US008075472B2

(12) **United States Patent**
Zilbershlag et al.

(10) **Patent No.: US 8,075,472 B2**
(45) **Date of Patent: Dec. 13, 2011**

(54) **PERMANENT VENTRICULAR ASSIST DEVICE FOR TREATING HEART FAILURE**

(75) Inventors: **Michael Zilbershlag**, Givat Shmuel (IL); **Moshe Levy**, Tel Mond (IL)

(73) Assignee: **Leviticus-Cardio Ltd.**, Givat Shmuel (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 49 days.

(21) Appl. No.: **12/527,595**

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(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**
A61N 1/00 (2006.01)

(52) **U.S. Cl.** **600/17**

(58) **Field of Classification Search** 600/16, 600/17

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,507,629	A	4/1996	Jarkiv	
6,129,704	A	10/2000	Forman	
6,135,729	A	10/2000	Aber	
2003/0163020	A1 *	8/2003	Frazier	600/16

FOREIGN PATENT DOCUMENTS

WO	WO2007003351	1/2007

OTHER PUBLICATIONS

WIPO, "Written Opinion of the International Search Authority for PCT/IL2008/000604," Jan. 31, 2009, European Patent Office, Netherlands.

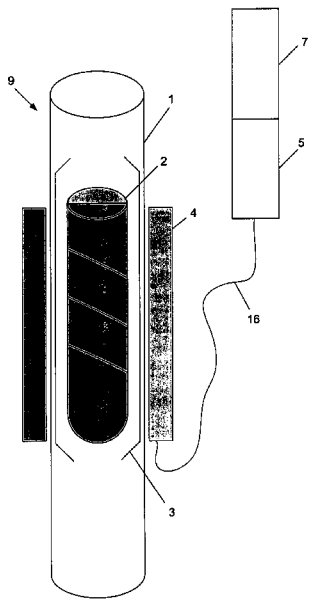
* cited by examiner

Primary Examiner — George Manuel
Assistant Examiner — Robert Wieland

(57) **ABSTRACT**

The invention is a kit for a permanent ventricular assist device that can be permanently implanted into the circulatory system of a patient. The kit comprises one or more passive cores (Pcore), a stator, a power supply, and a controller unit. The inventors have realized that major open heart surgery, generally used for implementing a magnetic blood pump in the circulatory system, can be wholly avoided if the rotor and the stator are physically separated and are implanted respectively inside and around the blood vessel at the location of interest. Therefore the kit is characterized in that the one or more Pcores are configured to allow them to be implanted inside a blood vessel and the stator is configure to enable it to be placed outside of the blood vessel surrounding the Pcores. Also described are illustrative medical procedures for implanting the components of the kit at different locations in the body.

4 Claims, 5 Drawing Sheets



US008579789B1

(12) **United States Patent**
Zilbershlag

(10) **Patent No.: US 8,579,789 B1**
(45) **Date of Patent: Nov. 12, 2013**

(54) **ENDOVASCULAR VENTRICULAR ASSIST DEVICE, USING THE MATHEMATICAL OBJECTIVE AND PRINCIPLE OF SUPERPOSITION**

(75) Inventor: **Michael Zilbershlag**, Givat Shmuel (IL)

(73) Assignee: **Leviticus Cardio Ltd.**, Givat Shmuel (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 417 days.

(21) Appl. No.: **12/887,536**

(22) Filed: **Sep. 22, 2010**

Related U.S. Application Data

(60) Provisional application No. 61/245,048, filed on Sep. 23, 2009.

(51) **Int. Cl.**
A61N 1/00 (2006.01)
A61N 1/362 (2006.01)
A61B 5/02 (2006.01)

(52) **U.S. Cl.**
USPC **600/16**; 600/15; 600/17; 607/34

(58) **Field of Classification Search**
USPC 600/15–17, 504; 607/34
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,906,229	A	3/1990	Wampler	
4,957,504	A	9/1990	Chardack	
5,749,855	A	5/1998	Reitan	
6,421,889	B1	7/2002	Chien	
6,527,699	B1	3/2003	Goldowsky	
6,772,011	B2	8/2004	Dolgin	
7,613,497	B2	11/2009	Govari et al.	
7,650,192	B2	1/2010	Wahlstrand	
7,741,734	B2	6/2010	Joannopoulos et al.	
7,825,543	B2	11/2010	Karalis et al.	
7,825,776	B2	11/2010	Smith et al.	
7,956,725	B2	6/2011	Smith	
8,075,472	B2	12/2011	Zilbershlag et al.	
8,244,367	B2	8/2012	Wahlstrand et al.	
8,285,388	B2	10/2012	Wahlstrand	
2004/0014315	A1	1/2004	Lai et al.	
2004/0054251	A1*	3/2004	Liotta	600/17
2004/0115038	A1	6/2004	Nuesser et al.	
2005/0220636	A1	10/2005	Henein et al.	
2007/0132587	A1	6/2007	Smith et al.	
2007/0182578	A1	8/2007	Smith	
2008/0041930	A1	2/2008	Smith et al.	
2008/0238680	A1	10/2008	Posamentier et al.	
2009/0243813	A1	10/2009	Smith et al.	
2010/0045114	A1	2/2010	Sample et al.	
2010/0052811	A1	3/2010	Smith et al.	
2010/0076247	A1	3/2010	Zilbershlag et al.	
2010/0081379	A1	4/2010	Cooper et al.	
2010/0187913	A1	7/2010	Smith et al.	

