ABSTRACT

An electrode system for use in conjunction with body implantable electro-medical devices is disclosed. The system includes a socket having first coupling means. The socket forms an electrical output terminal of the electro-medical device. A plug forms a part of the system and is disposed on the proximal end of an electrical conductor which also forms a part of the system. The plug comprises an electrical connector secured to the conductor and having second coupling means, and a compressible resilient means. The resilient means provides a locking biasing force between the first and second coupling means when the plug and socket are coupled.

4 Claims, 8 Drawing Figures
ELECTROMEDICAL STIMULATOR LEAD CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an electrode system. The invention will here be described in most detail in association with a catheter of the type utilized in connecting a body organ electric stimulator, such as a cardiac pacemaker, to a body organ since the electrode system according to the invention has been particularly developed for use with such cardiac pacemakers. The electrode system, however, may be used in conjunction with other electro-medical devices. It might perhaps be used in conjunction with an artificial heart pump system.

2. Description of the Prior Art

It may be explained that in the past decade body implantable cardiac pacemakers have been developed for artificially stimulating a heart which is beating improperly or which has stopped beating entirely. Essentially, this is accomplished by conducting current from an implanted cardiac pacemaker to the heart muscle by a suitable electrode system or catheter.

Various types of cardiac pacers as well as various types of catheters have been heretofore developed. The various designs of both the pacers and the catheters have in some respects simplified the surgical procedures required during the implantation of the pacers.

Typically, a catheter comprises an elongated tube of body compatible, nonconductive material which contains a helical coil of conductive material. An electrode tip is secured, as by welding, to the distal end of the helical coil and a connector of some type is provided on the proximal end of the catheter for electrically connecting the helical coil of the catheter with the cardiac pacemaker. A stylet is generally located in the lumen of the helical coil to provide additional stiffness during manipulation of the catheter.

One surgical procedure used for the implantation of a pacer includes advancing a catheter transvenously, such as through the jugular vein, until its distal end, i.e., the electrode tip, reaches the apex of the right ventricle of the patient's heart where it is impacted in the multiple trabeculae seen in this area, so that the electrode tip makes firm contact with the ventricular myocardium. Once the electrode tip has been properly positioned the stylet is withdrawn and the pacer is connected to the catheter by means of the connector provided on the proximal end of the catheter.

One form of a pacer-catheter connection that is presently used requires inserting of a catheter connector or contact provided on the proximal end of the catheter into a socket provided in the pacer; tightening a set screw provided on the pacer adjacent to the socket thereof to make electrical contact; tightening a sealing screw onto an "0" ring or "O" ring which sealing screw and "O" ring are also provided on the pacer; then sealing the screw heads with a sealing compound is required; and finally, the catheter tube must be sealed in a rubber boot cemented into the pacer by tying the boot with sutures. This type connector and these elaborate procedures are required, in part, to assure that the juncture of the catheter and pacer is sealed against the entrance of body fluids into the pacer which, if not prevented, would seriously affect the electronic circuitry of the pacer.

SUMMARY OF THE INVENTION

The present invention eliminates the loose hardware, i.e., screws, "O" rings, etc., and the required suturing for sealing of the juncture of the catheter and pacer while at the same time providing a sealed but releasable electrical and mechanical coupling at the juncture of the catheter and pacer.

Briefly, the present invention provides an electrode system for effecting the electrical connection between an electro-medical device, i.e., a pacer, and a patient. The electrode system includes an electrical conductor having proximal and distal ends. The distal end of the conductor is adapted for contact with a body organ of the patient. Socket means are provided which include pin means. The socket means is constructed and arranged to form an electrical output terminal of the electro-medical device. Finally, plug means are provided. The plug means is disposed on the proximal end of the electrical conductor and comprises an electrical connector and a compressible resilient means. The electrical connector is secured to the proximal end of the electrical conductor and has coupling means cooperating with the pin means of the socket means to effect a releasable electrical and mechanical coupling between the socket means and the plug means. The compressible resilient means partially extends over the electrical connector and has portions thereof engageable with cooperating portions of the electro-medical device. The compressible resilient means provides a locking biasing force between the coupling means of the electrical connector and the pin means of the socket means when the plug means and the socket means are coupled.

