US00RE46571E

(19) **United States**

(12) **Reissued Patent**

Virr et al.

(10) **Patent Number: US RE46,571 E**

(45) **Date of Reissued Patent: *Oct. 17, 2017**

(54) **HUMIDIFIER WITH STRUCTURE TO PREVENT BACKFLOW OF LIQUID THROUGH THE HUMIDIFIER INLET**

(71) Applicant: **ResMed Limited**, Bella Vista, New South Wales (AU)

(72) Inventors: **Alexander Virr**, Gosford (AU); **Ian Malcolm Smith**, Sydney (AU); **Perry David Lithgow**, Sydney (AU); **Richard Llewelyn Jones**, Sydney (AU); **Andrew Cheung**, Sydney (AU)

(73) Assignee: **ResMed Limited**, Bella Vista (AU)

(*) Notice: This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/182,919**

(22) Filed: **Jun. 15, 2016**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **7,614,398**
Issued: **Nov. 10, 2009**
Appl. No.: **11/181,807**
Filed: **Jul. 15, 2005**

U.S. Applications:

(63) Continuation of application No. 13/944,960, filed on Aug. 23, 2013, now Pat. No. Re. 46,079, which is an (Continued)

(30) **Foreign Application Priority Data**

Feb. 16, 2001 (AU) PR3117
Aug. 27, 2001 (AU) PR7288

(51) **Int. Cl.**
F23D 11/00 (2006.01)
F23D 14/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61M 16/16*** (2013.01); ***A61M 16/109*** (2014.02); *A61M 16/0066* (2013.01); *A61M 2205/21* (2013.01); *Y10S 261/65* (2013.01)

(58) **Field of Classification Search**
CPC A61M 16/16; A61M 16/109; A61M 16/0066; A61M 2205/21; Y10S 261/65
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,085,833 A 2/1914 Wilson
1,974,843 A * 9/1934 Blashfield 261/123
(Continued)

FOREIGN PATENT DOCUMENTS

AU 200065475 B2 4/2001
DE 275612 1/1913
(Continued)

OTHER PUBLICATIONS

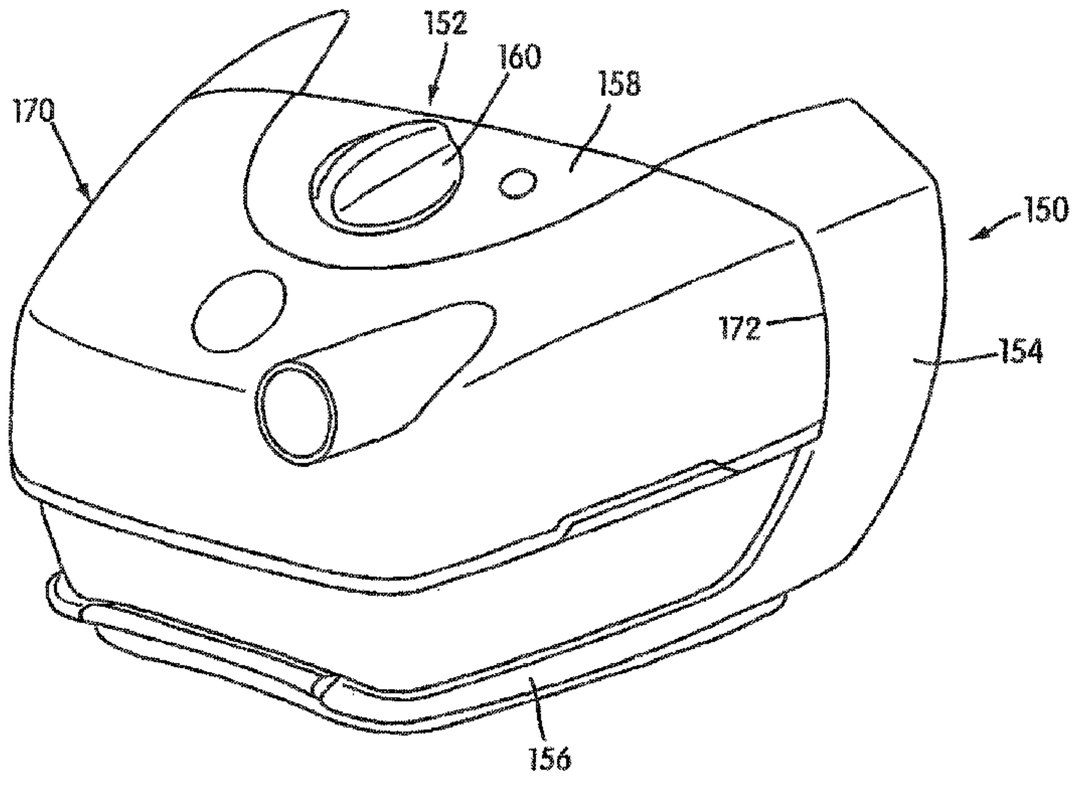
J. H. Emerson Co., Cough Assist, "Non-Invasive Removal of Bronchial Secretions," 2 pages.
(Continued)

Primary Examiner — Joseph Kaufman
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

A humidifier includes a base configured to retain a body of liquid therein, a top cover, and a seal disposed between the top cover and the base. At least a portion of the base is constructed of a heat conducting material. The top cover defines both an inlet and an outlet communicated with an interior of the base. The inlet is configured to receive pressurized breathable gas and the outlet is configured to deliver the pressurized breathable gas with added humidity.

78 Claims, 20 Drawing Sheets



Related U.S. Application Data

application for the reissue of Pat. No. 7,614,398, said application No. 13/944,960 is a continuation of application No. 13/100,783, filed on May 4, 2011, now Pat. No. Re. 44,453, which is a continuation of application No. 10/467,382, filed as application No. PCT/AU02/00155 on Feb. 14, 2002, now Pat. No. 6,935,337.

(51) **Int. Cl.**

A61M 15/00	(2006.01)
A61M 16/16	(2006.01)
A61M 16/10	(2006.01)
A61M 16/00	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

