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(54) **CONNECTEUR UTILE DANS LA PROTECTION CATHODIQUE ET PROCEDE D'UTILISATION ASSOCIE**

(54) **CONNECTOR FOR USE IN CATHODIC PROTECTION AND METHOD OF USE**

(57) L'invention concerne un ensemble, utile dans la protection cathodique d'une armature en acier de béton et comprenant : (i) une anode en métal laquelle possède un potentiel d'électrode négatif supérieur à celui de l'acier et est placée en contact avec l'acier, (ii) un connecteur électrique de forme allongée, par exemple un fil métallique en métal ductile, pouvant être enroulé autour de l'élément d'armature en acier à protéger. L'anode peut être sous la forme d'un bloc coulé autour d'une portion de la longueur du connecteur, lequel comprend, de préférence, plusieurs fils métalliques torsadés ensemble sur une portion de leur longueur, l'anode étant coulée autour de cette portion torsadée.

(57) An assembly for use in the cathodic protection of steel reinforcement in reinforced concrete said assembly comprises: (i) an anode of a metal having a more negative electrode potential than steel and, in electrical contact therewith, (ii) an elongate electrical connector eg a wire made of a ductile metal capable of being wound around the steel reinforcing element to be protected. The anode may be in the form of a block cast around a portion of the length of the elongate connector and preferably the elongate connector comprises a plurality of wires twisted together over a portion of their length with the anode cast around the twisted portion.

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(54) Title: CONNECTOR FOR USE IN CATHODIC PROTECTION AND METHOD OF USE

(57) Abstract

An assembly for use in the cathodic protection of steel reinforcement in reinforced concrete said assembly comprises: (i) an anode of a metal having a more negative electrode potential than steel and, in electrical contact therewith, (ii) an elongate electrical connector eg a wire made of a ductile metal capable of being wound around the steel reinforcing element to be protected. The anode may be in the form of a block cast around a portion of the length of the elongate connector and preferably the elongate connector comprises a plurality of wires twisted together over a portion of their length with the anode cast around the twisted portion.

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CONNECTOR FOR USE IN CATHODIC PROTECTION AND METHOD OF USE.

Field of the Invention

This invention relates to the cathodic protection of steel in reinforced concrete employing a sacrificial anode, more particularly to an electrical connector for connecting the sacrificial anode to the reinforcing steel it is intended to protect and to a method for the installation of the anode.

Background of the Invention

Sacrificial anodes are well known. To be effective the sacrificial anode is made of a metal which has a more negative electrode potential than the steel to be protected so that it will corrode in preference to the steel. Sacrificial anodes are described in European Patent No 0707667 and United States Patent No 5292411.

Problem to be solved by the Invention

To fulfil its purpose the sacrificial anode needs to be connected electrically to the steel to be protected. Metal conductors have been previously used for this purpose. Previously these metal conductors such as wires, have been attached to the steel reinforcement by drilling a hole into which a self tapping screw is inserted. Alternative methods have involved the use of clips or clamps to secure the wire to the metal to be protected.

These methods have problems in that the drilling of holes and use of self tapping screws is time consuming and there is always a risk that the clips and clamps may be dislodged.

The present invention provides a solution to these problems by the use of a ductile elongate connector that is connected to the steel reinforcing element by winding the connector around the reinforcing element..

Summary of the Invention

According to the present invention there is provided an assembly for use in the cathodic protection of steel reinforcement in reinforced concrete said assembly comprising:

(i) an anode of a metal having a more negative electrode potential than steel and, in electrical contact therewith,

(ii) an elongate electrical connector made of a ductile metal capable of being wound around the steel reinforcing element to be protected.

Advantageous Effect of the Invention

The connector can be installed in less time than the previously used methods involving the use of self tapping screws and is more secure than the clips or clamps.

Brief Description of the Drawings

Fig 1 is a perspective view of one embodiment of the invention in which two wires are twisted together

Fig 2 is a perspective view on a smaller scale than Fig 1 in which the anode has been cast around the wires of the connector and

Fig 3 is a perspective view on the same scale as Fig 2 of another embodiment in which the anode is surrounded by a mortar which been cast around it.

Detailed Description of the Invention.

The anode is preferably zinc but aluminium, cadmium or magnesium may be used. References to these metals include alloys containing them.

