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(54) **SACRIFICIAL ANODE AND METHOD FOR PRODUCING A SACRIFICIAL ANODE**

(57) The invention relates to a sacrificial anode and a method for casting the anode, the anode comprising an anode main part made from a first metal being a sacrificial metal arranged as a metal alloy, such as an aluminum or zinc alloy, and an elongated carrying part, extending from the main part, and arranged from a second metal. The carrying part being arranged for connection to said submerged structure and for leading a current between the sacrificial anode and the submerged structure, where the electrical resistance of the carrying part is substantial equal to, or smaller than the electrical resistance of the main part.

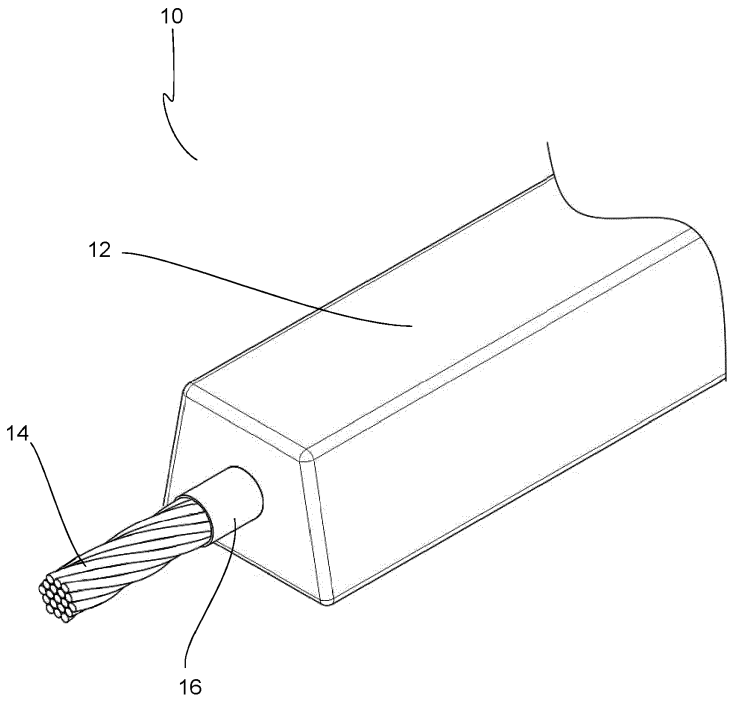

FIG. 4

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Description

TECHNICAL FIELD

[0001] The present invention relates to a sacrificial anode and a method for producing the anode.

BACKGROUND OF THE INVENTION

[0002] A sacrificial anode is the main component of a galvanic cathodic protection system used to protect buried or submerged metal structures from corrosion.

[0003] Sacrificial anodes are metals or alloys attached to the hull that have a more anodic, i.e. less noble, potential than steel when immersed in sea water. These anodes supply the cathodic protection current but will be consumed in doing so and therefore require replacement for the protection to be maintained.

[0004] It is desired to reduce the deterioration of the ferrous material, as this is the main structural material of the construction in question.

[0005] Therefore, a sacrificial metal ranking lower in the electrochemical scheme, and therefore being more prone to the electrochemical reaction, is placed in electrical connection with the main construction and protects this main construction from deterioration. The most often used anode materials are aluminum or zinc or alloys comprising aluminum or zinc as the main component, but other materials may be used as alternatives to zinc and aluminum, such as magnesium as well as alloys containing magnesium.

[0006] Relevant areas of deployment are numerous; however, constructions in operation in seawater are in particular vulnerable to corrosion and will almost always be protected from such corrosion by means of cathodic protection using sacrificial anodes. Ships, vessels and offshore oil exploitation constructions are well-known examples of such.

[0007] The sacrificial anodes should be of a type suitable to the environment of operation, i.e. taking into consideration the chemical composition of the environment and also the temperature. Furthermore, the size of the anode(s) as well as their mutual positioning are relevant to consider in order to provide a satisfactory protection.

[0008] Many offshore oil exploitation constructions, pipelines or other equipment are from their very first installation provided with a cathodic protection system using sacrificial anodes, and most often the dimensioning of the anodes is designed for the design life time of the oil exploitation construction, meaning that no further exchange of the sacrificial anodes is foreseen. The oil exploitation constructions, pipelines or other equipment are however in many cases kept in operation well beyond the initial design lifetime, meaning that the cathodic protection obtained through the sacrificial anodes will disappear when the anodes are consumed after a certain time.

[0009] The anodes comprise a main body arranged from a metal or metal alloy, such as a zinc or aluminum alloy. The main body is cast around a carrying structure of steel, which carrying structure is connected to the element needed to be protected from corrosion.

[0010] Smaller or shorter anodes may deteriorate faster that larger/longer-sized anodes. Depending on the needed protection against corrosion of the submerged structures, the anode may be cast in various spanning from less than a meter to above 2 meters.

[0011] However, the effectivity of the longer anodes is lower compared to shorter anodes, as the current from the structure must travel through the steel carrying structure over the entire length of the anode.

