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(54) Flexible electrical conductor, in particular for the rotating electrolytic machines used in electroplating processes

(57) Flexible electrical conductor, in particular for the rotating electrolytic machines used in electroplating processes, composed of a conductive metal head that is immersed in the electrolytic bath solution; a conducting wire or cable that carries current between a generator and the head, and which therefore carries current between the generator and the electrolytic bath solution; a tubular cable-connector element associated with the head, to which the conducting wire or cable is connected and secured, and in particular a cable-clamp bushing; an insulating sheath that covers the conducting wire or cable; and a single-piece head, a flexible inner cable and an outer insulating sheath.

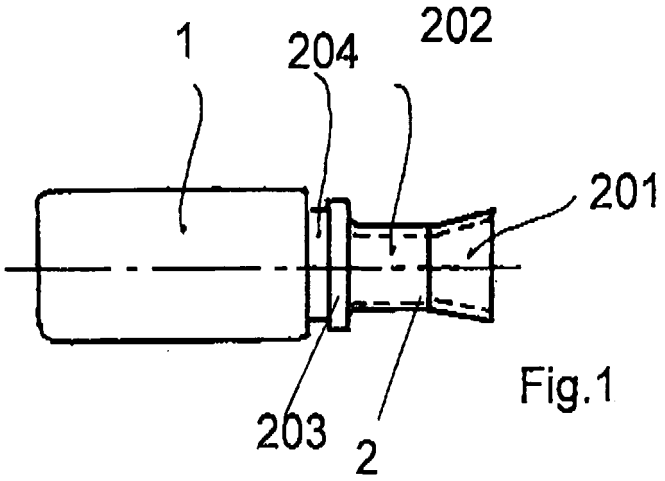

Fig.1

EP 2 065 977 A2

Description

[0001] The invention concerns the flexible electrical conductors having the characteristic features described in claim 1.

[0002] In a known arrangement such conductors are in fact used to carry current between the generator and the rotating baskets used for electrolytically plating metal or non-metallic objects with thin coatings of nickel, chrome, gold, etc.

[0003] There exist various types of conductors used for this purpose, essentially consisting of a flexible metal cord of stranded copper or other conducting material, terminating in a solid metal head intended for immersion in the electrolytic bath, and sheathed in a flexible insulating material such as rubber or PVC. The solid metal head is the only part that comes into contact with the electrolytic solution, while the rest of the conducting cable is kept electrically isolated by the outer sheath.

[0004] There is also a known method used for plating small metallic parts with a thin protective coating for preventing corrosion or as an aesthetic embellishment. This industrial process, known as electroplating, is carried out using a specific apparatus, essentially made up of:

- A direct current generator which supplies the circuit.
- Tanks containing the electrolytic solution in which the parts to be plated are immersed.
- Rotating baskets for holding small parts and components not suitable for direct immersion in the tanks.

[0005] The rotating baskets, containing the small parts to be plated, are immersed in the electrolytic bath, and sustained at either end by supports with perforated bushings which the direct current conductors pass through.

[0006] It is clear that in such an arrangement the terminating heads of the conductors, retained by the rotating basket containing the parts, will be dragged along with the rotation of the basket. As a result, the conducting cables will be subject to repeated flexion / torsion, for the entire duration of the treatment.

[0007] There exist various different conductors for electroplating on the market, which can be classified under two main types:

a) Conductors in which the solid metal head, made of brass, is fixed by pressure crimping directly onto a section of commercial cable, already provided with a protective rubber sheath.

b) Conductors in which the solid metal head is welded at one end to a tubular connecting element, inside which a stripped copper cable is secured by mechanical pressing. The conductor thus assembled is then covered with an insulating sheath that leaves only the head exposed.

[0008] The principal drawbacks of the above two solutions are: for type A, the short lifetime of the conductor, with the head tending to come off due to corrosion of the inner cable by the electrolytic solution which penetrates between the head and the protective sheath, at the point of the crimped connection; for type B, higher manufacturing cost due to the numerous process steps and greater number of parts required for assembly, as well as the imperfect electrical continuity of the welded join between the head and the tubular connecting element.