RE19,826	E		1/1936	Aisenstein	
2,220,669	A		11/1940	Allen	
2,780,708	A		2/1957	Glynn et al.	
2,945,619	A		7/1960	Ballard	
3,171,353	A		3/1965	McMahan	
3,316,910	A		5/1967	Davis	
3,584,401	A		6/1971	Cryer et al.	
3,612,710	A		10/1971	Mount	
3,620,638	A		11/1971	Kaye et al.	
3,638,926	A		2/1972	Melville et al.	
3,659,604	A		5/1972	Melville et al.	
3,690,317	A		9/1972	Millman	
3,806,102	A	*	4/1974	Valenta et al.	261/142
3,864,440	A	*	2/1975	Giocoechea	261/122.1
3,954,920	A		5/1976	Heath	
4,037,994	A		7/1977	Bird	
4,051,205	A	*	9/1977	Grant	261/70
4,152,379	A		5/1979	Suhr	
4,171,190	A		10/1979	Hudson	
4,222,971	A	*	9/1980	Eilert	261/92
4,229,142	A		10/1980	Le Dall et al.	
4,237,080	A		12/1980	Elliott	
4,243,396	A	*	1/1981	Cronenberg	96/311
4,336,798	A		6/1982	Beran	
4,383,800	A		5/1983	Becker et al.	
4,523,896	A		6/1985	Lhenry et al.	
4,532,088	A	*	7/1985	Miller	261/142
4,576,616	A		3/1986	Mottram et al.	
4,588,425	A		5/1986	Usry et al.	
4,621,632	A		11/1986	Bartels et al.	
4,657,713	A		4/1987	Miller	
4,686,354	A		8/1987	Makin	
4,753,758	A		6/1988	Miller	
4,799,287	A		1/1989	Belanger	
4,802,819	A		2/1989	Bevington	
4,807,616	A	*	2/1989	Adahan	128/204.21
4,838,258	A		6/1989	Dryden et al.	
4,906,417	A		3/1990	Gentry	
4,913,140	A		4/1990	Orec et al.	
4,921,642	A		5/1990	LaTorraca	
4,926,856	A		5/1990	Cambio et al.	
4,941,469	A		7/1990	Adahan	
4,946,348	A		8/1990	Yapp	
4,953,546	A	*	9/1990	Blackmer et al.	128/203.16
4,973,234	A		11/1990	Swenson	
4,993,411	A		2/1991	Callaway	
5,097,424	A		3/1992	Ginevri et al.	
5,127,800	A		7/1992	Hyll et al.	
5,199,009	A		3/1993	Svast	
5,231,979	A	*	8/1993	Rose et al.	128/204.14
5,237,987	A		8/1993	Anderson et al.	
5,271,391	A		12/1993	Graves	
5,329,939	A		7/1994	Howe	
5,391,063	A		2/1995	Hantle et al.	
5,443,061	A		8/1995	Champain et al.	
5,445,143	A		8/1995	Sims	
5,474,112	A		12/1995	Carola	
5,482,031	A		1/1996	Lambert	
5,537,997	A		7/1996	Mechlenburg et al.	
5,558,084	A	*	9/1996	Daniell et al.	128/203.17
5,564,415	A		10/1996	Dobson et al.	
5,577,496	A		11/1996	Blackwood et al.	
5,588,423	A		12/1996	Smith	
5,598,837	A		2/1997	Sirianne et al.	
5,651,775	A		7/1997	Walker et al.	
5,655,522	A		8/1997	Mechlenburg et al.	
5,673,687	A		10/1997	Dobson et al.	
5,794,219	A		8/1998	Brown	
5,822,715	A		10/1998	Worthington et al.	
5,828,943	A		10/1998	Brown	
5,832,448	A		11/1998	Brown	
5,848,592	A		12/1998	Sibley	
5,870,283	A		2/1999	Maeda et al.	
5,879,163	A		3/1999	Brown et al.	
5,887,133	A		3/1999	Brown et al.	
5,888,053	A		3/1999	Kobayashi et al.	
5,897,493	A		4/1999	Brown	
5,899,855	A		5/1999	Brown	
5,913,310	A		6/1999	Brown	
5,916,493	A		6/1999	Miller et al.	
5,918,603	A		7/1999	Brown	
5,933,136	A		8/1999	Brown	
5,940,801	A		8/1999	Brown	
5,943,473	A		8/1999	Levine	
5,951,300	A		9/1999	Brown	
5,956,501	A		9/1999	Brown	
5,960,403	A		9/1999	Brown	
5,985,559	A		11/1999	Brown	
5,997,476	A		12/1999	Brown	
D419,658	S		1/2000	Matchett et al.	
6,023,686	A		2/2000	Brown	
6,032,119	A		2/2000	Brown et al.	
6,050,260	A		4/2000	Daniell et al.	
6,101,478	A		8/2000	Brown	
6,109,865	A		8/2000	Ishikawa	
6,129,524	A		10/2000	Wollenweber et al.	
6,131,571	A		10/2000	Lampotang et al.	
6,135,432	A		10/2000	Hebblewhite et al.	
6,144,837	A		11/2000	Quy	
6,152,132	A		11/2000	Psaros	
6,158,978	A		12/2000	Norbury, Jr.	
6,161,095	A		12/2000	Brown	
6,185,095	B1		2/2001	Helot et al.	
6,189,870	B1		2/2001	Withall	
6,202,991	B1		3/2001	Coniglio et al.	
6,210,116	B1		4/2001	Kuczaj et al.	
6,213,119	B1		4/2001	Brydon et al.	
6,216,691	B1		4/2001	Kenyon et al.	
6,257,171	B1		7/2001	Rivard	
6,279,574	B1		8/2001	Richardson et al.	
6,308,706	B1		10/2001	Lammers et al.	
6,332,462	B1		12/2001	Krohn	
6,338,473	B1		1/2002	Hebblewhite et al.	
6,340,288	B1		1/2002	Hulkkonen et al.	
6,349,724	B1		2/2002	Burton et al.	
D454,393	S		3/2002	Lynch et al.	
6,397,841	B1		6/2002	Kenyon et al.	
6,398,197	B1		6/2002	Dickinson	
6,435,180	B1	*	8/2002	Hewson et al.	128/204.18
6,471,493	B2		10/2002	Choi et al.	
D467,335	S		12/2002	Lithgow et al.	
D468,011	S		12/2002	Lynch et al.	
D468,017	S		12/2002	McCombs	
6,514,053	B2		2/2003	Takura et al.	
6,543,449	B1		4/2003	Woodring et al.	
6,554,260	B1	*	4/2003	Lipscombe et al.	261/142
6,591,834	B1		7/2003	Colla et al.	
6,604,390	B1		8/2003	Nooner	
6,615,444	B2		9/2003	McGill et al.	
6,622,724	B1		9/2003	Truitt et al.	
6,672,300	B1		1/2004	Grant	
D487,311	S		3/2004	Lithgow et al.	
6,718,974	B1	*	4/2004	Moberg	128/204.14
D493,520	S		7/2004	Bertinetti et al.	
D493,884	S		8/2004	Virr et al.	