[0012] The electrical resistance called ohm (Ω) is regarding the known steel carrying structures between 10 to 100 $\times$ 10^{-8} Ωm, which is far greater that the electrical resistance of the material of the anode body but is commonly used due to its structural abilities. Pure aluminum has an electrical resistance of approximate 2.8 $\times$ 10^{-8} Ωm, and pure zinc has an electrical resistance of approximate 5.5 $\times$ 10^{-8} Ωm.

[0013] Thus, the longer the anode having a steel carrying structure, the greater the electrical resistance, resulting in a less effective anode construction. The anode is simply not sufficiently effective in leading the current from the submerged structure to protect, through the anode steel structure and anode body.

[0014] It is thus an object of the invention to provide an anode, and a method for manufacturing the anode, which is suitable to be arranged in long dimensions above at least 2 meters and where the effectivity and structural capabilities of the anode are maintained, compared to anodes having a shorter length.

[0015] The above object and advantages, together with numerous other objects and advantages, which will be evident from the description of the present invention, are according to a first aspect of the present invention obtained by:

> A sacrificial anode for protecting submerged metal structures, such as underwater pipes, the anode comprising an anode main part made from a first metal being a sacrificial metal arranged as a metal alloy, such as an aluminum or zinc alloy, and an elongated carrying part, extending from the main part, and arranged from a second metal, the main part having first and second ends,
> the carrying part being arranged for connection to the submerged structure and for leading a current between the sacrificial anode and the submerged structure, where the electrical resistance of the carrying part is substantial equal to, or smaller than the electrical resistance of the main part.

[0016] The sacrificial anode is preferably arranged as an elongated main part, also called anode body. In a preferred embodiment, the anode main part is manufac-

tured from an aluminum or zinc but may also be cast from pure metals.

[0017] The anode comprises at least one main part, also called anode body, interconnected with a carrying part suitable to be connected directly or indirectly with the submerged structure to be protected against corrosion.

[0018] The anode may be interconnected with the submerged structure directly, e.g., via mounting brackets, or alternatively arranged in a cage construction such as the one disclosed in EP3191618 B1.

[0019] Arranging the carrying part from a metal having an electrical resistance being equal to, or lower than the electrical resistance of the anode main part, has the technical effect that a longer anode, such as 2 meters or more, does not loser any effect, due to lower current travelling through the anode.

[0020] According to a further embodiment of the first aspect of the invention, the carrying part comprises copper.

[0021] In a preferred embodiment, the carrying part comprises a copper or copper alloy. Alternatively, the carrying part may be arranged from 2 or more carrying parts, e.g., two preferably interconnected parts, one part being e.g., steel, in order to secure a relatively rigid carrying construction, and a second part comprising a copper or copper alloy in order to ensure sufficient flow of electrical current through the anode.

[0022] Copper has an electrical resistance of approximately 1.7×10^{-8} Ωm, which is much lower than the resistance of steel and lower than the resistance of aluminum and zinc.

[0023] According to a further embodiment of the first aspect of the invention, the carrying part is arranged as a flexible cable.

[0024] The carrying part is preferably arranged from a flexible copper cable. The term "cable" is in the context understood as a cable made from a plurality of twisted copper wires. Arranging the carrying part as a cable increases the strength of the carrying part. In a further embodiment covered by the invention, the copper cable may be arranged from a plurality of twisted wires, both steel and copper wires, in order to even further increase the strength of the carrying part.

[0025] According to a further embodiment of the first aspect of the invention, the carrying part is embedded into the main part and extends through the main part in a longitudinal direction thereof.

[0026] As can be seen in relation to figure 1, the carrying part may be supporting the anode body or may be embedded within the anode main part. In a preferred embodiment, the carrying part is embedded within the anode main part, which ensures optimum transfer of electrical current from the carrying part and the anode main part.

[0027] According to a further embodiment of the first aspect of the invention, the anode comprises a bushing arranged between the main part and the carrying part.

[0028] The anode main part is cast using a mould and is cast circumventing the copper cable, which extends through the anode main part in the longitudinal direction thereof end extends from opposite ends of the anode for connection to the submerged structure. Copper has an electrical resistance of approximately 1.7×10^{-8} Ωm, which is below the electrical resistance of the anode main part if the anode main part is made from aluminum or zinc or an alloy thereof. Using a copper as a material of the carrying part has proven to show the best performance compromise between the conductive performance of the anode and the structural capabilities of the carrying part.

[0029] During casting of the anode, the metal or metal alloy is melted. In case of an aluminum alloy, the material is melted to at least the melting point of aluminum and poured into the mould. Before pouring, the copper cable is arranged in a predefined position within the mould, such that the melted aluminum alloy, when casted, correctly circumvents the copper cable.

[0030] The melting point of copper is higher than the melting point of aluminum. The copper cable, due to the heat of the melted aluminum, may distort, and the copper cable loses its shape and its integrity, whereby the copper cable is more prone to external impact from the environment and complicates the installation of the anode to the submerged construction, as the copper cable as the carrying part is compromised.