[0009] The purpose of this invention is to produce a conductor free of the above drawbacks, that is easy to construct, and which has a lower cost.

[0010] The above aims are achieved with a flexible cable composed of:

- A conductive metal head for immersion in the electrolytic bath solution.
- A conducting wire or cable that carries current between a generator and the above head, and thus carries current from the generator to the electrolytic bath solution.
- A tubular cable-connector element associated with the above head, used to connect and fix the conducting wire or cable, or more specifically a cable-clamp bushing.
- An insulating sheath covering the conducting wire or cable, in which the join between the conducting cable and the head is obtained by mechanical pressing of the cable inside a tubular connector that is an integral part of the solid head.

[0011] More specifically, the tubular connector for joining the cable and head is obtained through mechanical working of the same drawn part used for making the head.

[0012] The invention also concerns a method for producing a metal head incorporating an integral tubular element for connecting the conducting wire or cable. In particular, the tubular element for securing the cable to the head is obtained by automatic machining of a bar, preferably of brass, stainless steel, or drawn iron, of commercial grade and moderate cost. With the method described in this invention, once the metal head has been mechanically worked it is fully finished and ready for coupling with the conducting cable.

[0013] This thus eliminates separate working of the tubular element used to connect the cable to the head, and the operations for welding the head to the tubular element.

[0014] Additional advantages of constructing the head by this monolithic method, as compared with welding together two separate pieces, are improved electrical conductivity of the single-piece part, and superior resistance to mechanical stress and galvanic corrosion.

[0015] The invention offers additional improvements, which are described in the dependent claims.

[0016] These and other advantages are more clearly illustrated in the detailed description that follows and in the attached drawings, which give a schematic example of the construction of the flexible electrical conductor that

is the subject-matter of this invention.

[0017] With reference to the drawing:

Fig. 1 Illustrates the monolithic head incorporating a tubular element for connecting the conducting cable.
Fig. 2 Illustrates the flexible electrical conductor obtained by combining the above head with a conducting cable.

With reference to fig. 1, the flexible electrical conductor for rotating electrolytic machines used in electroplating processes consists of a conductive metal head 1 that is immersed in the electrolytic bath solution, connected to a conducting cable or wire 4 that carries current between a generator and the aforesaid head 1, and hence that carries current between the generator and the electrolytic bath solution in which the parts are immersed for coating with nickel, gold or similar the like, that is to say for undergoing an electroplating process.

[0018] The connection between the conducting cable 4 and the head 1 is achieved by means of a tubular element 2 connecting the cable 4 associated with said head 1, inside which cable 4 can be secured by mechanical pressing to permit the passage of a current from the generator to the metal head 1.

[0019] As illustrated in figure 1, the head 1 and the tubular connector 2 are monolithically worked from a single drawn bar, that is to say that tubular element 2 and the metal head 1 form a single piece.

[0020] Head 1, which in a preferred embodiment is a solid metal head of cylindrical shape, provides the point of contact between the electrical current and the electrolytic solution in which the flexible electrical conductors are immersed, while the remainder of conducting cable 4, composed of a bundle of copper strands or similar conducting material, is kept electrically isolated from the solution by an insulating sheath 5 which covers the entire length of the conducting wire or cable 4.

[0021] As illustrated in the figures, the tubular connector 2, or cable-clamp bushing, has a flared or tapered portion 201 that facilitates insertion of the conducting cable inside connector 2: the flared portion 201 is in fact outwardly tapered toward the end where cable 4 is inserted into connector 2.

[0022] Cable 4 is inserted through the flared portion 201 into tubular connector 2, and there secured along a central cylindrical portion 202 by crimping to connector 2 and hence to head 1. Crimping is achieved by pressing at least part of the length of the outer walls of cylindrical portion 202, thereby securely gripping the cable inside connector 2 along a ring-shaped perimeter, so as to permit the passage of current from cable 4 to the metal head 1.

