

[72] Inventor **James N. Karnegis**
5604 W. 65th St., Minneapolis, Minn.
55435
 [21] Appl. No. **762,017**
 [22] Filed **Sept. 24, 1968**
 [45] Patented **Mar. 9, 1971**

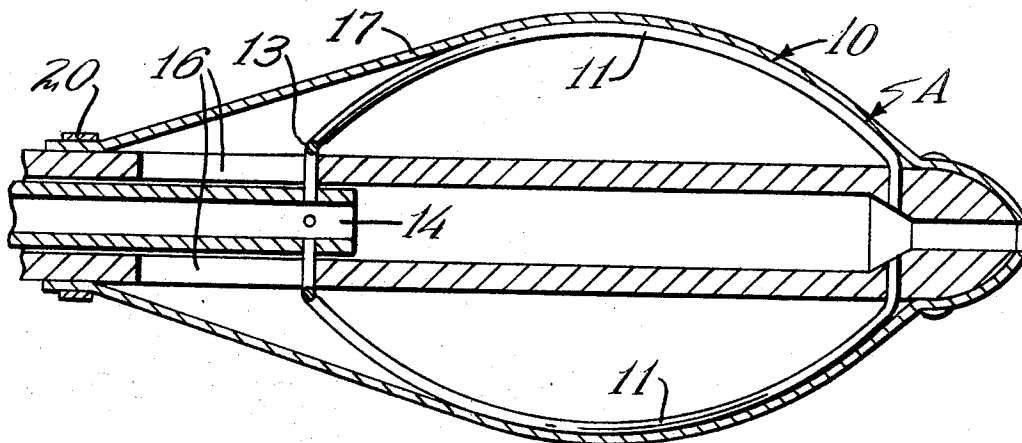
[56] **References Cited**
UNITED STATES PATENTS
 88,695 4/1869 Davidson..... 128/243
 1,621,159 3/1927 Evans..... 128/6
 2,586,553 2/1952 Moscarello..... 128/243
 3,266,487 8/1966 Watkins et al. 128/1

Primary Examiner—Richard A. Gaudet
Assistant Examiner—Ronald L. Frinks
Attorney—Robert M. Dunning

[54] **DISPOSABLE PERCUTANEOUS INTRACARDIAC PUMP AND METHOD OF PUMPING BLOOD**
5 Claims, 5 Drawing Figs.

[52] U.S. Cl..... **128/1,**
 128/243, 128/2, 128/2.05, 128/348
 [51] Int. Cl..... **A61b 19/00,**
 A61b 5/02
 [50] Field of Search..... 128/1,
 242—246, 348—351, 341—345, 328, 356, 303, 2,
 2.05 (D), 2.05 (E), 2.05 (V)

ABSTRACT: A heart pump is provided including a catheter and catheter tube having at its extremity a series of longitudinally extending ribs extending in angularly spaced relation about the catheter. The ribs are enclosed within a resilient tube which is expanded and contracted by said ribs to more or less fill the left ventricle of the heart. The ribs are flexed from a position generally parallel to the catheter axis to an outwardly bowed position by a flexible member extending into said catheter and through said catheter tube.