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,772,999	B2	8/2004	Lipscombe et al.	
6,775,882	B2	8/2004	Murphy et al.	
D498,527	S	11/2004	Virr et al.	
6,827,340	B2	12/2004	Austin et al.	
6,837,260	B1	1/2005	Kuehn	
6,874,771	B2	4/2005	Birdsell et al.	
6,896,478	B2	5/2005	Botros et al.	
6,910,483	B2	6/2005	Daly et al.	
6,918,389	B2	7/2005	Seakins et al.	
6,935,337	B2 *	8/2005	Virr et al.	128/203.16
7,096,864	B1	8/2006	Mayer et al.	
7,111,624	B2	9/2006	Thudor et al.	
7,137,388	B2 *	11/2006	Virr et al.	128/203.17
7,225,809	B1	6/2007	Bowen et al.	
7,413,173	B2	8/2008	DiMatteo et al.	
7,614,398	B2	11/2009	Virr et al.	
7,616,871	B2	11/2009	Kramer	
7,677,246	B2	3/2010	Kepler et al.	
8,091,547	B2	1/2012	Thudor et al.	
RE44,453	E	8/2013	Virr et al.	
8,550,072	B2	10/2013	Thudor et al.	
2001/0017134	A1	8/2001	Bahr	
2002/0020930	A1	2/2002	Austin et al.	
2002/0022973	A1	2/2002	Sun et al.	
2002/0056453	A1	5/2002	Klopp et al.	
2002/0159897	A1	10/2002	Kegg et al.	
2003/0062045	A1	4/2003	Woodring et al.	
2003/0084900	A1	5/2003	LeClerc et al.	
2003/0115085	A1	6/2003	Satoh	
2003/0208465	A1	11/2003	Yurko et al.	
2003/0230308	A1	12/2003	Linden	
2004/0035422	A1	2/2004	Truitt et al.	
2004/0055597	A1	3/2004	Virr et al.	
2004/0060559	A1	4/2004	Virr et al.	
2005/0005937	A1	1/2005	Farrugia et al.	
2005/0103339	A1	5/2005	Daly et al.	
2005/0217673	A1	10/2005	Daly et al.	
2006/0191531	A1	8/2006	Mayer	
2006/0237005	A1	10/2006	Virr et al.	
2007/0036662	A1	2/2007	Pensola et al.	
2007/0134085	A1	6/2007	Daly et al.	
2009/0229606	A1	9/2009	Tang et al.	
2010/0229867	A1	9/2010	Bertinetti et al.	

FOREIGN PATENT DOCUMENTS

DE	30 05 094	A1	8/1981
DE	3623162	A1	7/1986
DE	9014848.7		3/1991
DE	4138098	C2	11/1991
DE	4244493	A1	7/1993
DE	93 17 450		6/1994
DE	3789221	T2	8/1994
DE	9409231.1	U1	12/1994
DE	195 15 739	A1	11/1996
DE	19630466		2/1998
DE	694 09 024	T2	10/1998
DE	29817685	U1	10/1998
DE	29909611	U1	10/1999
DE	199 36 499	A1	2/2001
DE	10016005	A1	12/2001
DE	102005007773	A1	9/2005
EP	0 201 985	A1	11/1986
EP	0 274 996	A2	7/1988
EP	3823242	A1	2/1990
EP	0 376 584	A2	7/1990
EP	0 589 429	A1	3/1994
EP	0 589 429	B1	3/1994
EP	0 845 277	A2	6/1998
EP	0 893 750		1/1999
EP	0 903 160	A1	3/1999
EP	1023912	A2	8/2000
EP	1 055 431	A2	11/2000
EP	1 087 322	A2	3/2001
EP	1318307		6/2003
EP	1 374 938	A1	1/2004
FR	2 323 436		4/1977
FR	2 714 985		7/1995
GB	1556492	A	11/1979
GB	2177006	A	1/1987
JP	7-145795	A	6/1995
JP	11-398	A	1/1999
JP	2000-337670	A	12/2000
JP	2001-160102	A	6/2001
JP	2002-206498	A	7/2002
JP	2002-253672		9/2002
JP	2002-306601		10/2002
WO	WO 93/05451	A1	3/1993
WO	WO 95/15778	A1	6/1995
WO	WO 97/32619	A1	9/1997
WO	WO 98/04311	A1	2/1998
WO	WO 98/31937	A1	7/1998
WO	WO 98/33433		8/1998
WO	WO 98/57691	A1	12/1998
WO	WO 99/13932		3/1999
WO	WO 99/22794	A1	5/1999
WO	WO 99/64747		12/1999
WO	WO 00/21602	A1	4/2000
WO	WO 00/27457	A1	5/2000
WO	WO 00/32261	A1	6/2000
WO	WO 01/10489	A2	2/2001
WO	WO 01/32069	A2	5/2001
WO	WO 01/73653	A1	10/2001
WO	WO 02/02169	A1	1/2002
WO	WO 02/066106	A1	8/2002
WO	WO 02/066107	A1	8/2002
WO	WO 2007/019628	A1	2/2007
WO	WO 2009/059359	A1	5/2009
WO	WO 2009/156921	A1	12/2009
WO	WO 2010/092496		8/2010

OTHER PUBLICATIONS

Madaus Schwarzer Medizintechnik, "New Approaches in Diagnosis and Therapy—Moritz biLevel User Manual". May 1994, 38 pages.

German Patient Manual for Hoffrichter/Sandmann CPAP Respirator—Perfect CPAP Therapy, 30 pages plus Translation Verification Certificate, Mar. 1998.

Breas Medical AB "iSleep® 20" Brochure, Dec. 2007, 2 pages.

Fisher & Paykel Healthcare "S1eepStyle™ 600 CPAP Series" Specification Sheet, 2005, 4 pages.

Fisher & Paykel Healthcare Two Easy Steps to Comfort, Humidification and Nasal CPAP Therapy, Aug. 1995, 4 pages.

Hoffrichter GmbH "VECTOR therapy in perfection" Brochure, 2002, 2 pages.

MAP Medizin-Technologie GmbH "minni Max nCPAP®, The respiratory therapy device without an integrated humidifier", Dec. 2003, 17 pages.

MAP Medizintechnik fuer Arzt und Patient "max II nCPAP moritz II biLevel—The gentle therapy for sleep-related breathing disorders" Brochure, 2000, 4 pages.

Respironics "System One Heated Humidifier User Manual", May 2009, 20 pages.

ResMed, "The SULLIVAN® HumidAire™", 1997, 1 page.

De Vilbiss® Healthcare, "DeVilbiss IntelliPAP® Standard CPAP System," Nov. 2007, 2 pages.

Photos of HumidAire™, 11 pages.

Photos of tray system available before the critical date, with sample flow generator and humidifier, 5 pages.

Microfilm of Japanese Utility-Model Application No. S54-003858 (Japanese Utility-Model Application Publication No. S55-104925).

MAP Medizintechnik, "minni Max nCPAP®" brochure, 12 pages, Mar. 2005.

MAP Medizintechnik, "Moritz II biLEVEL®—The gentle therapy for sleep-related breathing disorders" brochure, 6 pages, Jan. 2001.

Photos of MAP Humidifier and Tub, 2 pages and cover sheet, undated.

Madaus Schwarzer Medizintechnik, "New Approaches in Diagnosis and Therapy—Max nCPAP User Manual", Mar. 1994, 38 pages.

