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(54) METHOD FOR MANUFACTURING CYLINDER BODY OF ACTUATING CYLINDER AND CONCRETE PUMPING APPARATUS

(57) The present invention discloses a cylinder body of an actuating cylinder, comprising an inner lining layer (1) and a first fibrous composite layer (2) bonded on the outside of the inner lining layer (1), wherein, the first fibrous composite layer is composited from a first fibrous material and a substrate resin material. The present invention further discloses a concrete pumping apparatus having the cylinder body. Accordingly, the present invention further discloses a method of manufacturing a cylinder body of cylinder body, comprising: an inner lining layer forming step: forming an inner lining layer; and, a bonding step: forming a first fibrous composite layer composited from a first fibrous material and a substrate resin material, and bonding the first fibrous composite layer on the outside of the inner lining layer. With the above technical scheme, the cylinder body of an actuating cylinder has high strength, light weight, high fatigue resistance, high corrosion resistance and low thermal expansibility. In addition, since the inner lining layer of the cylinder body can meet the requirements for leak tightness of the inner wall of cylinder body and wear resistance when contacts with the piston, the service performance of the cylinder body will not be degraded.

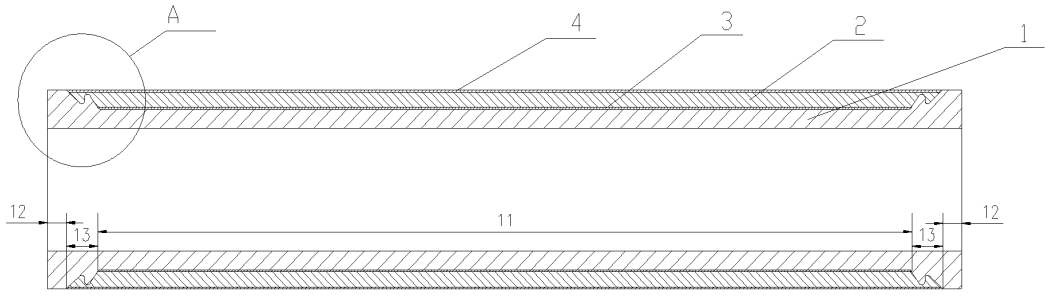

Figure 1

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Description

Field of the Invention

[0001] The present invention relates to actuating cylinders domain, in particular to a cylinder body of an actuating cylinder, a method of manufacturing the cylinder body, and a concrete pumping apparatus having the cylinder body.

Background of the Invention

[0002] Actuating cylinders usually include hydraulic cylinders and air cylinders, and are applied widely. For example, concrete pumping apparatuses (e.g., concrete pump trucks) usually have a hydraulic cylinder to drive a concrete cylinder to reciprocate and thereby deliver concrete. Presently, in concrete applications, more and more concrete delivery work is accomplished with concrete pump trucks. As the rapid development of the concrete machinery technology, it is required to deliver concrete to higher and farther locations in engineering work, and the materials for components of concrete machinery (e.g., boom, hydraulic cylinder, etc.) are developed towards a trend of light weight and high strength. The cylinder body of any existing hydraulic cylinder is made of alloy steel material solely. Owing to the high density of alloy steel, the self-weight of the hydraulic cylinder is high; therefore, the boom length of the concrete pump truck is severely limited, and the development of concrete pump trucks is limited. It is of great significance to develop a cylinder body of a hydraulic cylinder that can meet the strength requirement of concrete pump trucks and is light in weight, so as to extend the boom length of concrete pump trucks. In addition, the cylinder body of an actuating cylinder made of alloy steel solely has drawbacks such as low fatigue resistance, low corrosion resistance and high thermal expansibility, which limit the application of the actuating cylinder.

Summary of the Invention

[0003] An object of the present invention is to provide a cylinder body of an actuating cylinder, which has high strength, light weight, high fatigue resistance, high corrosion resistance and low thermal expansibility, to widen the application range of the actuating cylinder. Another object of the present invention is to provide a method of manufacturing the cylinder body of an actuating cylinder.

[0004] To attain the above objects, in an aspect, the present invention provides a cylinder body of an actuating cylinder, which comprises an inner lining layer and a first fibrous composite layer bonded on the outside of the inner lining layer, wherein, the first fibrous composite layer is composited from a first fibrous material and a substrate resin material.

[0005] In another aspect, the present invention provides a concrete pumping apparatus, wherein, a cylinder body of a pumping cylinder of the concrete pumping apparatus is the cylinder body of an actuating cylinder described above.

[0006] In another aspect, the present invention provides a method of manufacturing a cylinder body of an actuating cylinder, comprising: an inner lining layer forming step: forming an inner lining layer; and, a bonding step: forming a first fibrous composite layer with a first fibrous material and a substrate resin material and bonding the first fibrous composite layer on the outside of the inner lining layer.