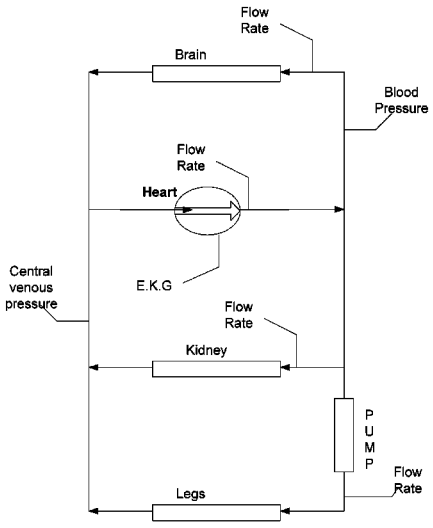
* cited by examiner

Primary Examiner — Nicole F Lavert
(74) *Attorney, Agent, or Firm* — Brown Rudnick LLP

(57) **ABSTRACT**

This embodiment suggests new approach for Endovascular Ventricular Assist Device, using the mathematical objective & principle of superposition allow design and calculation of the body response to VAD pump located in the Aorta. This new approach allows minimal invasive Endovascular VAD that result in similar relief to the heart as partial VAD. Using special power transfer technique will allow wireless power transformation into the aorta. This methods and technique should dramatic reduce VAD barrier.

4 Claims, 16 Drawing Sheets



human vascular hemodinamic system with pump

US008840539B2

(12) **United States Patent**
Zilbershlag

(10) **Patent No.: US 8,840,539 B2**
(45) **Date of Patent: Sep. 23, 2014**

(54) **ENDOVASCULAR VENTRICULAR ASSIST DEVICE, USING THE MATHEMATICAL OBJECTIVE AND PRINCIPLE OF SUPERPOSITION**

(71) Applicant: **Leviticus Cardio Ltd.**, Givat Shmuel (IL)

(72) Inventor: **Michael Zilbershlag**, Givat Shmuel (IL)

(73) Assignee: **Leviticus Cardio Ltd.** (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/050,766**

(22) Filed: **Oct. 10, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 12/887,536, filed on Sep. 22, 2010, now Pat. No. 8,579,789.

(60) Provisional application No. 61/245,048, filed on Sep. 23, 2009.

(51) **Int. Cl.**

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A61N 1/378	(2006.01)
A61F 2/82	(2013.01)
A61M 1/10	(2006.01)
A61B 5/02	(2006.01)
A61N 1/372	(2006.01)

(52) **U.S. Cl.**

CPC ***A61M 1/127*** (2013.01); ***A61N 1/3787*** (2013.01); ***A61F 2/82*** (2013.01); ***A61M 1/1072*** (2013.01); *A61N 1/37229* (2013.01); ***A61B 5/02*** (2013.01); ***A61M 1/125*** (2013.01)

USPC **600/16**; 600/15; 600/17; 607/34

(58) **Field of Classification Search**

USPC 600/15–17, 504; 607/34

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,906,229	A	3/1990	Wampler	
4,957,504	A	9/1990	Chardack	
5,095,903	A	3/1992	DeBellis	
5,749,855	A	5/1998	Reitan	
6,070,103	A	5/2000	Ogden	
6,280,377	B1 *	8/2001	Talpade	600/16
6,421,889	B1	7/2002	Chien	
6,527,699	B1	3/2003	Goldowsky	
6,761,681	B2	7/2004	Schmid et al.	
6,772,011	B2	8/2004	Dolgin	
7,613,497	B2	11/2009	Govari et al.	
7,650,192	B2	1/2010	Wahlstrand	
7,741,734	B2	6/2010	Joannopoulos et al.	
7,825,543	B2	11/2010	Karalis et al.	
7,825,776	B2	11/2010	Smith et al.	

(Continued)

Primary Examiner — Nicole F Lavert

(74) *Attorney, Agent, or Firm* — Brown Rudnick LLP

(57) **ABSTRACT**

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6 Claims, 16 Drawing Sheets