(56) **References Cited**

OTHER PUBLICATIONS

ResMed "Sullivan® HumidAire® User's Instructions", 8 pages, 1998.
MAP Medizin-Technologie GmbH, Moritz®S/Moritz®ST—Sailing toward therapeutic success . . . , Jul. 2004, 4 pages.
Hoffrichter "VECTOR CPAP—Therapy With Technical Mastery", 4 pages, Oct. 1998.
Fischer & Paykel, "Two Easy Steps to Comfort", 4 pages, Aug. 1995.
Notification of Second Office Action mailed Jan. 27, 2006 in Chinese Appln. No. 02804936.5, with English Translation (6 pages).
Notification of Reasons for Rejection mailed Feb. 19, 2008 in Japanese Appln. No. 2002-565664, with English translation (5 pages).
Final Notice of Reasons for Rejection delivered Sep. 24, 2008 in Japanese Appln. No. 2002-565664, with English translation (6 pages).
Notification of the First Office Action mailed Jul. 22, 2005 in Chinese Appln. No. 02804936.5, with English translation (8 pages).
Extended European Search Report mailed Apr. 28, 2011 in European Appln. No. 10189422.8 (5 pages).
International Search Report mailed Mar. 21, 2002 in International Appln. No. PCT/AU02/00155 (2 pages).
International Preliminary Examination Report completed Oct. 4, 2002 in International Appln. No. PCT/AU02/00155 (3 pages).
Office Action dated Jan. 22, 2008 in Japanese Patent Appln. No. 2002-565665 (w/English translation) (12 pages).
Examination Report mailed Oct. 10, 2003 in New Zealand Appin. No. 527088 (2 pages).
Supplementary European Search Report mailed Sep. 15, 2009 in European Appln. No. 02700014.0, (3 pages).
Communication mailed Jul. 1, 2010 in European Appln. No. 02 700 014.0 (5 pages).
Extended European Search Report mailed May 4, 2012 in European Appln. No. 12159042.6 (5 pages).
ITC Action related to Certain Sleep-Disordered Breathing Treatment Systems and Components Thereof, Inv. No. 337-TA-__, CBI 13-185, filed on Mar. 28, 2013, 57 pages.
ResMed's First Amended Complaint for Patent Infringement, filed in the United States District Court Central District of California Southern Division, filed on Apr. 8, 2013, 342 pages.
"Complaint for Patent Infringement—Jury Trial Demanded" as filed in the United States District Court, Southern District of California, Case No. 13CV1246 MMAWMC, dated May 31, 2013, 18 pages.
"Motion to Amend the Complaint and Notice of Investigation" as filed in the United States International Trade Commission, Investigation No. 337-TA-879, dated May 31, 2013, 18 pages.
Petition for Inter Partes Review of U.S. Pat. No. 7,614,398, mailed on Aug. 16, 2013.
Declaration of Joseph Dyro, Petition Exhibit 1007.
Notification of Acceptance of Request for Invalidation and English Translation for corresponding Chinese Patent No. 02804936.5, issued Mar. 20, 2014, 188 pages.
Petition for Inter Parties Review of U.S. Pat. No. RE44,453 Under to 35 U.S.C. §§ 311 ET SEQ. and 37 C.F.R. §42.100 ET SEQ., *Apex Medical Corp.*, Petitioner v. *ResMed Limited,* Patent Owner, Case No. IPR2014-00551, Mar. 27, 2014, 38 pages.
Apex Medical Corporation, Petition Exhibit 1002 in IPR2014-00551, "ResMed's First Amended Complaint for Patent Infringement—Jury Trial Demanded", Case No. SACV-13-00498 CJC (RNBx), USDC, Central District of California, Southern Division, 18 pages.
Petition Exhibit 1006 in IPR2014-00551, Patent Owner Amendment mailed Mar. 27, 2009, in U.S. Appl. No. 11/181,807, 10 pages.
Petition Exhibit 1007 in IPR2014-00551, Declaration of Joseph Dyro in Support of Inter Partes Review of U.S. Pat. No. RE44,453, executed Mar. 26, 2014, 15 pages.
Petition for Inter Parties Review of U.S. Pat. No. RE44,453 Under to 35 U.S.C. §§311-319 and 37 C.F.R. §42.100 et seq., *BMC Medical Co. Ltd.,* Petitioner v, *ResMed Limited,* Patent Owner, Case No. IPR2014-01196, Jul. 23, 2014, 62 pages.
Petition Exhibit 1003 in IPR2014-01196, REMStar® Heated Humidifier Manual, Mar. 15, 2001, 8 pages.
Petition Exhibit 1004 in IPR2014-01196, Declaration of Steve Bordewick, Jul. 22, 2014, 59 pages.
Petition Exhibit 1006 in IPR2014-01196, Patent Owner ResMed Limited's Preliminary Response filed Jul. 10, 2014 in IPR2014-00551, 41 pages.
Petition Exhibit 1007 in IPR2014-01196, ITC Investigation No. 337-TA-890,: Order No. 7: Initial Determination Granting Complainants' Motion to Amend Complaint and Notice of Investigation and Granting Respondents' Motion to Terminate the Investigation with Respect to U.S. Pat. No. 7,614,398, served Feb. 4, 2014, 8 pages.
Petition Exhibit 1008 in IPR2014-01196, Case No. 13-cv-1246-CAB (WMc), Order on Motion to Stay, Motion to Dismiss, and Related Discovery Request, Oct. 15, 2013, 3 pages.
Petition Exhibit 1009 in IPR2014-01196, Case No. SACV 13-00498: Order Granting Defendants' Motion to Stay Litigation Pending Inter Partes Review, Oct. 4, 2013, 3 pages.
Petition Exhibit 1010 in IPR2014-01196: Patent Prosecution History of Reissue U.S. Appl. No. 13/944,960, filed Jul. 18, 2013, 228 pages.
Petition Exhibit 1011 in IPR2014-01196: Patent Prosecution History of U.S. Pat. No. 7,614,398, 174 pages.
Petition Exhibit No. 1012 in IPR2014-01196: Patent Prosecution History of U.S. Pat. No. RE44,453, 2157 pages.
Petition Exhibit No. 1013 in IPR2014-01196: Proof of Service of 3B Medical, Inc. in Civil Action No. 13-cv-1246-MMA-WMC, 5 pages.
Petition Exhibit No. 1014 in IPR2014-01196: Australian Application No. PR 3117, filed Feb. 16, 2001, 17 pages.
Petition Exhibit No. 1015 in IPR2014-01196: ITC Investigation No. 337-TA-890: Order No. 8: Construing Terms of the Asserted Patents, served Jan. 17, 2014, 51 pages.
Petition Exhibit No. 1016 in IPR2014-01196: ITC Investigation No. 337-TA-890: Order No. 14: Denying Respondents' Motion for Summary Determination of Invalidity of U.S. Pat. No. RE44,453, served Mar. 26, 2014, 19 pages.
Petition Exhibit No. 1020 in IPR2014-01196: Australian Application No. PR 7288, filed Aug. 27, 2001, 23 pages.
Petition Exhibit No. 1022 in IPR2014-01196: ITC Investagation No. 337-TA-890: Notice of Commission Determination Not to Review an Initial Determination Granting the Complainants' Motion to Amend the Complaint and Notice of Investigation to Substitute U.S. Pat. No. RE44,453 for U.S. Pat. No. 7,614,398 and Granting Respondents' Motion to Terminate the Investigation with Respect to U.S. Pat. No. 7,614,398, Issued: Feb. 10, 2014, 3 pages.
Patent Owner Exhibit No. 2001 in IPR2014-00551, Applicant Transmittal to USPTO re Completion of National Phase Filing of the PCT Application for the Mayer Reference, Aug. 6, 2002, 4 pages.
Patent Owner Exhibit No. 2002 in IPR2014-00551, RE44,453 Patent Application Data Sheet, Initial May 4, 2011, 5 pages.
Patent Owner Exhibit No. 2003 in IPR2014-00551, Decision of the Patent Trial and Appeal Board Denying Institution of Inter Partes Review of U.S. Pat. No. 7,614,398, entered Feb. 20, 2014, 5 pages.
Patent Owner Exhibit No. 2005 in IPR2014-00551, U.S. National Stage Worksheet of USPTO re National Phase Requirements Completion for the Mayer Reference, 1 page.
Patent Owner Exhibit No. 2010 in IPR2014-00551, Deposition Transcript of Dr. Joseph F. Dyro in Connection with Inter Partes Review Proceedings IPR2013-00511, IPR2013-00512, IPR2013-00514, IPR2013-00515, and IPR2013-00516, Apr. 21, 2014, 46 pages.
Patent Owner Exhibit No. 2011 in IPR2014-00551, Patent Owner ResMed Limited's Preliminary Response to Apex Medical Corp.'s Petition for Inter Partes Review of U.S. Pat. No. 7,614,398, Case No. IPR2013-00513, Nov. 22, 2013, 15 pages.
Petition for Inter Parties Review of U.S. Pat. No. RE 44,453, *BMC Medical Co. Ltd.,* Petitioner v. *ResMed Limited,* Patent Owner, Case No. IPR2014-01363, Aug. 22, 2014, 66 pages.