[0031] Arranging a bushing, preferably a steel bushing between the carrying part and the main part in the region where the carrying part extends from the main part, insulates the copper cable from the hot melted material, such that the structure and integrity of the carrying part are maintained. The steel bushing may alternatively be arranged from another material than steel, which material is suitable to withstand, for at least a shorter period of time, the high temperatures of the melted material, such as melted aluminum. Such material may be a ceramic material or other material suitable to withstand the temperature of the melted anode main part material, such as melted aluminum.

[0032] According to a further embodiment of the first aspect of the invention, the bushing circumvents the carrying part where the carrying part extends from the main part and a distance therefrom.

[0033] The bushing circumvents the carrying part at a position where the carrying part extends from the anode body. It is further preferred that the bushing circumventing the carrying part extends on the carrying part a predefined distance.

[0034] This has the technical effect of insulating the carrying part over a distance extending from the anode main part, and further supporting the carrying part over that distance such that the structural stability of the carrying part in that region is maintained.

[0035] The distance of the bushing extending from the anode main part may be arranged according to specific needs. E.g., the extend may be adjusted according to the temperature of the melted anode main part material. One example may be that the bushing extends 100mm from

the anode main part and the anode main part comprises aluminum or aluminum alloy.

[0036] The extent may also be more than 100mm or less. Alternatively, the thickness of the bushing may be varied.

[0037] According to a further embodiment of the first aspect of the invention, the bushing circumventing the carrying part extends a distance embedded within the main part.

[0038] The bushing circumventing the carrying part preferably extends a corresponding distance within the anode main part.

[0039] The technical effect of the bushing extending within the anode main part is an insulation of the carrying part from the melted anode main part material, and a fixation between the anode main part and the bushing.

[0040] The distance of the bushing extending within the anode main part may be arranged according to specific needs. The extend may for example be adjusted according to the temperature of the melted anode main part material. The higher the temperature, the longer the extent. Alternatively, the thickness of the bushing may be varied.

[0041] One example may be that the bushing extends 100mm with the anode main part and the anode main part comprises aluminum or aluminum alloy. The extent may be more than 100mm or less.

[0042] In the most preferred embodiment, the bushing extends a distance within the anode main part and a distance from the anode main part. This embodiment provides the most optimal insulation and support of the carrying part from the melted anode main part material.

[0043] However, due to specific needs of mounting the anode to be submerged construction, the bushing extending from the anode main part is to be avoided, e.g., if the bushing interferes with a mounting construction, the bushing may alternatively be arranged such that it only extends within the anode main part. In such case, the thickness of the bushing may be increased in order to sufficiently insulate the carrying part.

[0044] The extent of the bushing within the anode main part may be different than the extent from the anode main part.

[0045] According to a further embodiment of the first aspect of the invention, the anode comprises a bushing arranged on the carrying part at opposite ends of the main part.

[0046] The anode is preferably arranged with the same configuration of the carrying part at both ends of the anode main part, whereby the anode preferably comprises a bushing at opposite ends, which has the technical effect of insulating the carrying part at opposite ends.

[0047] The bushing preferably does not extend the entire distance of the carrying part within the anode main part.

[0048] According to a further embodiment of the first aspect of the invention, the bushing is made from a material having a lower thermal conductivity than the material of the carrying part.

[0049] In order to secure the most optimum insulation and structural support of the carrying part, the bushing is manufactured from a material having a lower thermal conductivity than the material of the carrying part. The carrying part preferably comprises a copper material, and the bushing may be a steel or steel alloy or other material, such as a ceramic or other, which material has a lower thermal conductivity than the material of the carrying part.

[0050] According to a further embodiment of the first aspect of the invention, the sacrificial anode comprises two main parts arranged in a spaced relationship on the carrying part.

[0051] The anode may be arranged as an anode having a single anode main part, which is the standard when manufacturing sacrificial anodes.

[0052] The anode may however in a further preferred embodiment be arranged with more than one anode main part, such as two or more main parts. This has the technical effect that the carrying part may be arranged relative long, such as more than 2 meters or more than 5 meters, rendering the anode, which comprises e.g., two anode main parts, capable of being installed to a submerged construction over a relatively large extent thereof, compared to the known types of anodes.

[0053] According to a further embodiment of the first aspect of the invention, the bushing circumvents the carrying part over substantially the entire distance between the two main parts.

[0054] Where the carrying part comprises two anode main parts, or more than two main parts, the bushing extends substantially the entire distance, which has the technical effect that the carrying part is isolated from the surrounding environment and supports the carrying part between the two main parts.

[0055] According to a second aspect of the present invention, the above objects and advantages are obtained by:

A method for manufacturing a sacrificial anode according to the first aspect of the invention, the method comprising the steps of:

- arranging a mould for casting the anode,
- arranging the carrying part within the mould,
- melting the sacrificial metal, and
- casting the main part on the carrying part from the melted sacrificial metal.

[0056] The method provides the possibility of manufacturing a mould fulfilling the first aspect of the invention, namely an anode which is suitable to be arranged in long dimensions above at least 2 meters or above 5 meters, and where the effectivity and structural capabilities of the anode are maintained, compared to anodes having a shorter length.

