United States Patent	12383727
Kind Code	B2
Date of Patent	August 12, 2025
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Motor housing module for a heart support system, and heart support system and method for mounting a heart support system

Abstract

The invention relates to a motor housing module (**110**) for sealing a motor compartment of a motor of a heart support system. The motor housing module (**110**) has at least one feed-through portion (**205**), at least one feed-through line (**210**), and at least one contact pin (**215**). The feed-through portion (**205**) is designed to establish an electrical connection between the heart support system and a connection cable in order to externally contact the heart support system. The at least one feed-through line (**210**) is embedded in the feed-through portion (**205**) and extends through the feed-through portion (**205**). The feed-through line (**210**) can be connected to the motor and to the connection cable. A first end of the at least one contact pin (**215**) is embedded in the feed-through portion (**205**) and a second end of the contact pin (**215**) projects from the feed-through portion (**205**) on a side facing away from the motor compartment. The second end of the contact pin (**215**) can be connected to a sensor line to at least one sensor of the heart support system and to the connection cable.

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Appl. No.: **17/057243**

Filed (or PCT Filed): **May 30, 2019**

PCT No.: **PCT/EP2019/064156**

PCT Pub. No.: **WO2019/229222**

PCT Pub. Date: December 05, 2019

Prior Publication Data

Document Identifier	Publication Date
US 20210316133 A1	Oct. 14, 2021

Foreign Application Priority Data

DE	102018208539.0	May. 30, 2018

Publication Classification

Int. Cl.: **A61M60/878** (20210101); **A61M60/816** (20210101)

U.S. Cl.:

CPC **A61M60/878** (20210101); **A61M60/816** (20210101); A61M2205/3334 (20130101); A61M2205/8262 (20130101)

Field of Classification Search

CPC: A61M (60/878); A61M (60/816); A61M (2205/3334)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2254698	12/1940	Hansen, Jr.	N/A	N/A
2310923	12/1942	Bean	N/A	N/A
3085407	12/1962	Tomlinson	N/A	N/A
3505987	12/1969	Heilman	N/A	N/A
3568659	12/1970	Karnegis	N/A	N/A

3614181	12/1970	Meeks	N/A	N/A
3747998	12/1972	Klein et al.	N/A	N/A
3807813	12/1973	Milligan	N/A	N/A
3995617	12/1975	Watkins et al.	N/A	N/A
4115040	12/1977	Knorr	N/A	N/A
4245622	12/1980	Hutchins, IV	N/A	N/A
4471252	12/1983	West	N/A	N/A
4522194	12/1984	Normann	N/A	N/A
4625712	12/1985	Wampler	N/A	N/A
4643641	12/1986	Clausen et al.	N/A	N/A
4753221	12/1987	Kensey et al.	N/A	N/A
4779614	12/1987	Moise	N/A	N/A
4785795	12/1987	Singh et al.	N/A	N/A
4817586	12/1988	Wampler	N/A	N/A
4846152	12/1988	Wampler et al.	N/A	N/A
4888011	12/1988	Kung et al.	N/A	N/A
4889131	12/1988	Salem et al.	N/A	N/A
4895557	12/1989	Moise et al.	N/A	N/A
4896754	12/1989	Carlson et al.	N/A	N/A
4902272	12/1989	Milder et al.	N/A	N/A
4908012	12/1989	Moise et al.	N/A	N/A
4927407	12/1989	Dorman	N/A	N/A
4943275	12/1989	Stricker	N/A	N/A
4944722	12/1989	Carriker et al.	N/A	N/A
4968300	12/1989	Moutafis et al.	N/A	N/A
4971768	12/1989	Ealba	N/A	N/A
4985014	12/1990	Orejola	N/A	N/A
5044897	12/1990	Dorman	N/A	N/A
5061256	12/1990	Wampler	N/A	N/A
5089016	12/1991	Millner et al.	N/A	N/A
5090957	12/1991	Moutafis et al.	N/A	N/A
5112292	12/1991	Hwang et al.	N/A	N/A
5112349	12/1991	Summers et al.	N/A	N/A
5116305	12/1991	Milder et al.	N/A	N/A
5195877	12/1992	Kletschka	N/A	N/A
5297940	12/1993	Buse	N/A	N/A
5313765	12/1993	Martin	N/A	N/A
5344443	12/1993	Palma et al.	N/A	N/A
5354271	12/1993	Voda	N/A	N/A
5376114	12/1993	Jarvik	N/A	N/A
5399145	12/1994	Ito et al.	N/A	N/A
5405383	12/1994	Barr	N/A	N/A
5443503	12/1994	Yamane	N/A	N/A
5456715	12/1994	Liotta	N/A	N/A
5527159	12/1995	Bozeman, Jr. et al.	N/A	N/A
5599173	12/1996	Chen et al.	N/A	N/A
5613935	12/1996	Jarvik	N/A	N/A
5695471	12/1996	Wampler	N/A	N/A
5702430	12/1996	Larson, Jr. et al.	N/A	N/A
5713954	12/1997	Rosenberg et al.	N/A	N/A
5720771	12/1997	Snell	N/A	N/A
5746709	12/1997	Rom et al.	N/A	N/A
5749855	12/1997	Reitan	N/A	N/A
5752976	12/1997	Duffin et al.	N/A	N/A
5766207	12/1997	Potter et al.	N/A	N/A
5831365	12/1997	Keim et al.	N/A	N/A
5888241	12/1998	Jarvik	N/A	N/A
5888242	12/1998	Antaki et al.	N/A	N/A
5904646	12/1998	Jarvik	N/A	N/A
5911685	12/1998	Siess et al.	N/A	N/A
5921913	12/1998	Siess	N/A	N/A
5964694	12/1998	Siess et al.	N/A	N/A
6001056	12/1998	Jassawalla et al.	N/A	N/A
6007478	12/1998	Siess et al.	N/A	N/A
6018208	12/1999	Maher et al.	N/A	N/A
6050975	12/1999	Poirier	N/A	N/A
6071093	12/1999	Hart	N/A	N/A
6116862	12/1999	Rau et al.	N/A	N/A
6123659	12/1999	le Blanc et al.	N/A	N/A
6135710	12/1999	Araki et al.	N/A	N/A
6149405	12/1999	Abe et al.	N/A	N/A
6155969	12/1999	Schima et al.	N/A	N/A
6158984	12/1999	Cao et al.	N/A	N/A
6161838	12/1999	Balsells	N/A	N/A
6176848	12/2000	Rau et al.	N/A	N/A

6185460	12/2000	Thompson	N/A	N/A
6186665	12/2000	Maher et al.	N/A	N/A
6190324	12/2000	Kieval et al.	N/A	N/A
6210318	12/2000	Lederman	N/A	N/A
6217541	12/2000	Yu	N/A	N/A
6220832	12/2000	Schob	N/A	N/A
6227820	12/2000	Jarvik	N/A	N/A
6245007	12/2000	Bedingham et al.	N/A	N/A
6254359	12/2000	Aber	N/A	N/A
6264205	12/2000	Balsells	N/A	N/A
6264601	12/2000	Jassawalla et al.	N/A	N/A
6264645	12/2000	Jonkman	N/A	N/A
6293752	12/2000	Clague et al.	N/A	N/A
6324430	12/2000	Zarinetchi et al.	N/A	N/A
6324431	12/2000	Zarinetchi et al.	N/A	N/A
6351048	12/2001	Schob et al.	N/A	N/A
6361292	12/2001	Chang et al.	N/A	N/A
6366817	12/2001	Kung	N/A	N/A
6432136	12/2001	Weiss et al.	N/A	N/A
6445956	12/2001	Laird et al.	N/A	N/A
6447266	12/2001	Antaki et al.	N/A	N/A
6496733	12/2001	Zarinetchi et al.	N/A	N/A
6512949	12/2002	Combs et al.	N/A	N/A
6527698	12/2002	Kung et al.	N/A	N/A
6530876	12/2002	Spence	N/A	N/A
6533716	12/2002	Schmitz-Rode et al.	N/A	N/A
6540658	12/2002	Fasciano et al.	N/A	N/A
6540659	12/2002	Milbocker	N/A	N/A
6544216	12/2002	Sammler et al.	N/A	N/A
6579257	12/2002	Elgas et al.	N/A	N/A
6592620	12/2002	Lancisi et al.	N/A	N/A
6595743	12/2002	Kazatchkov et al.	N/A	N/A
6602182	12/2002	Milbocker	N/A	N/A
6607368	12/2002	Ross et al.	N/A	N/A
6623475	12/2002	Siess	N/A	N/A
6719791	12/2003	Nüsser et al.	N/A	N/A
6731976	12/2003	Penn et al.	N/A	N/A
6794789	12/2003	Siess et al.	N/A	N/A
6841910	12/2004	Gery	N/A	N/A
6879126	12/2004	Paden et al.	N/A	N/A
6912423	12/2004	Ley et al.	N/A	N/A
6942611	12/2004	Siess	N/A	N/A
6949066	12/2004	Bearnson et al.	N/A	N/A
6969345	12/2004	Jassawalla et al.	N/A	N/A
7011620	12/2005	Siess	N/A	N/A
7014620	12/2005	Kim	N/A	N/A
7022100	12/2005	Aboul-Hosn et al.	N/A	N/A
7027875	12/2005	Siess et al.	N/A	N/A
7062331	12/2005	Zarinetchi et al.	N/A	N/A
7070398	12/2005	Olsen et al.	N/A	N/A
7070555	12/2005	Siess	N/A	N/A
7083588	12/2005	Shmulewitz et al.	N/A	N/A
7144364	12/2005	Barbut et al.	N/A	N/A
7155291	12/2005	Zarinetchi et al.	N/A	N/A
7160243	12/2006	Medvedev	N/A	N/A
7238151	12/2006	Frazier	N/A	N/A
7241257	12/2006	Ainsworth et al.	N/A	N/A
7264606	12/2006	Jarvik et al.	N/A	N/A
7393181	12/2007	McBride et al.	N/A	N/A
7462019	12/2007	Allarie et al.	N/A	N/A
7479102	12/2008	Jarvik	N/A	N/A
7502648	12/2008	Okubo et al.	N/A	N/A
7736296	12/2009	Siess et al.	N/A	N/A
7762941	12/2009	Jarvik	N/A	N/A
7798952	12/2009	Tansley et al.	N/A	N/A
7841976	12/2009	McBride et al.	N/A	N/A
7850593	12/2009	Vincent et al.	N/A	N/A
7850594	12/2009	Sutton et al.	N/A	N/A
7878967	12/2010	Khanal	N/A	N/A
7914436	12/2010	Kung	N/A	N/A
7934909	12/2010	Nuesser et al.	N/A	N/A
7959551	12/2010	Jarvik	N/A	N/A
7963905	12/2010	Salmonsen et al.	N/A	N/A
7998190	12/2010	Gharib et al.	N/A	N/A
8012079	12/2010	Delgado, III	N/A	N/A

8075472	12/2010	Zilbershlag et al.	N/A	N/A
8088059	12/2011	Jarvik	N/A	N/A
8114008	12/2011	Hidaka et al.	N/A	N/A
8123669	12/2011	Siess et al.	N/A	N/A
RE43299	12/2011	Siess	N/A	N/A
8152845	12/2011	Bourque	N/A	N/A
8177703	12/2011	Smith et al.	N/A	N/A
8216122	12/2011	Kung	N/A	N/A
8371997	12/2012	Shifflette	N/A	N/A
8376926	12/2012	Benkowsi et al.	N/A	N/A
8382695	12/2012	Patel	N/A	N/A
8382830	12/2012	Maher et al.	N/A	N/A
8388565	12/2012	Shifflette	N/A	N/A
8419609	12/2012	Shambaugh, Jr. et al.	N/A	N/A
8449443	12/2012	Rodefeld et al.	N/A	N/A
8480555	12/2012	Kung	N/A	N/A
8485961	12/2012	Campbell et al.	N/A	N/A
8489200	12/2012	Zarinetchi et al.	N/A	N/A
8512012	12/2012	Akdis et al.	N/A	N/A
8535211	12/2012	Campbell et al.	N/A	N/A
8545380	12/2012	Farnan et al.	N/A	N/A
8562508	12/2012	Dague et al.	N/A	N/A
8585572	12/2012	Mehmanesh	N/A	N/A
8591393	12/2012	Walters et al.	N/A	N/A
8591538	12/2012	Gellman	N/A	N/A
8591539	12/2012	Gellman	N/A	N/A
8597170	12/2012	Walters et al.	N/A	N/A
8608635	12/2012	Yomtov et al.	N/A	N/A
8617239	12/2012	Reitan	N/A	N/A
8622949	12/2013	Zafirelis et al.	N/A	N/A
8641594	12/2013	LaRose et al.	N/A	N/A
8657875	12/2013	Kung et al.	N/A	N/A
8684362	12/2013	Balsells et al.	N/A	N/A
8684904	12/2013	Campbell et al.	N/A	N/A
8690749	12/2013	Nunez	N/A	N/A
8721517	12/2013	Zeng et al.	N/A	N/A
8727959	12/2013	Reitan et al.	N/A	N/A
8731664	12/2013	Foster et al.	N/A	N/A
8734331	12/2013	Evans et al.	N/A	N/A
8794989	12/2013	Kearsley et al.	N/A	N/A
8814933	12/2013	Siess	N/A	N/A
8849398	12/2013	Evans	N/A	N/A
8864642	12/2013	Scheckel	N/A	N/A
8864643	12/2013	Reichenbach et al.	N/A	N/A
8864644	12/2013	Yomtov	N/A	N/A
8882477	12/2013	Fritz, IV et al.	N/A	N/A
8888728	12/2013	Aboul-Hosn et al.	N/A	N/A
8894387	12/2013	White	N/A	N/A
8897873	12/2013	Schima et al.	N/A	N/A
8900060	12/2013	Liebing	N/A	N/A
8900115	12/2013	Bolling et al.	N/A	N/A
8932246	12/2014	Ferrari	N/A	N/A
8992406	12/2014	Corbett	N/A	N/A
8992407	12/2014	Smith et al.	N/A	N/A
9028216	12/2014	Schumacher et al.	N/A	N/A
9028392	12/2014	Shifflette	N/A	N/A
9033863	12/2014	Jarvik	N/A	N/A
9091271	12/2014	Bourque	N/A	N/A
9138518	12/2014	Campbell et al.	N/A	N/A
9144638	12/2014	Zimmermann et al.	N/A	N/A
9162017	12/2014	Evans et al.	N/A	N/A
9192705	12/2014	Yanai et al.	N/A	N/A
9199020	12/2014	Siess	N/A	N/A
9265870	12/2015	Reichenbach et al.	N/A	N/A
9297735	12/2015	Graichen et al.	N/A	N/A
9308305	12/2015	Chen et al.	N/A	N/A
9314556	12/2015	Tuseth	N/A	N/A
9327067	12/2015	Zeng et al.	N/A	N/A
9327068	12/2015	Aboul-Hosn et al.	N/A	N/A
9345824	12/2015	Mohl et al.	N/A	N/A
9370613	12/2015	Hsu et al.	N/A	N/A
9371826	12/2015	Yanai et al.	N/A	N/A
9381286	12/2015	Spence et al.	N/A	N/A
9421311	12/2015	Tanner et al.	N/A	N/A
9433713	12/2015	Corbett et al.	N/A	N/A