[0007] In the above technical scheme, the cylinder body of an actuating cylinder comprises an inner lining layer and a first fibrous composite layer; owing to the fact that the fibrous composite has lighter weight when compared with existing metallic materials with the same strength as well as has high fatigue resistance, high corrosion resistance and low thermal expansibility, the cylinder body of an actuating cylinder has high strength, light weight, high fatigue resistance, high corrosion resistance and low thermal expansibility; therefore, the actuating cylinder can be applied more widely. In addition, since the inner lining layer of the cylinder body can meet the requirements for leak tightness of the inner wall of the cylinder body and wear resistance when contacts with the piston, the service performance of the cylinder body will not be degraded. Other characteristics and advantages of the present invention will be further detailed in the embodiments hereunder.

Brief Description of the Drawings

[0008] The accompanying drawings are provided here to facilitate further understanding on the present invention, and are a part of this document. They are used together with the following embodiments to explain the present invention, but shall not be comprehended as constituting any limitation to the present invention. Among the drawings:

Figure 1 is a sectional view of a cylinder body of an actuating cylinder according to an embodiment of the present invention;

Figure 2 is a partially enlarged view of part A shown in Figure 1;

Figure 3 is a schematic diagram of the overall structure of the inner lining layer of the cylinder body of an actuating

cylinder shown in Figure 1.

Brief Description of the Symbols

[0009]

1	inner lining layer;	2	first fibrous composite layer;
3	insulating layer;	4	second fibrous composite layer;
11	middle part;	12	end part;
13	transition part;	131	ramp part;
132	raised part		

Detailed Description of the Embodiments

[0010] Hereunder the embodiments of the present invention will be detailed, with reference to the accompanying drawings. It should be appreciated that the embodiments described here are only provided to describe and explain the present invention, but shall not be deemed as constituting any limitation to the present invention. As shown in Figure 1 and Figure 2, in an embodiment, the present invention provides a cylinder body of an actuating cylinder, which comprises an inner lining layer 1 and a first fibrous composite layer 2 bonded on the outside of the inner lining layer 1.

[0011] In the above technical scheme, the cylinder body of an actuating cylinder comprises an inner lining layer 1 and a first fibrous composite layer 2; owing to the fact that the fibrous composite has lighter weight when compared with existing metallic materials with the same strength as well as has high fatigue resistance, high corrosion resistance and low thermal expansibility, the cylinder body of an actuating cylinder has high strength, light weight, high fatigue resistance, high corrosion resistance and low thermal expansibility; therefore, the actuating cylinder can be applied more widely. In addition, since the inner lining layer of the cylinder body can meet the requirements for leak tightness of the inner wall of cylinder body and wear resistance when contacts with the piston, the service performance of the cylinder body will not be degraded. The inner lining layer 1 may be made of an appropriate material that can meet the requirements for leak tightness of the inner wall of cylinder body and wear resistance when contacts with the piston; for example, the inner lining layer 1 may be made of an existing metallic material that is usually used to manufacture a cylinder body.

[0012] The fibrous composite material mentioned in the present invention (e.g., the fibrous composite material of the first fibrous composite layer 2 or second fibrous composite layer 4) refers to a material composited from a fibrous material and a substrate resin material, i.e., a fiber reinforced resin composite material.

[0013] The first fibrous composite layer 2 may be composited from any appropriate fibrous material and substrate resin material; for example, the fibrous material may be selected from one or more of fiber glass, aramid fiber, super-high molecular weight polyethylene fiber and carbon fiber. Preferably, the first fibrous composite layer 2 is made of a carbon fiber material and a substrate resin material. Carbon fiber composite materials have advantages such as light weight, high strength, high rigidity, high damping performance, high fatigue resistance, high corrosion resistance, etc. The carbon fiber material may be composited with a variety of substrate resin materials to form carbon fiber composite materials; for example, the substrate resin material may be unsaturated polyester, vinyl resin, phenolic resin, etc., preferably an epoxy resin system that has good machinability, high strength and high ductility. Among the fibrous materials that can be used to form the first fibrous composite layer 2, some are electroconductive materials, and others are non-electroconductive materials; in case the inner lining layer 1 and the first fibrous composite layer 2 are made of electro-conductive materials (e.g., the inner lining layer 1 is made of a metallic material, and the first fibrous composite layer is made of a carbon fiber composite material), an insulating layer 3 is preferably arranged between the inner lining layer 1 and the first fibrous composite layer 2. Thus, the electro-chemical corrosion between the inner lining layer 1 and the first fibrous composite layer 2 can be prevented, and the service life of the cylinder body of an actuating cylinder can be prolonged. The insulating layer 3 may be made of any appropriate insulating material; for example, it may be selected from one or more of fiber glass, aramid fiber, super-high molecular weight polyethylene fiber and basalt fiber. For example, the insulating layer 3 may be bonded to the inner lining layer 1 by a high-toughness adhesive.

[0014] Preferably, as shown in Figure 1 and Figure 2, a second fibrous composite layer 4 is arranged on the outside of the first fibrous composite layer 2. The second fibrous composite layer 4 is helpful for improving impact resistance of the cylinder body against external impacts. The second fibrous composite layer 4 may be composited from any appropriate fibrous material and substrate resin material; for example, the fibrous material may be selected from one or more of fiber glass, aramid fiber, super-high molecular weight polyethylene fiber and basalt fiber. The substrate resin material for the first fibrous composite layer 2 may be identical to or different from the substrate resin material for the second fibrous composite layer 4.