[0057] According to a further embodiment of the second aspect of the invention, the step of arranging the

carrying part within the mould comprises the step of tensioning the carrying part by a predetermined tensioning force (N) before casting the main part.

[0058] The anode, when the carrying part being made from a copper cable, needs to fulfil the same precise dimension as known standard types of anodes, and it is therefore important that the carrying part, when being flexible, such a copper cable, is correctly positioned in relation to the anode main part throughout the entire length and width of the anode main part.

[0059] In order to ensure such correct relationship between the anode main part and the carrying part, the carrying part is tensioned when arranged within the mould. The mould may thus comprise means, such as holes or cut-outs, for allowing the carrying part to extend through the mould, such that the means for tensioning the carrying part can be located outside the mould.

[0060] According to a further embodiment of the second aspect of the invention, the method comprises the step of arranging a number of bushings on the carrying part before casting the main part.

[0061] As explained in relation to the first aspect of the invention, providing a bushing on the carrying part has the technical effect of insulating the carrying part from the hot melted material, such that the structure and integrity of the carrying part are maintained. Therefore, the method provides the step of arranging one or more bushings on the carrying part so as to provide an anode having the claimed effect.

Fig. 1A-1C show a first, second and third embodiment of a known anode construction.

Fig. 2 shows part of an anode having a copper cable as a carrying part.

Fig. 3 shows part of an anode having a copper cable as a carrying part and a bushing.

Fig. 4 shows a full anode main part having a copper cable as a carrying part.

[0062] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like reference numerals refer to like elements throughout. Like elements will thus not be described in detail with respect to the description of each figure.

[0063] Fig. 1A-1C show a first, second and third embodiment of a known anode construction 10'. The anodes 10' comprise an anode body 12' and a carrying part 14 made from steel, which carrying part is arranged for connection with a submerged construction. The anode body 12 of the anodes 10 is made from a sacrificial metal, typically an aluminum or zinc alloy, and the carrying part is made from a steel structure extending in the longitudinal direction of the anode and extends from opposite ends of the anode in order to interconnect the anode 10 with the submerged structure directly or indirectly by using an anode structure as e.g., disclosed in EP3191618 B1.

[0064] Fig. 2 shows part of an anode 10 having a copper cable as a carrying part 14.

[0065] The anode 10 comprises an anode body 12 made from a metal or metal alloy such as a zinc or aluminum alloy. The anode body 12 is cast using a mould and is cast circumventing the copper cable, which extends through the anode body 12 in the longitudinal direction thereof. In figure 2, only one end of the anode 10 is shown, but the opposite not shown end may look substantially identical.

[0066] The copper has an electrical resistance of approximately 1.7×10^{-8} Ωm, which is below the electrical resistance of the anode body 12 if the anode body is made from aluminum or zinc. Using a copper as a material of the carrying part 14 has proven to show the best performance compromise between the performance of the anode and the structural capabilities of the carrying part.

[0067] During casting of the anode 10, the metal or metal alloy is melted. In case of an aluminum alloy, the material is melted to at least the melting point of aluminum and poured into the mould. Before pouring, the copper cable 14 is arranged in a predefined position within the mould, such that the melted aluminum alloy when casted correctly circumvents the copper cable 14.

[0068] The melting point of copper is higher than the melting point of aluminum.

[0069] However, as can be seen in the figure by reference 18, the copper cable 14, due to the heat of the melted aluminum, distorts and the copper cable loses its shape and its integrity, whereby the copper cable 14 is more prone to external impact from the environment and complicates the installation of the anode 10 to the submerged construction, as the copper cable as the carrying part 12 is compromised.

[0070] Fig. 3 shows part of an anode 10 having a copper cable 14 as a carrying part and a bushing 16. The anode construction 10 shown in figure 3 is cast in the same fashion as disclosed in relation to figure 2, however with the further feature of a bushing 16 arranged between the carrying part 14 and the anode main part 12. The bushing 16 may be manufactured from a steel or a ceramic or other material capable of to some degree withstanding the temperature of the melted anode main part material, at least for a period of time in order to allow the material to cool.

[0071] The bushing 16 is arranged as a tubing circumventing the copper cable 14 over a distance extending from the anode main part.

[0072] Fig. 4 shows a full anode 10 having a copper cable as a carrying part 14. The carrying part 14 extends from both ends of the anode and is arranged for connection to a submerged construction of e.g., an anode cage

as disclosed in EP3191618B1.

[0073] In the following is given a list of reference signs that are used in the detailed description of the invention and the drawings referred to in the detailed description of the invention.

10, 10'	Anode
12, 12'	Main part
14, 14'	Carrying part
16	Bushing
18	Overheated area

Claims

1. A sacrificial anode (10) for protecting submerged metal structures, such as underwater pipes, said anode (10) comprising an anode main part (12) made from a first metal being a sacrificial metal arranged as a metal alloy, such as an aluminum or zinc alloy, and an elongated carrying part (14), extending from said main part (12), and arranged from a second metal, said main part having first and second ends,
said carrying part (14) being arranged for connection to said submerged structure and for leading a current between said sacrificial anode (10) and said submerged structure, where the electrical resistance of said carrying part (14) is substantial equal to, or smaller than the electrical resistance of said main part (12).

