United States Patent

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[54] **HEART ASSIST METHOD AND CATHETER**
5 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** ..... **128/1 R,** 128/245, 128/348
[51] **Int. Cl.** **A61m 1/03,** A61b 19/00
[50] **Field of Search** ..... 128/1 R, 214, 348, 241, 245, 344; 3/1

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ABSTRACT: Method and device for augmenting the action of an ailing heart having an incompetent aortic valve, wherein blood is sucked up from the aorta, while blocking flow to the arterial tree, and then, upon reverse, a major portion of the blood is forced into the arterial tree and a minor portion forced into the coronary arteries of the heart itself.

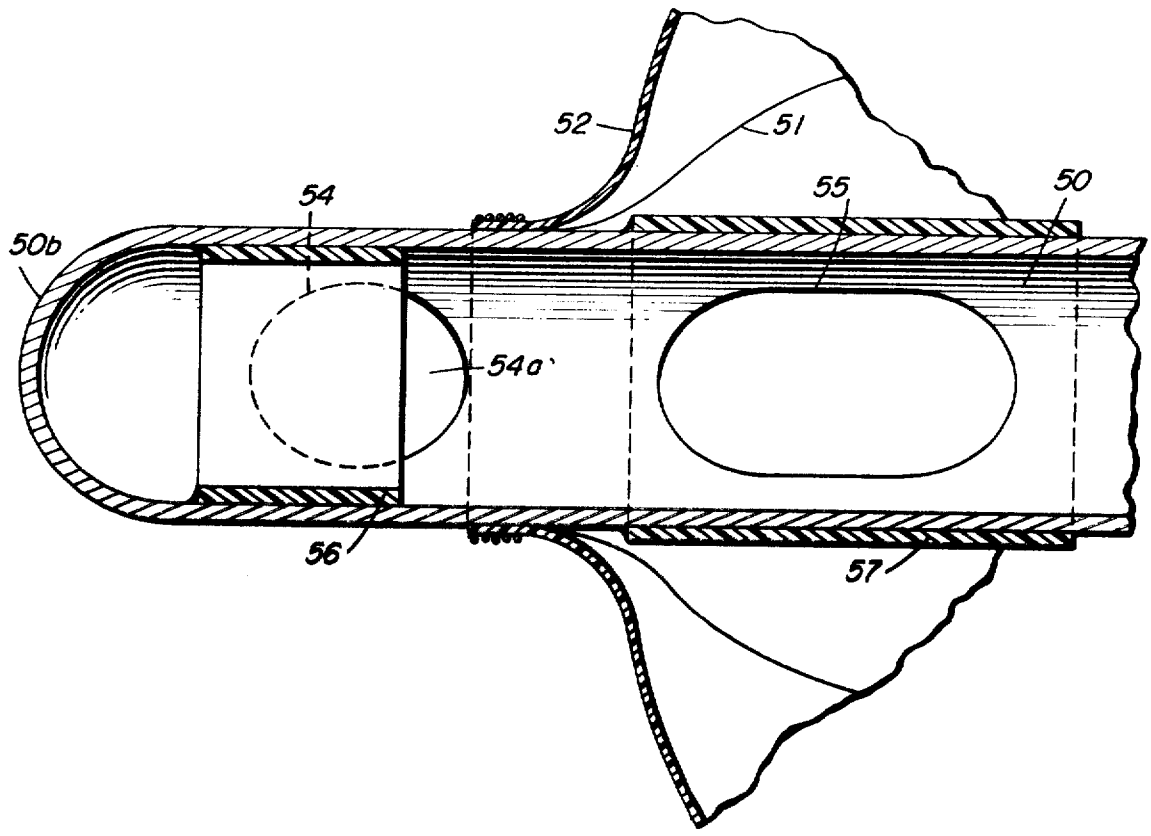


FIG. 1

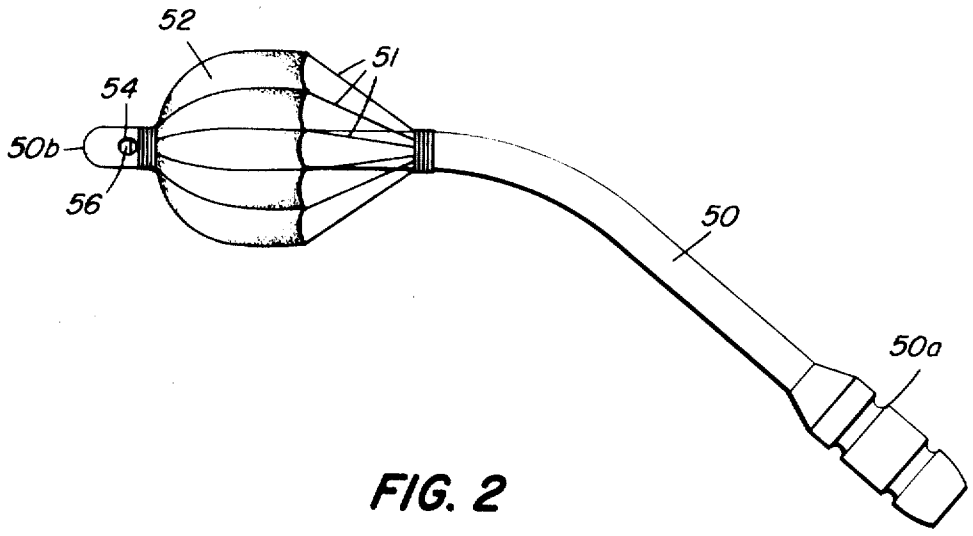
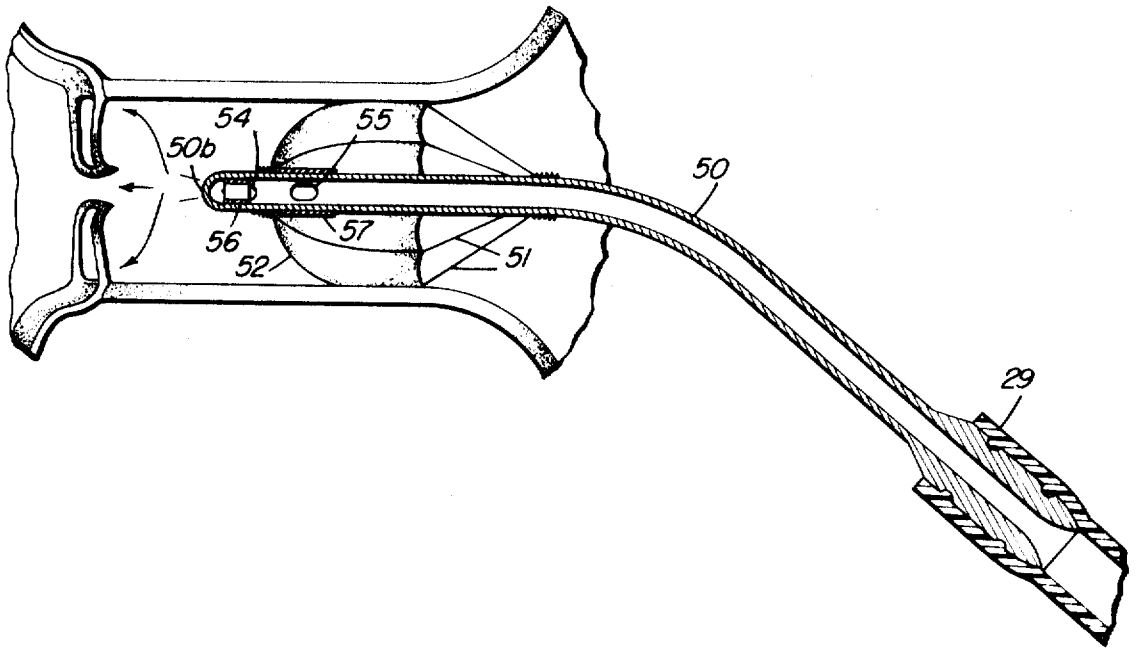