9440013	12/2015	Dowling et al.	N/A	N/A
9452249	12/2015	Kearsley et al.	N/A	N/A
9486566	12/2015	Siess	N/A	N/A
9492601	12/2015	Casas et al.	N/A	N/A
9533084	12/2016	Siess et al.	N/A	N/A
9539378	12/2016	Tuseth	N/A	N/A
9550017	12/2016	Spanier et al.	N/A	N/A
9555173	12/2016	Spanier	N/A	N/A
9555175	12/2016	Bulent et al.	N/A	N/A
9556873	12/2016	Yanai et al.	N/A	N/A
9561313	12/2016	Taskin	N/A	N/A
9561314	12/2016	Aboul-Hosn et al.	N/A	N/A
9566374	12/2016	Spence et al.	N/A	N/A
9579433	12/2016	LaRose et al.	N/A	N/A
9585991	12/2016	Spence	N/A	N/A
9592397	12/2016	Hansen et al.	N/A	N/A
9603984	12/2016	Romero et al.	N/A	N/A
9616157	12/2016	Akdis	N/A	N/A
9623162	12/2016	Graham et al.	N/A	N/A
9623163	12/2016	Fischi	N/A	N/A
9636442	12/2016	Karmon et al.	N/A	N/A
9656010	12/2016	Burke	N/A	N/A
9669144	12/2016	Spanier et al.	N/A	N/A
9675738	12/2016	Tanner et al.	N/A	N/A
9675739	12/2016	Tanner et al.	N/A	N/A
9675740	12/2016	Zeng et al.	N/A	N/A
9682180	12/2016	Hoarau et al.	N/A	N/A
9717833	12/2016	McBride et al.	N/A	N/A
9731058	12/2016	Siebenhaar et al.	N/A	N/A
9759222	12/2016	Zimmermann et al.	N/A	N/A
9770543	12/2016	Tanner et al.	N/A	N/A
9789238	12/2016	Aboul-Hosn et al.	N/A	N/A
9801990	12/2016	Lynch	N/A	N/A
9814813	12/2016	Corbett	N/A	N/A
9821100	12/2016	Corbett et al.	N/A	N/A
9833550	12/2016	Siess	N/A	N/A
9849223	12/2016	LaRose	N/A	N/A
9872948	12/2017	Siess	N/A	N/A
9878087	12/2017	Richardson et al.	N/A	N/A
9907890	12/2017	Muller	N/A	N/A
9919086	12/2017	Dowling et al.	N/A	N/A
9919087	12/2017	Pfeffer et al.	N/A	N/A
9950101	12/2017	Smith et al.	N/A	N/A
9950102	12/2017	Spence et al.	N/A	N/A
9968719	12/2017	Colella	N/A	N/A
9999714	12/2017	Spanier et al.	N/A	N/A
10029037	12/2017	Muller et al.	N/A	N/A
10123875	12/2017	Wildhirt et al.	N/A	N/A
10124102	12/2017	Bulent et al.	N/A	N/A
10130742	12/2017	Tuseth	N/A	N/A
10149932	12/2017	McBride et al.	N/A	N/A
10179197	12/2018	Kaiser et al.	N/A	N/A
10201645	12/2018	Muller	N/A	N/A
10207038	12/2018	Neumann	N/A	N/A
10220129	12/2018	Ayre et al.	N/A	N/A
10232099	12/2018	Peters et al.	N/A	N/A
10238782	12/2018	Barry	N/A	N/A
10238783	12/2018	Aboul-Hosn et al.	N/A	N/A
10251986	12/2018	Larose et al.	N/A	N/A
10279093	12/2018	Reichenbach et al.	N/A	N/A
10293090	12/2018	Bonde et al.	N/A	N/A
10300185	12/2018	Aboul-Hosn et al.	N/A	N/A
10300249	12/2018	Tao et al.	N/A	N/A
10322217	12/2018	Spence	N/A	N/A
10327858	12/2018	Dumesnil	N/A	N/A
10342906	12/2018	D'Ambrosio et al.	N/A	N/A
10350342	12/2018	Thomas et al.	N/A	N/A
10357598	12/2018	Aboul-Hosn et al.	N/A	N/A
10361617	12/2018	Mueller et al.	N/A	N/A
10371150	12/2018	Wu et al.	N/A	N/A
10376162	12/2018	Edelman et al.	N/A	N/A
10413651	12/2018	Yomtov et al.	N/A	N/A
10420869	12/2018	Cornen	N/A	N/A
10426563	12/2018	Dumesnil	N/A	N/A
10434232	12/2018	Wu et al.	N/A	N/A

10449275	12/2018	Corbett	N/A	N/A
10449279	12/2018	Muller	N/A	N/A
10478538	12/2018	Scheckel et al.	N/A	N/A
10478539	12/2018	Pfeffer et al.	N/A	N/A
10478542	12/2018	Jahangir	N/A	N/A
10493191	12/2018	Whisenant et al.	N/A	N/A
10500323	12/2018	Heuring et al.	N/A	N/A
10512537	12/2018	Corbett et al.	N/A	N/A
10525178	12/2019	Zeng	N/A	N/A
10537670	12/2019	Tuseth et al.	N/A	N/A
10537672	12/2019	Tuseth et al.	N/A	N/A
10549020	12/2019	Spence et al.	N/A	N/A
10557475	12/2019	Roehn	N/A	N/A
10561771	12/2019	Heilman et al.	N/A	N/A
10561772	12/2019	Schumacher	N/A	N/A
10576191	12/2019	LaRose	N/A	N/A
10584589	12/2019	Schumacher et al.	N/A	N/A
10589012	12/2019	Toellner et al.	N/A	N/A
10589013	12/2019	Bourque	N/A	N/A
10610626	12/2019	Spanier et al.	N/A	N/A
10617808	12/2019	Hastie et al.	N/A	N/A
10632241	12/2019	Schenck et al.	N/A	N/A
10660998	12/2019	Hodges	N/A	N/A
10662967	12/2019	Scheckel	N/A	N/A
10668195	12/2019	Flores	N/A	N/A
10669855	12/2019	Toellner et al.	N/A	N/A
10722631	12/2019	Salahieh et al.	N/A	N/A
10773002	12/2019	Siess et al.	N/A	N/A
10814053	12/2019	Throckmorton et al.	N/A	N/A
10857273	12/2019	Hodges et al.	N/A	N/A
10857275	12/2019	Granegger	N/A	N/A
10864308	12/2019	Muller et al.	N/A	N/A
D923797	12/2020	Parks et al.	N/A	N/A
D923798	12/2020	Goulet et al.	N/A	N/A
11027114	12/2020	D'Ambrosio et al.	N/A	N/A
11033729	12/2020	Scheckel et al.	N/A	N/A
11045638	12/2020	Keenan et al.	N/A	N/A
11058863	12/2020	Demou	N/A	N/A
11058865	12/2020	Fitzgerald et al.	N/A	N/A
11065434	12/2020	Egler et al.	N/A	N/A
11092158	12/2020	Siess et al.	N/A	N/A
11097092	12/2020	Siess et al.	N/A	N/A
11103689	12/2020	Siess et al.	N/A	N/A
11103690	12/2020	Epple	N/A	N/A
11107626	12/2020	Siess et al.	N/A	N/A
11123538	12/2020	Epple et al.	N/A	N/A
11123539	12/2020	Pfeffer et al.	N/A	N/A
11123541	12/2020	Corbett et al.	N/A	N/A
11129978	12/2020	Pfeffer et al.	N/A	N/A
11141579	12/2020	Steingräber	N/A	N/A
11160970	12/2020	Muller et al.	N/A	N/A
11167124	12/2020	Pfeffer et al.	N/A	N/A
11173297	12/2020	Muller	N/A	N/A
11179557	12/2020	Georges et al.	N/A	N/A
11185678	12/2020	Smith et al.	N/A	N/A
11185680	12/2020	Tuval et al.	N/A	N/A
11191944	12/2020	Tuval et al.	N/A	N/A
11197989	12/2020	Arslan et al.	N/A	N/A
11202901	12/2020	Barry	N/A	N/A
11219756	12/2021	Tanner et al.	N/A	N/A
11229786	12/2021	Zeng et al.	N/A	N/A
11235138	12/2021	Gross-Hardt et al.	N/A	N/A
11235140	12/2021	Siess et al.	N/A	N/A
11241568	12/2021	Keenan et al.	N/A	N/A
11241569	12/2021	Delgado, III	N/A	N/A
11253693	12/2021	Pfeffer et al.	N/A	N/A
11260212	12/2021	Tuval et al.	N/A	N/A
11260213	12/2021	Zeng et al.	N/A	N/A
11260215	12/2021	Scheckel et al.	N/A	N/A
11273299	12/2021	Wolman et al.	N/A	N/A
11273300	12/2021	Schafir	N/A	N/A
11273301	12/2021	Pfeffer et al.	N/A	N/A
11278711	12/2021	Liebing	N/A	N/A
11280345	12/2021	Bredenbreuker et al.	N/A	N/A
11285309	12/2021	Tuval et al.	N/A	N/A

11291824	12/2021	Schwammenthal et al.	N/A	N/A
11291825	12/2021	Tuval et al.	N/A	N/A
11291826	12/2021	Tuval et al.	N/A	N/A
11298519	12/2021	Josephy et al.	N/A	N/A
11298520	12/2021	Schwammenthal et al.	N/A	N/A
11298521	12/2021	Schwammenthal et al.	N/A	N/A
11298523	12/2021	Tuval et al.	N/A	N/A
11298524	12/2021	El Katerji et al.	N/A	N/A
11298525	12/2021	Jahangir	N/A	N/A
11305103	12/2021	Larose et al.	N/A	N/A
11305105	12/2021	Corbett et al.	N/A	N/A
11311711	12/2021	Casas et al.	N/A	N/A
11311712	12/2021	Zeng et al.	N/A	N/A
11313228	12/2021	Schumacher et al.	N/A	N/A
D951435	12/2021	Motomura et al.	N/A	N/A
11317988	12/2021	Hansen et al.	N/A	N/A
11318295	12/2021	Reyes et al.	N/A	N/A
11324940	12/2021	Earles et al.	N/A	N/A
11324941	12/2021	Xu et al.	N/A	N/A
11331465	12/2021	Epple	N/A	N/A
11331466	12/2021	Keen et al.	N/A	N/A
11331467	12/2021	King et al.	N/A	N/A
11331470	12/2021	Muller et al.	N/A	N/A
11338124	12/2021	Pfeffer et al.	N/A	N/A
11338125	12/2021	Liu et al.	N/A	N/A
11344716	12/2021	Taskin	N/A	N/A
11344717	12/2021	Kallenbach et al.	N/A	N/A
11351356	12/2021	Mohl	N/A	N/A
11351357	12/2021	Mohl	N/A	N/A
11351359	12/2021	Clifton et al.	N/A	N/A
11357438	12/2021	Stewart et al.	N/A	N/A
11357967	12/2021	Zeng et al.	N/A	N/A
11364373	12/2021	Corbett et al.	N/A	N/A
11368081	12/2021	Vogt et al.	N/A	N/A
11369785	12/2021	Callaway et al.	N/A	N/A
11369786	12/2021	Menon et al.	N/A	N/A
11376415	12/2021	Mohl	N/A	N/A
11389639	12/2021	Casas	N/A	N/A
11389641	12/2021	Nguyen et al.	N/A	N/A
11413443	12/2021	Hodges et al.	N/A	N/A
11413446	12/2021	Siess et al.	N/A	N/A
11415150	12/2021	Richert et al.	N/A	N/A
11421701	12/2021	Schumacher et al.	N/A	N/A
11428236	12/2021	McBride et al.	N/A	N/A
11433168	12/2021	Wu et al.	N/A	N/A
11434921	12/2021	McBride et al.	N/A	N/A
11434922	12/2021	Roehn	N/A	N/A
11439806	12/2021	Kimball et al.	N/A	N/A
11446481	12/2021	Wolman et al.	N/A	N/A
11446482	12/2021	Kirchhoff et al.	N/A	N/A
11452859	12/2021	Earles et al.	N/A	N/A
11460030	12/2021	Shambaugh et al.	N/A	N/A
11471662	12/2021	Akkerman et al.	N/A	N/A
11471663	12/2021	Tuval et al.	N/A	N/A
11471665	12/2021	Clifton et al.	N/A	N/A
11478627	12/2021	Siess et al.	N/A	N/A
11478628	12/2021	Muller et al.	N/A	N/A
11478629	12/2021	Harjes et al.	N/A	N/A
11484698	12/2021	Radman	N/A	N/A
11484699	12/2021	Tuval et al.	N/A	N/A
11486400	12/2021	Schumacher	N/A	N/A
11491320	12/2021	Siess	N/A	N/A
11491322	12/2021	Muller et al.	N/A	N/A
11497896	12/2021	Tanner et al.	N/A	N/A
11497906	12/2021	Grace et al.	N/A	N/A
11511101	12/2021	Hastie et al.	N/A	N/A
11511103	12/2021	Salahieh et al.	N/A	N/A
11511104	12/2021	Dur et al.	N/A	N/A
11517726	12/2021	Siess et al.	N/A	N/A
11517736	12/2021	Earles et al.	N/A	N/A
11517737	12/2021	Struthers et al.	N/A	N/A
11517738	12/2021	Wisniewski	N/A	N/A
11517739	12/2021	Toellner	N/A	N/A
11517740	12/2021	Agarwa et al.	N/A	N/A
11524137	12/2021	Jahangir	N/A	N/A

11524165	12/2021	Tan et al.	N/A	N/A
11527322	12/2021	Agnello et al.	N/A	N/A
11529062	12/2021	Moyer et al.	N/A	N/A
11534596	12/2021	Schafir et al.	N/A	N/A
11565103	12/2022	Farago et al.	N/A	N/A
11569015	12/2022	Mourran et al.	N/A	N/A
11572879	12/2022	Mohl	N/A	N/A
11577067	12/2022	Breidall et al.	N/A	N/A
11577068	12/2022	Spence et al.	N/A	N/A
11583659	12/2022	Pfeffer et al.	N/A	N/A
11583670	12/2022	Pfeifer et al.	N/A	N/A
11583671	12/2022	Nguyen et al.	N/A	N/A
11583672	12/2022	Weber et al.	N/A	N/A
11590336	12/2022	Harjes et al.	N/A	N/A
11590337	12/2022	Granegger et al.	N/A	N/A
11590338	12/2022	Barry	N/A	N/A
11592028	12/2022	Schumacher et al.	N/A	N/A
11596727	12/2022	Siess et al.	N/A	N/A
11602627	12/2022	Leonhardt	N/A	N/A
11617876	12/2022	Scheckel et al.	N/A	N/A
11628293	12/2022	Gandhi et al.	N/A	N/A
11632015	12/2022	Sconzert et al.	N/A	N/A
11633586	12/2022	Tanner et al.	N/A	N/A
11638813	12/2022	West	N/A	N/A
11639722	12/2022	Medvedev et al.	N/A	N/A
11642511	12/2022	Delgado, III	N/A	N/A
11648387	12/2022	Schwammenthal et al.	N/A	N/A
11648388	12/2022	Siess et al.	N/A	N/A
11648389	12/2022	Wang et al.	N/A	N/A
11648390	12/2022	Spanier et al.	N/A	N/A
11648391	12/2022	Schwammenthal et al.	N/A	N/A
11648392	12/2022	Tuval et al.	N/A	N/A
11648393	12/2022	Taskin et al.	N/A	N/A
11654273	12/2022	Granegger et al.	N/A	N/A
11654275	12/2022	Brandt	N/A	N/A
11654276	12/2022	Fitzgerald et al.	N/A	N/A
11660441	12/2022	Fitzgerald et al.	N/A	N/A
11666747	12/2022	Tuval et al.	N/A	N/A
11666748	12/2022	Kronstedt et al.	N/A	N/A
11668321	12/2022	Richert et al.	N/A	N/A
11674517	12/2022	Mohl	N/A	N/A
11679234	12/2022	King et al.	N/A	N/A
11679249	12/2022	Scheckel et al.	N/A	N/A
11684275	12/2022	Tuval et al.	N/A	N/A
11684769	12/2022	Harjes et al.	N/A	N/A
11690521	12/2022	Tuval et al.	N/A	N/A
11690996	12/2022	Siess et al.	N/A	N/A
11697016	12/2022	Epple	N/A	N/A
11701510	12/2022	Demou	N/A	N/A
11702938	12/2022	Schumacher et al.	N/A	N/A
11703064	12/2022	Bredenbreuker et al.	N/A	N/A
11708833	12/2022	McBride et al.	N/A	N/A
11744987	12/2022	Siess et al.	N/A	N/A
11745005	12/2022	Delgado, III	N/A	N/A
11746906	12/2022	Balta et al.	N/A	N/A
11752322	12/2022	Aboulhosn et al.	N/A	N/A
11752323	12/2022	Edwards et al.	N/A	N/A
11754075	12/2022	Schuelke et al.	N/A	N/A
11754077	12/2022	Mohl	N/A	N/A
11759612	12/2022	Tanner et al.	N/A	N/A
11759622	12/2022	Siess et al.	N/A	N/A
11766555	12/2022	Matthes et al.	N/A	N/A
11771884	12/2022	Siess et al.	N/A	N/A
11771885	12/2022	Liu et al.	N/A	N/A
11779234	12/2022	Harjes et al.	N/A	N/A
11779751	12/2022	Earles et al.	N/A	N/A
11781550	12/2022	Siess et al.	N/A	N/A
11786386	12/2022	Brady et al.	N/A	N/A
11786700	12/2022	Pfeffer et al.	N/A	N/A
11786720	12/2022	Muller	N/A	N/A
11793994	12/2022	Josephy et al.	N/A	N/A
11804767	12/2022	Vogt et al.	N/A	N/A
11806116	12/2022	Tuval et al.	N/A	N/A
11806117	12/2022	Tuval et al.	N/A	N/A
11806517	12/2022	Petersen	N/A	N/A