The electrical contact between the connector and the anode is preferably provided by having the anode in the form of a block which has been cast (by cast we mean allowing the liquid metal to solidify to form the block) around a portion of the length of the elongate connector. Alternatively the electrical contact may provided by the elongate connector being wound around the anode or by the connector being soldered or similarly attached to the anode.

The elongate connector is conveniently in the form of a wire, although other elongate forms may be used. The wire may conveniently be of steel, preferably a mild steel.

Preferably the wire is as noble or more noble than the steel of the reinforcement.

The connector may comprise a plurality of wires twisted together over a portion of their length and the anode may be cast around the twisted portion. By the word twisted we mean to include folded or bent or crimped. The purpose of the twisted portion is to increase the surface area of the wire forming the interface with the cast anode and thereby improve the electrical contact. The wires may be twisted together at a position which is intermediate their ends (for example near the middle of their lengths) so that lengths of wire extend on both sides of the cast anode.

Patent Application No WO 94/29496 (European Patent Application No 0707667) describes a method of cathodic protection in which to maintain the cathodic protection over a sustained period of time the anode is surrounded by a material containing an electrolyte of high pH. To avoid passivation of the anode it recommends that in the case of a zinc anode the pH is at least about 14.

Suitable materials described in this patent are cementitious mortars which may be cast around the anode to form a unit. It is not essential that the mortar is cementitious although such mortars are more readily available. The mortar may be prepared from a cement that has an intrinsically high alkali content or additional alkali may be added to the mortar eg sodium hydroxide or lithium hydroxide, the latter being preferred.

The assembly of anode and connector of the present invention may have a porous material eg a cementitious mortar cast around the anode. By cast we mean forming a solid block from the liquid or semiliquid mortar. The casting is preferably carried out in a mold. The porous material is one that preferably contains a high pH electrolyte as described in European Patent Application No 0707667 ie one containing an electrolyte solution whose pH is sufficiently high to maintain corrosion of the anode and passive film formation on the anode to be avoided when the anode is galvanically connected to the steel reinforcement. In the case of a cementitious mortar the electrolyte solution is the pore solution.

The mortar will preferably have a content of alkali equivalent to at least 1% lithium hydroxide based on the dry weight of the ingredients used to make the mortar. An equivalent amount of sodium hydroxide is 2% by weight. Conveniently the amount of lithium hydroxide is greater than 2% or an equivalent amount of sodium hydroxide of 4%.

Lithium hydroxide is the preferred alkali because lithium ions provide protection against alkali silica (or alkali aggregate) reactions in concrete. However mixtures of alkalis may be used for example mixtures of lithium hydroxide and sodium hydroxide.

The anode, the porous material eg mortar and the casting may also be as described in European Patent Application No 0707667.

According to another aspect of the present invention there is provided a method of installing a sacrificial anode to protect the reinforcement of reinforced concrete which method comprises the following steps (a) and (b) in any order

(a) making an electrical connection between an elongate connector and the anode and

(b) making electrical contact with the steel reinforcement by winding the elongate connector around the steel reinforcement.

The step (a) may comprise casting the anode around a portion of the length of the elongate connector.

A further step (c) may be carried out before or after step (b) which step (c) comprises casting around the anode a porous material containing an electrolyte solution having a pH sufficiently high for corrosion of the anode to occur and passive film formation to be avoided.

Preferably the anode is zinc in which case the pH of the electrolyte solution is desirably at least about 14. When the anode is of another metal such as aluminium the pH may be lower, for example at least 13.3 or 13.5

The pH may be determined by measuring the hydroxyl ion concentration and applying the equation

$pH = 14 + \log (OH^-)$ after Sorensen.

The invention is applicable to the construction of new reinforced concrete structures in which the anode assembly is connected to the reinforcement by means of the connector and a high pH porous material such as a mortar cast around the anode.