FIG. 2



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FIG. 3

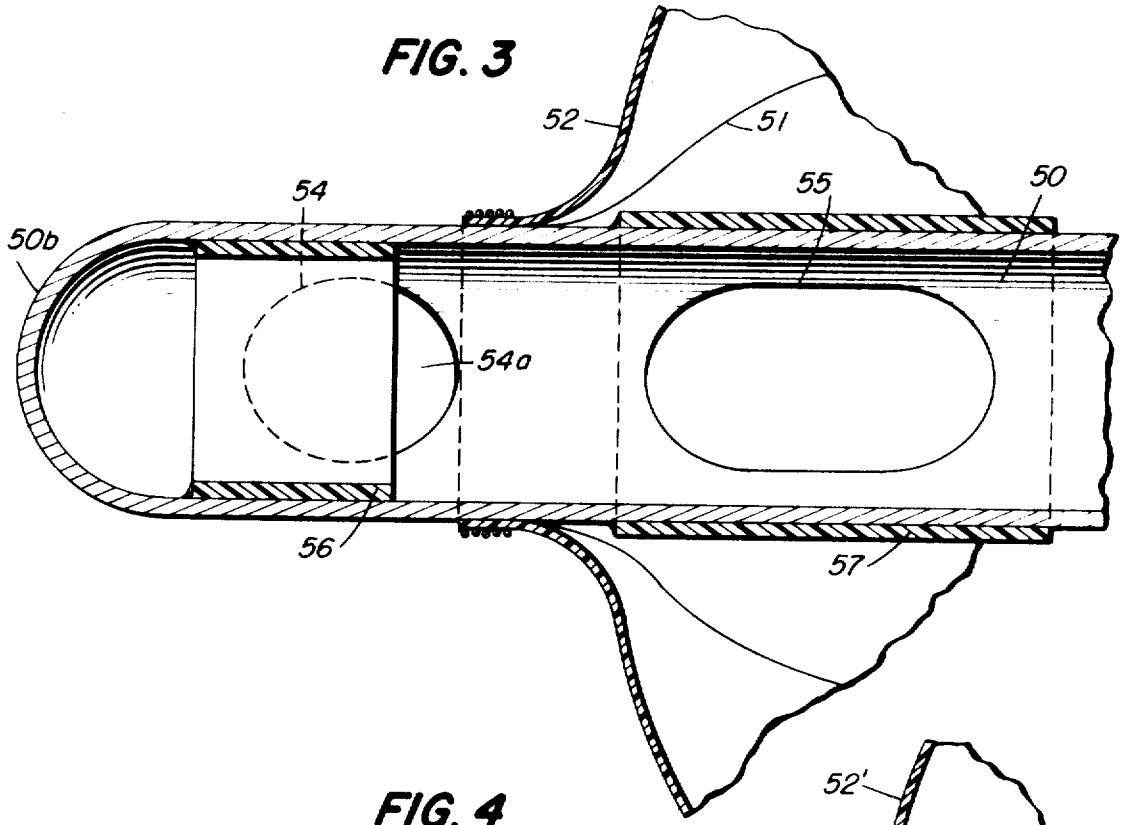
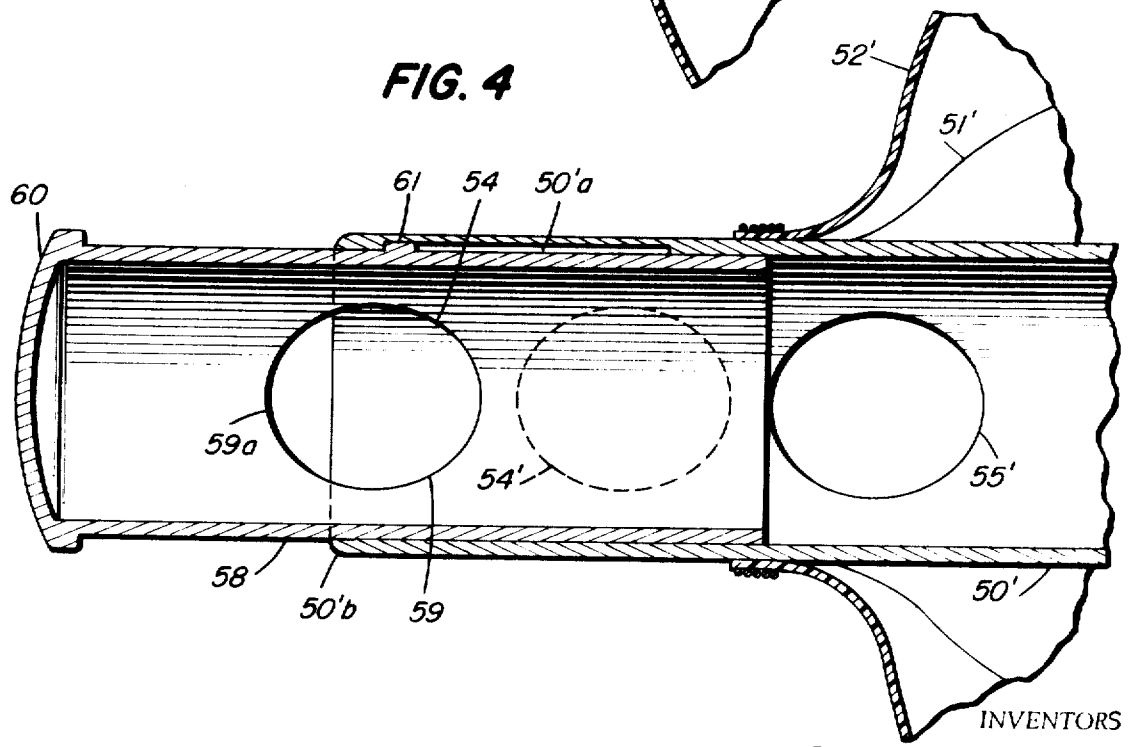