Other features and advantages of the invention will appear in the ensuing description of the preferred embodiment when taken together with the accompanying drawings which form a part of this specification.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view partially in section and partially in elevation illustrating the electrode system in accordance with the invention in assembled relation with a pacer;

FIG. 2 is a side elevational view of the electrical connector in accordance with the invention;

FIG. 3 is a view taken along the line III—III of FIG. 2;

FIG. 4 is a longitudinal sectional view of the electrical connector of FIG. 2;

FIG. 5 is a top elevational view of the socket in accordance with the invention;

FIG. 6 is a longitudinal sectional view of the socket of FIG. 5;

FIG. 7 is a view taken along the lines VII—VII of FIG. 6; and

FIG. 8 is an enlargement of a portion of FIG. 1 in the vicinity of the socket and plug means in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein like reference numerals refer to like parts throughout the several views, the electrical connector in accordance with the invention is shown generally at 10. The connector 10 is preferably fabricated from stainless steel such as 316 stainless steel. The connector 10 is provided with a gen-
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erally cylindrical outer surface 12 and an axial passage 14. The right end of the connector 10, as viewed in FIG. 2, is provided with an enlarged generally hexagonal surface 16 which projects radially outwardly from the surface 12. The left end of the connector, as viewed in FIG. 2, is provided with a coupling means in the form of oppositely disposed axial aligning grooves 18 and 20 and radial locking grooves 22 and 24 which are all provided in the outer surface 12 of the connector 10. The locking grooves 22 and 24 extend circumferentially in the same direction. Disposed within the axial passage 14 is a generally tubular member 26 which is secured therein as by soldering.

The socket means in accordance with the invention is shown generally at 30 in FIGS. 5-7. The socket 30 is also preferably fabricated from stainless steel such as 316 stainless steel. The socket 30 is provided with a generally hexagonal outer surface 32 and a cylindrical cavity 34. The outer surface 32 has a pair of openings 36 and 38 provided therein and press fitted within each opening is a coupling means or pin member 40 each of which extends into the cavity 34. A tapped hole 42 is also provided in the socket 30 into which a screw (not shown) may be screwed. The screw and tapped hole 42 serve as a means of making an electrical connection to the socket 30.

Reference to FIGS. 1 and 8, there is illustrated the electrode system, in accordance with the invention, in assembled relation with an electro-medical device, i.e., a pacemaker. A catheter is shown generally at 44. The catheter 44 preferably comprises an electrical conductor 46 having proximal and distal ends, 48 and 50 respectively. The electrical conductor 46 may be fabricated of any suitable electrically conductive material but is preferably fabricated of Eligloy and, if preferably constructed in the form of a helix. The distal end 50 of the conductor 46 is provided with an electrode tip 52 which may be suitably secured to the distal end by conventional means. The electrode tip 52 is that portion of the catheter via which electrical impulses are applied to a body organ, i.e., the heart in the case of a pacemaker, as is the portion of the pacemaker which is in electrical contact with the patient. The remaining portions of the electrical conductor 46 are insulated from contact with the patient. To this end, the conductor 46 is coated with an insulating sheath 54 which coats substantially the entire length of the conductor 46 with the exception of exposed electrode tip 52 and the proximal end 48 which is disposed within the tube 26 of connector 10. The insulating sheath 54 is enlarged at the left end, as viewed in FIG. 8 and partially extends over the electrical connector 10 terminating short of the left end of the connector 10 in a frusto-conical surface 56. As will be more apparent hereinafter, the enlarged end of the catheter together with the connector 10 forms a plug means 55 by which a connection between the pacemaker and the conductor 46 is made. The sheath 54, while characterized as a coating, may be formed on the conductor 46 and connector 10 in any suitable manner, as for example, it may be molded onto these parts in a one step operation or in multiple molding operations. The sheath 54 is preferably comprised of a compressible resilient material, i.e., polysiloxane such as silicon rubber.