(56) **References Cited**

OTHER PUBLICATIONS

Petition Exhibit 1004 in IPR2014-01363, Declaration of Steve Bordewick, Aug. 22, 2014, 90 pages.
Notification of Acceptance of Request for Invalidation, Issued: Dec. 24, 2014, in Chinese Patent No. 02804936.5, with English translation, 62 pages.
U.S. International Trade Commission, Inv. No. 337-TA-890, "Office of Unfair Import Investigations' Petition for Review of the Initial Determination," dated Sep. 3, 2014 (Public Version Filed: Oct. 8, 2014), 34 pages.
U.S. International Trade Commission, Inv. No. 337-TA-890, "Office of Unfair Import Investagations' Response to the Petitions for Review of the Initial Determination," dated Sep. 11, 2014 (Public Version Filed: Oct. 8, 2014), 37 pages.
U.S. International Trade Commission, Inv. No. 337-TA-890, "Office of Unfair Import Investigations' Reply to the Private Parties' Responses to the Commission Question," dated Nov. 7, 2014 (Public Version Filed: Dec. 3, 2014), 19 pages.
U.S. International Trade Commission, Inv. No. 337-TA-890, "Office of Unfair Import Investigations' Response to ResMed's Motion to Withdraw the '487 Patent or Alternatively Find No Violation Based on Technical Prong," dated Nov. 19, 2014 (Public Version Filed: Dec. 3, 2014), 5 pages.
U.S. International Trade Commission, Inv. No. 337-TA-890, "Notice of the Commission's Final Determination; Issuance of a Limited Exclusion Order and Cease and Desist Orders; Termination of the Investigation," Issued: Dec. 23, 2014, 25 pages.
U.S. Patent and Trademark Office, Case IPR2014-01196, U.S. Pat. No. RE 44,453 E, "Decision Institution of Inter Partes Review 37 C.F.R. §42.108," Paper No. 7, Entered: Dec. 21, 2014, 11 pages.
U.S. Patent and Trademark Office, Case IPR2014-01196 and IPR2014-01363, U.S. Pat. No. RE 44,453 E, "Scheduling Order," Entered: Jan. 21, 2015, 9 pages.
US. Patent and Trademark Office, Case IPR2014-01363, U.S. Pat. No. RE 44,453 E, Decision Institution of Inter Partes Review 37 C.F.R. §42.108, Paper No. 7, Entered: Jan. 21, 2015, 21 pages.
Communication Pursuant to Article 94(3) EPC mailed Feb. 4, 2015 in European Application No. 12 159 042.6 (4 pages).
Fisher & Paykel Limited, New Zealand Application No. 503495, filed Mar. 21, 2000, 29 pages.
Communication pursuant to Article 94(3) EPC (examination report) mailed Jun. 5, 2015 in European Application No. 10 189 422.8 (4 pages).
Communication pursuant to Article 94(3) EPC (examination report) mailed Jun. 12, 2015 in European Application No. 02 700 014.0 (3 pages).
Communication Pursuant to Article 94(3) EPC (European Examination Report) mailed Oct. 7, 2015 in EP Application No. 12 159 042.6 (4 pages).
Fisher & Paykel Healthcare, "HC200 Series Nasal CPAP Blower & Heated Humidifier User's Manual", 1998, 17 pages.
Fisher & Paykel Healthcare "SleepStyle™ 200 CPAP Series" Specification Sheet, 2005, 4 pages.
United States Patent and Trademark Office, Before the Patent Trial and Appeal Board, *BMC Medical Co., Ltd., 3B Products, L.L.C. and 3B Medical Inc.* (Petitioner) v. *ResMed Limited* (Patent Owner), Final Written Decision, Paper 25, Entered Jan. 20, 2016 in IPR2014-01363 (39 pages).
United States Patent and Trademark Office, Before the Patent Trial and Appeal Board, *BMC Medical Co., Ltd., 3B Products, L.L.C. and 3B Medical Inc.* (Petitioner) v. *ResMed Limited* (Patent Owner), Final Written Decision, Paper 25, Entered Jan. 19, 2016 in IPR2014-01196 (14 pages).
Virr et al., U.S. Appl. No. 13/944,960, filed Aug. 23, 2013, entitled Humidifier with Structure to Prevent Backflow of Liquid Through the Humidifier Outlet.