FIG. 4



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HEART ASSIST METHOD AND CATHETER

As a matter of introduction, our invention relates to method and apparatus for augmenting the action of the ailing heart of a patient.

Among the objects of our invention is the provision of a method and a device for safely, effectively and reliably moving blood from the incompetent aortic valve of a failing heart and then discharging the same into the arterial tree while supplying a minor portion of the blood to the coronary arteries of the heart itself.

Other objects in part will be apparent and in part particularly pointed to in the description which follows.

Our invention may be considered to reside in the combination of elements, features of construction and arrangement of parts and in the several operational steps and the relation of each of the same to one or more of the others, all as described herein and set out in the claims at the end of this specification.

CROSS-REFERENCE TO RELATED APPLICATION

The present application for patent is generally related to our application of May 27, 1969, Ser. No. 828,151 entitled Heart Assist Method and Apparatus.

BACKGROUND OF THE INVENTION

In order to gain a better understanding of certain features of our invention, it is to be noted at this point that situations occur wherein the heart action of the patient is wholly insufficient to supply the bodily needs. In certain of these instances the patient has an incompetent aortic valve. And blood pumped out of the left ventricle of the heart partially flows back into the left ventricle, this as a result of the inability of the aortic valve to prevent the back flow. As a result, there is a loss of pressure, and a loss of blood supplied the arterial tree. Moreover, in many instances there is insufficient blood supplied the coronary arteries of the heart itself.

Although many efforts have been made in the past to overcome the deficiencies of an ailing heart, and indeed to take account of an incompetent aortic valve, for one reason or another these have not been entirely satisfactory. In some instances prior systems and apparatus have been too complicated. In others they have been either too costly or not sufficiently reliable for most use.