[0023] The wall thickness of tubular connector 2, and in particular the wall thickness of its cylindrical clamping portion 202, is therefore such as to allow the walls of portion 202 to be pressed so that they at least partially grip the conducting cable 4.

[0024] Given the need to isolate cable 4 from the electrolytic solution in which it is immersed, in such a way that its only conducting part is the head 1, adhesion of the insulating sheath 5 to the head is facilitated by providing the tubular connector 2 with at least one ring flange 203 near the end associated with head 1.

[0025] In a preferred embodiment, the tubular connector 2 is provided with an indentation or groove 204, situated between the metal head 1 and the flange 203 described above, able to elastically engage an inner terminating flange 501 on the end of insulating sheath 5, in such a way as to form a tight seal between the insulating sheath 5 and the connector 2.

[0026] As illustrated in figure 1, the flexible conductor has a solid metal head 1 of cylindrical or similar shape, that monolithically integrates a tubular cable-connector 2: the conducting cable 4 is inserted inside said connector 2 through the flared end portion 201 of connector 2. Cable 4 is pushed along inside connector 2 so that part of the cable goes inside the cylindrical portion 202 of connector 2. This makes it possible to create an electrical connection between the cable 4 and the head 1 by pressing the walls of cylindrical portion 202 on the cable 4 contained inside.

[0027] Electrical isolation of cable 4 is accomplished by an outer sheath 5 made from a flexible insulating plastic material, that is pulled over cable 4 and brought up against head 1.

[0028] Figure 2 illustrates a preferred embodiment in which the outer diameter of sheath 5 is identical to the diameter of head 1, and in which the outer diameter of tubular connector 2, and in particular the diameter of flange 203, is less than or equal to the diameter of the metal head 1, in order to avoid any discontinuities or gaps between head 1 and sheath 5 that might allow the electrolytic solution to penetrate and so corrode the cable 4 inside.

[0029] The sheath 5 is thus pulled up over the flared portion 201, and then over the cylindrical portion 202 that lies between the flared portion 201 and a radial ring flange 203.

[0030] As illustrated in the figures, the flared portion 201 is smooth, but it is also possible for at least part of its outer surface to be provided with threads or similar elements to facilitate insertion of the insulating sheath 5 on connector 2.

[0031] After being pushed over the cylindrical portion 202, the sheath is forced over the flange 203 in such a way that the inner radial flange 501 on the end of sheath 5 engages with the groove 204, situated on connector 2 between the head 1 and ring flange 203, to create an additional elastically tight seal between head 1 and sheath 5.

[0032] As illustrated in the figures, to facilitate positioning of the insulating sheath 5, the outer diameter of the tubular connector 2, and in particular the diameter of its flared end portion, is smaller than the inside diameter of the insulating sheath 5 of the conducting cable or wire 4.

[0033] It is possible for connector 2 to be provided with more than one radial ring flange 203, and hence with more than one groove 204, so as to elastically engage more than one inner flange 501 of sheath 5 in the corresponding grooves 204, for improved protection against penetration of the solution between the sheath 5 and the head 1, and hence against corrosion of the inner cable 4.

[0034] To facilitate insertion of the cable 4 inside the tubular connector 2 associated with head 1, it is possible for connector 2 to have an inside diameter slightly larger than the diameter of conducting cable 4.

[0035] The present invention also concerns a method for producing a flexible electrical conductor composed of a metal head 1 and a conducting cable or wire 4, in which the cable 4 is fixed to a tubular connector 2 associated with the head 1, and where the tubular connector 2 is mechanically worked from the same piece of drawn material used for obtaining the head 1.

[0036] In particular, the head 1 and the tubular connector 2 are obtained by automatic machining of a bar, preferably of brass, stainless steel or drawn iron.

[0037] After obtaining the head 1 with integral connector 2, the conducting cable 4 is pushed inside connector 2 and at least partly along the length of connector 2, and secured by pressing or crimping at a point coinciding with the cylindrical portion 202 of said connector 2, so as to allow an electrical current to pass between a generator and head 1, through cable 4.