The socket 30 is molded into the encapsulation material 58 which encapsulates the pacemaker electronic circuitry and the batteries thereof (not shown), and forms an electrical output terminal for the pacemaker. The electrical connection is made between the pacemaker circuitry and the socket 30 by means described, prior to the encapsulation of the pacemaker circuitry.

As will be evident from the description, the pacemaker may be entirely encapsulated with a suitable body implantable material with the exception of the cavity 34 which is left exposed for later insertion of the connector 10. Accordingly, upon subsequent implantation of the pacemaker, there will be a minimum opportunity for body fluids to enter into the pacemaker via any screw holes or openings that would otherwise be required in the absence of the present invention.

The plug 55 and the socket 30 are simply and quickly brought in operative engagement by inserting the connector 10 of the plug 55 into the cavity 34 with the axial grooves 18 and 20 of the connector 10 being aligned with the pins 40. The plug 55 is forced into the cavity until the radial grooves 22 and 24 are in alignment with the pins 40 which will occur automatically when the extreme left end 60 of the connector abuts the back wall 62 of the cavity 34. This action of course, will impose a compressive force on the enlarged portion of the catheter, i.e., the plug 55, due to the frusto-conical portion of the plug being engaged with the mating and cooperating portions of the pacemaker in the vicinity of the socket 30. When the radial grooves are aligned with the pins 40, the plug is partially rotated so that the pins 40 are located opposite the regressed portions 64 and 65 of the grooves 22 and 24. Again, this will automatically occur when the plug is rotated and the pins 40 abut the side walls of the radial grooves. The force being used to insert the plug 55 is then relaxed, and the pins will enter the regressed portions 64 and 65 of the radial grooves 22 and 24. The plug 55, or more specifically, the compressible resilient portion thereof, will then provide a locking biasing force between the side walls of the regressed portions of the radially grooves of the connector 10 and the pins 40.

To separate the plug 55 from the socket 30 requires that the plug 55 be depressed into the socket and a reverse rotation that effected from that utilized in joining of the plug and socket. The required dual combined motion, i.e., axial insertion of the plug into the socket and the rotation thereof to effect a mechanical coupling, prevents inadvertent disconnection. Further, at the time of joining of the plug and socket together, if the socket and plug are not properly joined, when pressure is released during assembly, the plug and socket will immediately separate. Accordingly, if they do not separate, the surgeon can be assured that there is in fact a mechanical coupling between the plug and socket.

Having thus described my invention, I claim:

1. An electrical connector assembly for providing an electrical connection between an electromedical device and an electrical conductor, the electrical conductor having proximal and distal ends with the distal end of the conductor being adapted for contact with a body organ of a patient, the electrical connector assembly comprising:
   a. socket means constructed and arranged to form an electrical output terminal of the electromedical device, the socket means having a cylindrical cavity and pair of spaced, oppositely disposed pin means extending into the cavity; and
   b. plug means, the plug means comprising
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i. an electrical connector secured to the proximal end of the conductor, the electrical connector being cylindrical and having coupling means co-operative with each of the pin means of the socket means to effect a electrical and positive locking coupling between the socket means and the plug means, the coupling means of the electrical connector comprising a pair of oppositely disposed radial grooves all located in the cylindrical outer surface of the connector, the radial grooves extending circumferentially in the same direction and each having a regressed portion into which a pin means of the socket means is disposed when the plug means and the socket means are coupled; and

ii. compressible resilient means partially extending over the electrical connector and having portions thereof engageable with cooperating portions of the electromedical device for providing a locking biasing force between the socket means and the electrical connector when the plug means and the socket means are coupled.

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2. An electrical connector assembly as defined in claim 1 wherein the electrical connector has an axial passage therethrough and includes a tubular member disposed within the axial passage, the proximal end of the conductor being located within the tubular member and secured thereto.

3. In apparatus so defined in claim 1 wherein the compressible resilient means comprises a body compatible material.

4. In apparatus as defined in claim 3 wherein the compressible resilient means comprises silicon rubber.