11806518	12/2022	Michelena et al.	N/A	N/A
11813443	12/2022	Hanson et al.	N/A	N/A
11813444	12/2022	Siess et al.	N/A	N/A
11819678	12/2022	Siess et al.	N/A	N/A
11824381	12/2022	Conyers et al.	N/A	N/A
11826127	12/2022	Casas	N/A	N/A
11833278	12/2022	Siess et al.	N/A	N/A
11833342	12/2022	Tanner et al.	N/A	N/A
11839754	12/2022	Tuval et al.	N/A	N/A
11844592	12/2022	Tuval et al.	N/A	N/A
11844940	12/2022	D'Ambrosio et al.	N/A	N/A
11850412	12/2022	Grauwinkel et al.	N/A	N/A
11850413	12/2022	Zeng et al.	N/A	N/A
11850414	12/2022	Schenck et al.	N/A	N/A
11850415	12/2022	Schwammenthal et al.	N/A	N/A
11857743	12/2023	Fantuzzi et al.	N/A	N/A
11857777	12/2023	Earles et al.	N/A	N/A
11865238	12/2023	Siess et al.	N/A	N/A
11872384	12/2023	Cotter	N/A	N/A
11883005	12/2023	Golden et al.	N/A	N/A
11883207	12/2023	El Katerji et al.	N/A	N/A
11883310	12/2023	Nolan et al.	N/A	N/A
11883641	12/2023	Dur et al.	N/A	N/A
11890212	12/2023	Gilmartin et al.	N/A	N/A
11896199	12/2023	Lent et al.	N/A	N/A
11896482	12/2023	Delaloye et al.	N/A	N/A
11898642	12/2023	Stanton et al.	N/A	N/A
11904104	12/2023	Jahangir	N/A	N/A
11911579	12/2023	Tanner et al.	N/A	N/A
11918470	12/2023	Jarral et al.	N/A	N/A
11918496	12/2023	Folan	N/A	N/A
11918726	12/2023	Siess et al.	N/A	N/A
11918800	12/2023	Muller et al.	N/A	N/A
11925356	12/2023	Anderson et al.	N/A	N/A
11925570	12/2023	Lydecker et al.	N/A	N/A
11925794	12/2023	Malkin et al.	N/A	N/A
11925795	12/2023	Muller et al.	N/A	N/A
11925796	12/2023	Tanner et al.	N/A	N/A
11925797	12/2023	Tanner et al.	N/A	N/A
11938311	12/2023	Corbett et al.	N/A	N/A
11944805	12/2023	Stotz	N/A	N/A
11980385	12/2023	Haselman	N/A	N/A
11986604	12/2023	Siess	N/A	N/A
12005248	12/2023	Vogt et al.	N/A	N/A
12011583	12/2023	Wang	N/A	N/A
12017058	12/2023	Kerkhoffs et al.	N/A	N/A
12023476	12/2023	Tuval et al.	N/A	N/A
12023477	12/2023	Siess	N/A	N/A
12029891	12/2023	Siess et al.	N/A	N/A
12059559	12/2023	Muller et al.	N/A	N/A
12064120	12/2023	Hajjar et al.	N/A	N/A
12064611	12/2023	D'Ambrosio et al.	N/A	N/A
12064614	12/2023	Agah et al.	N/A	N/A
12064615	12/2023	Stotz et al.	N/A	N/A
12064616	12/2023	Spanier et al.	N/A	N/A
12076544	12/2023	Siess et al.	N/A	N/A
12076549	12/2023	Stotz et al.	N/A	N/A
12090314	12/2023	Tuval et al.	N/A	N/A
12092114	12/2023	Siess	N/A	N/A
12097016	12/2023	Goldvasser	N/A	N/A
12102815	12/2023	Dhaliwal et al.	N/A	N/A
12107474	12/2023	Vollmer	N/A	N/A
12121713	12/2023	Calomeni et al.	N/A	N/A
12144936	12/2023	Tao et al.	N/A	N/A
12144976	12/2023	Baumbach et al.	N/A	N/A
12161854	12/2023	Earles et al.	N/A	N/A
12161855	12/2023	Hastie et al.	N/A	N/A
12171993	12/2023	Higgins et al.	N/A	N/A
12194287	12/2024	Kassel et al.	N/A	N/A
2001/0009645	12/2000	Noda	N/A	N/A
2001/0041934	12/2000	Yamazaki et al.	N/A	N/A
2002/0076322	12/2001	Maeda et al.	N/A	N/A
2002/0082585	12/2001	Carroll et al.	N/A	N/A
2002/0147495	12/2001	Petroff	N/A	N/A
2002/0153664	12/2001	Schroeder	N/A	N/A

2003/0060685	12/2002	Houser	N/A	N/A
2003/0091450	12/2002	Davis et al.	N/A	N/A
2003/0100816	12/2002	Siess	N/A	N/A
2003/0111800	12/2002	Kreutzer	N/A	N/A
2003/0139643	12/2002	Smith et al.	N/A	N/A
2003/0191357	12/2002	Frazier	N/A	N/A
2003/0199727	12/2002	Burke	N/A	N/A
2004/0044266	12/2003	Siess et al.	N/A	N/A
2004/0102674	12/2003	Zadini et al.	N/A	N/A
2004/0115038	12/2003	Nuesser et al.	N/A	N/A
2004/0167376	12/2003	Peters et al.	N/A	N/A
2004/0234391	12/2003	Izraelev	N/A	N/A
2004/0241019	12/2003	Goldowsky	N/A	N/A
2004/0260346	12/2003	Overall et al.	N/A	N/A
2005/0006083	12/2004	Chen et al.	N/A	N/A
2005/0008509	12/2004	Chang	N/A	N/A
2005/0019167	12/2004	Nusser et al.	N/A	N/A
2005/0085683	12/2004	Bolling et al.	N/A	N/A
2005/0220636	12/2004	Henein et al.	N/A	N/A
2005/0254976	12/2004	Carrier et al.	N/A	N/A
2006/0030809	12/2005	Barzilay et al.	N/A	N/A
2006/0062672	12/2005	McBride et al.	N/A	N/A
2006/0155158	12/2005	Aboul-Hosn	N/A	N/A
2006/0224110	12/2005	Scott et al.	N/A	N/A
2006/0276682	12/2005	Bolling et al.	N/A	N/A
2007/0004959	12/2006	Carrier et al.	N/A	N/A
2007/0073352	12/2006	Euler et al.	N/A	N/A
2007/0142696	12/2006	Crosby et al.	N/A	N/A
2007/0156006	12/2006	Smith et al.	N/A	N/A
2008/0015517	12/2007	Geistert et al.	N/A	N/A
2008/0058925	12/2007	Cohen	N/A	N/A
2008/0086027	12/2007	Siess et al.	N/A	N/A
2008/0114339	12/2007	McBride et al.	N/A	N/A
2008/0262289	12/2007	Goldowsky	N/A	N/A
2008/0292478	12/2007	Baykut et al.	N/A	N/A
2008/0306328	12/2007	Ercolani	N/A	N/A
2009/0004037	12/2008	Ito	N/A	N/A
2009/0112312	12/2008	Larose et al.	N/A	N/A
2009/0203957	12/2008	LaRose et al.	N/A	N/A
2009/0204205	12/2008	Larose et al.	N/A	N/A
2010/0041939	12/2009	Siess	N/A	N/A
2010/0082099	12/2009	Vodermayer et al.	N/A	N/A
2010/0191035	12/2009	Kang et al.	N/A	N/A
2010/0268017	12/2009	Siess	N/A	N/A
2010/0298625	12/2009	Reichenbach et al.	N/A	N/A
2011/0152600	12/2010	Scott et al.	N/A	N/A
2011/0172505	12/2010	Kim	N/A	N/A
2011/0184224	12/2010	Garrigue	N/A	N/A
2011/0230821	12/2010	Babic	N/A	N/A
2011/0237863	12/2010	Ricci et al.	N/A	N/A
2011/0238172	12/2010	Akdis	N/A	N/A
2012/0029265	12/2011	LaRose	N/A	N/A
2012/0035645	12/2011	Gross	N/A	N/A
2012/0088954	12/2011	Foster	N/A	N/A
2012/0093628	12/2011	Liebing	N/A	N/A
2012/0134793	12/2011	Wu et al.	N/A	N/A
2012/0172655	12/2011	Campbell et al.	N/A	N/A
2012/0178986	12/2011	Campbell et al.	N/A	N/A
2012/0245404	12/2011	Smith	N/A	N/A
2012/0247200	12/2011	Ahonen et al.	N/A	N/A
2012/0283506	12/2011	Meister et al.	N/A	N/A
2012/0310036	12/2011	Peters et al.	N/A	N/A
2013/0053623	12/2012	Evans	N/A	N/A
2013/0085318	12/2012	Toellner	N/A	N/A
2013/0209292	12/2012	Baykut et al.	N/A	N/A
2013/0281761	12/2012	Kapur	N/A	N/A
2013/0289376	12/2012	Lang	N/A	N/A
2013/0303830	12/2012	Zeng et al.	N/A	N/A
2013/0303831	12/2012	Evans	N/A	N/A
2013/0303832	12/2012	Wampler	N/A	N/A
2013/0330219	12/2012	LaRose et al.	N/A	N/A
2014/0005467	12/2013	Farnan et al.	N/A	N/A
2014/0030122	12/2013	Ozaki	N/A	N/A
2014/0051908	12/2013	Khanal et al.	N/A	N/A
2014/0079557	12/2013	LaRose et al.	N/A	N/A

2014/0107399	12/2013	Spence	N/A	N/A
2014/0167545	12/2013	Bremner et al.	N/A	N/A
2014/0194717	12/2013	Wildhirt et al.	N/A	N/A
2014/0200389	12/2013	Yanai et al.	N/A	N/A
2014/0207232	12/2013	Garrigue	N/A	N/A
2014/0275721	12/2013	Yanai et al.	N/A	N/A
2014/0303426	12/2013	Kerkhoffs et al.	N/A	N/A
2014/0309733	12/2013	Cotter	N/A	N/A
2014/0330069	12/2013	Hastings et al.	N/A	N/A
2014/0341726	12/2013	Wu et al.	N/A	N/A
2015/0031936	12/2014	LaRose et al.	N/A	N/A
2015/0051435	12/2014	Siess et al.	N/A	N/A
2015/0051438	12/2014	Taskin	N/A	N/A
2015/0099923	12/2014	Magovern et al.	N/A	N/A
2015/0141842	12/2014	Spanier et al.	N/A	N/A
2015/0171694	12/2014	Dallas	N/A	N/A
2015/0190092	12/2014	Mori	N/A	N/A
2015/0273184	12/2014	Scott et al.	N/A	N/A
2015/0290372	12/2014	Muller et al.	N/A	N/A
2015/0290373	12/2014	Rudser et al.	N/A	N/A
2015/0306291	12/2014	Bonde et al.	N/A	N/A
2015/0343179	12/2014	Schumacher et al.	N/A	N/A
2015/0365738	12/2014	Purvis et al.	N/A	N/A
2015/0374892	12/2014	Yanai et al.	N/A	N/A
2016/0008531	12/2015	Wang et al.	N/A	N/A
2016/0030649	12/2015	Zeng	N/A	N/A
2016/0038663	12/2015	Taskin et al.	N/A	N/A
2016/0045654	12/2015	Connor	N/A	N/A
2016/0067395	12/2015	Jimenez et al.	N/A	N/A
2016/0144089	12/2015	Woo et al.	N/A	N/A
2016/0144166	12/2015	Decréet al.	N/A	N/A
2016/0166747	12/2015	Frazier et al.	N/A	N/A
2016/0213828	12/2015	Sievers	N/A	N/A
2016/0223086	12/2015	Balsells et al.	N/A	N/A
2016/0254704	12/2015	Hansen et al.	N/A	N/A
2016/0256620	12/2015	Scheckel et al.	N/A	N/A
2016/0279311	12/2015	Cecere et al.	N/A	N/A
2016/0367739	12/2015	Wiesener et al.	N/A	N/A
2016/0375187	12/2015	Lee et al.	N/A	N/A
2017/0021069	12/2016	Hodges	N/A	N/A
2017/0021074	12/2016	Opfermann et al.	N/A	N/A
2017/0035952	12/2016	Muller	N/A	N/A
2017/0043074	12/2016	Siess	N/A	N/A
2017/0049947	12/2016	Corbett et al.	N/A	N/A
2017/0080136	12/2016	Janeczek et al.	N/A	N/A
2017/0087286	12/2016	Spanier et al.	N/A	N/A
2017/0087288	12/2016	Groß-HardtTim et al.	N/A	N/A
2017/0128644	12/2016	Foster	N/A	N/A
2017/0136225	12/2016	Siess et al.	N/A	N/A
2017/0143952	12/2016	Siess et al.	N/A	N/A
2017/0157309	12/2016	Begg et al.	N/A	N/A
2017/0209633	12/2016	Cohen	N/A	N/A
2017/0232169	12/2016	Muller	N/A	N/A
2017/0274128	12/2016	Tamburino et al.	N/A	N/A
2017/0333607	12/2016	Zarins	N/A	N/A
2017/0333608	12/2016	Zeng	N/A	N/A
2017/0340787	12/2016	Corbett et al.	N/A	N/A
2017/0340788	12/2016	Korakianitis et al.	N/A	N/A
2017/0340789	12/2016	Bonde et al.	N/A	N/A
2017/0343043	12/2016	Walsh et al.	N/A	N/A
2018/0015214	12/2017	Lynch	N/A	N/A
2018/0021494	12/2017	Muller et al.	N/A	N/A
2018/0021495	12/2017	Muller et al.	N/A	N/A
2018/0050141	12/2017	Corbett et al.	N/A	N/A
2018/0055979	12/2017	Corbett et al.	N/A	N/A
2018/0064860	12/2017	Nunez et al.	N/A	N/A
2018/0093070	12/2017	Cottone	N/A	N/A
2018/0099076	12/2017	LaRose	N/A	N/A
2018/0110907	12/2017	Keenan et al.	N/A	N/A
2018/0133379	12/2017	Farnan et al.	N/A	N/A
2018/0154058	12/2017	Menon et al.	N/A	N/A
2018/0169312	12/2017	Barry	N/A	N/A
2018/0169313	12/2017	Schwammenthal et al.	N/A	N/A
2018/0199635	12/2017	Longinotti-Buitoni et al.	N/A	N/A
2018/0207336	12/2017	Solem	N/A	N/A