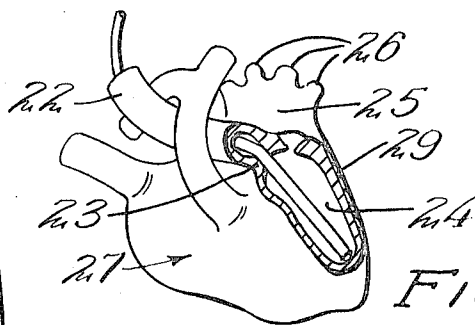
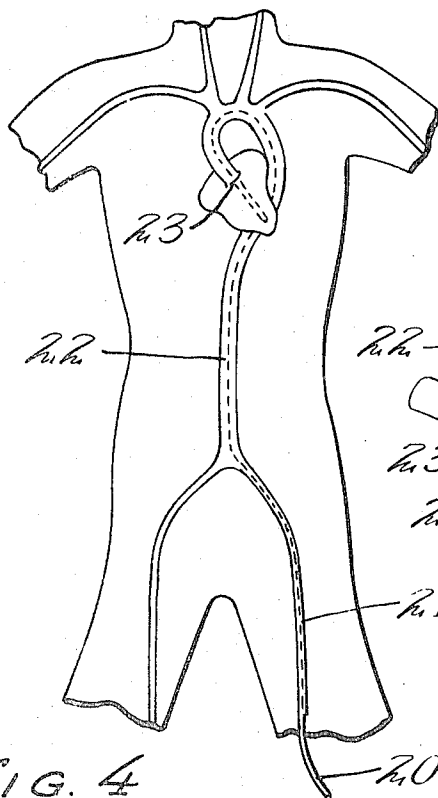
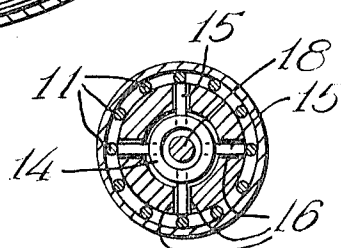
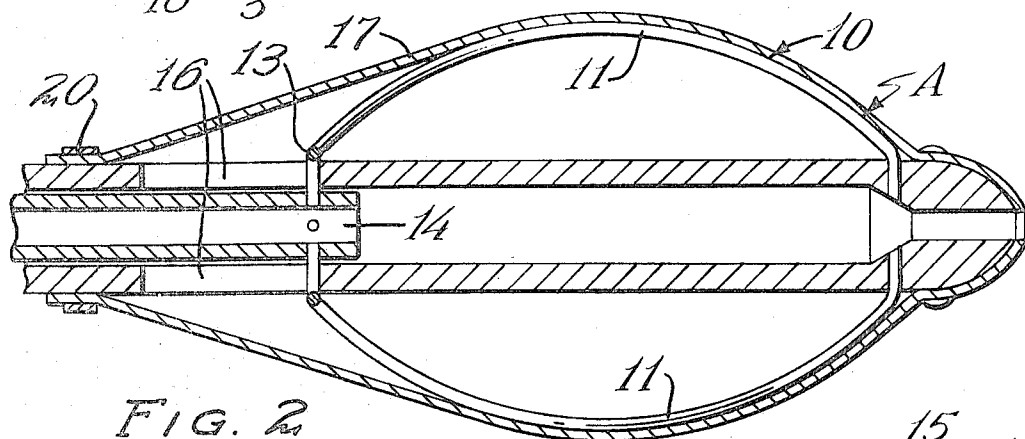
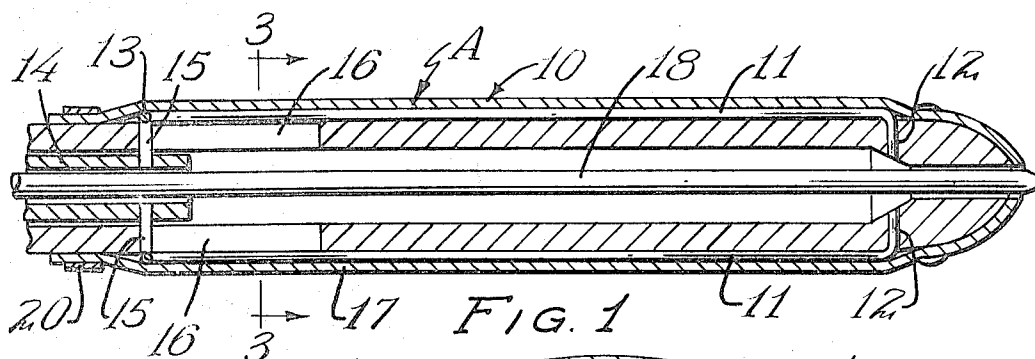


FIG. 3

FIG. 5

INVENTOR

JAMES N. KARNEGIS

BY

William Dunning

ATTORNEY

DISPOSABLE PERCUTANEOUS INTRACARDIAC PUMP AND METHOD OF PUMPING BLOOD

This invention relates to an improvement in disposable percutaneous intracardiac pump, and deals particularly with a means of expanding and contracting the left ventricle of the heart chamber to promote the flow of blood through the blood stream of the body.

The heart is a pump whose job is to circulate oxygenated blood to all parts of the body. There are times, as for example, when the patient suffers a myocardial infarction, that the heart is weakened to such a degree that it can no longer adequately pump blood to maintain life. Since this weakened state may at times by transient, tremendous effort has been, and is being, expended in the search for a method to temporarily mechanically support the heart.

A variety of methods have been attempted. Some previous devices have been used which in effect encircle the ventricle and by intermittently squeezing the heart, aid in expelling blood into circulation. Another method is to place sausage shaped balloons in the aorta, and by alternately inflating the balloon from the proximal to the distal end, create a "milking action" in the aorta which helps propel blood in a forward direction.

The object of the present invention lies in the provision of somewhat different device which does not require an operation of the opening of the chest. The only anesthesia needed would be a skin wheal of local anesthetic. The device could be involved with fluoroscopy even in the patient's room. It is anticipated that the device may be produced very inexpensively and thus be disposable.

A feature of the present invention resides in the provision of a device which is mounted upon the end of a catheter which may be percutaneously inserted into a systemic artery under local anesthesia. By means of a spring guide wire, the aortic valve is crossed in the retrograde direction, and the end of the catheter is lodged in the cavity of the left ventricle of the heart. This may be readily accomplished using fluoroscopy.