An object of the present invention, therefore, is to provide a system, as well as a method and device, for overcoming the deficiencies of the prior art and assure effective movement of blood from an incompetent aortic valve of the heart and discharge a major portion of the same into the arterial tree while at the same time supplying a minor portion to the coronary arteries.

SUMMARY OF THE INVENTION

Directing attention to the practice of our invention, we provide a method and device of novel construction. A catheter is introduced into the aorta, or into the left subclavian artery, by means of an arterialotomy incision. The proximate end of the catheter of course protrudes from the artery and is provided with a plastic tube connecting to a reciprocating pump and apparatus of the character more generally shown and described in our copending application for patent identified above. The distal end of the catheter is directed toward the heart. It is this end of the catheter which is provided with one hole or port. Back from this first opening there is provided a further hole or port. An expandible membrane is located circumferentially and radially extending about the catheter at a position between the two holes or ports referred to.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings in which we disclose two preferred embodiments of our invention:

FIG. 1 is the catheter of our invention on a somewhat enlarged scale;

FIG. 2 is a sectional view of the catheter of FIG. 1 as installed in the aorta of a patient at a position adjacent to the aortic valve;

FIG. 3 is a detached view of a portion of the catheter of FIG. 1 on enlarged scale in order to best illustrate certain features of the invention; and

FIG. 4 is a similar sectional view on an enlarged scale of an alternate embodiment of the catheter of our invention.

Like reference characters denote like parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to a preferred embodiment of our invention, attention is directed to FIGS. 1, 2 and 3 of the drawings. It is seen that our catheter essentially comprises a hollow shaft portion **50** with proximate end **50***a* received and secured in tube **29** leading to a suitable blood pump (not shown). The distal end of the catheter is provided with a suitable port or opening **54** just back from tip **50***b* (see FIG. The the distal end, moreover, is provided with a further port **55** back from port **54**. Surrounding the catheter at a point between the ports **54** and **55** there is an expansible imperforate membrane **52** serving as valve means exteriorly of said catheter. This is suitably secured to catheter **50** and flares outwardly and circumferentially about the same. The outer circumferential extremity of the flaring membrane is secured to catheter shaft **50** by suitable radial filaments **51**.

During the cyclic operation of the blood pump associated with our device, and connecting to the catheter by way of tube **29** as indicated above, with the suction stroke of the pump the blood coming from the aortic valve enters port **54**. In this action a membrane valve means **56** secured to the inner walls of the catheter adjacent the distal end thereof collapses inwardly. Such action permits the free flow of blood into the catheter and to the pump. During this action any loss of blood through the second port **55** is prevented by virtue of the collapse of the exteriorly mounted membrane valve means **57** (see FIG. 3) against the outer wall of the catheter. And any inflow of blood from the arterial tree toward the distal end of the catheter and into port **54** is prevented by the expansion of circumferential membrane **52**. Membrane **52** also serves to prevent any collapse of the walls of the aorta under the reduced pressure conditions obtaining during this cycle in the pump.

With a reverse of pump action, that is, the discharge stroke, blood flows back into the catheter by way of tube **29** and out through port **55** into the aorta. During this action the exteriorly positioned membrane **57** is expanded outwardly under the pressure of the blood and allows an unimpeded flow into the arterial tree.

It will be noted that port **54** adjacent to the distal end of the catheter is not completely closed by the interiorly positioned membrane **56**. The construction is such that there is provided a portion **54***a* that amounts roughly to some one-third the area of the entire port **54**. As a result, a substantial portion of the blood coming from the pump with the discharge stroke passes into the aorta near its distal end, this by way of port **54***a*, and effectively supplies the coronary arteries of the heart itself. While provision is made for sufficient blood to flow into the coronary arteries, there is no undue reverse filling of the incompetent left ventricle.

A modified catheter construction is shown in FIG. 4 of the drawings. In this the distal end of the catheter is provided with a reciprocable sleeve **58**, with valve means comprising closed end **60** and port **59**. A lug **61** provided on sleeve **58** rides back and forth in slot **50'***a* provided in the catheter wall. With the pressure stroke of the pump, movement of sleeve **58** to the left, as seen in FIG. 4, is arrested by lug **61** striking one end of slot **50'***a*, and with the suction stroke the reverse movement is arrested by the lug striking the other end of the slot.