2018/0219452	12/2017	Boisclair	N/A	N/A
2018/0221551	12/2017	Tanner et al.	N/A	N/A
2018/0221553	12/2017	Taskin	N/A	N/A
2018/0228950	12/2017	Janeczek et al.	N/A	N/A
2018/0228953	12/2017	Siess et al.	N/A	N/A
2018/0243004	12/2017	von Segesser et al.	N/A	N/A
2018/0243489	12/2017	Haddadi	N/A	N/A
2018/0250456	12/2017	Nitzan et al.	N/A	N/A
2018/0256797	12/2017	Schenck	N/A	A61M 60/414
2018/0280598	12/2017	Curran et al.	N/A	N/A
2018/0289877	12/2017	Schumacher et al.	N/A	N/A
2018/0303990	12/2017	Siess et al.	N/A	N/A
2018/0311421	12/2017	Tuseth	N/A	N/A
2018/0311423	12/2017	Zeng et al.	N/A	N/A
2018/0318483	12/2017	Dague et al.	N/A	N/A
2018/0318547	12/2017	Yokoyama	N/A	N/A
2018/0326132	12/2017	Maimon et al.	N/A	N/A
2018/0333059	12/2017	Casas	N/A	N/A
2018/0335037	12/2017	Shambaugh et al.	N/A	N/A
2018/0345028	12/2017	Aboud et al.	N/A	N/A
2018/0361042	12/2017	Fitzgerald et al.	N/A	N/A
2018/0369469	12/2017	Le Duc De Lillers et al.	N/A	N/A
2019/0001034	12/2018	Taskin et al.	N/A	N/A
2019/0004037	12/2018	Zhang et al.	N/A	N/A
2019/0030228	12/2018	Keenan et al.	N/A	N/A
2019/0046702	12/2018	Siess et al.	N/A	N/A
2019/0046703	12/2018	Shambaugh et al.	N/A	N/A
2019/0054223	12/2018	Frazier et al.	N/A	N/A
2019/0060539	12/2018	Siess et al.	N/A	N/A
2019/0060543	12/2018	Khanal et al.	N/A	N/A
2019/0076167	12/2018	Fantuzzi et al.	N/A	N/A
2019/0083690	12/2018	Siess et al.	N/A	N/A
2019/0099532	12/2018	Er	N/A	N/A
2019/0101130	12/2018	Bredenbreuker et al.	N/A	N/A
2019/0105437	12/2018	Siess et al.	N/A	N/A
2019/0117865	12/2018	Walters et al.	N/A	N/A
2019/0125948	12/2018	Stanfield et al.	N/A	N/A
2019/0143016	12/2018	Corbett et al.	N/A	N/A
2019/0143018	12/2018	Salahieh et al.	N/A	N/A
2019/0154053	12/2018	McBride et al.	N/A	N/A
2019/0167122	12/2018	Obermiller et al.	N/A	N/A
2019/0167875	12/2018	Simon et al.	N/A	N/A
2019/0167878	12/2018	Rowe	N/A	N/A
2019/0170153	12/2018	Scheckel	N/A	N/A
2019/0175806	12/2018	Tuval et al.	N/A	N/A
2019/0184078	12/2018	Zilbershlag et al.	N/A	N/A
2019/0184080	12/2018	Mohl	N/A	N/A
2019/0192752	12/2018	Tiller et al.	N/A	N/A
2019/0201603	12/2018	Siess et al.	N/A	N/A
2019/0209755	12/2018	Nix et al.	N/A	N/A
2019/0209758	12/2018	Tuval et al.	N/A	N/A
2019/0211836	12/2018	Schumacher et al.	N/A	N/A
2019/0211846	12/2018	Liebing	N/A	N/A
2019/0211847	12/2018	Walsh et al.	N/A	N/A
2019/0223877	12/2018	Nitzen et al.	N/A	N/A
2019/0269840	12/2018	Tuval et al.	N/A	N/A
2019/0275224	12/2018	Hanson et al.	N/A	N/A
2019/0282741	12/2018	Franano et al.	N/A	N/A
2019/0282744	12/2018	D'Ambrosio et al.	N/A	N/A
2019/0282746	12/2018	Judisch	N/A	N/A
2019/0290817	12/2018	Guo et al.	N/A	N/A
2019/0298902	12/2018	Siess et al.	N/A	N/A
2019/0316591	12/2018	Toellner	N/A	N/A
2019/0321527	12/2018	King et al.	N/A	N/A
2019/0321529	12/2018	Korakianitis et al.	N/A	N/A
2019/0321531	12/2018	Cambronne et al.	N/A	N/A
2019/0336664	12/2018	Liebing	N/A	N/A
2019/0344000	12/2018	Kushwaha et al.	N/A	N/A
2019/0344001	12/2018	Salahieh et al.	N/A	N/A
2019/0351117	12/2018	Cambronne et al.	N/A	N/A
2019/0351119	12/2018	Cambronne et al.	N/A	N/A
2019/0351120	12/2018	Kushwaha et al.	N/A	N/A
2019/0358378	12/2018	Schumacher	N/A	N/A
2019/0358379	12/2018	Wiessler et al.	N/A	N/A
2019/0358384	12/2018	Epple	N/A	N/A

2019/0365975	12/2018	Muller et al.	N/A	N/A
2019/0383298	12/2018	Toellner	N/A	N/A
2020/0016309	12/2019	Kallenbach et al.	N/A	N/A
2020/0023109	12/2019	Epple	N/A	N/A
2020/0030507	12/2019	Higgins et al.	N/A	N/A
2020/0030509	12/2019	Siess et al.	N/A	N/A
2020/0030510	12/2019	Higgins	N/A	N/A
2020/0030511	12/2019	Higgins	N/A	N/A
2020/0030512	12/2019	Higgins et al.	N/A	N/A
2020/0038567	12/2019	Siess et al.	N/A	N/A
2020/0038568	12/2019	Higgins et al.	N/A	N/A
2020/0038571	12/2019	Jahangir	N/A	N/A
2020/0069857	12/2019	Schwammenthal et al.	N/A	N/A
2020/0088207	12/2019	Schumacher et al.	N/A	N/A
2020/0114053	12/2019	Salahieh et al.	N/A	N/A
2020/0129684	12/2019	Pfeffer et al.	N/A	N/A
2020/0139028	12/2019	Scheckel et al.	N/A	N/A
2020/0139029	12/2019	Scheckel et al.	N/A	N/A
2020/0147283	12/2019	Tanner et al.	N/A	N/A
2020/0164125	12/2019	Muller et al.	N/A	N/A
2020/0164126	12/2019	Muller	N/A	N/A
2020/0261633	12/2019	Spanier	N/A	N/A
2020/0345337	12/2019	Muller et al.	N/A	N/A
2020/0350812	12/2019	Vogt et al.	N/A	N/A
2021/0052793	12/2020	Struthers et al.	N/A	N/A
2021/0236803	12/2020	Stotz	N/A	N/A
2021/0268264	12/2020	Stotz	N/A	N/A
2021/0290929	12/2020	Stotz	N/A	N/A
2021/0290930	12/2020	Kasel	N/A	N/A
2021/0290932	12/2020	Stotz	N/A	N/A
2021/0290937	12/2020	Baumbach	N/A	N/A
2021/0313869	12/2020	Strasswiemer et al.	N/A	N/A
2021/0322756	12/2020	Vollmer et al.	N/A	N/A
2021/0330958	12/2020	Stotz et al.	N/A	N/A
2021/0338999	12/2020	Stotz et al.	N/A	N/A
2021/0339004	12/2020	Schlebusch et al.	N/A	N/A
2021/0339005	12/2020	Stotz et al.	N/A	N/A
2021/0346678	12/2020	Baumbach et al.	N/A	N/A
2021/0346680	12/2020	Vogt et al.	N/A	N/A
2021/0379352	12/2020	Schlebusch et al.	N/A	N/A
2021/0379355	12/2020	Schuelke et al.	N/A	N/A
2021/0384812	12/2020	Vollmer et al.	N/A	N/A
2022/0008714	12/2021	Stotz	N/A	N/A
2022/0016411	12/2021	Winterwerber	N/A	N/A
2022/0072296	12/2021	Mori	N/A	N/A
2022/0072297	12/2021	Tuval et al.	N/A	N/A
2022/0080178	12/2021	Salahieh et al.	N/A	N/A
2022/0080180	12/2021	Siess et al.	N/A	N/A
2022/0080182	12/2021	Earles et al.	N/A	N/A
2022/0080183	12/2021	Earles et al.	N/A	N/A
2022/0080184	12/2021	Clifton et al.	N/A	N/A
2022/0080185	12/2021	Clifton et al.	N/A	N/A
2022/0105337	12/2021	Salahieh et al.	N/A	N/A
2022/0105339	12/2021	Nix et al.	N/A	N/A
2022/0126083	12/2021	Grauwinkel et al.	N/A	N/A
2022/0161018	12/2021	Mitze et al.	N/A	N/A
2022/0161019	12/2021	Mitze et al.	N/A	N/A
2022/0161021	12/2021	Mitze et al.	N/A	N/A
2022/0241580	12/2021	Stotz et al.	N/A	N/A
2022/0323742	12/2021	Grauwinkel et al.	N/A	N/A
2023/0001178	12/2022	Corbett et al.	N/A	N/A
2023/0091199	12/2022	Siess et al.	N/A	N/A
2023/0191141	12/2022	Wenning et al.	N/A	N/A
2023/0277833	12/2022	Sharma et al.	N/A	N/A
2023/0277836	12/2022	Schellenberg et al.	N/A	N/A
2023/0293878	12/2022	Christof et al.	N/A	N/A
2023/0364411	12/2022	Bette	N/A	N/A
2024/0074828	12/2023	Wenning	N/A	N/A
2024/0075277	12/2023	Schellenberg	N/A	N/A
2024/0102475	12/2023	Schuelke et al.	N/A	N/A
2024/0198084	12/2023	Stotz	N/A	N/A
2024/0245902	12/2023	Schlebusch et al.	N/A	N/A
2024/0269459	12/2023	Schellenberg et al.	N/A	N/A
2024/0277998	12/2023	Vogt et al.	N/A	N/A
2024/0285935	12/2023	Popov et al.	N/A	N/A

2024/0335651	12/2023	Mitze et al.	N/A	N/A
2024/0399135	12/2023	Stotz et al.	N/A	N/A

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
7993698	12/1998	AU	N/A
2002308409	12/2004	AU	N/A
2012261669	12/2012	AU	N/A
2013203301	12/2012	AU	N/A
2013273663	12/2013	AU	N/A
PI0904483-3	12/2010	BR	N/A
2 026 692	12/1991	CA	N/A
2 026 693	12/1991	CA	N/A
2 292 432	12/1997	CA	N/A
2 664 835	12/2007	CA	N/A
2 796 357	12/2010	CA	N/A
2 947 984	12/2021	CA	N/A
1222862	12/1998	CN	N/A
1254598	12/1999	CN	N/A
1376523	12/2001	CN	N/A
2535055	12/2002	CN	N/A
1118304	12/2002	CN	N/A
2616217	12/2003	CN	N/A
1202871	12/2004	CN	N/A
1833736	12/2005	CN	N/A
200977306	12/2006	CN	N/A
101112628	12/2007	CN	N/A
101128168	12/2007	CN	N/A
201150675	12/2007	CN	N/A
101677812	12/2009	CN	A61B 18/148
201437016	12/2009	CN	N/A
201618200	12/2009	CN	N/A
201658687	12/2009	CN	N/A
201710717	12/2010	CN	N/A
201894758	12/2010	CN	N/A
102475923	12/2011	CN	N/A
102545538	12/2011	CN	N/A
202314596	12/2011	CN	N/A
102743801	12/2011	CN	N/A
103143072	12/2012	CN	N/A
103845766	12/2013	CN	N/A
103861162	12/2013	CN	N/A
103915980	12/2013	CN	N/A
203842087	12/2013	CN	N/A
104208763	12/2013	CN	N/A
104208764	12/2013	CN	N/A
203971004	12/2013	CN	N/A
104274873	12/2014	CN	N/A
204106671	12/2014	CN	N/A
204219479	12/2014	CN	N/A
103877630	12/2015	CN	N/A
205215814	12/2015	CN	N/A
103977464	12/2015	CN	N/A
104162192	12/2015	CN	N/A
104888293	12/2016	CN	N/A
106512117	12/2016	CN	N/A
104225696	12/2016	CN	N/A
107019824	12/2016	CN	N/A
206443963	12/2016	CN	N/A
107281567	12/2016	CN	N/A
104707194	12/2016	CN	N/A
107921187	12/2017	CN	N/A
105498002	12/2017	CN	N/A
106310410	12/2017	CN	N/A
106902404	12/2018	CN	N/A
209790495	12/2018	CN	N/A
110665079	12/2019	CN	N/A
210020563	12/2019	CN	N/A
111166948	12/2019	CN	N/A
111166949	12/2019	CN	N/A
1 001 642	12/1956	DE	N/A
1 165 144	12/1963	DE	N/A
27 07 951	12/1976	DE	N/A
26 24 058	12/1976	DE	N/A
3 545 214	12/1985	DE	N/A

4105278	12/1991	DE	A61M 60/829
195 46 336	12/1996	DE	N/A
695 01 834	12/1997	DE	N/A
198 54 724	12/1998	DE	N/A
198 21 307	12/1998	DE	N/A
199 10 872	12/1998	DE	N/A
199 56 380	12/1998	DE	N/A
200 13 876	12/2000	DE	N/A
100 59 714	12/2001	DE	N/A
102 26 305	12/2002	DE	N/A
103 45 694	12/2004	DE	N/A
697 31 709	12/2004	DE	N/A
101 55 011	12/2004	DE	N/A
601 19 592	12/2005	DE	N/A
11 2004 001 809	12/2005	DE	N/A
20 2005 020 288	12/2006	DE	N/A
10 2006 019 206	12/2006	DE	N/A
10 2006 036 948	12/2007	DE	N/A
10 2008 060 357	12/2009	DE	N/A
10 2009 039 658	12/2010	DE	N/A
20 2009 018 416	12/2010	DE	N/A
10 2010 041 995	12/2011	DE	N/A
11 2009 000 185	12/2012	DE	N/A
10 2012 022 456	12/2013	DE	N/A
10 2013 007 562	12/2013	DE	N/A
10 2014 210 299	12/2014	DE	N/A
10 2014 212 323	12/2014	DE	N/A
11 2014 001 418	12/2014	DE	N/A
10 2014 224 151	12/2015	DE	N/A
10 2015 216 050	12/2016	DE	N/A
10 2015 219 263	12/2016	DE	N/A
10 2015 222 199	12/2016	DE	N/A
20 2015 009 422	12/2016	DE	N/A
10 2012 207 042	12/2016	DE	N/A
10 2016 013 334	12/2017	DE	N/A
10 2017 209 917	12/2017	DE	N/A
10 2017 212 193	12/2018	DE	N/A
10 2018 207 564	12/2018	DE	N/A
10 2018 207 578	12/2018	DE	N/A
10 2018 207 585	12/2018	DE	N/A
10 2018 207 591	12/2018	DE	N/A
10 2018 207 594	12/2018	DE	N/A
10 2018 207 611	12/2018	DE	N/A
10 2018 207 622	12/2018	DE	N/A
10 2018 208 536	12/2018	DE	N/A
10 2018 208 540	12/2018	DE	N/A
10 2018 208 541	12/2018	DE	N/A
10 2018 208 550	12/2018	DE	N/A
10 2018 208 945	12/2018	DE	N/A
10 2018 210 076	12/2018	DE	N/A
10 2018 207 624	12/2019	DE	N/A
10 2018 211 327	12/2019	DE	N/A
10 2018 211 328	12/2019	DE	N/A
10 2018 212 153	12/2019	DE	N/A
10 2018 213 350	12/2019	DE	N/A
10 2018 220 658	12/2019	DE	N/A
10 2018 222 505	12/2019	DE	N/A
10 2020 102 473	12/2020	DE	N/A
11 2020 003 063	12/2021	DE	N/A
11 2020 004 148	12/2021	DE	N/A
0 050 814	12/1981	EP	N/A
0 629 412	12/1993	EP	N/A
0 764 448	12/1996	EP	N/A
0 855 515	12/1997	EP	N/A
0 890 179	12/1998	EP	N/A
0 904 630	12/1998	EP	N/A
0 916 359	12/1998	EP	N/A
1 013 294	12/1999	EP	N/A
1 186 873	12/2001	EP	N/A
1 011 803	12/2003	EP	N/A
1 475 880	12/2003	EP	N/A
1 169 072	12/2004	EP	N/A
1 176 999	12/2004	EP	N/A
1 801 420	12/2006	EP	N/A
2 009 233	12/2007	EP	N/A