2. A sacrificial anode (10) according to claim 1, wherein said carrying part (14) comprises copper.

3. A sacrificial anode (10) according to claim 2, wherein said carrying part (14) is arranged as a flexible cable.

4. A sacrificial anode (10) according to any of the previous claims, wherein said carrying part (14) is embedded into said main part (12) and extends through said main part (12) in a longitudinal direction thereof.

5. A sacrificial anode (10) according to claim 4, wherein said anode (10) comprises a bushing arranged between said main part (12) and said carrying part (14).

6. A sacrificial anode (10) according to claim 5, wherein said bushing circumvents said carrying part (14) where said carrying part (14) extends from said main part (12) and a distance therefrom.

7. A sacrificial anode (10) according to claim 5 or 6, wherein said bushing (16), circumventing said carrying part (14), extends a distance embedded within said main part (12).

8. A sacrificial anode (10) according to any of claims 5-7, said anode (10) comprising a bushing (16) arranged on said carrying part (14) at opposite ends of said main part (12).

9. A sacrificial anode (10) according to any of claims 5-8, said bushing being made from a material having a lower thermal conductivity, than the material of said carrying part (14).

10. A sacrificial anode (10) according to any of the previous claims, said sacrificial anode (10) comprising two main parts (12) arranged in a spaced relationship on said carrying part (14).

11. A sacrificial anode (10) according to claim 10, said bushing circumventing said carrying part (10) over substantially the entire distance between said two main parts (12).

12. A method for manufacturing a sacrificial anode according to any of claims 1-11, said method comprising the steps of:

    - arranging a mould for casting said anode (10),
    - arranging said carrying part (14) within said mould,
    - melting said sacrificial metal, and
    - casting said main part (12) on said carrying part from said melted sacrificial metal.

13. A method according to claim 12, wherein said step of arranging said carrying part (14) within said mould comprises the step of tensioning said carrying part (14) by a predetermined tensioning force (N) before casting said main part (12).

14. A method according to claims 12 or 13, wherein said method comprises the step of arranging a number of bushings (16) on said carrying part before casting said main part.

FIG. 1A

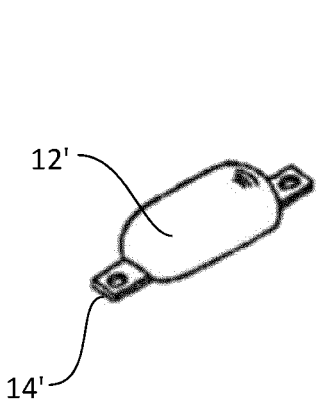


FIG. 1B

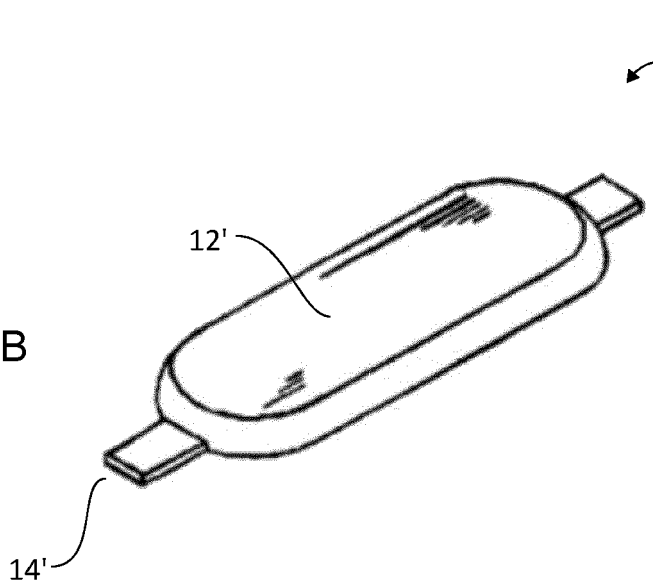
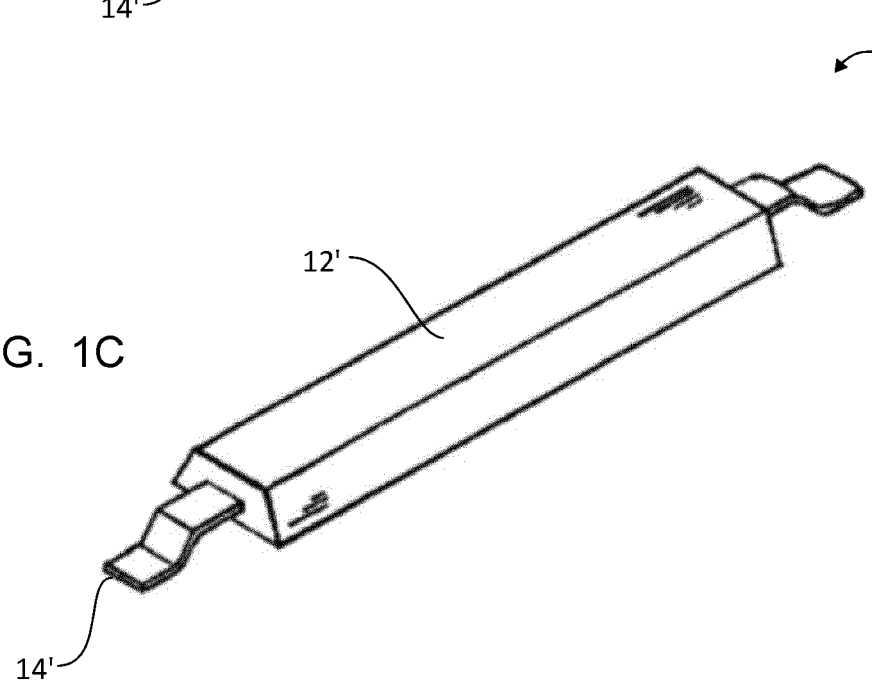