[0015] The present invention doesn't involve any change to the overall shape of the cylinder body of an actuating

cylinder, which is to say, the overall shape of the cylinder body of an actuating cylinder may be identical to the overall shape of the cylinder body of any existing actuating cylinder; for example, the cylinder body of an actuating cylinder may be generally in a hollow cylinder structure, with connecting thread and/or an oil port arranged on both ends, wherein, the connecting thread is mainly designed to connect an end cap of the actuating cylinder, and the oil port is mainly designed to connect a working oil circuit of the actuating cylinder, so that the working oil circuit can communicate with a working chamber within the cylinder body. The main innovative ideal of the present invention lies in: the cylinder body comprises multiple material layers, so as to improve the strength, corrosion resistance and fatigue resistance of the cylinder body and decrease the weight and thermal expansibility of the cylinder body. The multiple material layers of the cylinder body (e.g., the above-mentioned inner lining layer 1, first fibrous composite layer 2, insulating layer 3 and second fibrous composite layer 4) may have even thickness or uneven thickness respectively. Preferably, as shown in Figure 1~3, the inner lining layer 1 is generally in a cylindrical shape, and comprises a middle part 11 and two end parts 12 at the sides of the middle part 11, wherein, the thickness of the middle part 11 is smaller than the thickness of each end part 12. The middle part 11 and two end parts 12 are arranged essentially along the axial direction of the cylinder body, and the inner lining layer 1 is essentially in a structure that is bigger at both ends and smaller in the middle, which is helpful for processing and port arrangement, and provides fixing effect for the fibrous composite material formed on the outside of the two end parts 12 and the middle part 11.

[0016] More preferably, a transition part 13 is arranged between each end part 12 and the middle part 11, and the thickness of the transition part 13 transits from the thickness of the end part 12 to the thickness of the middle part 11. With the transition part 13, stress concentration incurred by abrupt change of thickness can be prevented.

[0017] Preferably, an oil port and/or connecting thread is/are arranged on the end parts 12 of the inner lining layer 1, and the first fibrous composite layer 2 is arranged on the outside of the middle part 11 and transition part 13 of the inner lining layer 1. Thus, the oil port and/or connecting thread of the cylinder body can be pre-formed on the end parts 12 as required, and the oil part and/or connecting thread is/are not covered by the first fibrous composite layer 2, insulating layer 3 and second fibrous composite layer 4 (if any); therefore, the cylinder body has high machinability, and it is unnecessary to work out additional oil port and/or connecting thread on any other material layer (e.g., the first fibrous composite layer 2, insulating layer 3 and second fibrous composite layer 4) except for the inner lining layer 1.

[0018] The transition part 13 may have a ramp profile with uniformly transiting thickness, or a staged profile with thickness transiting by stages, or any other appropriate profile. More preferably, as shown in Figure 1~3, the transition part 13 comprises a ramp part 131 and a raised part 132 arranged on the ramp part 131, wherein, the thickness of the ramp part 131 transits uniformly from the thickness of the end part 12 to the thickness of the middle part 11. The raised part 132 is helpful for bonding between the inner lining layer 1 and other material layers (e.g., the first fibrous composite layer 2) and improving the bonding force, and can prevent the inner lining layer 1 from separated from other material layers. The raised part 132 may be one raised continuous ring or multiple raised continuous rings (one continuous ring as shown in Figure 3), or may be a plurality of discrete raised bars or raised ribs.

[0019] In another aspect, the present invention provides a concrete pumping apparatus, wherein, a cylinder body of a pumping cylinder of the concrete pumping apparatus is the cylinder body of an actuating cylinder described above.

[0020] In another aspect, the present invention provides a method of manufacturing a cylinder body of an actuating cylinder, comprising: an inner lining layer forming step: forming an inner lining layer 1; and, a bonding step: forming a first fibrous composite layer 2 with a first fibrous material and a substrate resin material and bonding the first fibrous composite layer 2 on the outside of the inner lining layer 1.

[0021] In the above technical scheme, the cylinder body of an actuating cylinder comprises an inner lining layer 1 and a first fibrous composite layer 2; owing to the fact that the fibrous composite has lighter weight when compared with existing metallic materials with the same strength as well as has high fatigue resistance, high corrosion resistance and low thermal expansibility, the cylinder body of an actuating cylinder has high strength, light weight, high fatigue resistance, high corrosion resistance and low thermal expansibility; therefore, the actuating cylinder can be applied more widely. In addition, since the inner lining layer of the cylinder body can meet the requirements for leak tightness of the inner wall of cylinder body and wear resistance when contacts with the piston, the service performance of the cylinder body will not be degraded. The inner lining layer 1 may be made of an appropriate material that can meet the requirements for leak tightness of the inner wall of cylinder body and wear resistance when contacts with the piston; for example, the inner lining layer 1 may be made of an existing metallic material that is usually used to manufacture a cylinder body.