2 098 746	12/2008	EP	N/A
2 314 744	12/2010	EP	N/A
2 403 109	12/2011	EP	N/A
2 187 807	12/2011	EP	N/A
2 330 724	12/2011	EP	N/A
1 827 573	12/2012	EP	N/A
3 326 567	12/2013	EP	N/A
1 898 971	12/2014	EP	N/A
2 519 273	12/2014	EP	N/A
2 217 302	12/2014	EP	N/A
2 438 936	12/2014	EP	N/A
2 438 937	12/2014	EP	N/A
2 960 515	12/2014	EP	N/A
2 968 718	12/2015	EP	N/A
1 996 252	12/2015	EP	N/A
2 475 415	12/2015	EP	N/A
2 906 265	12/2015	EP	N/A
3 069 739	12/2015	EP	N/A
1 931 403	12/2016	EP	N/A
3 127 562	12/2016	EP	N/A
2 585 129	12/2016	EP	N/A
3 187 210	12/2016	EP	N/A
3 222 301	12/2016	EP	N/A
3 222 302	12/2016	EP	N/A
3 020 426	12/2016	EP	N/A
3 038 669	12/2017	EP	N/A
3 062 730	12/2017	EP	N/A
3 180 050	12/2017	EP	N/A
3 287 154	12/2017	EP	N/A
1 789 129	12/2017	EP	N/A
2 366 412	12/2017	EP	N/A
3 205 359	12/2017	EP	N/A
3 205 360	12/2017	EP	N/A
3 131 599	12/2018	EP	N/A
3 456 367	12/2018	EP	N/A
3 478 333	12/2018	EP	N/A
3 119 451	12/2018	EP	N/A
3 536 360	12/2018	EP	N/A
3 542 835	12/2018	EP	N/A
3 542 836	12/2018	EP	N/A
2 505 090	12/2018	EP	N/A
3062877	12/2018	EP	A61M 1/1001
3 668 560	12/2019	EP	N/A
3 711 785	12/2019	EP	N/A
3 711 786	12/2019	EP	N/A
3 711 787	12/2019	EP	N/A
3 720 520	12/2019	EP	N/A
3 069 740	12/2019	EP	N/A
3 142 722	12/2019	EP	N/A
3 579 894	12/2019	EP	N/A
3 188 769	12/2020	EP	N/A
3 490 122	12/2020	EP	N/A
2 869 866	12/2020	EP	N/A
3 398 626	12/2020	EP	N/A
3 487 549	12/2020	EP	N/A
3 113 806	12/2020	EP	N/A
3 615 103	12/2020	EP	N/A
4 271 461	12/2020	EP	N/A
2 344 218	12/2020	EP	N/A
3 436 104	12/2020	EP	N/A
3 749 383	12/2020	EP	N/A
3 821 938	12/2020	EP	N/A
3 131 615	12/2020	EP	N/A
3 338 825	12/2020	EP	N/A
3 432 944	12/2020	EP	N/A
3 827 876	12/2020	EP	N/A
3 684 439	12/2020	EP	N/A
2 582 414	12/2020	EP	N/A
3 407 930	12/2020	EP	N/A
3 782 665	12/2020	EP	N/A
3 782 666	12/2020	EP	N/A
3 782 668	12/2020	EP	N/A
3 858 397	12/2020	EP	N/A
3 216 467	12/2020	EP	N/A
3 463 505	12/2020	EP	N/A

3 884 968	12/2020	EP	N/A
3 884 969	12/2020	EP	N/A
3 027 241	12/2020	EP	N/A
3 579 904	12/2020	EP	N/A
2 628 493	12/2020	EP	N/A
3 556 409	12/2021	EP	N/A
3 624 868	12/2021	EP	N/A
3 930 785	12/2021	EP	N/A
3 955 985	12/2021	EP	N/A
3 624 867	12/2021	EP	N/A
3 689 389	12/2021	EP	N/A
3 697 464	12/2021	EP	N/A
3 737 436	12/2021	EP	N/A
3 972 661	12/2021	EP	N/A
2 967 630	12/2021	EP	N/A
3 142 721	12/2021	EP	N/A
3 520 834	12/2021	EP	N/A
3 586 887	12/2021	EP	N/A
3 638 336	12/2021	EP	N/A
3 689 388	12/2021	EP	N/A
3 765 110	12/2021	EP	N/A
3 782 667	12/2021	EP	N/A
3 829 673	12/2021	EP	N/A
3 976 129	12/2021	EP	N/A
3 984 589	12/2021	EP	N/A
3 986 528	12/2021	EP	N/A
3 079 758	12/2021	EP	N/A
3 649 926	12/2021	EP	N/A
3 653 113	12/2021	EP	N/A
3 654 006	12/2021	EP	N/A
3 735 280	12/2021	EP	N/A
3 897 814	12/2021	EP	N/A
3 219 339	12/2021	EP	N/A
3 737 310	12/2021	EP	N/A
3 711 788	12/2021	EP	N/A
3 899 994	12/2021	EP	N/A
3 487 550	12/2021	EP	N/A
3 606 575	12/2021	EP	N/A
3 834 876	12/2021	EP	N/A
3 000 492	12/2021	EP	N/A
3 600 477	12/2021	EP	N/A
3 897 768	12/2021	EP	N/A
3 914 310	12/2021	EP	N/A
3 914 311	12/2021	EP	N/A
3 000 493	12/2021	EP	N/A
3 328 311	12/2021	EP	N/A
3 858 422	12/2021	EP	N/A
3 866 876	12/2021	EP	N/A
3 941 546	12/2021	EP	N/A
2 892 583	12/2022	EP	N/A
3 393 542	12/2022	EP	N/A
3 597 231	12/2022	EP	N/A
3 656 292	12/2022	EP	N/A
3 768 345	12/2022	EP	N/A
2 868 332	12/2022	EP	N/A
3 003 420	12/2022	EP	N/A
3 539 585	12/2022	EP	N/A
3 956 010	12/2022	EP	N/A
3 046 594	12/2022	EP	N/A
3 127 563	12/2022	EP	N/A
3 256 186	12/2022	EP	N/A
3 288 609	12/2022	EP	N/A
3 538 173	12/2022	EP	N/A
3 606 576	12/2022	EP	N/A
3 927 390	12/2022	EP	N/A
3 384 940	12/2022	EP	N/A
3 441 616	12/2022	EP	N/A
3 938 005	12/2022	EP	N/A
3 946 511	12/2022	EP	N/A
3 544 649	12/2022	EP	N/A
3 634 528	12/2022	EP	N/A
3 809 959	12/2022	EP	N/A
3 912 673	12/2022	EP	N/A
2 961 984	12/2022	EP	N/A
3 352 808	12/2022	EP	N/A

2 878 061	12/2022	EP	N/A
3 554 576	12/2022	EP	N/A
3 737 435	12/2022	EP	N/A
3 795 208	12/2022	EP	N/A
4 052 754	12/2022	EP	N/A
4 149 606	12/2022	EP	N/A
3 157 596	12/2022	EP	N/A
3 515 525	12/2022	EP	N/A
3 621 669	12/2022	EP	N/A
3 744 362	12/2022	EP	N/A
3 766 428	12/2022	EP	N/A
3 808 390	12/2022	EP	N/A
4 061 470	12/2022	EP	N/A
3 072 210	12/2022	EP	N/A
3 449 958	12/2022	EP	N/A
3 687 596	12/2022	EP	N/A
3 710 076	12/2022	EP	N/A
3 768 340	12/2022	EP	N/A
3 787 707	12/2022	EP	N/A
3 926 194	12/2022	EP	N/A
3 735 733	12/2023	EP	N/A
3 784 305	12/2023	EP	N/A
3 801 675	12/2023	EP	N/A
3 925 659	12/2023	EP	N/A
4 115 919	12/2023	EP	N/A
3 634 526	12/2023	EP	N/A
3 768 342	12/2023	EP	N/A
3 768 347	12/2023	EP	N/A
3 769 799	12/2023	EP	N/A
3 790 606	12/2023	EP	N/A
3 930 780	12/2023	EP	N/A
3 782 695	12/2023	EP	N/A
3 854 448	12/2023	EP	N/A
4 140 532	12/2023	EP	N/A
3 693 038	12/2023	EP	N/A
3 768 344	12/2023	EP	N/A
3 970 765	12/2023	EP	N/A
3 854 444	12/2023	EP	N/A
3 534 985	12/2023	EP	N/A
3 793 674	12/2023	EP	N/A
3 893 957	12/2023	EP	N/A
3 914 334	12/2023	EP	N/A
3 618 885	12/2023	EP	N/A
4 034 221	12/2023	EP	N/A
4 087 641	12/2023	EP	N/A
4 039 289	12/2023	EP	N/A
1458525	12/1965	FR	N/A
2 768 056	12/1998	FR	N/A
0 648 739	12/1950	GB	N/A
2 213 541	12/1988	GB	N/A
2 345 387	12/1999	GB	N/A
2 451 161	12/2010	GB	N/A
2 545 062	12/2016	GB	N/A
2 545 750	12/2016	GB	N/A
59-119788	12/1983	JP	N/A
S61-500059	12/1985	JP	N/A
S62-113555	12/1986	JP	N/A
S64-68236	12/1988	JP	N/A
H02-055886	12/1989	JP	N/A
2-79738	12/1989	JP	N/A
H04-176471	12/1991	JP	N/A
H04-108384	12/1991	JP	N/A
H08-057042	12/1995	JP	N/A
H10-052489	12/1997	JP	N/A
2888609	12/1998	JP	N/A
2889384	12/1998	JP	N/A
H11-239617	12/1998	JP	N/A
2001-037728	12/2000	JP	N/A
2001-515374	12/2000	JP	N/A
2001-515375	12/2000	JP	N/A
2003-019197	12/2002	JP	N/A
2003525438	12/2002	JP	G01N 35/1016
2004-019468	12/2003	JP	N/A
2004-278375	12/2003	JP	N/A
2005-028137	12/2004	JP	N/A

2005-507039	12/2004	JP	N/A
2008-511414	12/2007	JP	N/A
2008-516654	12/2007	JP	N/A
2010-518907	12/2009	JP	N/A
2010-258181	12/2009	JP	N/A
2010-534080	12/2009	JP	N/A
2013-013216	12/2012	JP	N/A
2013-519497	12/2012	JP	N/A
2014-004303	12/2013	JP	N/A
2014-524274	12/2013	JP	N/A
2015-514529	12/2014	JP	N/A
2015-514531	12/2014	JP	N/A
2015-122448	12/2014	JP	N/A
2016-002466	12/2015	JP	N/A
2016-532500	12/2015	JP	N/A
6063151	12/2016	JP	A61B 18/12
6267625	12/2017	JP	N/A
2018-057878	12/2017	JP	N/A
6572056	12/2018	JP	N/A
2020-072985	12/2019	JP	N/A
2018-510708	12/2020	JP	N/A
10-2011-0098192	12/2010	KR	N/A
131676	12/2016	RO	N/A
2 051 695	12/1995	RU	N/A
374317	12/1998	TW	N/A
97202	12/2011	UA	N/A
WO 94/009835	12/1993	WO	N/A
WO 97/037696	12/1996	WO	N/A
WO 97/039785	12/1996	WO	N/A
WO 99/049912	12/1998	WO	N/A
WO 00/033047	12/1999	WO	N/A
WO 00/033446	12/1999	WO	N/A
WO 02/022200	12/2001	WO	N/A
WO 02/041935	12/2001	WO	N/A
WO 02/070039	12/2001	WO	N/A
WO 03/075981	12/2002	WO	N/A
WO 03/103745	12/2002	WO	N/A
WO 2005/020848	12/2004	WO	N/A
WO 2005/028014	12/2004	WO	N/A
WO 2005/037345	12/2004	WO	N/A
WO 2007/033933	12/2006	WO	N/A
WO 2007/105842	12/2006	WO	N/A
WO 2008/017289	12/2007	WO	N/A
WO 2008/081783	12/2007	WO	N/A
WO 2009/010888	12/2008	WO	N/A
WO 2009/046789	12/2008	WO	N/A
WO 2009/046790	12/2008	WO	N/A
WO 2009/073037	12/2008	WO	N/A
WO 2010/119267	12/2009	WO	N/A
WO 2011/003043	12/2010	WO	N/A
WO 2011/081626	12/2010	WO	N/A
WO 2011/160858	12/2010	WO	N/A
WO 2012/018917	12/2011	WO	N/A
WO 2012/047540	12/2011	WO	N/A
WO 2012/112129	12/2011	WO	N/A
WO 2013/037380	12/2012	WO	N/A
WO 2013/120957	12/2012	WO	N/A
WO 2013/167432	12/2012	WO	N/A
WO 2013/173239	12/2012	WO	N/A
WO 2015/039605	12/2014	WO	N/A
WO 2015/063281	12/2014	WO	N/A
WO 2015/085076	12/2014	WO	N/A
WO 2015/109028	12/2014	WO	N/A
WO 2015/172173	12/2014	WO	N/A
WO 2015/175718	12/2014	WO	N/A
WO 2016/028644	12/2015	WO	N/A
WO 2016/137743	12/2015	WO	N/A
WO 2016/146661	12/2015	WO	N/A
WO 2016/146663	12/2015	WO	N/A
WO 2017/004175	12/2016	WO	N/A
WO 2017/015764	12/2016	WO	N/A
WO 2017/021465	12/2016	WO	N/A
WO 2017/040218	12/2016	WO	N/A
WO 2017/053988	12/2016	WO	N/A
WO 2017/060257	12/2016	WO	N/A

WO 2017/112695	12/2016	WO	N/A
WO 2017/112698	12/2016	WO	N/A
WO 2017/147291	12/2016	WO	N/A
WO 2017/159849	12/2016	WO	N/A
WO 2017/162619	12/2016	WO	N/A
WO 2017/205909	12/2016	WO	N/A
WO 2018/005228	12/2017	WO	N/A
WO 2018/007120	12/2017	WO	N/A
WO 2018/036927	12/2017	WO	N/A
WO 2018/088939	12/2017	WO	N/A
WO 2018/081040	12/2017	WO	N/A
WO 2018/089970	12/2017	WO	N/A
WO 2018/109038	12/2017	WO	N/A
WO 2018/139508	12/2017	WO	N/A
WO 2018/197306	12/2017	WO	N/A
WO 2019/034670	12/2018	WO	N/A
WO 2019/035804	12/2018	WO	N/A
WO 2019/038343	12/2018	WO	N/A
WO 2019/057636	12/2018	WO	N/A
WO 2019/067233	12/2018	WO	N/A
WO 2019/078723	12/2018	WO	N/A
WO 2019/135767	12/2018	WO	N/A
WO 2019/137911	12/2018	WO	N/A
WO 2019/138350	12/2018	WO	N/A
WO 2019/145253	12/2018	WO	N/A
WO 2019/158996	12/2018	WO	N/A
WO 2019/161245	12/2018	WO	N/A
WO 2019/180104	12/2018	WO	N/A
WO 2019/180179	12/2018	WO	N/A
WO 2019/180181	12/2018	WO	N/A
WO 2018/135477	12/2018	WO	N/A
WO 2018/135478	12/2018	WO	N/A
WO 2019/211410	12/2018	WO	N/A
WO 2019/219868	12/2018	WO	N/A
WO 2019/219871	12/2018	WO	N/A
WO 2019/219872	12/2018	WO	N/A
WO 2019/219874	12/2018	WO	N/A
WO 2019/219876	12/2018	WO	N/A
WO 2019/219881	12/2018	WO	N/A
WO 2019/219882	12/2018	WO	N/A
WO 2019/219883	12/2018	WO	N/A
WO 2019/219884	12/2018	WO	N/A
WO 2019/219885	12/2018	WO	N/A
WO 2019/229210	12/2018	WO	N/A
WO 2019/229211	12/2018	WO	N/A
WO 2019/229214	12/2018	WO	N/A
WO 2019/229220	12/2018	WO	N/A
WO 2019/229221	12/2018	WO	N/A
WO 2019/229222	12/2018	WO	N/A
WO 2019/229223	12/2018	WO	N/A
WO 2019/234146	12/2018	WO	N/A
WO 2019/239259	12/2018	WO	N/A
WO 2019/241556	12/2018	WO	N/A
WO 2019/243582	12/2018	WO	N/A
WO 2019/243588	12/2018	WO	N/A
WO 2020/003110	12/2019	WO	N/A
WO 2020/011760	12/2019	WO	N/A
WO 2020/011795	12/2019	WO	N/A
WO 2020/011797	12/2019	WO	N/A
WO 2020/016438	12/2019	WO	N/A
WO 2020/028312	12/2019	WO	N/A
WO 2020/028537	12/2019	WO	N/A
WO 2020/030700	12/2019	WO	N/A
WO 2020/064911	12/2019	WO	N/A
WO 2020/073047	12/2019	WO	N/A
WO 2020/132211	12/2019	WO	N/A
WO 2020/176236	12/2019	WO	N/A
WO 2020/187797	12/2019	WO	N/A
WO 2020/219430	12/2019	WO	N/A
WO 2020/234785	12/2019	WO	N/A
WO 2020/242881	12/2019	WO	N/A
WO 2021/046275	12/2020	WO	N/A
WO 2021/062265	12/2020	WO	N/A
WO 2021/067691	12/2020	WO	N/A
WO 2021/119478	12/2020	WO	N/A

