be considered to comprise a sealed, hollow pipe, of sufficient strength to withstand the ambient pressure at the installation location.

The dimensions and / or filling material of the cavity are preferably selected to make the anode 3 substantially buoyancy neutral. This provides various advantages, particularly that the operation to install / replace the anode 3 would be much simpler and more cost effective. Below about one kilometre depth (i.e. the depth of the pycnocline), the density of water does not vary greatly with increasing depth, however it may be preferable to select the appropriate anode buoyancy dependent on the depth of installation. As an alternative, the anode may be made slightly more dense than the sea water at the installation, such that in the event of accidental release, the anode would sink to the sea floor to facilitate recovery.

In practice, a suitable installation procedure may be as follows:

a) As many anodes 3 as required are loaded onto an ROV launch frame, such launch frames being known in the art;

b) The launch frame is picked up by an ROV and taken to the required installation location;

c) Individual anodes 3 are placed in respective well tree receptacles 7 by ROV, to create a friction fit between projection 6 and receptacle 7;

d) The positive locking mechanism is engaged to more securely retain the anode 3 in the receptacle 7.

Of course, following initial installation, old, spent, anodes would be removed by ROV before a new anode may be inserted. This would require disengagement of the positive locking mechanism, by ROV.

The anodes would preferably be included in a regular inspection process using ROV (or diver) and camera. Thus visual inspection would determine when replacement would be necessary.

The above-described embodiment is exemplary only, and other possibilities and alternatives within the scope of the invention will be apparent to those skilled in the art. For example for some installations, the buoyancy cavity 9 may be filled with materials other than air. For example, it may be preferable to fill the cavity 9 with a solid material, so that the support body is more capable of withstanding high ambient pressure without undue deformation.

Alternatively, the buoyancy means may comprise buoyancy tanks attached to the support body for example.

The anodes may optionally be fitted with simple current / voltage monitoring means to detect when CP protection lowers to unacceptable levels, indicating that replacement of the anode is required. In this case the current / voltage monitoring means could be connected to a condition monitoring system of the well.

Where the terms “comprise”, “comprises”, “comprised” or “comprising” are used in this specification (including the claims) they are to be interpreted as specifying the presence of the stated features, integers, steps or components, but not precluding the presence of one or more other features, integers, steps or components, or group thereto.

The claims defining the present invention are as follows:

1. An anode for cathodic protection of underwater-located equipment, comprising:
a support body;
sacrificial material retained by the support body; and
attachment means for releasably attaching the anode to the equipment.

2. An anode according to claim 1, wherein the attachment means comprises a member for frictional engagement with the equipment, said frictional engagement causing the anode to be retained in use at the equipment.

3. An anode according to claim 2, wherein member comprises a tapered projection from the support body, for insertion and retention within a receptacle located at the equipment.

4. An anode according to any one of the preceding claims, wherein the attachment means comprises a releasable positive locking mechanism.

5. An anode according to any one of the preceding claims, comprising a handle specifically designed for manipulation by a remotely operated vehicle.

6. An anode according to claim 5, wherein the handle is mounted on the support body.

7. An anode comprising buoyancy means for enabling the density of the anode to be selected.

8. An anode according to claim 7, wherein the buoyancy means comprises a cavity located within the support body.

9. An anode according to claim 8, wherein the cavity is air-filled.

10. An anode according to any one of the preceding claims, wherein the sacrificial material comprises one of the group consisting of aluminium, zinc and magnesium.

11. An anode according to any one of the preceding claims, wherein the underwater-located equipment comprises a subsea well tree.

12. A method for providing corrosion protection of underwater-located equipment, comprising the steps of:
providing an anode for cathodic protection of the equipment, the anode comprising: a support body, sacrificial material retained by the support body, and attachment means for releasably attaching the anode to the equipment; and
attaching the anode to the equipment.

13. A method according to claim 12, wherein the anode is attached to the equipment by manipulation by a remotely operated vehicle.

14. A method according to either of claims 12 and 13, wherein the anode is provided with buoyancy means for enabling the density of the anode to be selected.

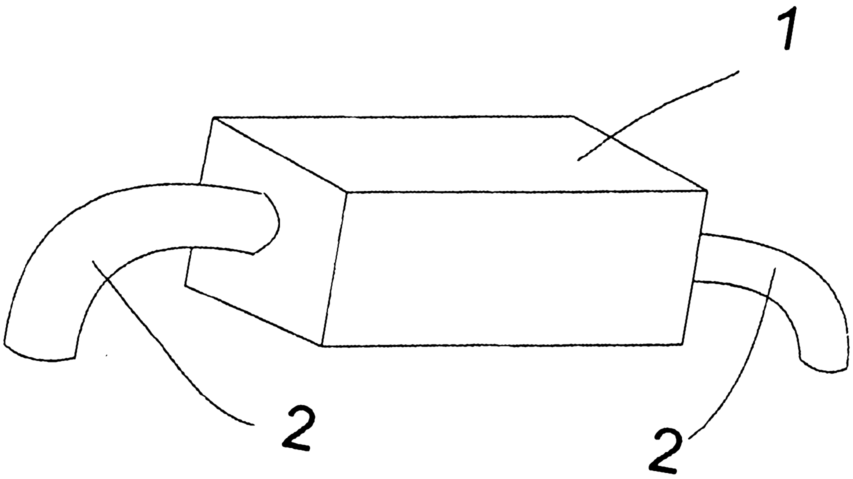
15. A method according to any one of claims 12 to 14, wherein the underwater-located equipment comprises a subsea well tree.