[0022] The first fibrous composite layer 2 may be composited from any appropriate fibrous material and substrate resin material; for example, the fibrous material may be selected from one or more of fiber glass, aramid fiber, super-high molecular weight polyethylene fiber and carbon fiber. Preferably, in the bonding step, the first fibrous composite layer 2 is formed from a carbon fiber and a substrate resin. Carbon fiber composite materials have advantages such as light weight, high strength, high rigidity, high damping performance, high fatigue resistance, high corrosion resistance, etc. The carbon fiber material may be composited with a variety of substrate resin materials to form carbon fiber composite materials; for example, the substrate resin material may be unsaturated polyester, vinyl resin, phenolic resin, etc., preferably an epoxy resin system that has good machinability, high strength and high ductility. Among the fibrous materials

that can be used to form the first fibrous composite layer 2, some are electroconductive materials, and others are non-electroconductive materials. Preferably, in the inner lining layer forming step, the inner lining layer 1 is formed from a electroconductive material (e.g., a metallic material, more specifically, 27SiMn); in the bonding step, the first fibrous composite layer 2 is formed from a electroconductive material (e.g., a carbon fiber composite material); in addition, the manufacturing method further comprises an insulating layer forming step: forming an insulating layer 3 on the outside of the inner lining layer 1 before the bonding step, so that the insulating layer 3 is arranged between the inner lining layer 1 and the first fibrous composite layer 2. Thus, the electro-chemical corrosion between the inner lining layer 1 and the first fibrous composite layer 2 can be prevented, and the service life of the cylinder body of an actuating cylinder can be prolonged. The insulating layer 3 may be made of any appropriate insulating material; for example, it may be selected from one or more of fiber glass, aramid fiber, super-high molecular weight polyethylene fiber and basalt fiber. For example, the insulating layer may be formed by wrapping a piece of fiber cloth (e.g., glass fiber cloth) on the outside of the inner lining layer 1. For example, the insulating layer 3 may be bonded to the inner lining layer 1 by a high-toughness adhesive.

[0023] The first fibrous composite layer may be formed and bonded in an appropriate manner; preferably, in the bonding step, a bundle of the first fibrous material dipped with the substrate resin is wound on the outside of the inner lining layer 1 by a wet winding process. Specifically, a bundle of continuous first fiber is dipped with prepared epoxy resin, and then wound to the fixed inner lining layer 1 through a winding guide head of a winding machine, so as to accomplish fiber winding. A product obtained by wet winding gives full play to the properties of the composite material; therefore, the product is afforded with required structural performance as far as possible, and the forming cost is low and the process is relatively simple.

[0024] More preferably, when the bundle of the first fibrous composite material is wound, the angle between the extension direction of the bundle of the first fibrous composite material and the axial line of the cylinder body is 70°~90°, i.e., the winding angle of the first fibrous composite material is 70°~90°. Owing to the fact that the stress on the cylinder body in radial direction is usually 2-3 times of the stress on the cylinder body in circumferential direction, the wrapping angle is helpful for improving the radial strength of the cylinder body (i.e., improving the mechanical properties of the cylinder body) and reducing the overall thickness of the cylinder body, and thereby can provide favorable fatigue resistance performance for the cylinder body. Preferably, the manufacturing method further comprises: forming a second fibrous composite layer 4 on the outside of the first fibrous composite layer 2. The second fibrous composite layer 4 is helpful for improving impact resistance of the cylinder body against external impacts. The second fibrous composite layer 4 may be composited from any appropriate fibrous material and substrate resin material; for example, the fibrous material may be selected from one or more of fiber glass, aramid fiber, super-high molecular weight polyethylene fiber and basalt fiber. For example, the second fibrous composite layer 4 may be formed by wrapping a piece of cloth made of a second fibrous material on the outside of the first fibrous composite layer 2 so as to make the substrate resin in the first fibrous composite layer 2 infiltrate into the cloth made of a second fibrous material. Of course, when the second fibrous composite layer 4 is formed, substrate resin may be added on the second fibrous material cloth additionally, instead of utilizing the substrate resin in the first fibrous composite layer 2.

[0025] The present invention doesn't involve any change to the overall shape of the cylinder body of an actuating cylinder, which is to say, the overall shape of the cylinder body of an actuating cylinder may be identical to the overall shape of the cylinder body of any existing actuating cylinder; for example, the cylinder body of an actuating cylinder may be generally in a hollow cylinder structure, with connecting thread and/or an oil port arranged on both ends. The main innovative ideal of the present invention lies in: the cylinder body comprises multiple material layers, so as to improve the strength, corrosion resistance and fatigue resistance of the cylinder body and decrease the weight and thermal expansibility of the cylinder body. The multiple material layers of the cylinder body (e.g., the above-mentioned inner lining layer 1, first fibrous composite layer 2, insulating layer 3 and second fibrous composite layer 4) may have even thickness or uneven thickness respectively. Preferably, the inner lining layer forming step comprises: providing a blank of the inner lining layer that is generally in a hollow cylinder shape; and, a machining procedure: reducing the thickness of a part of the blank of the inner lining layer by machining (e.g., turning), so that the inner lining layer 1 is formed to have a middle part 11 and two end parts 12 at the sides of the middle part 11, wherein, the thickness of the middle part 11 is smaller than the thickness of each end part 12. The middle part 11 and two end parts 12 are arranged essentially along the axial direction of the cylinder body, and the inner lining layer 1 is essentially in a structure that is bigger at both ends and smaller in the middle which is helpful for processing and port arrangement, and provides fixing effect for the fibrous composite material formed on the outside of the two end parts 12 and the middle part 11.

