

[54] **SINGLE CATHETER FOR ATRIAL AND VENTRICULAR STIMULATION**

[75] Inventor: **Barough V. Berkovits**, Newton Highlands, Mass.

[73] Assignee: **American Optical Corporation**, Southbridge, Mass.

[22] Filed: **Dec. 14, 1972**

[21] Appl. No.: **315,252**

[52] U.S. Cl. **128/404, 128/419 P**

[51] Int. Cl. **A61n 1/34**

[58] Field of Search **128/404, 418, 419 D, 419 P, 128/419 R**

[56] **References Cited**

UNITED STATES PATENTS

3,253,595	5/1966	Murphy, Jr. et al.	128/419 P
3,478,746	11/1969	Greatbatch	128/419 P
3,595,242	7/1971	Berkovits	128/419 P

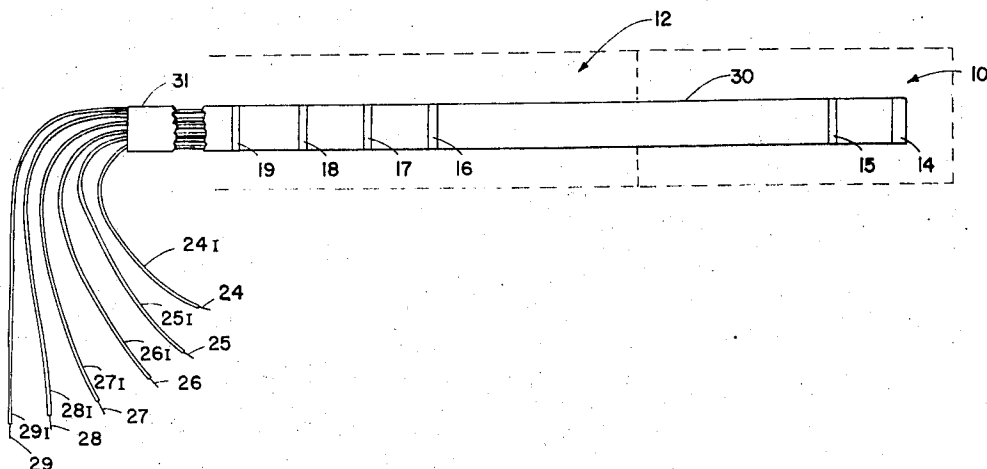
3,718,142 2/1973 Mulier 128/419 P

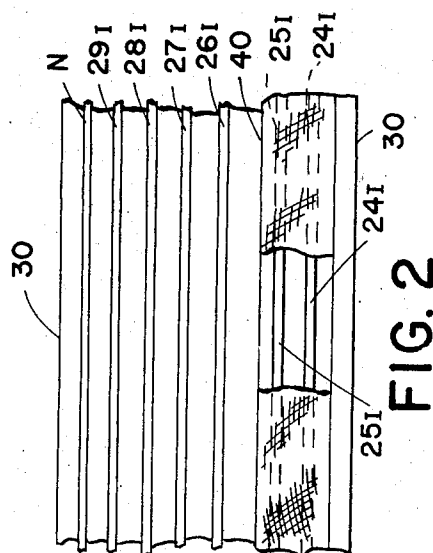
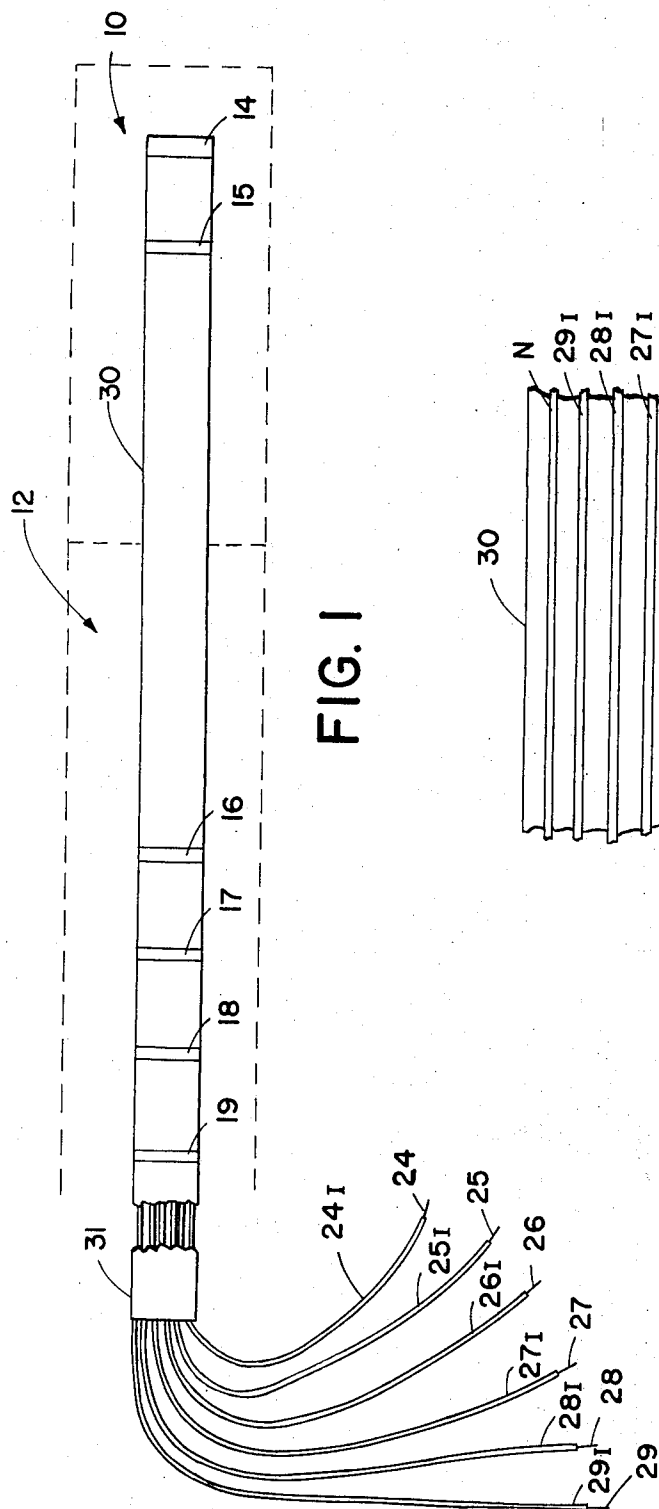
Primary Examiner—William E. Kamm
Attorney, Agent, or Firm—Joel Wall; William C. Nealon

[57] **ABSTRACT**

A single catheter for atrial and ventricular stimulation. A single catheter is disclosed that provides separate electrical stimulation to the atrium and separate electrical stimulation to the ventricle on mutually insulated conductors. All conductors are encapsulated in the single catheter and electrical interference between the atrial and ventricular conductors is eliminated through the use of electro-static shielding. The catheter provides two or more mutually insulated electrical conductors for stimulating the atrium. The best electrical contact made between the atrial conductors and the atrium may be measured and selected for use.

3 Claims, 2 Drawing Figures





SINGLE CATHETER FOR ATRIAL AND VENTRICULAR STIMULATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to electro-medical equipment and in particular relates to heart stimulation devices. More particularly, it relates to the conduction of electrical stimulation from a heart stimulating device to the atrial and ventricular chambers of the heart.

Description of Prior Art

In the electro-medical field, therapeutic heart stimulating devices are well known. Some of these devices are heart pacers which provide stimulation to the heart in order to cause the heart to beat. Some pacers provide stimulation only to a ventricle but another type of pacer provides sequential stimulation to both atrium and to ventricle to cause the heart to beat in a more efficient manner. This latter type of pacer is disclosed in U.S. Pat. No. 3,595,242 entitled "Atrial and Ventricular Demand Pacer" which has issued in the name of the inventor of the instant invention. Background material disclosed in this patent is incorporated herein by reference.