WO 2021/150777	12/2020	WO	N/A
WO 2021/152013	12/2020	WO	N/A
WO 2022/056542	12/2021	WO	N/A
WO 2022/063650	12/2021	WO	N/A
WO 2022/072944	12/2021	WO	N/A
WO 2022/076862	12/2021	WO	N/A
WO 2022/076948	12/2021	WO	N/A
WO 2022/109589	12/2021	WO	N/A
WO 2022/109590	12/2021	WO	N/A
WO 2022/109591	12/2021	WO	N/A
WO 2022/173970	12/2021	WO	N/A
WO 2022/174249	12/2021	WO	N/A
WO 2023/278599	12/2022	WO	N/A
WO 2023/014742	12/2022	WO	N/A
WO 2023/049813	12/2022	WO	N/A
WO 2023/076869	12/2022	WO	N/A
WO 2023/230157	12/2022	WO	N/A
WO 2024/243154	12/2023	WO	N/A

OTHER PUBLICATIONS

International Search Report and Written Opinion received in PCT Application No. PCT/EP2019/064156, dated Aug. 26, 2019 in 10 pages. cited by applicant
International Preliminary Report on Patentability and Written Opinion received in PCT Application No. PCT/EP2019/064156, dated Dec. 10, 2020 in 7 pages.
"ABMD—Taking a Closer Look at Impella ECP as the Pivotal Trial Gets Underway", Guggenheim, Press Release, Mar. 29, 2022, pp. 4. cited by applicant
Vollkron et al., "Advanced Suction Detection for an Axial Flow Pump", Artificial Organs, 2006, vol. 30, No. 9, pp. 665-670. cited by applicant
Vollkron et al., "Development of a Suction Detection System for Axial Blood Pumps", Artificial Organs, 2004, vol. 28, No. 8, pp. 709-716. cited by applicant
Escudeiro et al., "Tribological behavior of uncoated and DLC-coated CoCr and Ti-alloys in contact with UHMWPE and PEEK counterbodies;" Tribology Inte
Hinkel et al., "Pump Reliability and Efficiency Increase Maintenance Program—Utilizing High Performance Thermoplastics;" Proceedings of the 16th Interna
Neale, Michael J., "The Tribology Handbook;" 1999, Butterworth-Heinemann, Second Edition, pp. 582. cited by applicant
Park et al., "A Novel Electrical Potential Sensing Method for in Vitro Stent Fracture Monitoring and Detection", Jan. 1, 2011, vol. 21, No. 4, pp. 213-222. cite
Sak et al., "Influence of polyetheretherketone coatings on the Ti-13Nb-13Zr titanium alloy's bio-tribological properties and corrosion resistance;" Materials Sc
"Edwards SAPIEN 3 Kit—Transapical and Transaortic", Edwards Lifesciences, Released Nov. 8, 2016, p. 11. chrome-extension://efaidnbmnnnibpcajpcglclef
Gopinath, Divya, "A System for Impedance Characterization of Coronary Stents", University of Strathclyde Engineering, Thesis, Aug. 2015, pp. 77. cited by a
Ai, X. (2013). Radial Bearings. In: Wang, Q.J., Chung, YW. (eds) Encyclopedia of Tribology. Springer, Boston, MA https://doi.org/10.1007/978-0-387-92897
GGB by Timken Bearings FAQ; "What is a Slide Bearing?;" https://www.ggbearings.com/en/why-choose-ggb/faq/bearings-faq/what-slide-bearing; accessed
Google.com, "Spider Bearing—Search Results;" https://www.google.com/search?
q=spider+bearing&rlz=X1C1GCEA_enUS1059US1059&oq=spider+beari&gs_lcrp=EgZjaHJvbWUqCQgAEEUYOxiABDIJCAAQRRg7GIAEMgYIARBF
8, accessed Oct. 18, 2024, pp. 4. cited by applicant
McMaster-Carr Online Catalog, "Bearings search results;" https://www.mcmaster.com/products/bearings/; accessed Oct. 18, 2024, pp. 5. cited by applicant
McMaster-Carr Online Catalog, "Slide Bearings search results;" https://www.mcmaster.com/products/slide-bearings/; accessed Oct. 18, 2024, pp. 21. cited by
RBCbearings.com, "RBC Bearings Incorporated—Products;" https://www.rbcbearings.com/Products; accessed Oct. 18, 2024, pp. 2. cited by applicant
SKF.com; "Products: Bearings;" https://www.skf.com/us/products/bearings; accessed Oct. 18, 2024, pp. 8. cited by applicant
Wikipedia, "Plain Bearing," https://en.wikipedia.org/wiki/Plain_bearing; accessed Oct. 18, 2024, pp. 10. cited by applicant

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Background/Summary

BACKGROUND

Field

(1) The invention relates to a motor housing module for sealing a motor compartment of a motor of a heart support system and to a heart support system and a method for mounting a heart support system.

Description of the Related Art

(2) Heart support systems, such as a left ventricular heart support system, can be implanted into a heart chamber and have integrated electronic components, such as sensors. Electronic components are mostly integrated into the heart support system in the traditional manner, constructed on substrates, e.g., circuit boards or printed circuit boards (PCBs), and integrated into correspondingly sized cavities of the heart support system. These heart support systems can be implanted by means of a sternotomy, for example. In addition, it is possible to implant more compactly constructed heart support systems, for example also left ventricular heart support systems, into a blood vessel in a minimally invasive manner. Due to the installation size requirements, these more compactly constructed heart support systems do not yet have any integrated electronic components with implanted processing electronics.

(3) U.S. Pat. No. 9,474,840 B2 describes the integration of an optical pressure sensor into the tip of a more compactly constructed heart support system for minimally invasive implantation. The optical supply line is elaborately realized by means of a glass fiber in a channel. The entire evaluation electronics are positioned remotely in an extracorporeal control console as a result of the glass fiber.

(4) For fully implanted systems, however, it is also necessary to implant the processing electronics.

SUMMARY

(5) The object of the invention is to provide an improved heart support system. It is in particular an object of the invention to create electrical connection possibilities in a heart support system in a small installation space both for a motor for driving a blood pump supporting the heart function and for sensors.

(6) This object is achieved by a motor housing module having the features specified in claim **1** and by a heart support system according to claim **14** and the method specified in claim **15** for mounting a heart support system.

(7) Advantageous embodiments of the invention are specified in the dependent claims.
(8) In light of this background, the approach presented here presents a motor housing module for sealing a motor compartment of a motor of a heart support system, a heart support system, and a method for mounting a heart support system according to the main claims. Advantageous developments and improvements of the device specified in the independent claim are possible by means of the measures listed in the dependent claims.
(9) This approach presents a motor housing module for a heart support system. The motor housing module can seal the motor compartment of the heart support system in a fluid-tight manner and connect the motor of the heart support system to a connection cable via which the motor can be supplied with power. In addition, by means of the motor housing module, sensor signals can be combined, processed, and forwarded via the connection cable. The motor housing module and the heart support system can advantageously be designed to be so compact that they can be used, for example, for a left ventricular heart support system (LVAD, left ventricular assist device) for minimally invasive implantation as a fully implanted system. The heart support system can in particular be designed such that it can be inserted into a ventricle or the aorta by means of a catheter.
(10) It is thus advantageously possible to integrate electronic components even in a compactly constructed heart support system.
(11) A motor housing module for sealing a motor compartment of a motor of a heart support system is presented. The motor housing module has a feed-through portion, at least one feed-through line, and at least one contact pin. The feed-through portion is designed to establish an electrical connection between the heart support system and a connection cable for externally contacting the heart support system. The at least one feed-through line is embedded in the feed-through portion and extends through the feed-through portion. The feed-through line can be connected to the motor and the connection cable. A first end of the at least one contact pin is embedded in the feed-through portion, and a second end projects from the feed-through portion on a side facing away from the motor compartment. The second end of the contact pin can be connected to a sensor line to at least one sensor of the heart support system and to the connection cable.
(12) The motor housing module can be designed in one or two parts, for example. For example, the motor housing module can have titanium components or glass components. The heart support system can, for example, be a left ventricular heart support system that has a heart pump with a motor. The motor compartment can, for example, be a portion of the heart support system, e.g., also a housing portion. The motor compartment can advantageously be sealed hermetically, i.e., in a fluid-tight manner, by means of the housing presented here. The motor housing module can, for example, consist of a material that allows a weld connection between the motor or the motor compartment and the motor housing module in order to seal the motor compartment. The feed-through portion for establishing an electrical connection between the heart support system and the connection cable can be designed in one part, for example. Alternatively, the feed-through portion can, for example, comprise a milled part and a glass component which are hermetically connected to one another by laser welding or sintering, for example. The feed-through line and the contact pin can, for example, consist of an electrically conductive material, e.g., a metal, such as an iron-nickel-cobalt alloy, with a low heat expansion coefficient or stainless steel. The connection cable for externally contacting the heart support system can, for example, establish an electrical connection to another implanted component, e.g., a power source and/or control unit of the heart support system. The sensor line can, for example, comprise a group of lines and be designed to forward sensor signals of a sensor in the pump head of the heart support system and/or sensor signals of several sensors. The sensor line can, for example, be realized as an applied flexible thin-film substrate.
(13) According to one embodiment, the feed-through portion can have at least one through-opening filled with an electrically insulating material for embedding the at least one feed-through line and at least one blind hole filled with an electrically insulating material for embedding the at least one contact pin. The feed-through portion can thus advantageously be produced of glass, for example, and both the feed-through line and the contact pin can be embedded. This embodiment advantageously allows a particularly cost-saving production.
(14) It is also advantageous according to one embodiment if the at least one feed-through line and, additionally or alternatively, the at least one contact pin are cylindrical or cup-shaped. If the at least one feed-through line and the at least one contact pin are designed to be cylindrical, i.e., as straight pins, the connection cable can be connected, for example, by soldering, gluing, crimping, or welding the connection cable strands directly to the pin or by using a sleeve or a plug. In the case of a cup-shaped or tulip-shaped forming of the at least one feed-through line and, additionally or alternatively, of the at least one contact pin, the connection to the connection cable can occur, for example, by inserting the strands of the connection cable into the cup of the through line or of the contact pin, wherein the fixing can be realized by means of soldering, gluing, crimping, or welding. According to this embodiment, various application forms can advantageously be realized, which is advantageous with respect to the simplest possible design. In addition, an additional mechanical stabilization of the connection can occur by means of a plug as part of the connection, for example.
(15) According to one embodiment, the motor housing module can comprise a body. The body can have a sensor groove for accommodating at least one electronic component, in particular a sensor, and additionally or alternatively a sensor hub. A sensor can thus advantageously be positioned on the body of the motor housing module, which enables a compact design. The electrical contacting of an electronic component accommodated in the sensor groove with the feed-through portion can, for example, take place by means of an electrically conductive substrate, e.g., a flexible thin-film substrate. The sensor groove can also be formed as a depression or as a cavity, for example. The body can be a milled part made of titanium, for example. The body can be formed, for example, in order to enclose the feed-through portion. The feed-through portion, which can, for example, have glass, can then be hermetically joined to the milled part by laser welding, sintering, or injection molding. Integration of the feed-through portion into the body can be advantageous with respect to the design since the body of the motor housing module can be welded particularly easily to another portion of the heart support system, e.g., the motor compartment or the motor.
(16) If the motor housing module according to one embodiment has a sensor groove, the motor housing module can additionally have a sensor cap for covering the at least one electronic component accommodated in the sensor groove. The sensor cap can, for example, have a metal and be fixed by gluing. This advantageously allows an accommodated electronic component to be protected by the sensor cap.
(17) In addition, according to this embodiment, the motor housing can have a sensor line portion of the sensor line. In the region of the sensor groove, the sensor line portion can form a sensor carrier for connecting the at least one electronic component. The sensor line portion represents a part of the sensor line of the heart support system; the sensor line can be designed modularly for this purpose, for example. For forming the sensor carrier, the sensor line can expand in the region of the sensor line portion, for example. Advantageously, according to this embodiment, connection to the sensor line and integration of an electronic component, such as an additional sensor, is possible in a particularly space-saving and simple manner.
(18) According to one embodiment, the electronic component can have a sensor hub. The sensor hub can be designed to process at least one sensor signal of the at least one sensor of the heart support system. Additionally or alternatively, the sensor hub can be designed to provide the sensor signal via the at least one contact pin to the connection cable. For example, the sensor hub can be understood to be a device that connects nodes of several sensors to one another in the shape of a star, for example. The sensor hub may be a computer network. The sensor hub may be referred to as a coupling element of several sensors. The sensor hub can, for example, connect the sensor at the pump head to a sensor accommodated in the sensor groove of the motor housing module. The connection of several sensors by means of a sensor hub can be advantageous in order to increase reliability with respect to a physical bus network. The sensor hub can, for example, comprise calibration and identification information of the pump and of the sensors of the heart support system and can be read via a communication bus in the connection cable by a central control device of the heart support system. In this way, the control device can be parameterized with motor data, for example. The sensor hub can also be used to pre-process, e.g., to aggregate, to filter, or to calibrate, sensor data of the sensors of the pump and to translate the communication protocol of the sensors into a more robust communication protocol and add artificial redundancy or checksums.
(19) According to one embodiment, the sensor line portion can advantageously have a contact portion. The contact portion can be arranged on a side of the feed-through portion facing away from the motor compartment. In addition, the contact portion can be O-shaped or U-shaped. The contact portion can advantageously be used for electrically contacting the sensor line with the feed-through portion, wherein this embodiment is particularly space-saving. For this purpose, the contact portion can be formed, for example, as an end portion of the sensor line portion and can be folded on or