[0026] More preferably, in the machining procedure, a transition part 13 is formed between each end part 12 and the middle part 11, and the thickness of the transition part 13 transits from the thickness of the end part 12 to the thickness of the middle part 11. With the transition part 13, stress concentration incurred by abrupt change of thickness can be prevented.

[0027] More preferably, in the inner lining layer forming step, an oil port and/or connecting thread is/are formed on the end parts 12 of the inner lining layer 1, and in the bonding step, the first fibrous composite layer 2 is bonded on the outside of the middle part 11 and transition parts 13 of the inner lining layer 1. Thus, the oil port and/or connecting thread

of the cylinder body can be pre-formed on the end parts 12 as required, and the oil part and/or connecting thread is/are not covered by the first fibrous composite layer 2, insulating layer 3 and second fibrous composite layer 4 (if any); therefore, the cylinder body has high machinability, and it is unnecessary to work out additional oil port and/or connecting thread on any other material layer (e.g., the first fibrous composite layer 2, insulating layer 3 and second fibrous composite layer 4) except for the inner lining layer 1.

[0028] The transition part 13 may have a ramp profile with uniformly transiting thickness or a staged profile with thickness transiting by stages, or any other appropriate profile. Preferably, in the machining procedure, the transition part 13 is formed to have a ramp part 131 and a raised part 132 arranged on the ramp part 131, wherein, the thickness of the ramp part 131 transits uniformly from the thickness of the end part 12 to the thickness of the middle part 11. The raised part 132 is helpful for bonding between the inner lining layer 1 and other material layers (e.g., the first fibrous composite layer 2) and improving the bonding force, and can prevent the inner lining layer 1 from separated from other material layers. The raised part 132 may be one raised continuous ring or multiple raised continuous rings (one continuous ring as shown in Figure 3), or may be a plurality of discrete raised bars or raised ribs.

[0029] More preferably, the inner lining layer forming step further comprises: a sand blasting procedure: carrying out sand blasting on the outer surface of the inner lining layer 1 formed in the machining procedure, to increase roughness of the outer surface of the inner lining layer 1. In that way, the bonding force between the inner lining layer 1 and other material layers (e.g., insulating layer 3, first fibrous composite layer 2, etc.) can be increased.

[0030] Hereunder the manufacturing process of the cylinder body will be described briefly taking the embodiment of cylinder body of an actuating cylinder shown in Figure 1~3 as an example.

(1) Forming the inner lining layer 1 shown in Figure 3 by machining;

(3) Bonding a piece of glass fiber cloth on the outside of the middle part 11 of the inner lining layer 1 by a high-toughness adhesive, to form an insulating layer 3;

(3) Forming a first fibrous composite layer 2 on the outside of the insulating layer 3 and the transition part 13 of the inner lining layer 1 by wet winding;

(4) Wrapping a piece of glass fiber cloth on the outside of the first fibrous composite layer 2 so as to control the substrate resin in the first fibrous composite layer 2 infiltrate into the glass fiber cloth, to form a second fibrous composite layer 4;

(5) Loading the cylinder body into a baking oven, to accomplish forming by thermosetting.

[0031] The cylinder body of an actuating cylinder and the method of manufacturing the cylinder body described above are applicable to different types of actuating cylinders, including hydraulic cylinders, gas cylinders, etc.; for example, the cylinder body may be widely used as a cylinder body of an actuating cylinder in different engineering machines, such as concrete pump trucks, lifters, excavators, fire engines, overhead working trucks, environmental sanitation vehicles, etc.

[0032] While some preferred embodiments of the present invention are described above with reference to the accompanying drawings, the present invention is not limited to the details in those embodiments. Those skilled in the art can make modifications and variations to the technical scheme of the present invention, without departing from the spirit of the present invention. However, all these modifications and variations shall be deemed as falling into the protected domain of the present invention.

[0033] In addition, it should be appreciated that the technical features described in the above embodiments can be combined in any appropriate manner, provided that there is no conflict among the technical features in the combination. To avoid unnecessary iteration, such possible combinations will not be described here in the present invention.

[0034] Moreover, the different embodiments of the present invention can be combined freely as required, as long as the combinations don't deviate from the ideal and spirit of the present invention. However, such combinations shall also be deemed as falling into the scope disclosed in the present invention.