FIG. 1C



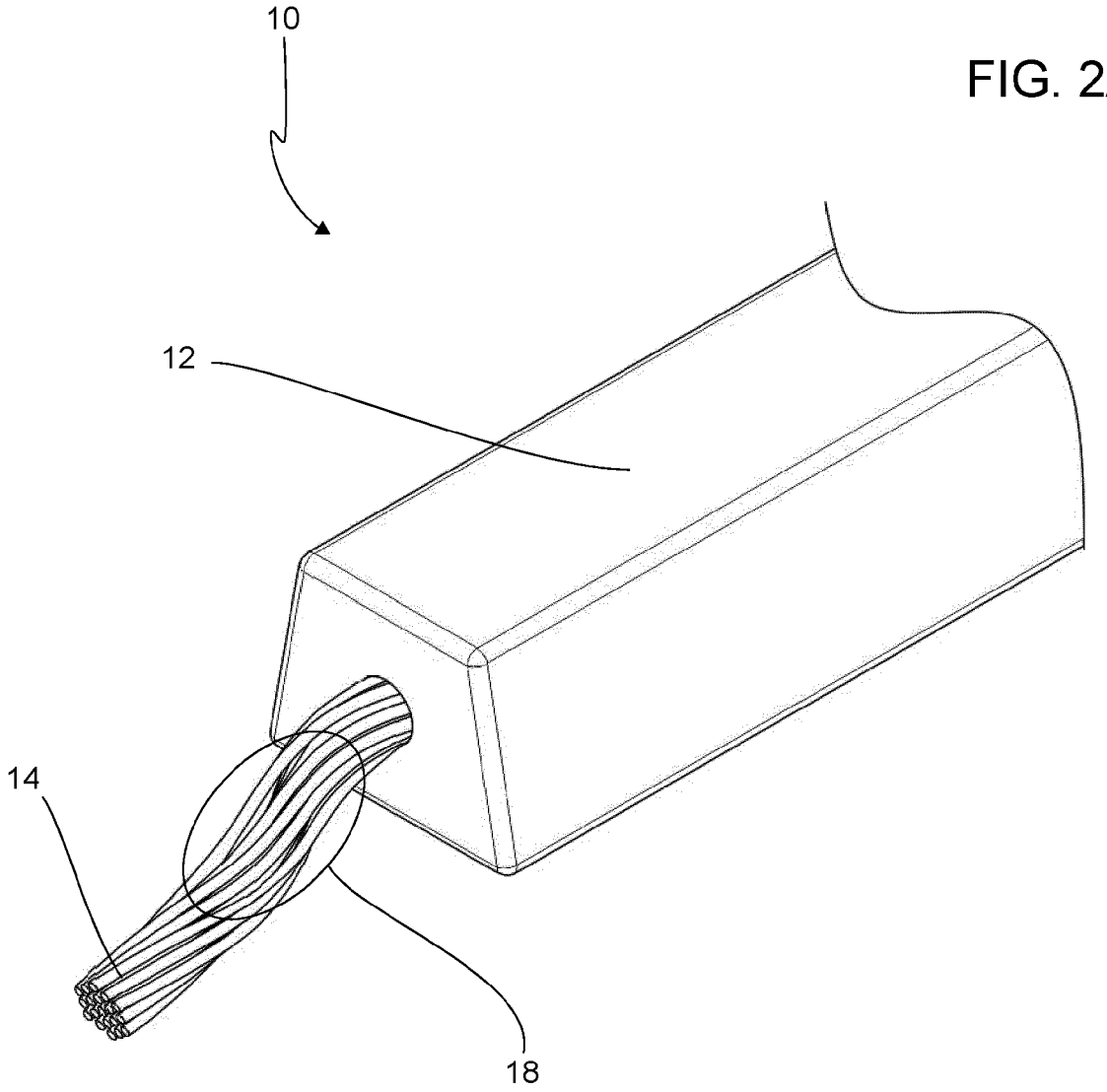


FIG. 2A

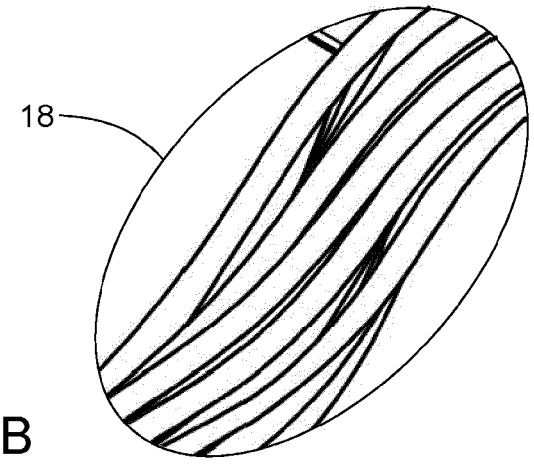


FIG. 2B

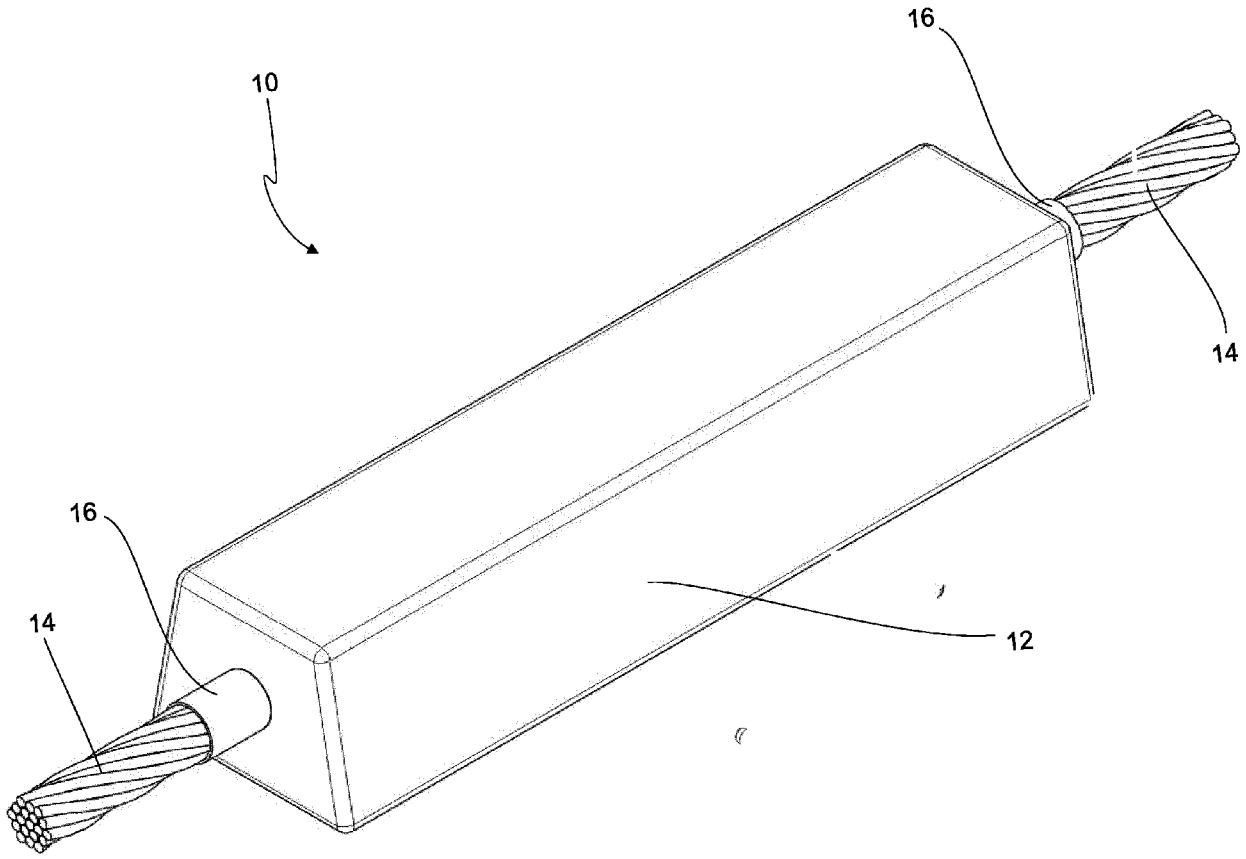


FIG. 3

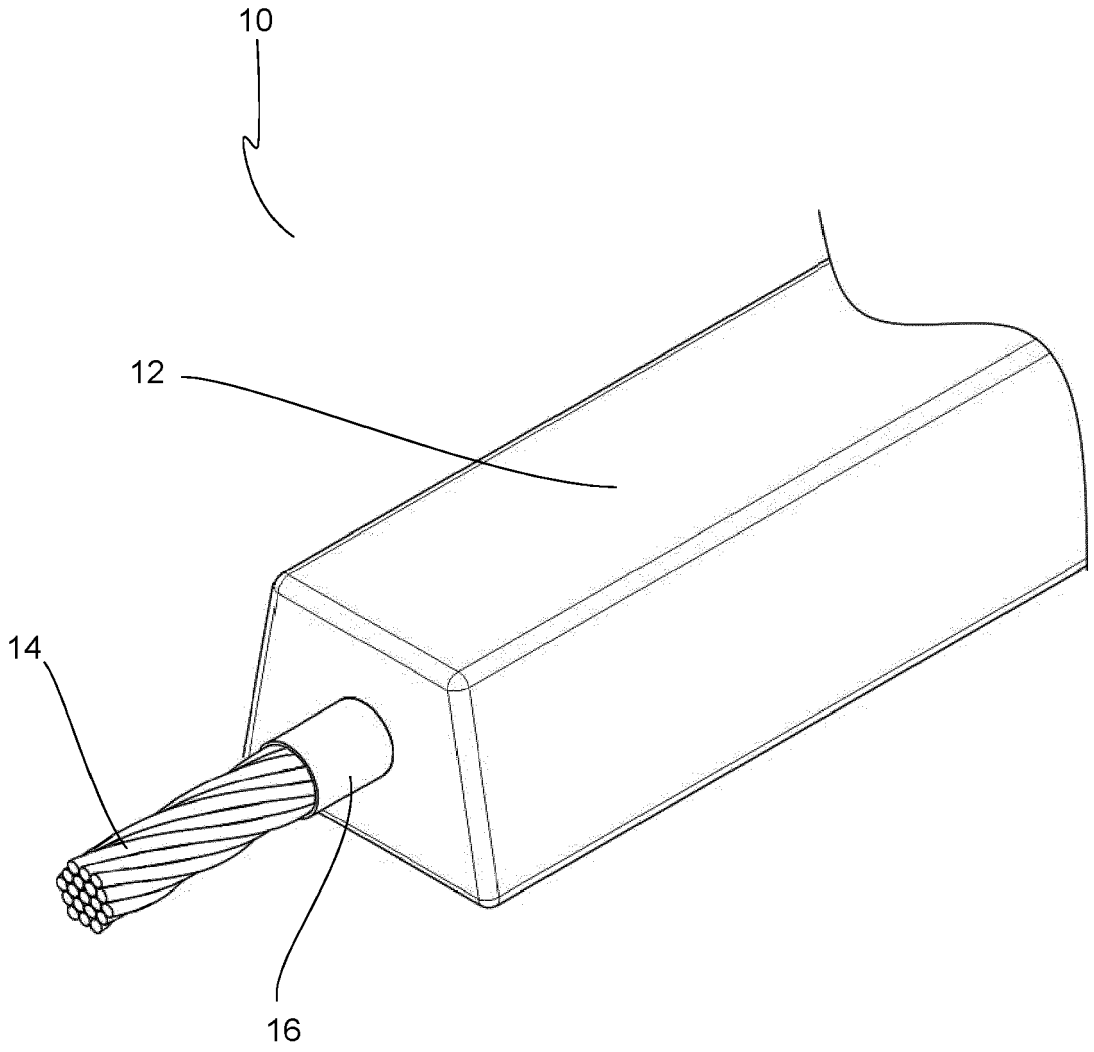


FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 8435

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 3 447 167 A1 (WHITMORE DAVID WILLIAM [CA]) 27 February 2019 (2019-02-27) * abstract; figures 1-8 * * paragraph [0027] - paragraph [0052] *	1-4,12, 13 5-9	INV. C23F13/10 C23F13/18 C23F13/20
X Y	US 4 544 465 A (MARSH GLENN A [US]) 1 October 1985 (1985-10-01) * abstract; figures 1, 2 * * column 4, line 34 - column 6, line 35 *	1,4,10, 12,13 5-9,11	