A problem associated with this type of improved heart pacing is that electrical contact made between the atrium wall and the electrode may be difficult to maintain. This is due to the nature of the atrial chamber's shape and motion. A solution to this problem is presented in a co-pending application Ser. No. 101,836 filed on Dec. 28, 1970 and which has since matured into U.S. Pat. No. 3,729,008 and entitled Electrode for Atrial Pacing with Curved End for Atrial Wall Engagement, wherein a hook-type electrode for gripping the atrium wall is disclosed. This type of electrode solves the atrial wall-electrode contact problem. However, use of this "hook" catheter for atrial stimulation necessitates a separate catheter for stimulation of the ventricle. Thus, two catheters are used which require additional surgical procedures. The instant invention solves both the electrical contact problem and the dual catheter problem. The present invention provides a single catheter which contains electrodes that separately stimulate both the atrium and the ventricle and simultaneously provide good contact the the atrium through electrode selection.

SUMMARY OF THE INVENTION

A single catheter contains a plurality of mutually insulated electrical conductors which are electrically connected within the catheter to conductive rings. The rings extend through the surface of the catheter and are exposed to the heart chamber walls. They are spaced from each other to provide proper stimulation to atrium and ventricle. The catheter is designed to be inserted into the ventricle by way of the atrium and a blood vessel leading to the atrium. Two exposed rings nearest one end of the catheter are separated by approximately 6 centimeters from the next ring. These first two rings are used for stimulation of the ventricle. The 6 centimeter distance provides a separation so that the other exposed rings lie only within the atrium. There are at least three rings which lie within the atrium, but there may be as many rings as is conceivably practical. The distance between the two ventricu-

lar rings is selected for optimum performance as are the distances among the atrial rings.

Some of the atrial rings will make better contact with the atrium than others. These contacts are determined by testing different pairs of conductors after insertion of the catheter into the heart but prior to permanent connection to the heart stimulator. Thus, two of the atrial rings or terminals are selected for providing the stimulation, but more than two may be selected if it is felt that parallel paths of conductors in a particular case will provide a more reliable and efficient electrical contact.

The construction of the catheter utilizes an electrostatic shield around the ventricular electrodes thereby electromagnetically separating atrial stimulation from ventricular stimulation. In a particular embodiment, the shield may be utilized as one of the conductors for ventricular stimulation.

It is an advantage of this invention to provide atrial and ventricular stimulation of the kind that may be utilized by a demand atrial and ventricular heart pacer where there is no need for separate atrial and ventricular catheters thereby reducing surgical problems involved.

It is thus an object of this invention to provide improved heart stimulation equipment.

It is yet another object of this invention to provide improved atrial and ventricular demand heart pacing.

It is still another object of this invention to provide atrial and ventricular stimulation utilizing a single catheter allowing a single insertion into the heart and a simplified surgical procedure.

Other objects and advantages of the present invention will become apparent to one having reasonable skill in the art after referring to the detailed description of the appended drawings wherein:

FIG. 1 is a schematic representation of an illustrative embodiment of the present invention; and

FIG. 2 is a more detailed schematic representation of part of the illustrative embodiment depicted in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, enclosure 10 is intended to schematically represent the ventricle of a heart and enclosure 12 is intended to schematically represent the atrium of the heart. Single catheter 30 is depicted as being inserted into ventricle 10 via atrium 12. Conductive rings 14 and 15 make electrical contact with the inside of the ventricle chamber, and conductive rings 16, 17, 18 and 19 are conductively connected to the inside wall of the atrium chamber. Typical distances between rings 16, 17, 18 and 19 may be on the order of 1 centimeter respectively as may be the distance between rings 14 and 15. The distance between rings 15 and 16 is on the order of 6 centimeters. However, all these ring locations can be varied with respect to each other; the distances therebetween are not necessarily critical. However, the constraint of rings 14 and 15 lying in the ventricle and rings 16-19 lying in the atrium must be satisfied.

Terminal 24 is conductively connected to ring 14, terminal 25 is conductively connected to ring 15, terminal 26 is conductively connected to ring 16, terminal 27 is conductively connected to ring 17, terminal 28 is

conductively connected to ring 18, and terminal 29 is conductively connected to ring 19. The respective numbers with the subscript I is intended to represent the respective insulated conductors. For example, insulated conductor 24I is associated with terminal 24.