Claims

1. A cylinder body of an actuating cylinder, comprising an inner lining layer (1) and a first fibrous composite layer (2) bonded on the outside of the inner lining layer (1), wherein the first fibrous composite layer (2) is composited from a first fibrous material and a substrate resin material.

2. The cylinder body of an actuating cylinder according to claim 1, wherein, the inner lining layer (1) is made of a metallic material.

3. The cylinder body of an actuating cylinder according to claim 1, wherein, the inner lining layer (1) and the first fibrous composite layer (2) are made of a electroconductive material, and an insulating layer (3) is arranged between the

inner lining layer (1) and the first fibrous composite layer (2).

4. The cylinder body of an actuating cylinder according to claim 1, wherein, the first fibrous composite layer (2) is composited from a carbon fiber material and a substrate resin material.

5. The cylinder body of an actuating cylinder according to claim 1, wherein, a second fibrous composite layer (4) is arranged on the outside of the first fibrous composite layer (2), and the second fibrous composite layer (4) is composited from a second fibrous material and a substrate resin material.

6. The cylinder body of an actuating cylinder according to any of claims 1~5, wherein, the inner lining layer (1) is generally in a cylindrical shape, and comprises a middle part (11) and two end parts (12) at the sides of the middle part (11), and the thickness of the middle part (11) is smaller than the thickness of each end part (12).

7. The cylinder body of an actuating cylinder according to claim 6, wherein, a transition part (13) is respectively arranged between each end part (12) and the middle part (11), and the thickness of the transition part (13) transits from the thickness of the end part (12) to the thickness of the middle part (11).

8. The cylinder body of an actuating cylinder according to claim 7, wherein, the transition part (13) comprises a ramp part (131) and a raised part (132) arranged on the ramp part (131), and the thickness of the ramp part (131) transits uniformly from the thickness of the end part (12) to the thickness of the middle part (11).

9. The cylinder body of an actuating cylinder according to claim 7, wherein, an oil port and/or connecting thread is/are arranged on the end parts (12) of the inner lining layer (1), and the first fibrous composite layer (2) is arranged on the outside of the middle part (11) and the transition part (13) of the inner lining layer (1).

10. A concrete pumping apparatus, wherein, a cylinder body of a pumping cylinder of the concrete pumping apparatus is the cylinder body of an actuating cylinder as set forth in any of claims 1~9.

11. A method of manufacturing a cylinder body of an actuating cylinder, comprising:

an inner lining layer forming step: forming an inner lining layer (1); and
a bonding step: forming a first fibrous composite layer (2) composited from a first fibrous material and a substrate resin material, and bonding the first fibrous composite layer (2) on the outside of the inner lining layer (1).

12. The method of manufacturing a cylinder body of an actuating cylinder according to claim 11, wherein, in the inner lining layer forming step, the inner lining layer (1) is formed from a metallic material.

13. The method of manufacturing a cylinder body of an actuating cylinder according to claim 11, wherein:

in the inner lining layer forming step, the inner lining layer (1) is formed from a electroconductive material;
in the bonding step, the first fibrous composite layer (2) is formed from a electroconductive material; and
the method further comprises an insulating layer forming step: forming an insulating layer (3) on the outside of the inner lining layer (1) before the bonding step, so that the insulating layer (3) is arranged between the inner lining layer (1) and the first fibrous composite layer (2).

14. The method of manufacturing a cylinder body of an actuating cylinder according to claim 11, wherein, in the bonding step, the first fibrous composite layer (2) is composited from a carbon fiber material and a substrate resin material.

15. The method of manufacturing a cylinder body of an actuating cylinder according to claim 11, wherein, in the bonding step, a bundle of the first fibrous material dipped with the substrate resin is wound on the outside of the inner lining layer (1) by a wet winding process.

16. The method of manufacturing a cylinder body of an actuating cylinder according to claim 15, wherein, when the bundle of first fibrous material is wound, the angle between the extension direction of the bundle of the first fibrous material and the axial direction of the cylinder body is 70°~90°.

17. The method of manufacturing a cylinder body of an actuating cylinder according to claim 11, further comprising: forming a second fibrous composite layer (4) on the outside of the first fibrous composite layer (2).

18. The method of manufacturing a cylinder body of an actuating cylinder according to claim 17, wherein, the second fibrous composite layer (4) is formed by wrapping a piece of cloth made of a second fibrous material on the outside of the first fibrous composite layer (2) so as to make the substrate resin in the first fibrous composite layer (2) infiltrate into the cloth made of a second fibrous material.

19. The method of manufacturing a cylinder body of an actuating cylinder according to any of claims 11~18, wherein, the inner lining layer forming step comprises:

providing a blank of the inner lining layer that is generally in a hollow cylinder shape; and
a machining procedure: reducing the thickness of a part of the blank of the inner lining layer by machining, so that the inner lining layer (1) is formed to have a middle part (11) and two end parts (12) at the sides of the middle part (11), wherein, the thickness of the middle part (11) is smaller than the thickness of each end part (12).

20. The method of manufacturing a cylinder body of an actuating cylinder according to claim 19, wherein, in the machining procedure, a transition part (13) is respectively formed between each end part (12) and the middle part (11), and the thickness of the transition part (13) transits from the thickness of the end part (12) to the thickness of the middle part (11).