During the suction stroke of the pump, sleeve **58** is drawn to the right. With this movement the walls of sleeve **58** effectively close port **55'** of the catheter. And concurrently with this

action, port **59** of sleeve **58** is brought into register with port **54'** of the catheter. Blood from the aorta then is sucked into catheter **50'** by way of registered ports **54'** and **59**. Any flow of blood from the arterial tree under the back pressure of the tree and the suction conditions maintaining in the area of the aorta is prevented by the outward expansion of membrane valve **52'**.

With the reverse stroke of the pump during the discharge cycle of the same, the reciprocable sleeve **58** is forced outwardly or to the left, as seen in the drawing, under the pressure conditions then maintaining. This provides free access of the blood to port **55'** and thence to the arterial tree. Under the pressure action port **59** is brought forward from register with port **54'** and extends somewhat beyond the end portion **50'***b* of the catheter, this providing an opening of the port equal to about one-third of that of port **59** itself. We conveniently refer to this portion of the opening as **59***a*. While the major portion of the blood exits through port **55'**, and thence to the arterial tree, a minor portion exits through port **59***a* to supply the coronary arteries. The amount of this minor portion, however, and the conditions of pressure associated therewith are not sufficient to discharge blood back into the incompetent left ventricle.

It will be seen that in the method and apparatus of our invention the content of the left ventricle of the heart is exhausted with a suction stroke. Yet, even with an incompetent aortic valve, any backflow of blood under the pressure conditions obtaining with a succeeding discharge stroke, there is no undue reverse filling as encountered with normal operation of a defective heart with incompetent valve.

Thus, it will be seen that we provide in our invention a method and apparatus in which the various objects hereinbefore set forth are successfully had. The method and apparatus is simple, direct and reliable.

Since many embodiments may be made of our invention, and since many changes may be made in the embodiments hereinbefore set forth, it should be understood that all matter described herein, or shown in the accompanying drawings, is to be interpreted as illustrative, and not by way of limitation.

We claim:

1. Method for augmenting the action of an ailing heart having associated aorta and arterial tree supplied thereby and coronary arteries supplying the heart itself wherein an open ended catheter is inserted into the aortic, or left subclavian artery, to a point adjacent the aortic valve, comprising in sequential operation sucking blood from said aorta through said catheter during systolic heart pulsation, while blocking backflow from the said arterial tree; and on reverse cycle forcing the major portion of the said blood back through said catheter into the arterial tree while forcing a minor portion into the said coronary arteries during diastolic period.

2. Method according to claim **1** wherein about two-thirds of the blood on reverse cycle is supplied the arterial tree and about one-third is supplied the coronary arteries of the heart itself.

3. Heart assist device comprising catheter means including an elongated member with a bore extending therethrough and having a distal end with opening therein and a second opening back from said first-mentioned opening; expandible and imperforate membrane valve means flaring out circumferentially and extending radially extending about said catheter means from a point between said two openings; valve means engaging said catheter closing said second opening upon a suction being established in said catheter; and valve means within said catheter largely closing said first-mentioned opening upon a pressure being established in said catheter.

4. Device according to claim **3** wherein said catheter engaging valve means is in the form of an expandible sleeve positioned externally of said catheter and secured thereto; and said valve means within the catheter is in the form of an expandible sleeve positioned internally of said catheter and secured thereto.

5. Device according to claim **3** wherein said catheter engaging valve means and said valve means within said catheter comprise a single reciprocable chamber closely fitting within said catheter and having a first port therein adapted to register with the said opening in the distal end of the catheter upon the suction cycle of operation, the walls of the chamber closing off said further opening in said catheter; and a second port therein for but partially registering with and largely closing off said distal end opening upon application of pressure during the succeeding cycle of operation.