Catheter portion 30 is illustrated as being broken away from catheter portion 31. However, these portions are part of the same catheter and are illustrated as such for the purpose of indicating relative distance. For example, the distance between catheter portion 30 and catheter portion 31 may be on the order of several feet.

Referring to FIG. 2, one observes the insulated conductors depicted in FIG. 1. Insulated conductor N is intended to mean that the number of insulated conductors contained within a catheter are to be limited only by physical space available and there is no special total number of catheters that can be used. Electro-static shield 40 is depicted as encompassing insulated conductors 24I and 25I which provide ventricular stimulation. Electro-static shield 40 effectively prevents interference from the stimulation provided on the ventricular conductors from being picked up by the atrial conductors and vice versa. In an alternative embodiment, one of the ventricular conductors can be comprised of shield 40 itself. Typically, but not necessarily, shield 40 is braided.

In a particular embodiment, the conductive rings 14-19 may be made from a platinum compound and the respective conductors contained within catheter 30 are welded to the inner portion of the conductive rings. The catheter itself may be constructed of a typical high grade durameter rubber which is normally used in surgical implantations. The conductors themselves in a particular embodiment may be ordinary conductive copper wire, but can also be constructed from coiled wire as well.

In operation, catheter 30 is inserted through a blood vessel and into atrium 12. It is then further urged into ventricle 10 so that catheter 30 comes to rest in the manner schematically depicted. Conductive rings 14 and 15 make electrical contact with ventricle 10, and conductive rings 16-19 make electrical contact with atrium 12. Although the catheter is depicted as linear, in reality it is a flexible tube and certain of the conductive rings will become located within the atrium 12 to provide better electrical contact than other of those rings. The best contacts are determinable from external measurements made on terminals 26-29 and at least two of the atrial rings are selected. More than two can be selected by utilizing two rings in parallel if this seems to be advisable. Otherwise, the unselected electrodes need not be used.

The optimum electrode combination for best atrial-ventricular stimulation is thus selectable after insertion of the catheter into the heart. Since the size of the heart tends to vary from person to person, it is desirable to select from the above-described electrode stimulation to provide best electrical contact. The availability of these different contact combinations permits the adapt-

ing of this electrode to the size of the particular heart in which it is implanted and provides optimum contact. It is thus seen that the need for separate catheters, one for insertion into the ventricle, and another for insertion into the atrium, are eliminated by use of this single catheter for atrial and ventricular stimulation.

The invention may be embodied in other specific forms without departing from the spirit or the essential characteristics thereof. It should be understood that the number of conductive rings utilized is limited only by physical size. It should be understood further that the distances between the atrial rings, the ventricular rings, and between the two groups, can be selected for optimum performance. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description. It should be further understood that no limitations are placed upon utilization of the invention with an implantable or external heart stimulating device. When utilized with an implantable device, after the conductive measurements are made, the selected conductors are utilized, the others are ignored by sealing them within the catheter. Of course, in the external configuration the unused conductors are merely ignored without any sealing necessary. Thus, all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A single catheter for use with a heart stimulator which generates electrical impulses for the purpose of separately stimulating the atrium and ventricle of said heart, said catheter comprising first means for conducting atrial stimulation from said stimulator to said atrium, said first means including a plurality of at least three insulated electrical conductors disposed internal to said single catheter and terminating at different locations along said catheter from which at least two said conductors are chosen to conduct said atrial stimulation, second means for conducting ventricular stimulation from said stimulator to said ventricle, and means for preventing electro-magnetic interference between said first and second stimulation application means.

2. A single catheter as recited in claim 1 and wherein said first means further includes a plurality of at least three regularly spaced conductive rings exposed to the surface of said catheter, each of said rings being conductively connected respectively to one of said plurality of at least three insulated electrical conductors.

3. A single catheter as recited in claim 2 and wherein said second means includes a plurality of at least two insulated electrical conductors disposed internal to said catheter and a plurality of at least two conductive rings exposed to the surface of said catheter where each of said plurality of at least two conductive rings is conductively connected respectively to one of said plurality of at least two insulated electrical conductors.

* * * * *