The invention is also applicable to the protection of existing concrete structures in which method a hole may be made in the concrete and (i) the anode inserted into the hole and (ii) the connector connected to the reinforcement and (iii) the high pH material cast around the anode. Steps (i), (ii) and (iii) may be carried out in any order

Referring to Fig 1 of the drawings two wires each being a 16 SWG (standard wire guage) mild steel wire are twisted together over part of their length at 6. The length of the twisted portion 6 is typically from about 38 to 42 mm. Four lengths of wire in the form of arms 2, 4, 8 and 10 extend from the twisted portion 6. The length of the arms 2, 4, 8 and 10 is typically from about 148 to 152mm and at the end of each arm are loops 12, 13 14 and 15. The arms are each wound around the reinforcement. Usually one or two complete winds around the reinforcement is sufficient to make a satisfactory electrical contact. The diameter of the loops is typically from about 9 to 11mm. The purpose of the loops is to facilitate the use of a tool of the type used to close paper sacks for potatoes and the like. A suitable tool is a spring loaded ratchet twisting tool known as the Stanley tying tool and is available from Direct Wire Ties Limited. By means of the tool the arms which have been wound around the steel reinforcement (not shown) in reinforced concrete may then be twisted together. This has the effect of tightening the wire around the reinforcement.

In Fig 2 a cylindrical zinc block 20 of about 40 mm diameter and about 7mm thickness has been cast around the twisted wires. In the Figure the centre of the cylindrical block 20 has been omitted to show the wires. The top and bottom edges of the block 20 have been rounded to prevent crack inducement.

The assembly shown in Fig 2 was made by first twisting the wires together near the middle of their length and placing the twisted portion in a ceramic casting mould. Molten zinc was then poured into the mould. After solidifying the product which was removed from the mould. The wire arms 2, 4 8, and 10 extend on both sides of the anode and enable the anode to be connected to more than one reinforcing element if desired.

In Fig 3 a block of mortar 24 has been cast around the zinc shown in Fig 2 to give a thickness of 10 mm all round the zinc.

The assembly shown in Fig 3 was made by positioning the assembly shown in Fig 2 in a previously vacuum formed plastic mould so as to locate the zinc centrally in the mould. A high pH cementitious mortar containing a pore solution of pH greater than 14 was prepared by mixing a Portland cement powder (containing 2% by weight of added lithium hydroxide based on the weight of the cement powder) with water and poured into the mould. This was allowed to harden for four hours and then removed from the mould to yield the product shown in Fig 3.

CLAIMS:

1. An assembly for use in the cathodic protection of steel reinforcement in reinforced concrete said assembly comprising:
(i) an anode of a metal having a more negative electrode potential than steel and, in electrical contact therewith,
(ii)an elongate electrical connector made of a ductile metal capable of being wound around the steel reinforcing element to be protected.

2. An assembly as claimed in claim 1 wherein the elongate connector is in the form of a wire.

3. An assembly as claimed in claim 1 wherein the anode is in the form of a block cast around a portion of the length of the elongate connector.

4. An assembly as claimed in claim 3 wherein the elongate connector comprises a plurality of wires twisted together over a portion of their length and the anode has been cast around the twisted portion.

5. An assembly as claimed in claim 4 wherein the wires are twisted together at a position intermediate their ends so that the wires extend on both sides of the cast anode.

6. An assembly as claimed in claim 1 wherein the anode is enclosed in a porous material which has been cast around the anode, the porous material containing an electrolyte solution whose pH is sufficiently high for corrosion of the anode to occur and passive film formation on the anode to be avoided when the anode is galvanically connected to the reinforcement.

7. An assembly as claimed in claim 6 wherein the anode is made of zinc and the porous material is a cementitious mortar containing an electrolyte solution of pH at least about 14.

8. An assembly as claimed in claim 1 which assembly has been connected to the reinforcement by winding the elongate connector round the reinforcement.

9. A method of making an assembly for use in the cathodic protection of steel reinforcement in reinforced concrete the assembly comprising an anode of a metal having a more negative elctrode potential than steel and in electrical contact therewith an elongate electrical connector made of a ductile metal capable of being wound around the steel reinforcing element to be protected, which method comprises
casting the anode from the liquid metal in a mold to form a block of metal around a portion of the length of the elongate electrical connector

10. A method as claimed in claim 9 which further includes the step of forming, from a liquid or semiliquid mixture, a solid block around the anode of a porous material containing an electrolyte solution having a pH sufficiently high for corrosion of the anode to occur and passive film formation on the anode to be avoided when connected to a steel reinforcement.

11. A method of installing a sacrificial anode to protect the steel reinforcement of reinforced concrete which method comprises the following steps (a) and (b) in any order
(a) making an electrical connection between the sacrificial anode and an elongate connector, the elongate connector being made of a ductile metal capable of being wound around the reinforcement and
(b) making electrical contact between the elongate connector and the steel reinforcement by winding the elongate connector around the steel reinforcement.