21. The method of manufacturing a cylinder body of an actuating cylinder according to claim 20, wherein, in the machining procedure, the transition part (13) is formed to have a ramp part (131) and a raised part (132) arranged on the ramp part (131), and the thickness of the ramp part (131) transits uniformly from the thickness of the end part (12) to the thickness of the middle part (11).

22. The method of manufacturing a cylinder body of an actuating cylinder according to claim 20, wherein, the inner lining layer forming step further comprises a sand blasting procedure, in the sand blasting procedure, carrying out sand blasting on the outer surface of the inner lining layer (1) formed in the machining procedure, to increase roughness of the outer surface of the inner lining layer (1).

23. The method of manufacturing a cylinder body of an actuating cylinder according to claim 19, wherein:

in the inner lining layer forming step, an oil port and/or connecting thread is/are formed on the end parts (12) of the inner lining layer (1);
in the bonding step, the first fibrous composite layer (2) is bonded on the outside of the middle part (11) and transition parts (13) of the inner lining layer (1).

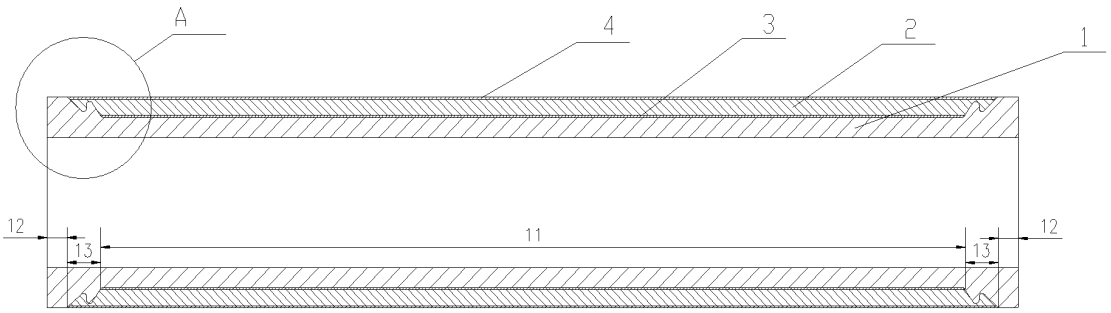

Figure 1

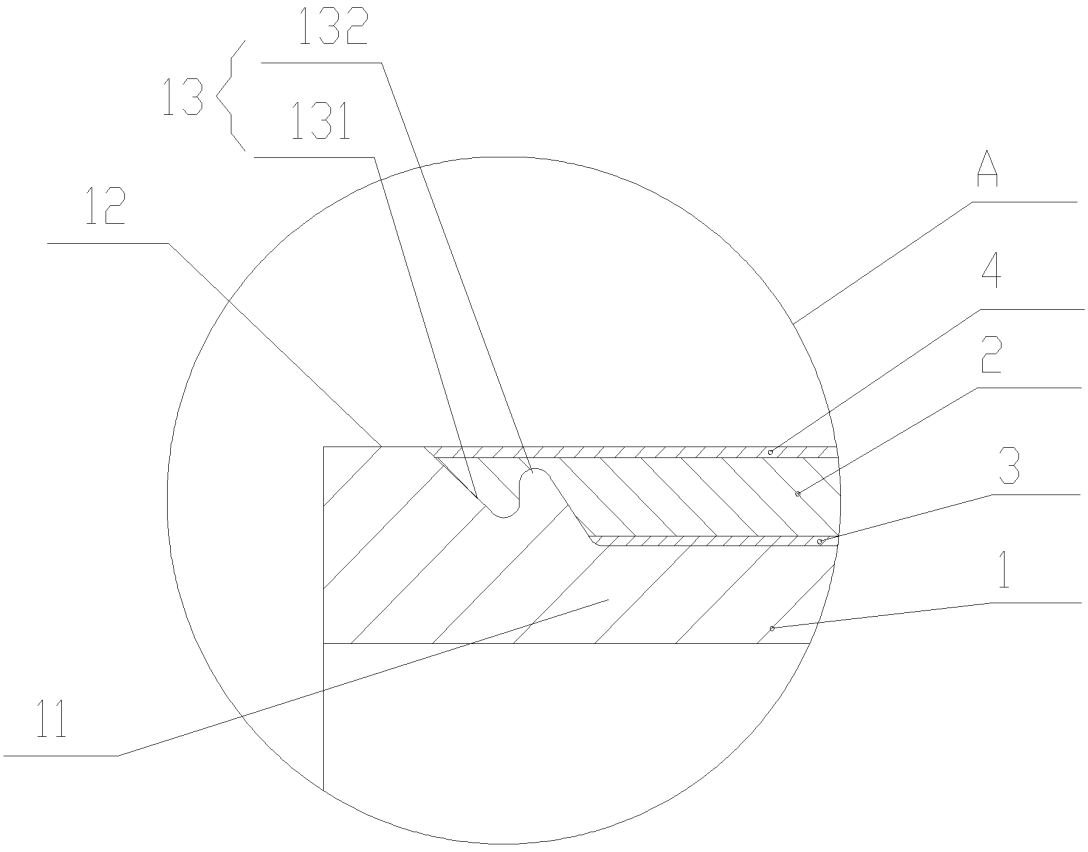

Figure 2

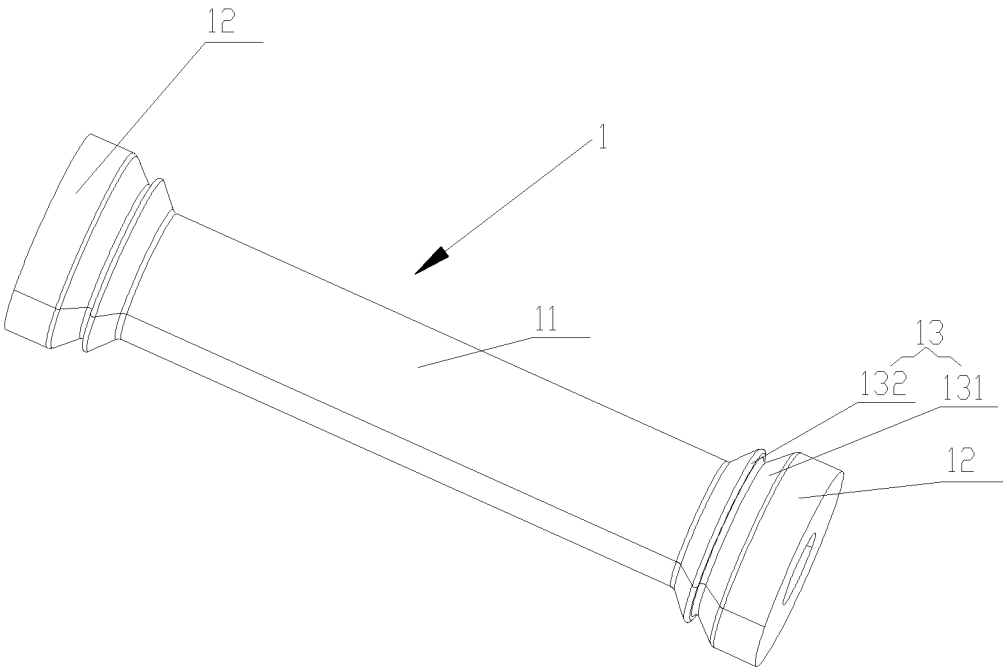

Figure 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/086108

A. CLASSIFICATION OF SUBJECT MATTER

F15B 15/14 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F15B, B29C, B23P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, WPI, EPODOC: ZOOMLION HEAVY INDUSTRY SCIENCE & TECHNOLOGY DEVELOPMENT, liner, substrate, cylinder, composition, fibre, funicle, hemp, thread, resin, rosin, colophony, pitch, metal, steel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	CN 102705293 A (ZOOMLION HEAVY INDUSTRY SCIENCE & TECHNOLOGY DEVELOPMENT CO., LTD.), 03 October 2012 (03.10.2012)see description, paragraphs [0015]-[0044], and figures 1-3	1-23