The end of the catheter which lies within the left ventricle is covered by a plastic tube or plastic bag which is sealed relative to the catheter at both ends. The surface of the catheter, inwardly of the plastic tube, is provided with a series of angularly spaced resilient wires each of which is anchored at one end to the body of the catheter. Means are provided extending through the hollow catheter to move the other end of each of these wires toward the anchored end. This causes the wires to bow outwardly, expanding the encircling plastic tubing and materially increasing the volume thereof. As the tube is expanded, the blood is forced from the left ventricle in the proper direction to enter the circulatory system.

A feature of the present invention resides in the provision of a catheter of the type described which includes a series of angularly spaced wires or resilient filaments extending longitudinally thereof, and which are preferably anchored at the distal end of the catheter. The proximal end of the wires are connected to a wire or similar means extending through the catheter tube to a point externally of the body. The proximal end of the wires are held from expansion by suitable means, such as by a ring encircling the catheter. When the ring anchored to the proximal end of the wires is moved toward the distal end of the catheter, the wires are caused to bow outwardly, expanding the encircling resilient tube or bag.

A feature of the present invention resides in the provision of a device which may be extended into the left ventricle and which may be expanded and contracted at virtually any desired interval. As the device is expanded, blood flows from the left ventricle through the aorta in the usual manner. As the device is collapsed, the blood is drawn into the left ventricle from the left atrium in the usual manner. Accordingly, the flow of blood is natural and follows the natural path.

A further feature of the present invention resides in the provision of a device which lends itself to inflation and deflation at shorter intervals than would otherwise be obtained. For example, if the usual type of balloon were inserted into the heart, it would be necessary to inflate and deflate the balloon

at short intervals. Such inflation and deflation would be impractical due to the necessary movement of fluid of one type or another to expand or contract the balloon. The present device may be inflated and deflated by movement of a wire extending through the catheter and accordingly the present device is much more flexible in its time cycle.

A further feature of the present invention resides in the device which may, if desired, be controlled or triggered by the electrocardiogram. There is a wave form in the electrocardiogram called the "QRS complex." This electrical wave precedes the mechanical contraction of the ventricle. The present device may be coupled or connected electrically in such a way as to trigger the action of the device as desired in relation to the QRS wave. Thus the device may be triggered at the peak of the wave or after any time interval had elapsed as desired. These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims.

In the drawings forming a part of the specification:

FIG. 1 is a sectional view through the tip of a catheter, showing the device in its collapsed form.

FIG. 2 is a view similar to FIG. 1, showing the device in its expanded form.

FIG. 3 is a cross-sectional view, the position of the section being indicated by the line 3-3 of FIG. 1.

FIG. 4 is a diagrammatic view of a portion of the circulatory system of a human showing the relative general position of the femoral artery, the aorta, the heart, and the left ventricle, and the left atrium.

FIG. 5 is an enlarged detail showing a portion of the art.

The intracardiac pump is indicated in general by the letter A in FIGS. 1, 2, and 3 of the drawings. The numeral 10 indicates the catheter which is of a size capable of being inserted into a systemic artery such as the femoral artery. The catheter 10 comprises an elongated tube having a plurality of angularly spaced resilient wires or other such elements 11 extending parallel to the axis of the tube and normally extending longitudinally thereof parallel to the axis. The term wire has been used for the purpose of description, but any filaments which are resilient and which act in the manner of resilient wires can be used in place thereof.

In the particular arrangement illustrated, the wires 11 are shown as including intumed ends 12 which extend into the catheter tube 10 and are thus anchored thereto. The other ends of the wires 11 are secured to a ring 13 which encircles the catheter tube and which is slidable relative thereto. A tube 14 extends through the catheter and the associated catheter tube, and extends beyond the end of the catheter tube so that it may be moved axially of the tube. For the purpose of illustration, pins such as 15 are attached to the tube 14 and project radially therefrom, and are terminally connected to the ring 13. The purpose of this arrangement is to permit the ring 13 to be moved axially of the catheter tube 10 by movement of the tube 14.

As indicated in FIGS. 1 and 2 of the drawings, the catheter tube 10 is longitudinally slotted as indicated at 16 to permit the pins 15 and ring 13 to move longitudinally of the axis of the catheter tube within certain predetermined limits. FIG. 1 of the drawings shows the pump in its deflated or relaxed position. FIG. 2 of the drawings shows the same pump in its expanded or inflated position. As will be obvious from these drawings, as the ring 13 moves toward the right in the FIGS. indicated, the wires 11 will be flexed from their straight position generally parallel to the axis of the catheter tube to an outwardly bowed position as indicated in FIG. 2. This can be controlled completely from the end of the catheter tube which is external of the human body.