12. A method as claimed in claim 11 wherein the step (a) comprises casting the anode from the liquid metal in a mold to form a block of metal around a portion of the length of the elongate connector.

13. A method as claimed in claim 12 wherein a further step (c) which may be carried out before or after step (b) comprises casting around the anode a porous material containing an electrolyte solution having a pH sufficiently high for corrosion of the anode to occur and passive film formation to be avoided.

14. A method as claimed in claim 13 wherein the anode is zinc and the pH of the electrolyte solution is at least about 14.

15. A method as claimed in claim 11 wherein to tighten the wire around the reinforcement, the method further includes twisting the ends of the flexible elongate connector together using a ratchet twisting tool.

FIG 1

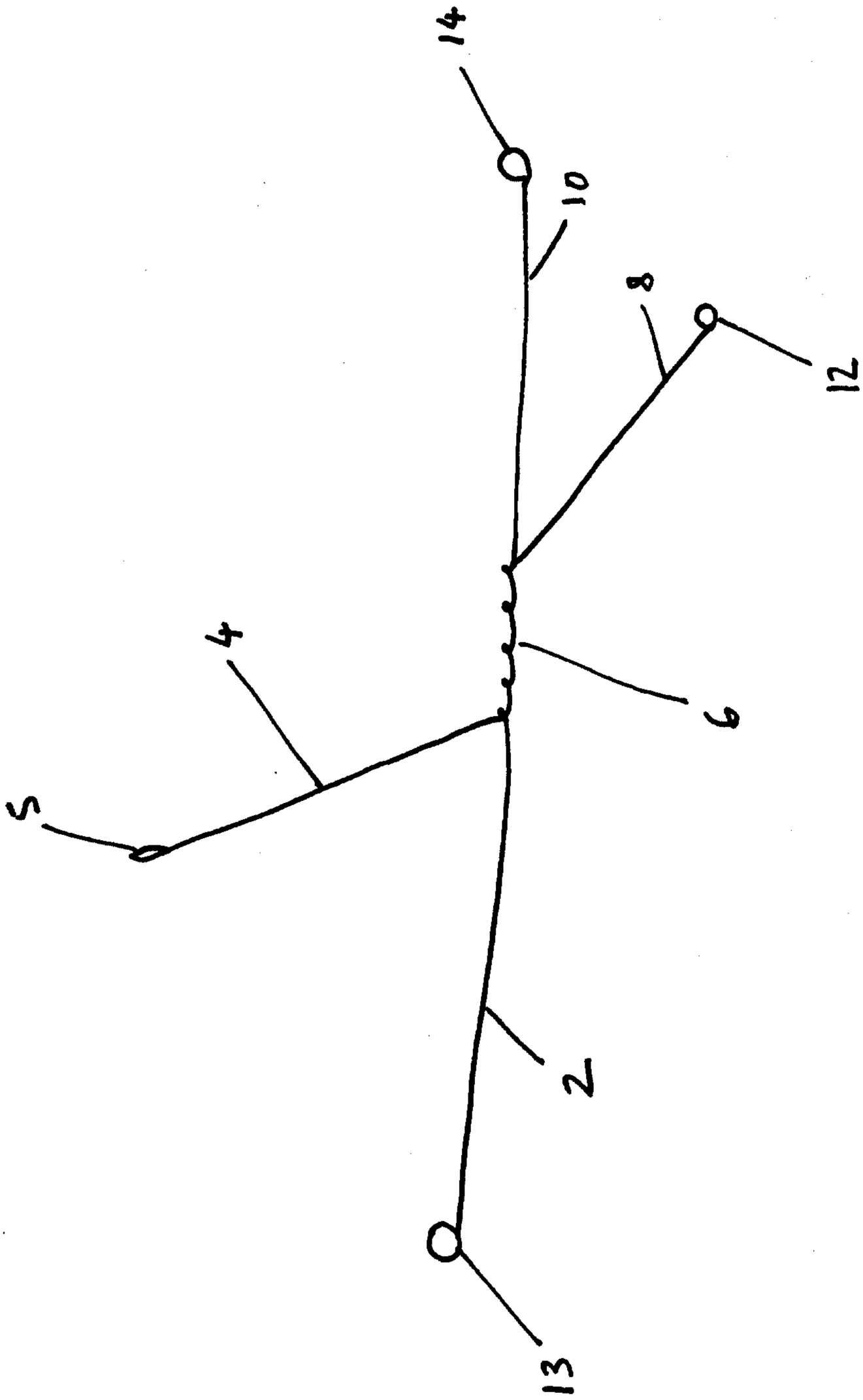

FIG 2

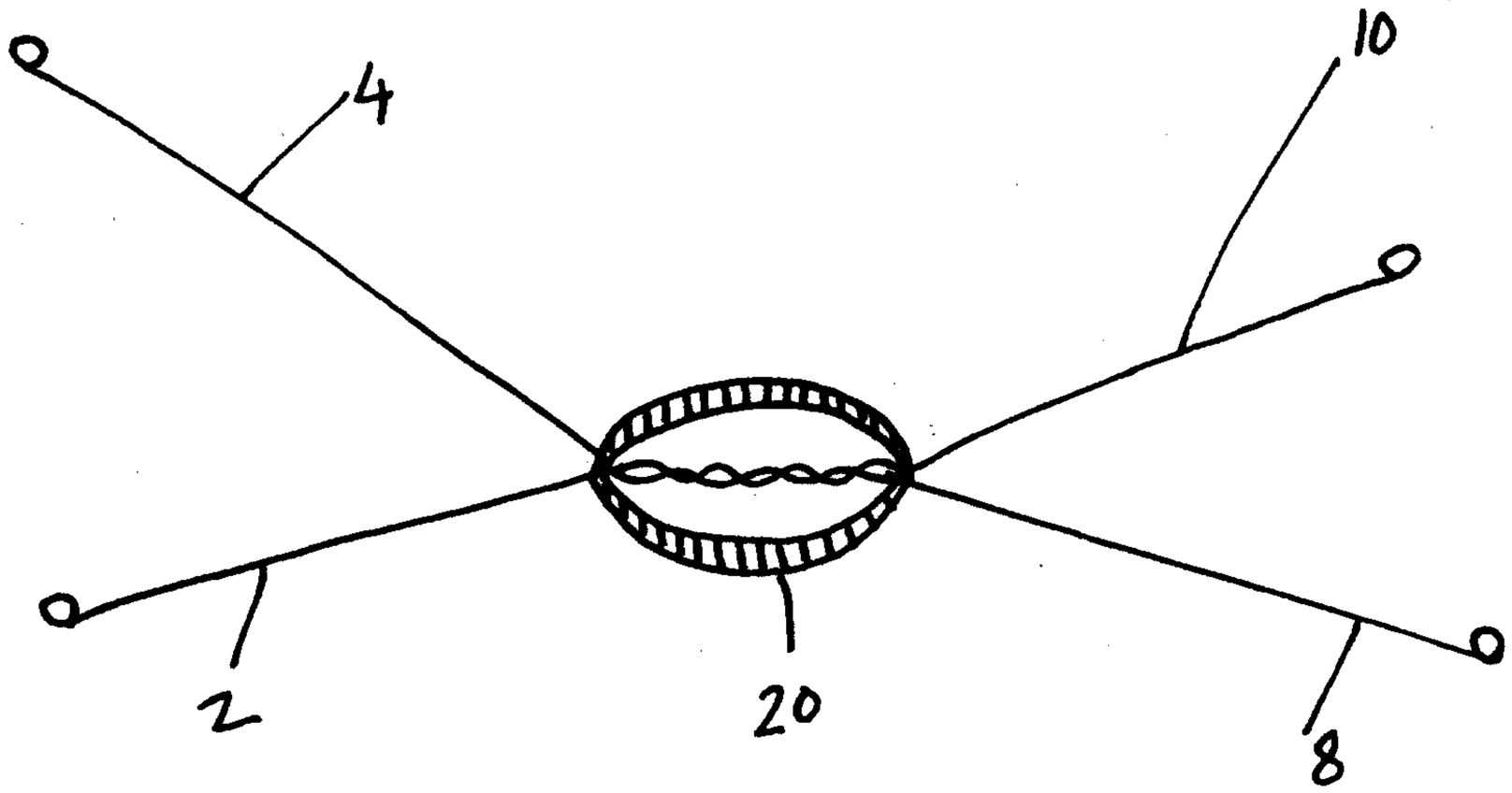

FIG 3