P, X	CN 102689436 A (ZOOMLION HEAVY INDUSTRY SCIENCE & TECHNOLOGY DEVELOPMENT CO., LTD.), 26 September 2012 (26.09.2012), see description, paragraphs [0017]-[0050], and figures 1-3	1-23
P, X	CN 102720721 A (HENGSHEN CO., LTD.), 10 October 2012 (10.10.2012), see description, paragraphs [0018]-[0023], and figures 1-2	1, 2, 4, 6-8, 10-12, 14-16
E	CN 202597323 U (ZOOMLION HEAVY INDUSTRY SCIENCE & TECHNOLOGY DEVELOPMENT CO., LTD.), 12 December 2012 (12.12.2012), see description, paragraphs [0026]-[0055], and figures 1-3	1-23
X	CN 101362387 A (WU, Jiqun), 11 February 2009 (11.02.2009), see description, page 2, line 20 to page 4, line 6, and figures 1-2	1-4, 10-16

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 March 2013 (10.03.2013)	**28 March 2013 (28.03.2013)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **QU, Wei** Telephone No.: (86-10) **62085250**

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2012/086108

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101900246 A (JIANGBEI MACHINERY PLANT), 01 December 2010 (01.12.2010), see description, paragraphs [0004]-[0022], and figure 1	1-4, 10-16
X	CN 101180176 A (QUICKSTEP TECHNOLOGIES PTY LTD.), 14 May 2008 (14.05.2008), see description, page 8, line 2 to page 12, line 7, and figures 1-8	1-4, 10-16
A	US 3793104 A (LAWRON INDUSTRIES LIMITED), 19 February 1974 (19.02.1974), see the whole document	1-23

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/086108

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102705293 A	03.10.2012	None	
CN 102689436 A	26.09.2012	None	
CN 102720721 A	10.10.2012	None	
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