Y	US 3 169 105 A (PREISER HERMAN S ET AL) 9 February 1965 (1965-02-09) * abstract * * column 13, line 51 - line 58 *	5-9,11	
X	WO 02/16670 A2 (EXXONMOBIL UPSTREAM RES CO [US]) 28 February 2002 (2002-02-28) * abstract; claims 1-14; figure 1 * * page 8, line 14 - line 26 * * page 11, line 16 - page 13, line 4 *	1-14	

TECHNICAL FIELDS SEARCHED (IPC)

C23F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	31 May 2024	Leu, Oana

CATEGORY OF CITED DOCUMENTS

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31-05-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3447167 A1	27-02-2019	AU 2018208712 A1	14-03-2019
		CA 3012387 A1	25-02-2019
		EP 3447167 A1	27-02-2019
		JP 7093966 B2	01-07-2022
		JP 2019039066 A	14-03-2019
		US 2019062927 A1	28-02-2019
US 4544465 A	01-10-1985	NONE	
US 3169105 A	09-02-1965	NONE	
WO 0216670 A2	28-02-2002	AU 8346101 A	04-03-2002
		AU 2001283461 A1	04-03-2002
		US 6461082 B1	08-10-2002
		WO 0216670 A2	28-02-2002

EPO FORM P0459

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Patent documents cited in the description

- EP 3191618 B1 **[0018] [0063] [0072]**