onto the feed-through portion, wherein as a result of the O-shape or U-shape, the contacting of the connection cable with the at least one contact pin can, for example, be realized without contact of the contact portion to the feed-through line.
(20) According to one embodiment, the contact portion can have at least one contact surface for connection to the at least one contact pin. The contact surface can be formed in order to at least partially enclose the at least one contact pin. For this purpose, the contact surface can be semicircular or elliptical, for example. The contact surface can, for example, have an exposed electrically contactable area, wherein the electrical contact between the sensor line portion and the contact pin can be established by solder or adhesive, for example.
(21) According to one embodiment, the motor housing module can have a connection point cap for covering a connection point between the feed-through portion and the connection cable. This is advantageous in order to protect the connection point. The connection point cap can also be a part of the sensor cap, for example. The connection point cap, like the sensor cap, can be filled with a casting compound, e.g., a silicone or epoxy resin, in order to protect sensors and contact points from corrosion and conductive liquids. The connection point cap can be flexibly formed in order to be able to realize bend protection and strain relief in addition to mechanical protection.
(22) In addition, according to one embodiment, the motor housing module can have a coupling device for coupling an insertion device for inserting the heart support system to the motor housing module, wherein the coupling device can in particular have at least one fixing element. This is advantageous in order to be able to, for example, fix the motor housing module in a form-fitting and/or force-fitted manner to the insertion device in order to, for example, be able to introduce the heart support system, which comprises the motor housing module, in a minimally invasive manner and to decouple it after successful implantation of the insertion device in order to release the heart support system at the destination. The fixing element can, for example, have a clamp or the like. According to one embodiment, the coupling device can be realized on the body of the motor housing module.
(23) A heart support system is also presented. The heart support system has a housing with a motor compartment, a motor arranged in the motor compartment, at least one sensor, a sensor line electrically connected to the at least one sensor, a connection cable for externally contacting the heart support system, and an embodiment of the aforementioned motor housing module as part of the housing. The motor and the at least one sensor are electrically connected to the connection cable by means of the motor housing module.
(24) The heart support system can be a ventricular heart support system, in particular a left ventricular heart support system. The heart support system can, for example, have an electric motor or an electrically operated motor-clutch-pump unit. The sensor can be arranged, for example, on the pump head and, additionally or alternatively, on the motor housing module. The sensor can, for example, be a pressure sensor or a sensor for measuring the blood flow direction. The heart support system can, for example, be cylindrical for minimally invasive insertion and have a diameter that is smaller than that of the human aorta, e.g., 5 to 12 millimeters.
(25) In addition, a method for mounting a heart support system is presented. The heart support system has a motor, a motor compartment, at least one sensor, a sensor line electrically connected to the at least one sensor, and a connection cable for externally contacting the heart support system. The method comprises a step of providing, a step of establishing, a step of contacting, and a step of producing. In the step of providing, an embodiment of the aforementioned motor housing module is provided. In the step of establishing, an electrically conductive connection is established between the at least one feed-through line of the motor housing module and the motor of the heart support system. In the step of producing, a firmly bonded connection is produced between the motor housing module and the heart support system in order to seal the motor compartment of the heart support system. In the step of contacting, the at least one contact pin of the motor housing module is contacted with the sensor line of the heart support system.
(26) The firmly bonded connection can be produced by welding, for example. Optionally, after welding, a sensor cap and, additionally or alternatively, a connection point cap for covering and protecting an electronic component or an electrically conductive interface of a component of the heart support system can also be mounted.
(27) According to one embodiment, the method can also comprise a step of connecting the connection cable of the heart support system to the at least one feed-through line and the at least one contact pin of the motor housing module. The step of connecting can take place before or after the step of producing. If the step of connecting is after the step of producing, the motor housing module can have a passage opening for the connection cable.
(28) This method can, for example, be implemented in software or hardware or in a mixed form of software and hardware in a control device, for example.
(29) A computer program product or computer program having program code which can be stored in a machine-readable carrier or storage medium, such as a semiconductor memory, a hard drive memory, or an optical memory, and is used to carry out, implement, and/or control the steps of the method according to one of the embodiments described above is also advantageous, in particular if the program product or program is executed on a computer or a device.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Advantageous exemplary embodiments of the approach presented here are shown in the drawings and explained in more detail in the following description. The drawings show:
(2) FIG. **1** a schematic illustration of a heart support system according to an exemplary embodiment;
(3) FIG. **2** a schematic illustration of a motor housing module according to an exemplary embodiment;
(4) FIG. **3** a schematic illustration of a motor housing module according to an exemplary embodiment;
(5) FIG. **4** a schematic illustration of a motor housing module according to an exemplary embodiment;
(6) FIG. **5** a schematic illustration of a sensor line portion of a motor housing module according to an exemplary embodiment;
(7) FIG. **6** a schematic illustration of a cap element for a motor housing module according to an exemplary embodiment;
(8) FIG. **7** a schematic illustration of a motor housing module according to an exemplary embodiment;
(9) FIG. **8** a schematic illustration of a motor housing module according to an exemplary embodiment; and
(10) FIG. **9** a flow diagram of a method for mounting a heart support system according to an exemplary embodiment.
DETAILED DESCRIPTION
(11) In the following description of favorable exemplary embodiments of the present invention, the same or similar reference signs are used for the elements which are shown in the various figures and have a similar effect, wherein a repeated description of these elements is omitted.
(12) FIG. **1** shows a schematic illustration of a heart support system **100** according to an exemplary embodiment. Shown is a side view of the heart support system **100**, which is designed here, by way of example, as a left ventricular heart support system **100**. The heart support system **100** has a housing **105**. As part of the housing **105**, the heart support system **100** comprises a motor housing module **110**. A motor compartment **112** is enclosed by the housing **105** and the motor housing module **110**. A motor **115** is arranged in the motor compartment **112**. At least one sensor **120** is arranged in a sensor assembly on a head side of the heart support system **100**. The sensor **120** is electrically connected to a sensor line **125**. The sensor line **125** is laid here, by way of example, across the housing **105** to the motor housing module **110**; it can also run at least in portions within the housing **105** or be laid in the shape of a spiral across the housing **105**. The sensor **120** can, for example, be a pressure sensor or a flow sensor for blood flow measurement by means of ultrasound or laser, for example. On the side of the motor housing module **110** facing away from the motor compartment **112**, the heart support system **100** has a connection cable **130** for externally contacting the heart support system **100**. The motor housing module **110** can be referred to as an electrical connecting element: The motor **115** and the at least one sensor **120** are electrically connected to the connection

cable **130** by means of the motor housing module **110**. The motor housing module **110**, also called the motor backend, is formed to hermetically seal the motor compartment **112** and thus to seal it in a fluid-tight manner. In addition, the motor housing module **110** is designed to establish an electrical connection between the hermetically sealed motor interior of the motor **115** and the surroundings of the heart support system **100**: The motor housing module **110** assumes the tasks of joining the sensor line **125**, which conducts electrical signals from a pump head **135** of the heart support system **100** to the motor housing module **110**, to the connection cable **130**, which forwards the sensor signals and supplies the motor with electrical energy. For this purpose, electrical conductors from the interior of the motor **115** can be joined to the sensor cable **125** laid on the outside of the motor **115** and to the connection cable **130**, also called supply cable. In this way, a mechanically secure connection of the connection cable **130** to the motor housing module **110** can be established. Via the connection cable **130**, the heart support system **100** can be connected to another component, such as an energy source, a data processing device, or a control device.

(13) The heart support system **100** has a cylindrical, elongated structure with a substantially constant outer diameter and rounded, tapered ends for easy positioning by means of a catheter in a blood vessel, e.g., the aorta. The motor housing module **110** has the shape of a truncated cone. It is conically formed, with a base surface in the direction of the motor compartment **112**, which corresponds to the outer diameter of the heart support system **100**, and with a smaller top surface as a transition to the connection cable **130**.

(14) FIG. **2** shows a schematic illustration of a motor housing module **110** for sealing a motor compartment of a motor of a heart support system according to an exemplary embodiment. The motor housing module **110** corresponds or is similar to the motor housing module **110** of FIG. **1**. A cross-section of a side view of the motor housing module **110** is shown. The motor housing module **110** has at least one feed-through portion **205** for establishing an electrical connection between the heart support system and a connection cable for externally contacting the heart support system. In addition, the motor housing module **110** has at least one feed-through line **210**, which is embedded in the feed-through portion **205** and extends through the feed-through portion **205**. The feed-through line **210** can be connected to the motor and the connection cable of the heart support system. The motor housing module **110** furthermore has at least one contact pin **215**. For example, two differently formed contact pins **215** are shown here. A first end of the contact pin **215** is embedded in the feed-through portion **205** and a second end projects from the feed-through portion **205** on a side facing away from the motor compartment. The second end of the contact pin **215** can be connected to a sensor line to at least one sensor of the heart support system and to the connection cable.

(15) As in the exemplary embodiment shown here, the feed-through portion **205** can have at least one through-opening **225** filled with an electrically insulating material for embedding the at least one feed-through line **210** and at least one blind hole **230** filled with an electrically insulating material for embedding the at least one contact pin **215**. One of the blind holes can also be filled conductively, e.g., with an electrically conductive adhesive, in order to establish an electrical connection between the motor housing and a conductor of the connection cable. This can serve to electrically shield the motor and connection cable, for example. The feed-through portion **205** is formed from titanium, for example. The through-opening **225** and the two blind holes **230** shown are formed in the feed-through portion **205** and filled, for example, with glass as electrically insulating material. The blind holes **230** can accordingly also be referred to as blind glass feed-throughs since they do not lead all the way into the interior of the hermetically sealed motor. The feed-through line **210**, which can be realized as a feed-through pin or pin, is used to electrically contact the motor. The contact pins **215**, also called blind pins, are used to rewire the sensor line. The feed-through line **210** as well as the at least one contact pin **215** are formed from an electrically conductive material, e.g., from a metal, such as an iron-nickel-cobalt alloy, with a low thermal expansion coefficient or such as stainless steel.

(16) The at least one feed-through line **210** and/or the at least one contact pin **215** can be designed to be cylindrical, i.e., as straight pins, as shown here by way of example in the case of the feed-through line **210** and the upper of the two contact pins **215**. The feed-through line **210** and/or the at least one contact pin **215** can alternatively also be cup-shaped, as shown by way of example in the case of the lower of the two contact pins **215**. If the feed-through line **210** and/or the at least one contact pin **215** are cylindrical, the connection cable can be connected, for example, by soldering, gluing, crimping, or welding the connection cable strands directly to the feed-through line **210** and/or the contact pin **215** or by using a sleeve or a plug. If the feed-through line **210** and/or the at least one contact pin **215** are cup-shaped, the cable connection to the connection cable can be realized by inserting the strands into the cup. Fixing can take place by soldering, gluing, crimping, or welding.

(17) According to the exemplary embodiment shown in FIG. **2**, the motor housing module **110** is designed in two parts, with a body **220** and the feed-through portion **205**, which is formed, for example, as a so-called glass feed-through component. The two-part design of the motor housing module **110** is advantageous in terms of production technology. In this case, the electrical contacting of the motor and the sensor line with the feed-through portion **205** can be made possible in the interior of the motor housing module **110**, hereinafter also referred to as backend, wherein motor strands can be soldered to the feed-through portion **205**, for example. An advantage of the two-part design of the motor housing module **110** is that a standard glass feed-through can be used for the feed-through portion **205**, which can then, for example, be hermetically joined to the body **220** designed as a milled part by laser welding, sintering, or insert molding, wherein the body can have additional features, such as the integration of clamps as fixing element of the coupling device and a sensor depression in the form of the sensor groove, as described, for example, with reference to FIG. **8**. The two-part design of the motor housing module **110** is also advantageous with respect to the assembly since the following production procedure can be implemented, for example: contacting the feed-through portion **205** with the motor interior; connecting the feed-through portion **205** to the body **220** by sliding the body **220** onto and over the feed-through portion **205**, for example; welding the body **220** to the motor housing **112**; welding the body **220** to the feed-through portion **205**; establishing an electrical connection of the sensor cable to the contact pins **215**; and contacting the connection cable with the feed-through line **210** and the contact pins **215**. The mounting of a cap element as a protective cap as shown in FIG. **6** can then optionally take place by casting.

(18) The two-part design of the motor housing module **110** can be realized by a combination of a milled part as a body **220** for producing the corresponding geometry with advantageous mechanical robustness and strength and by a feed-through portion **205** with classic glass feed-throughs. The body **220** as a milled part can advantageously be formed from titanium in order to be able to weld the motor housing module **110** particularly easily and efficiently to a motor housing **112** of the motor **115**, which can also consist of titanium, for example. In this way, a hermetically sealed connection can be established between the body **220** and the motor housing **112** in order to seal the motor compartment in a fluid-tight manner. The forming of the contact pins **215** as glass blind pins, i.e., as blindly ending glass feed-through, allows robust rewiring of the flexible sensor line to the connection cable on the basis of glass feed-through technology by means of the possibility of connecting the contact pins **215** to the sensor line and to the connection cable. FIG. **2** thus shows a backend or motor housing module **110** with blind pins for rewiring in the form of the two contact pins **215** shown, by way of example, in the blind holes **230**.

(19) FIG. **3** shows a schematic illustration of a motor housing module **110** according to an exemplary embodiment. A side view of the motor housing module **110** with the body **220** and the feed-through portion **205** is shown, wherein the feed-through portion **205** for embedding the feed-through line and the at least one contact pin is formed and has, by way of example, recesses for this purpose.

(20) The motor housing module **110**, also called the pump backend, has a cylindrical shape with a depressed plane in the direction of the feed-through portion **205**. For example, a sensor can be positioned on this depressed plane. The depressed plane can be formed as a depression or as a cavity or as a groove. According to the exemplary embodiment shown here, the body **220** correspondingly has a sensor groove **305** in the form of the depressed plane for accommodating at least one electronic component, in particular a sensor and/or a sensor hub.

(21) An electrically conductive substrate can be arranged in the sensor groove **305** in order to realize an electrical contact of an electronic component accommodated in the sensor groove **305**. The substrate can be formed, for example, in order to connect the electrical component accommodated in the sensor groove **305** to electrically conductive pins of the backend, i.e., to the at least one contact pin embedded in the feed-through portion **205**. The substrate is a flexible thin-film substrate, for example. According to the exemplary embodiment shown in the following FIG. **4**, the substrate can