[0038] To complete the flexible electrical conductor, the conducting cable 4 is electrically insulated by inserting said cable 4 and at least a part of the tubular connector 2 inside an insulating sheath 5, to create a tight seal between at least one inner terminating flange 501 of sheath 5 and the corresponding groove 204 on tubular connector 2. In a preferred embodiment, the sheath 5 is positioned up against the cylindrical head 1.

[0039] The subject-matter of this invention, illustrated and described schematically and through examples, is also understood to embrace those accessory variants of materials and forms that, as such, fall within the scope of the following claims.

Claims

1. Flexible electrical conductor, in particular for the rotating electrolytic machines used in electroplating processes, composed of:

- A conductive metal head (1) that is immersed in the electrolytic bath solution.
- A conducting wire or cable (4) that carries current between a generator and the head (1), and which therefore carries current between the generator and the electrolytic bath solution.
- A tubular cable-connector element (2) associated with the head (1), to which the conducting wire or cable (4) is connected and secured, and in particular a cable-clamp bushing.
- An insulating sheath (5) that covers the conducting wire or cable (4),

characterised in that the tubular connector (2) is of a single piece with the metal head (1).

2. Flexible electrical conductor according to claim 1, **characterised in that** the connector element (2) is hollow and has a flared end portion (201) through which the conducting cable is inserted into said connector (2).

3. Flexible electrical conductor according to claim 1 or 2, **characterised in that** the connector (2) has at least one angle ring flange (203) situated near the end associated with head (1).

4. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the connector (2) has a cylindrical portion (202) for securing cable (4) inside the connector (2), situated between the flared portion (201) and at least one flange (203).

5. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the tubular connector (2) has an inside diameter slightly greater than that of the conducting cable (4).

6. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the wall thickness of connector (2), and in particular the wall thickness of its cylindrical clamping portion (202), is such as to allow the walls of said portion (202) to be crimped onto the conducting cable (4).

7. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the outside diameter of said tubular connector, and in particular the diameter of its flared end portion, is less than the inside diameter of the insulating sheath (5) which covers the conducting wire or cable (4).

8. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the flared end portion has a smooth outer surface.

9. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** at least part of the outer surface of the flared end portion (201) is provided with threads or similar elements to facilitate insertion of the insulating sheath (5) on the connector (2).

10. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the connector (2) has an indentation or groove (204),

situated between the metal head (1) and the flange (203) and/or between two such adjacent flanges, that elastically engages one end of the insulating sheath (5) covering the conducting wire or cable (4).

11. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the insulating sheath (5) is made from a flexible insulating material.

12. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** said insulating sheath (5) has, at one of its ends, at least one inner terminating flange (501) that elastically engages at least one indentation or groove (204) on the connector (2), so as to form a tight seal between the insulating sheath (5) and the connector (2).

13. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** said insulating sheath (5) is inserted up against the metal head (1).

14. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the outside diameter of the sheath (5) is identical to the diameter of head (1).

15. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** the outer diameter of the connector (2), and in particular the diameter of flange (203), is less than or equal to the diameter of the metal head (1).

16. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** a conducting cable or wire (4) for carrying current is secured inside the connector (2), and specifically in its cylindrical clamping portion (202) by means of mechanical pressing.

17. Flexible electrical conductor according to one or more of the preceding claims, **characterised in that** it has a single ring flange (203) near the metal head (1) and a groove (204) between the flange (203) and the head (1), in such a way as to permit a tight seal between the inner flange (501) of insulating sheath (5) and the groove (204), and insertion of the sheath (5) up against the head (1).

18. Method for obtaining a flexible electrical conductor composed of a metal head (1) and a conducting wire or cable (4), according to one or more of the preceding claims 1 to 17, **characterised in that** the cable (4) is fixed to a tubular connector (2) associated with the head (1), and that the connector (2) is mechanically worked from the same piece of drawn material from which the head (1) is obtained.

19. Method according to claim 18 **characterised in that** head (1) and the tubular connector (2) are obtained by automatic machining of a bar, preferably of brass, stainless steel or drawn iron.