An elongated sheathing or tube 17 of resilient plastic or similar material encircles the portion of the catheter tube end which includes the wires 11. The sheathing 17 is normally secured to the catheter tube beyond the end of the wires 11. The sheathing 17 is preferably anchored to the end of the catheter 10 by any suitable means such as by adhesive or by a

binding ring. The tube 17 is also secured and sealed to the catheter tube 10 in the area 20 which is beyond the ends of the slots 16. As a result, the portion of the catheter tube which bears the various wires 11 is completely enclosed by the sheathing.

A guide wire 18 may extend through the tube 14 and may serve to guide the catheter tube 10 into the artery. The guide wire may serve also to guide the tip of the catheter across the aortic valve and into the left ventricle. The guide wire 18 may then be removed, leaving the tube 14 open. This may be of advantage for using the lumen for measurement of pressure generated within the left ventricle, or for injection of liquids or dye or radiopaque material through the lumen and into the circulatory system.

FIG. 4 of the drawings indicates diagrammatically portions of a human body. A systemic artery, such as the femoral artery 21 is connected to the aorta 22 which leads to the aortic valve 23 leading to the left ventricle 24 of the heart. As is indicated in FIG. 5 of the drawings, the left atrium 25 of the heart is connected by suitable passages 26 leading from the lungs. When the left ventricle 24 of the heart 27 is expanded blood is drawn into the left ventricle from the lungs through the passages 26. Similarly, when the left ventricle of the heart 24 is collapsed, blood is forced through the aortic valve to the aorta and through the blood system.

In order to function, the heart is enclosed in a relatively inelastic layer 29 which is known as the paracardium. This permits the expansion and contraction of the left ventricle within natural limits and maintains the proper size left ventricle chamber.

The operation of the device is generally as follows. The catheter preferably through the use of the guide wire 18, is inserted into a systemic artery percutaneously. This is normally done under a local anesthesia. By means of the spring guide wire 18, the catheter is moved past the aortic valve in a retrograde direction, and the end of the catheter is positioned in the cavity of the left ventricle. This is normally accomplished through the use of fluoroscopy.

Once the expandable and contractable end of the catheter is within the left ventricle chamber, the resilient covering of the catheter tip is expanded and contracted at regular intervals. Each time the catheter tip is expanded, blood is forced from the left ventricle through the aorta and into the artery system. Each time the catheter tip is contracted, blood is drawn into the left ventricle from the left atrium and the lungs. As a result, blood may be circulated through the body much in the same manner as it would if the heart pump were functioning properly.

If it is desired, the tube 14 may be moved or reciprocated within the catheter tube by suitable mechanical means. This mechanical means may be timed to move the lumen in proper timed relation to the QRS wave on the electrocardiogram. Each time this wave is experienced in the electrocardiogram, means may be provided for reciprocating the tube 14 within the catheter tube. If preferred, the tube may be moved at a

predetermined time interval after the QRS wave is experienced. As a result, the blood may be pumped through the body much in the same manner as it would be by the heart, and may be used to supplement the action of the heart.

In the foregoing description the member 14 has been described as a tube which slides within the catheter tube. As an alternative, the tube 14 may be a wire mesh material which expands and decreases in length as the mesh is rotated within the catheter tube. In other words means other than reciprocatory movement of the tube 14 may be employed for flexing the wires 11.

In accordance with the Pat. Statutes, I have described the principles of construction and operation of my improvement in disposable percutaneous intracardiac pump, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A heart pump including:
 - a catheter having a tip end;
 - a series of resilient flexible ribs in angularly spaced relation about said catheter and extending parallel to the axis thereof;
 - means securing an end of each of said ribs to said catheter adjoining the tip end thereof;
 - a ring slidably supported on said catheter and to which the other ends of said ribs are anchored;
 - a reciprocating member slidably supported within the catheter;
 - said catheter having longitudinally extending slot means therein inwardly of said ring;
 - means extending through said slot means connecting said ring with said reciprocating member; and
 - a flexible resilient tube encircling said ribs and anchored to said catheter beyond the ends of said ribs.
2. The structure of claim 1 and in which said reciprocating member is hollow.
3. The structure of claim 2 and including a guide wire slidably supported within said reciprocating member and extendable through said tip end of said catheter.
4. A method of pumping blood from the heart by use of a catheter having on its extremity an expandable and contractable member including the steps of:
 - inserting the catheter through the aorta and into the left ventricle of the heart;
 - mechanically expanding the member to force blood through the aorta; and
 - contracting the member to draw blood into the left ventricle.
5. The method of claim 4 and in which the expandable and contractable member is actuated by a flexible member extending into said catheter, and including the step of reciprocating said flexible member.

60

65

70

75