* cited by examiner

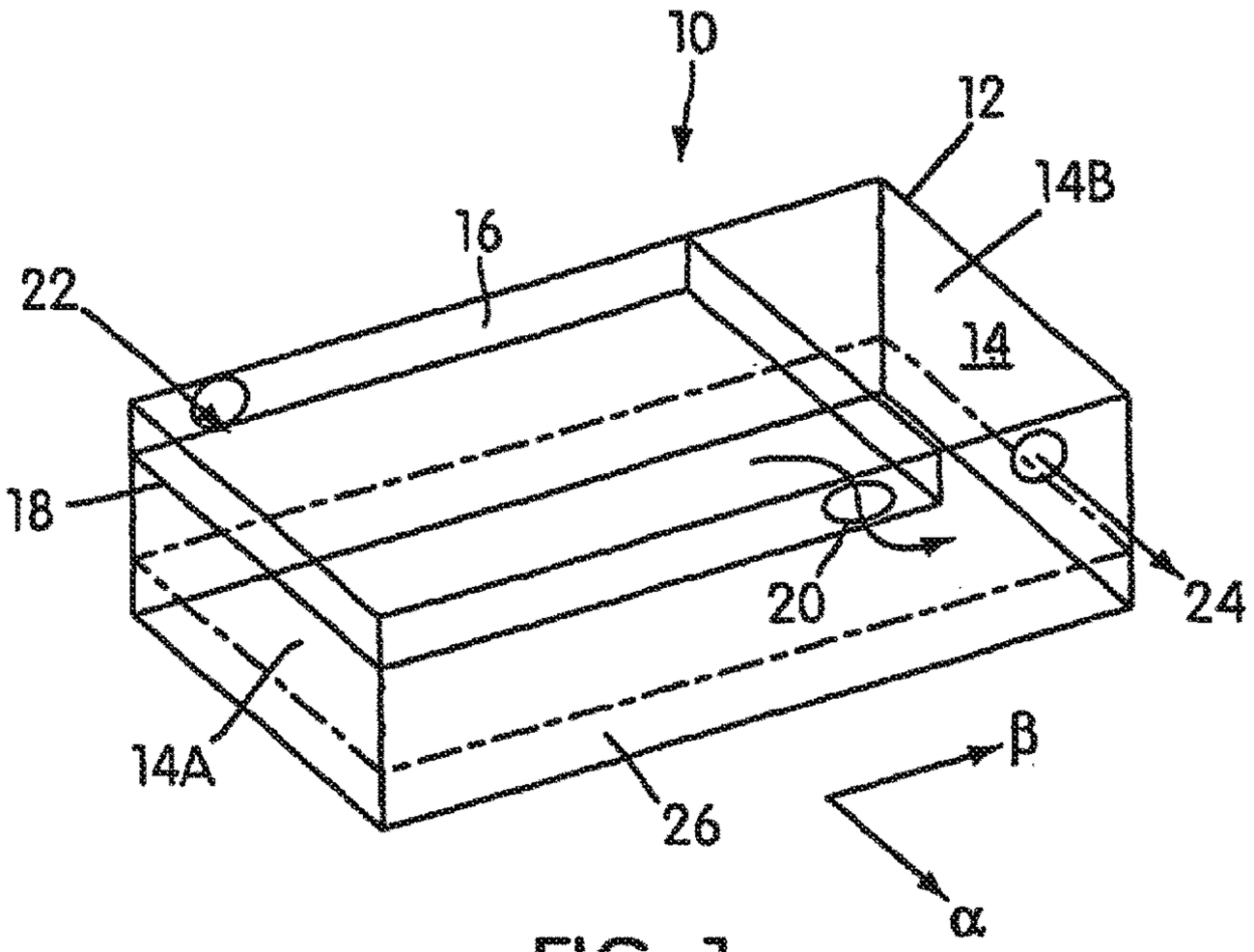

10
12
14B
16
22
14
18
20
24
14A
26
β
α

FIG. 1

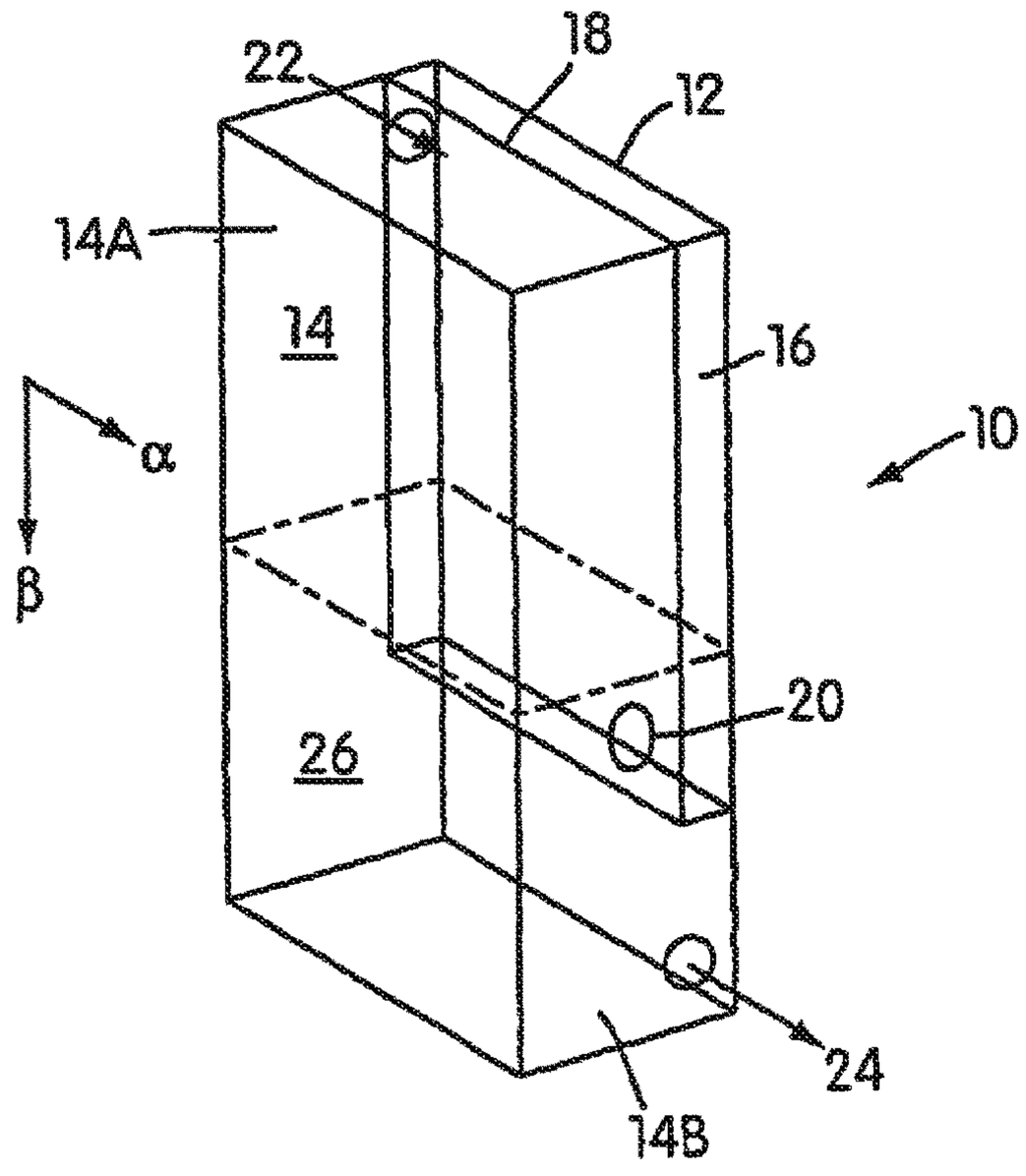