also be part of the sensor line or of a sensor line portion.
(22) The motor housing module **110** can optionally have a coupling device for coupling an insertion device with the heart support system, as shown in FIG. **8**. In addition, the motor housing module **110** can optionally have a fit for attaching a cap element as shown in FIG. **6** as a protective cap or as a bend protection grommet. The cap element can be formed, for example, in order to cover the sensor groove **305** and the feed-through portion **205**.
(23) The body **220** can be formed from the same material as the motor of the heart support system in order to be able to establish a hermetic welded connection between the motor and the backend in the form of the motor housing module **110**. A fixed connection, e.g., by ultrasonic welding or injection molding of a polymer, is also possible, as well as sintering processes and glazing processes of ceramic components if the motor housing module **110** has ceramic components, for example. The feed-through portion **205**, which can realize both an electrical feed-through into the hermetically sealed interior and a rewiring for the sensor line, is significant for the use of the motor housing module **110** as an electrical connecting element. Manufacturing the motor housing module **110** of one part dispenses with a weld seam and requires correspondingly formed glass feed-throughs for the feed-through portion **205**.
(24) FIG. **4** shows a schematic illustration of a motor housing module **110** according to an exemplary embodiment. A side view of the motor housing module **110** connected to the motor compartment **112** of the heart support system is shown, wherein only a proximal portion of the cylindrical heart support system comprising the motor compartment **112** is shown of the heart support system. On the side facing the motor compartment **112**, the motor housing module **110** has the same diameter and the same material as the motor compartment **112**. In order to form a sensor groove, the motor housing module **110** can taper conically in order to create installation space for positioning sensors. The sensor line **125** is laid here, by way of example, along the longitudinal axis of the heart support system **100** in a band-shaped manner on the housing of the heart support system across the motor chamber **112** to the motor housing module **110**.
(25) According to the exemplary embodiment shown here, the motor housing module **110** comprises a sensor line portion **405** of the sensor line **125**. In the region of the sensor groove **305**, the sensor line portion **405** has a sensor carrier **410** for connecting the at least one electronic component. The sensor carrier **410** can also be understood as a portion, e.g., a planar region, of the motor housing module **110**. The sensor line portion **405** is formed, for example, for integrating a sensor in the sensor groove **305**.
(26) The sensor line **125** and the sensor line portion **405** can be formed from an electrically conductive flexible thin-film substrate. The sensor groove **305** is formed here in a band-shaped manner circumferentially around the motor housing module **110**. The sensor line portion **405** is connected to the sensor line **125** and extends in one part along the sensor groove **305** around a portion of the lateral surface of the motor housing module **110**, wherein the sensor line portion **405** is expanded in this region in order to allow several sensor carriers **410** for connecting several electronic components to be formed on the sensor line portion **405** along the sensor groove **305**, as shown in the following FIG. **5**. The shaping of the sensor groove **305** can be designed according to the exemplary embodiment shown here in order to enable both the cable routing of the sensor line **125** in the described portion of the sensor line portion **405** and the sensor integration on the sensor line portion **405** in the sensor groove **305**. In another part, the sensor line portion **405** extends in the direction of the feed-through portion **205** from the sensor groove **305** toward the cross-sectional area of the feed-through portion **205**.
(27) According to the exemplary embodiment shown here, the sensor line portion **405** has a contact portion **415**. The contact portion **415** is arranged on a side of the feed-through portion **205** facing away from the motor compartment **112**. The contact portion **415** is arranged at least partially on the feed-through portion **205**. The contact portion **415** can be O-shaped or U-shaped. Here, the contact portion **415** extends, by way of example, over a large part of the cross-sectional area of the feed-through portion **205**. According to the exemplary embodiment shown here, the contact portion **415** has recesses in the region of the through-opening and/or of the blind holes. In order to contact the at least one contact pin **215** with the sensor line **125**, the sensor line portion **405** can have an exposed, electrically contactable region in the form of an electrically conductive contact surface **510**, which connects to the at least one contact pin **215** embedded in the feed-through region **205**. By way of example, four contact pins **215** are shown here. The contact portion **415** has, per contact pin **215**, a semicircular recess **510** adjacent to the contact pins. The sensor line portion **405**, and thus the sensor line **125**, is electrically connected via the contact portion **415** to the contact pins **215** in the feed-through portion **205** of the motor module housing **110**. This design of the connection can also be referred to as a connection of the flexible sensor line **125**, also called sensor flex, to the blind pins in the form of the contact pins **215**.
(28) FIG. **5** shows a schematic illustration of a sensor line portion **405** of a motor housing module according to an exemplary embodiment. Here, the sensor line portion **405** is designed, by way of example, as a thin-film substrate for contacting the blind pins in the form of contact pins and for integrating additional sensors of the heart support system on the motor housing module and is shown in a top view as a fold. The form of the sensor line portion **405** shown here is suitable for contacting the sensor line to the motor housing module and enables sensor integration on the sensor line portion **405**. The form of the sensor line portion **405** substantially corresponds to that of the sensor line portion **405** described in FIG. **4**, with the expansion of the sensor line portion **405** into a circumferential portion, which corresponds to the sensor groove, around the motor housing module. In this region of the expansion of the sensor line portion **405**, three sensor carriers **410** are formed, by way of example, in the exemplary embodiment shown here. Electronic components, for example sensors, can be integrated on these sensor carriers **410**. Here, the contact portion **415** additionally has an O-shaped recess **505**, through which the feed-through line can be fed through if the contact portion **415** lies on the feed-through portion **205**.
(29) The contact portion **415** comprises at least one contact surface **510** for connecting to the at least one contact pin. The at least one contact surface **510** is formed in order to at least partially enclose the at least one contact pin. The contact surface **510** can also be referred to as a contact pad. According to the exemplary embodiment shown here, the contact portion **415** has, by way of example, four contact surfaces **510** in order to electrically connect four contact pins embedded in the feed-through portion to the sensor line portion **405**. Depending on the form of the contact portion **415**, the contact surfaces **510** can be semicircular or elliptical in order to at least partially enclose one contact pin each for electrically contacting with the sensor line portion **405**. The forms of the motor housing module and of the sensor line are, for example, adapted to each other by the forming of the sensor line portion **405** such that the contact pads **510** enclose the contact pins of the motor housing module. For this purpose, the contact pads **510** have an exposed, electrically contactable region. An electrical contact can be established by solder or adhesive, for example. The contacting of the feed-through line to connect the motor can take place in the same way as the contacting of the contact pins with the sensors, or the contact portion **415** has, as shown here, the recess **505** in the shape of an O or U so that a connection of the feed-through line to the connection cable without contact to the contact portion **415** of the sensor line portion **405** is possible. The arrangement of the contact portion **415** on the feed-through portion, and thus the contacting of the sensor line to the blind pins of the motor housing module, can take place in the production process, e.g., by folding the sensor line portion **405** onto the feed-through portion and subsequently producing the electrical connections.
(30) Additional installation space for accommodating electronic components, such as sensors, in the sensor groove can be created by additional depressions in the sensor groove of the motor housing module, in particular if the sensor line section **405** has several sensor carriers **410** as shown here. Components accommodated in the sensor groove can additionally be mechanically protected by a cap element.
(31) According to one exemplary embodiment, an electronic component accommodated on the sensor line portion **405** in the sensor groove of the motor housing module can have a sensor hub. The sensor hub is designed to process at least one sensor signal of the at least one sensor of the heart support system. Additionally or alternatively, the sensor hub is designed to provide at least one sensor signal via the at least one contact pin to the connection cable. The integration of a sensor hub enables the pre-processing of sensor data and the translation of the data interfaces. In addition, calibration parameters and operating parameters, such as identification information of the heart support system or accommodated sensors, can be stored in the heart support system by means of the sensor hub and can be provided by means of the connection cable to a connected control device, e.g., via a communication bus in the connection cable. In this way, the control device can be parameterized with motor data, for example. The sensor hub can be used to pre-process, e.g., to aggregate, to filter, or to calibrate, sensor data from sensors of the heart support system pump and to translate

the communication protocol of the sensors into a more robust communication protocol (transceiver) and add artificial redundancy or checksums.
(32) FIG. **6** shows a schematic illustration of a cap element **605** for a motor housing module according to an exemplary embodiment. The cap element **605** is provided for use with the motor housing module of one of the figures shown here. The cap element **605** is formed to cover electronic components of a motor housing module, as described with reference to FIG. **3**. The cap element **605** can therefore be used as mechanical protection of the motor housing module. A side view of the cap element **605** is shown in a one-piece design.
(33) In the direction of the motor compartment, the cap element **605** has at least one recess **610** as a sensitive measurement window for one of the sensors **120**/**410**/**710**. The sensor can, for example, be a pressure sensor so that the measurement window **610** is to be positioned above the pressure-sensitive membrane of the pressure sensor so that the blood pressure of the surrounding blood can act in an unimpeded manner on the pressure sensor. Adjacent to the recess **610**, the cap element has the sensor cap **615**. The sensor cap is formed in order to create a sensor groove, e.g., the sensor groove described in FIG. **3**, which is formed by way of example as a depressed plane of the cylindrical body of the motor housing module. If the sensor groove is formed, for example, according to the exemplary embodiments described in FIGS. **4** and **5** as a circumferential depression, the sensor cap can be formed correspondingly to cover this region. Formed conically in the manner of an arrow tip, a connection point cap **620**, which has an opening **625** for feeding through the connection cable, adjoins the sensor cap **615**.
(34) According to the exemplary embodiment shown here, the cap element **605** thus has the sensor cap **615** for covering the at least one electronic component accommodated in the sensor groove. The cap element **605** furthermore has the optional connection point cap **620** for covering a connection point between the feed-through portion and the connection cable. The sensor cap **615** and the connection point cap **620** can, as shown here, be designed as a combined one-piece component as cap element **605**.
(35) Alternatively, the sensor cap **615** and the connection point cap **620** can also be designed as respectively separate components. In this case, the sensor cap **615** can, for example, be a metallic cap that is fixed by gluing. The connection point cap **620** can be formed flexibly, for example, in order to enable bend protection and strain relief in addition to mechanical protection. The cap element **605** can, for example, be filled with a casting compound, e.g., a silicone or epoxy resin, in order to protect sensors and contact points from corrosion and conductive liquids.
(36) FIG. **7** shows a schematic illustration of a motor housing module **110** according to an exemplary embodiment. Here, the motor housing module **110** corresponds or resembles the motor housing module of one of the above-described figures. The side view shows, as a section of the mounted cylindrical heart support system, the motor compartment **112** with a motor compartment housing **705**. The motor housing module **110** is connected to the motor compartment housing **705** and has, in the direction of the motor compartment **112**, a circumferential depression as a sensor groove **305**. In the region of the sensor groove **305**, a sensor **710** is integrated, by way of example, as an electronic component on the sensor line portion **405**. In order to illustrate the possibility of filling the sensor **710** with a casting compound using the sensor cap and/or the cap element, as described with reference to the previous FIG. **6**, the correspondingly filled region **715** is shown here by way of example. On the side facing away from the motor compartment **112**, the motor housing module **110** has the feed-through portion **205**, from which four contact pins **215** project by way of example.
(37) FIG. **8** shows a schematic illustration of a motor housing module **110** according to an exemplary embodiment. The motor housing module **110** is shown here in a top view. The body **220** is realized as a titanium part. For the electrical functionalization of the motor housing module **110** as an electrical connecting element, the sensor line portion **405** is laid from the direction of the motor compartment into the sensor groove **305**. The sensor line portion **405** is here formed as a thin-film substrate by way of example. The body **220** in the form of a milled part made of titanium has a depressed plane as a sensor groove **305**. The sensor line portion **405** expands in the region of the sensor groove **305** and, as a thin layer, almost completely fills a lower region of the base surface of the sensor groove **305**. A sensor carrier **410**, on which, by way of example, an electronic component **805** is accommodated, is located in the sensor groove **305** on the sensor line portion **405**.
(38) According to one exemplary embodiment, the motor housing module **110** has a coupling device for coupling with the motor housing module **110** an insertion device for inserting the heart support system, wherein the coupling device in particular has at least one fixing element **810**. The fixing element **810** can serve for the form-fitting coupling of a clamp element, a so-called clamp. The body **220**, as a titanium part, has here, by way of example, three round fixing elements **810** as a coupling device. The fixing elements **810** can additionally or alternatively also be used to fix a cap element for covering an electronic component **805** or an electrical connection point of the motor housing module **110**; the fixing elements **810** then serve as a fit for attaching the cap element.
(39) The exemplary embodiment of the motor housing module **110** shown here has the body **220** and the feed-through portion **205** realized as a so-called glass feed-through. By way of example, three feed-through lines **210** for electrically connecting the motor of the heart support system to the connection cable are embedded in the feed-through portion **205**. In addition, eight contact pins **215** arranged in the shape of a U are embedded in the feed-through portion **205** by way of example. The contact pins **215** are spaced apart substantially evenly. Tapered in the shape of a band in the direction of the feed-through portion **205**, the sensor line portion **405** is guided out of the sensor groove **305** and forms the O-shaped contact portion **415**. Adjacent to the contact pins **215**, the contact portion **415** respectively has a semicircular contact surface for electrically connecting the contact pins **215** to the sensor line portion **405**. The connection cable can be connected to the feed-through line **210** and to the contact pins **215** in order to externally contact the heart support system by means of the motor housing module **110**.
(40) FIG. **9** shows a flow diagram of a method **900** for mounting a heart support system according to an exemplary embodiment. The heart support system has a motor, a motor compartment, at least one sensor, a sensor line electrically connected to the at least one sensor, and a connection cable for externally contacting the heart support system. The method **900** comprises a step **901** of providing, a step **903** of establishing, a step **905** of contacting, and a step **907** of producing. In step **901** of providing, a motor housing module is provided. Here, the motor housing module corresponds or resembles the motor housing module of one of the above-described figures. In step **903** of establishing, an electrically conductive connection is established between the at least one feed-through line of the motor housing module and the motor of the heart support system. In step **905** of contacting, the at least one contact pin of the motor housing module is contacted with the sensor line of the heart support system. In step **907** of producing, a firmly bonded connection is produced between the motor housing module and the heart support system in order to seal the motor compartment of the heart support system. In addition, in step **907** of producing, a sensor cap and/or a connection point cap for covering and protecting an electronic component or an electrically conductive interface of a component of the heart support system can optionally be mounted.
(41) A sequence of the steps of the method presented here can also be provided in a special exemplary embodiment as follows: 1. Attaching the feed-through pin to the motor interior 2. Positioning the body **220** 3. Tightly welding the body to the motor housing so that the connection established in this way is retained mechanically 4. Tightly welding the contact element in the body 5. Affixing the sensor line **125**, folding the contact portion **415** onto the feed-through portion **205**, contacting the contact surface **510** to the contact pin **215** 6. Contacting the sleeves to wires of the connection cable **130** 7. Sliding the contacted sleeves onto contact pin **215** and feed-through line **210** and welding them thereto 8. Casting and positioning the sensor cap **615** and the connection point cap **620**
(42) According to one exemplary embodiment, the method **900** optionally has a step **909** of connecting the connection cable of the heart support system to the at least one feed-through line and the at least one contact pin of the motor housing module. The step **909** of connecting can be carried out before or after step **907** of producing.
(43) If an exemplary embodiment includes an “and/or” conjunction between a first feature and a second feature, this should be read to mean that the exemplary embodiment according to one embodiment comprises both the first feature and the second feature and according to another embodiment comprises either only the first feature or only the second feature.

Claims

1. A heart support system, comprising: a blood pump; a motor compartment; a motor arranged in the motor compartment and configured to drive the blood pump; at least one sensor disposed on a surface of the blood pump; a motor housing module comprising: a feed-through portion configured to establish an electrical connection between the heart support system and a connection cable; and at least one contact terminal, wherein the at least one contact terminal is configured to form a connection between the connection cable and the at least one sensor via an electrical connection external to the motor housing module, wherein the at least one contact terminal has a distal end embedded in a blind hole electrically insulated from the interior of the motor compartment and a proximal end that protrudes proximally beyond the motor housing module, wherein the blind hole is disposed on a side of the motor housing module opposite a pump head of the blood pump, and wherein the at least one contact terminal is accessible from a side of the motor housing module facing away from the motor compartment; and at least one feed-through line extending through the motor housing module, wherein the at least one feed-through line is configured to connect to the motor.
2. The heart support system according to claim 1, wherein the at least one contact terminal is configured to connect to a conductor of the connection cable.
3. The heart support system according to claim 1, wherein the at least one contact terminal comprises at least one contact pin.
4. The heart support system according to claim 3, wherein the feed-through portion comprises at least one through-opening filled with an electrically insulating material configured to facilitate embedding the at least one feed-through line and at least one blind hole filled with an electrically insulating material configured to facilitate embedding the at least one contact terminal.
5. The heart support system according to claim 1, wherein the at least one feed-through line and/or the at least one contact terminal is cylindrical or cup-shaped.
6. The heart support system according to claim 1, wherein the motor housing module comprises a sensor groove configured to receive the at least one sensor and/or a sensor hub.
7. The heart support system according to claim 6, wherein the sensor groove is configured to receive the at least one sensor, the heart support system further comprising a sensor cap positioned at least partially over the sensor groove and having a measurement window for the at least one sensor within the sensor groove.
8. The heart support system according to claim 6, further comprising a sensor line portion comprising a sensor carrier in a region of the sensor groove, the sensor carrier being configured to connect to the sensor and/or the sensor hub.
9. The heart support system according to claim 8, wherein the sensor groove is configured to receive the sensor hub, and wherein the sensor hub is configured to process at least one sensor signal of the at least one sensor and/or to provide the at least one sensor signal to the connection cable.
10. The heart support system according to claim 8, wherein the sensor line portion comprises a contact portion, wherein the contact portion is arranged on a side of the feed-through portion facing away from the motor compartment.
11. The heart support system according to claim 10, wherein the contact portion is O-shaped or U-shaped.
12. The heart support system according to claim 10, wherein the contact portion comprises at least one contact surface for connecting to the at least one contact terminal, and wherein the at least one contact surface is formed to at least partially enclose the at least one contact terminal.
13. The heart support system according to claim 1, having a connection point cap configured to cover a connection point between the feed-through portion and the connection cable.
14. The heart support system according to claim 1, further comprising a coupling device for coupling the motor housing module to an insertion device configured to insert the heart support system, wherein the coupling device comprises at least one fixing element.
15. The heart support system according to claim 1, wherein the heart support system is configured to be inserted into a heart chamber or an aorta by means of a catheter.
16. The heart support system according to claim 1, wherein the at least one contact terminal is configured to connect to the at least one sensor via a sensor line.
17. A method for mounting a heart support system, wherein the heart support system comprises a blood pump, a motor, a motor compartment, at least one sensor disposed on a surface of the blood pump, a sensor line electrically connected to the at least one sensor, and a connection cable, wherein the method comprises: providing a motor housing module, the motor housing module comprising: a feed-through portion configured to establish an electrical connection between the heart support system and the connection cable; and at least one contact terminal, wherein the at least one contact terminal is configured to form a connection between the connection cable and the at least one sensor via an electrical connection external to the motor housing module, wherein the at least one contact terminal has a distal end embedded in a blind hole electrically insulated from the interior of the motor compartment and a proximal end that protrudes proximally beyond the motor housing module, wherein the blind hole is disposed on a side of the motor housing module opposite a pump head of the blood pump; and contacting the at least one contact terminal of the motor housing module with the sensor line of the heart support system.
18. The method according to claim 17, further comprising connecting the connection cable of the heart support system to the at least one contact pin of the motor housing module.
19. The method according to claim 17, wherein the at least one contact terminal is configured to connect to a conductor of the connection cable.
20. The method according to claim 17, wherein the at least one contact terminal comprises at least one contact pin.
21. The method according to claim 17, wherein the motor housing module comprises a sensor groove configured to receive the least one sensor.
22. The method according to claim 17, wherein the heart support system further comprising a sensor cap positioned at least partially over the sensor groove and having a measurement window for the at least one sensor.