20. Method according to claims 18, 19 **characterised in that** the conducting wire (4) is inserted at least partially along the length of connector (2), and in particular so as to reach the cylindrical portion (202) of said connector (2).

21. Method according to one or more of the preceding claims 18 to 20 **characterised in that** the cable (4) is crimped inside said connector (2) at a point coinciding with at least part of the cylindrical portion (202), in such a way as to permit passage of current from a generator to head (1) through the cable (4).

22. Method according to one or more of the preceding claims 18 to 20 **characterised in that** the conducting cable (4) is electrically insulated by inserting the cable (4) and at least part of the tubular connector (2) inside an outer insulating sheath (5).

23. Method according to one or more of the preceding claims 18 to 22 **characterised in that** the insulating sheath (5) is fitted over the tubular connector (2) in such a way as to create an elastically tight seal between at least one inner terminating flange (501) on sheath (5) and the corresponding groove (204) on tubular connector(2).

24. Method according to one or more of the preceding claims 18 to 23 **characterised in that** the insulating sheath (5) is pushed up against the head (1).

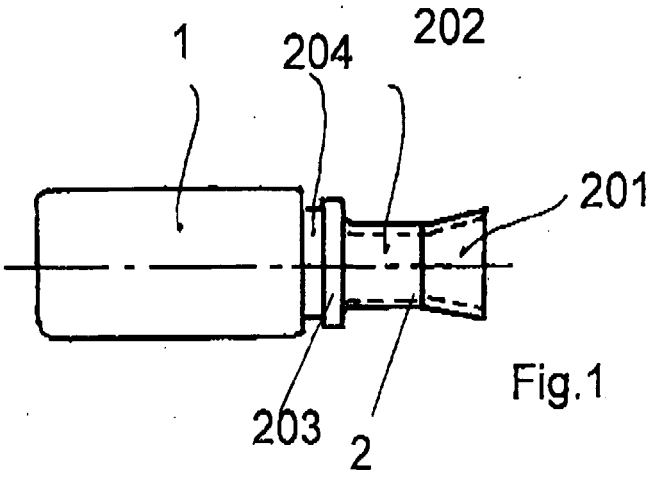

Fig.1

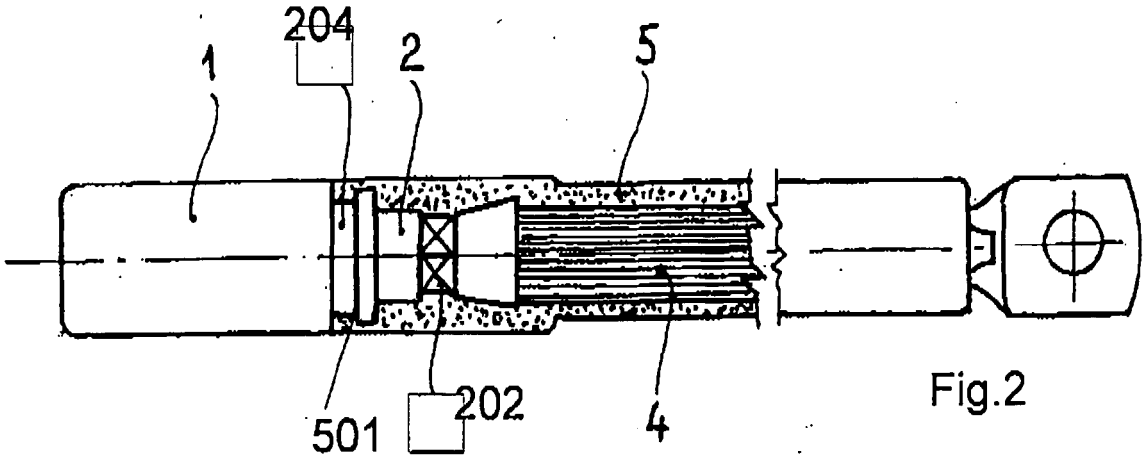

Fig.2