18
22
12
14A
14
16
α
β
10
20
26
24
14B

FIG. 2

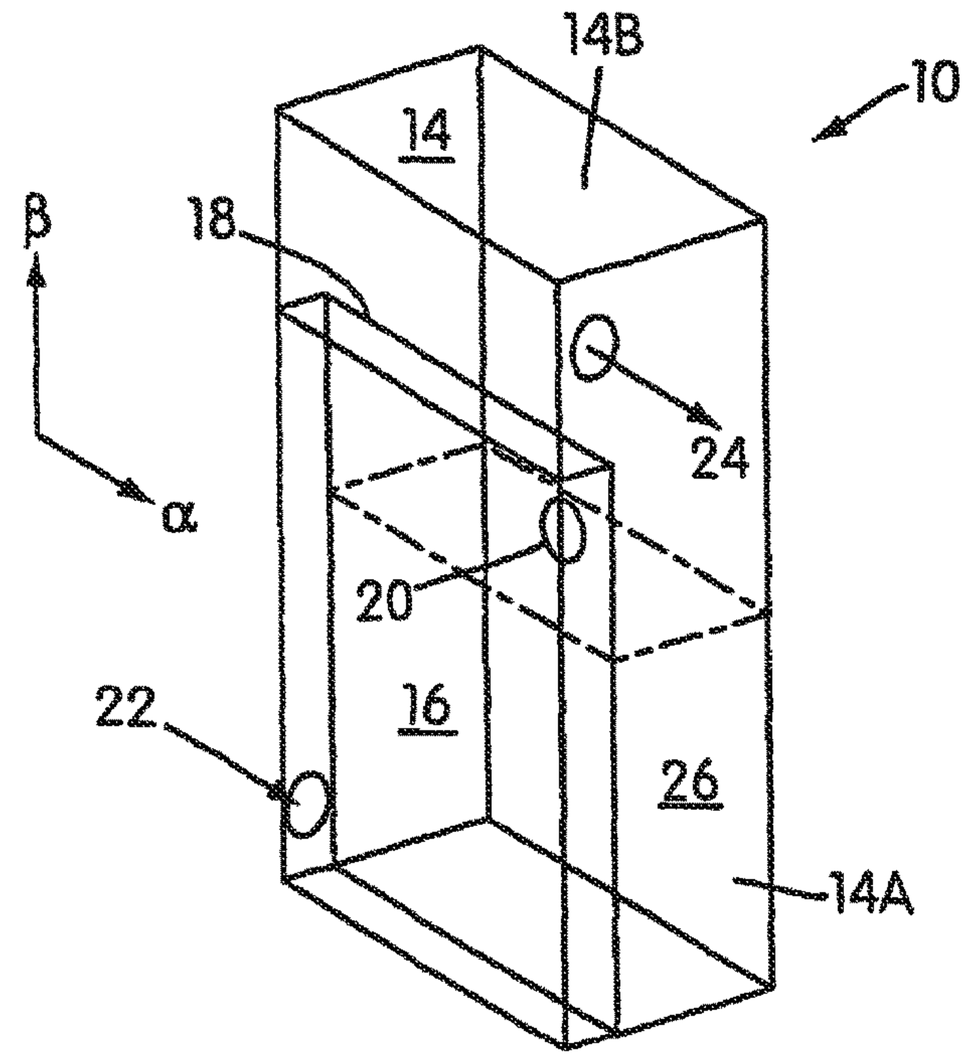


FIG. 3