16. An anode for cathodic protection of underwater-located equipment substantially as hereinbefore described with reference to the embodiments shown in Figure 2.

17. A method for providing corrosion protection of underwater-located equipment substantially as hereinbefore described.

2012201570 16 Mar 2012

Fig. 1 - Prior Art



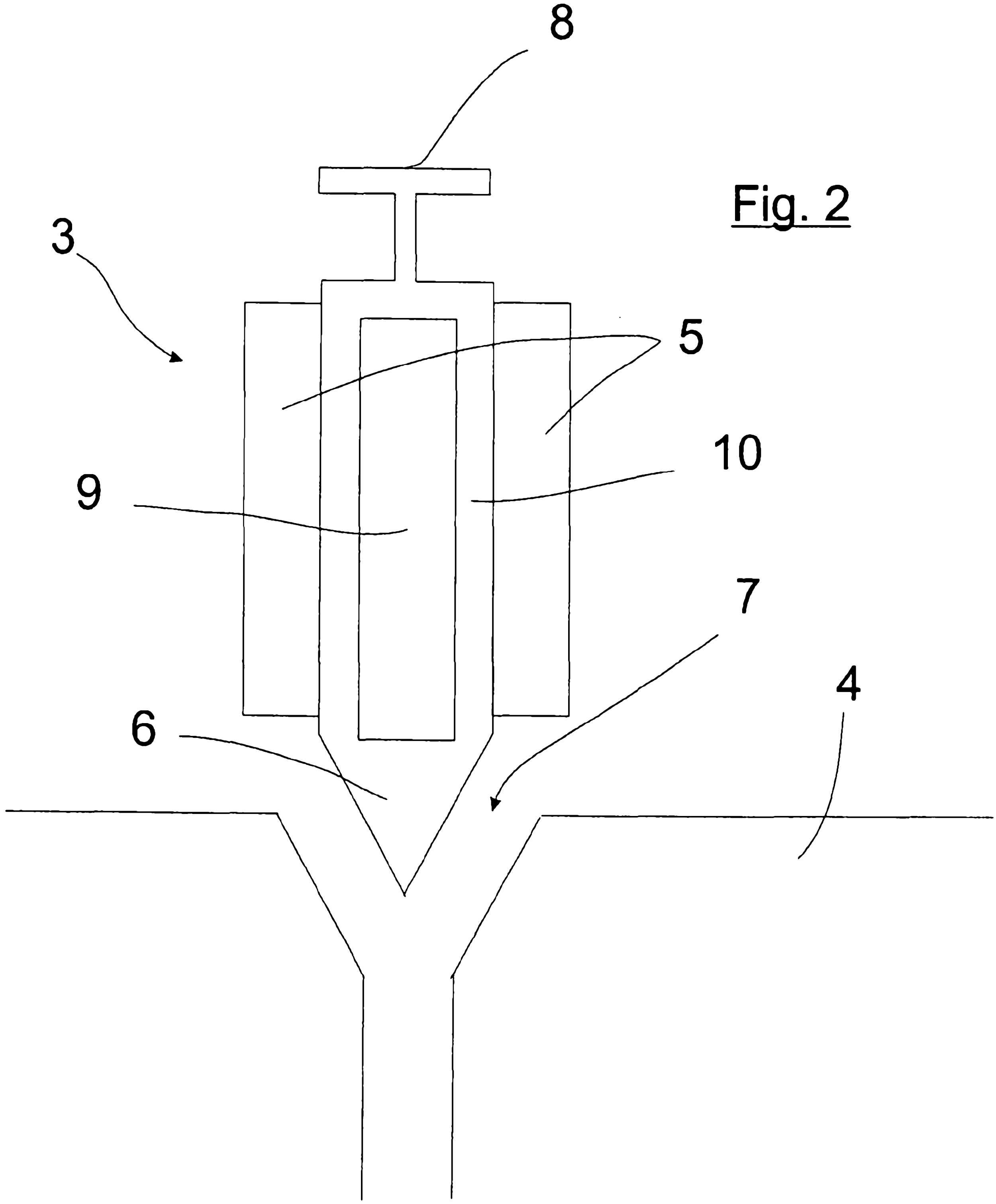


Fig. 2