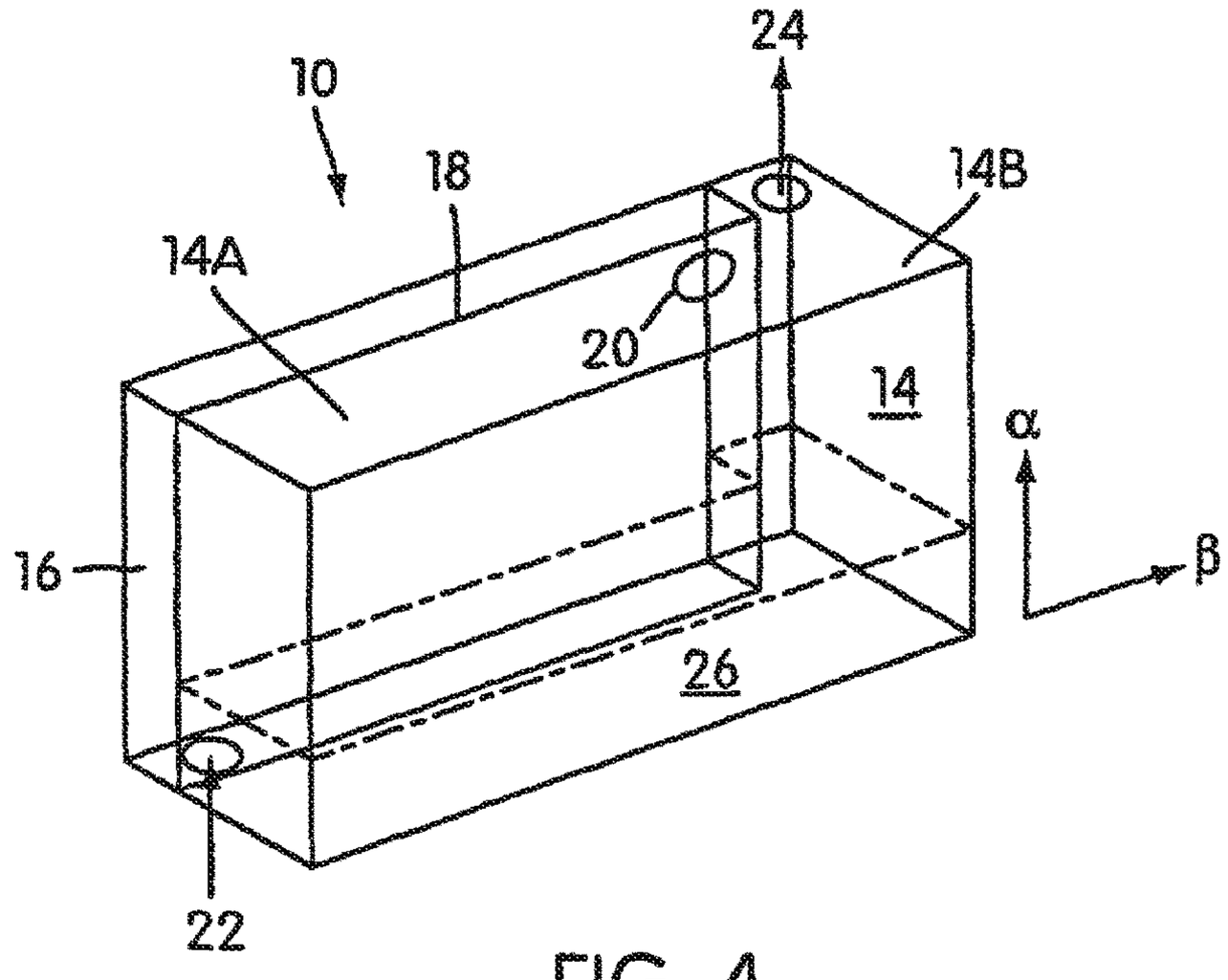


FIG. 4

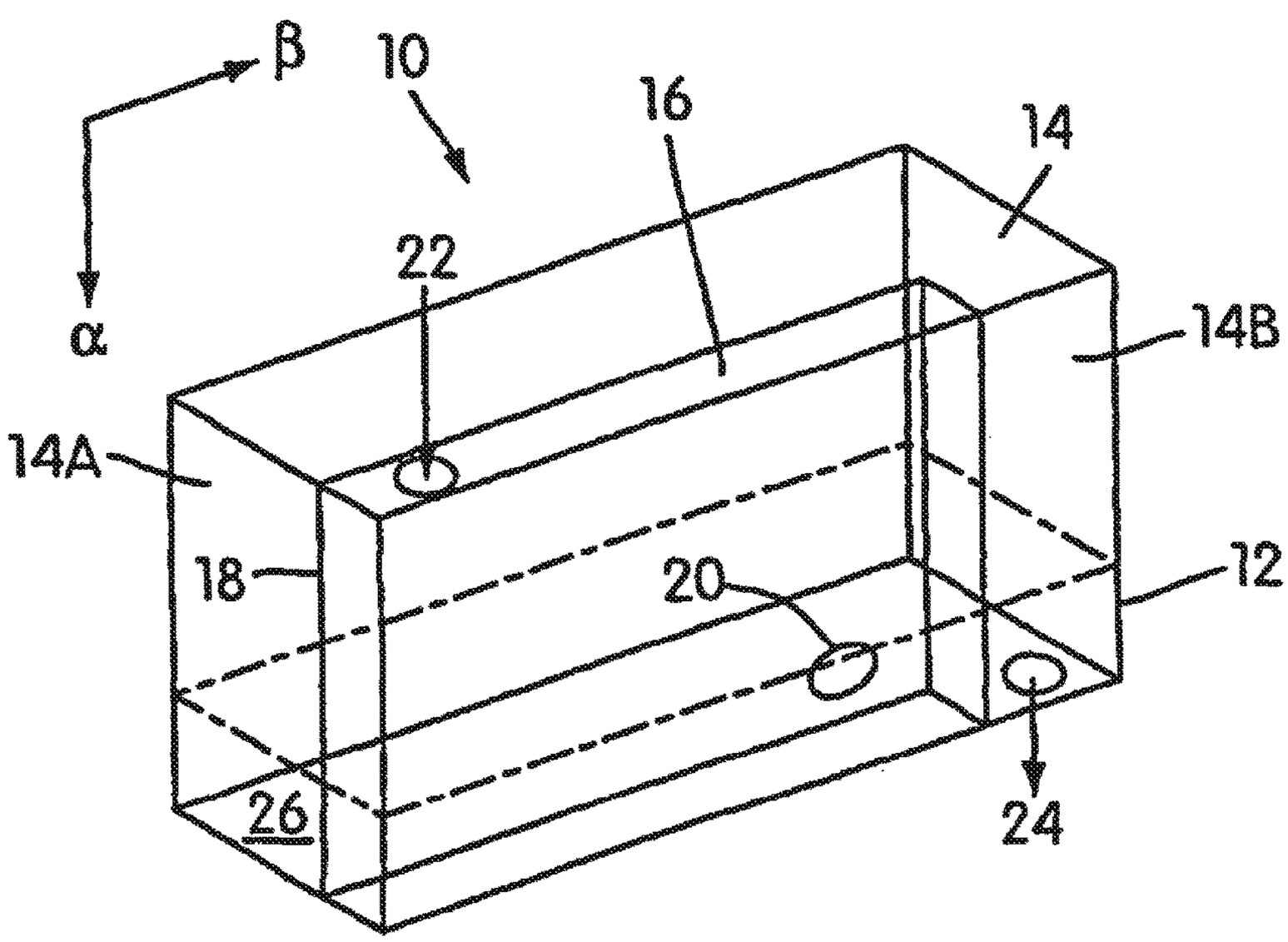


FIG. 5

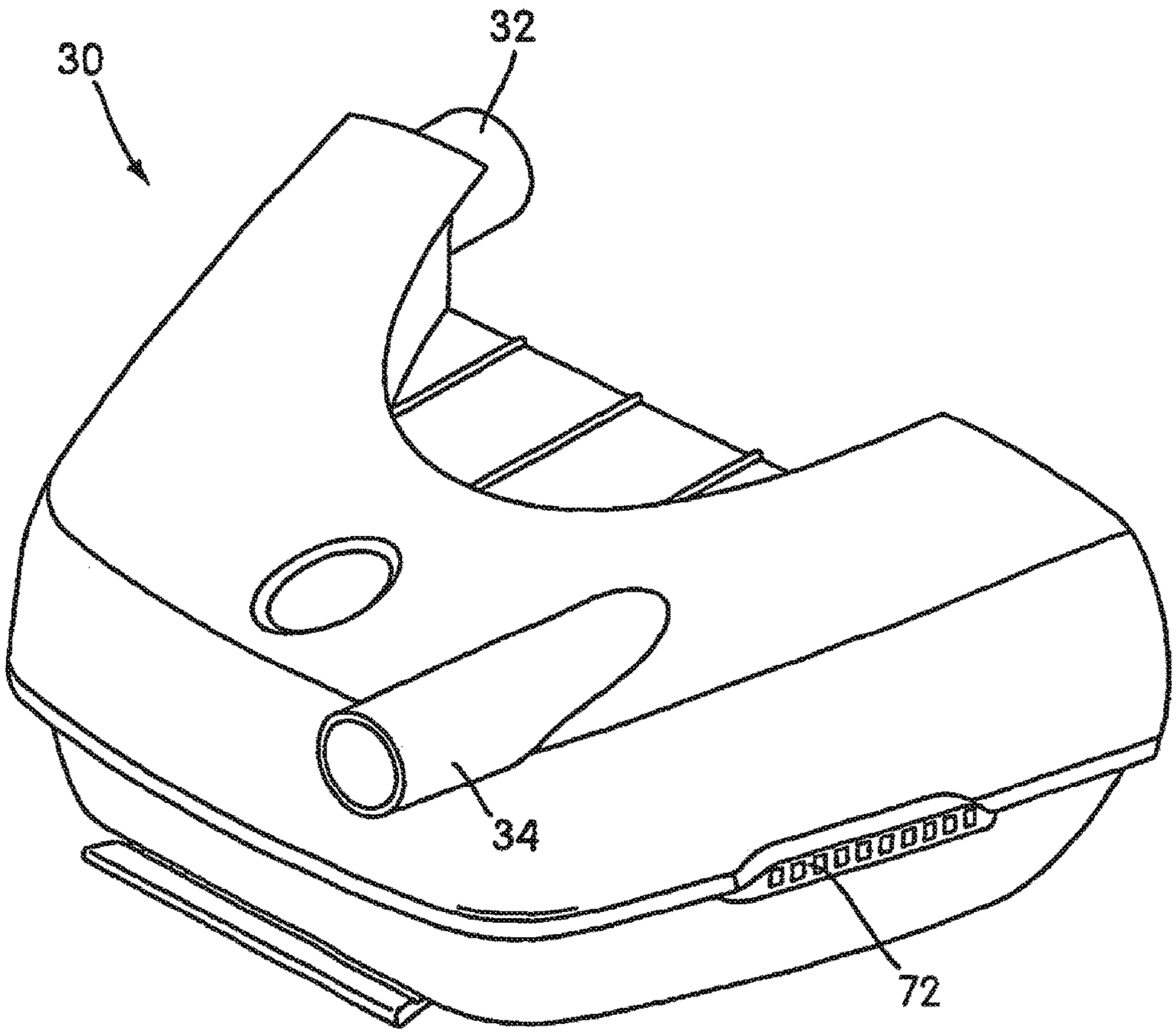


FIG. 6

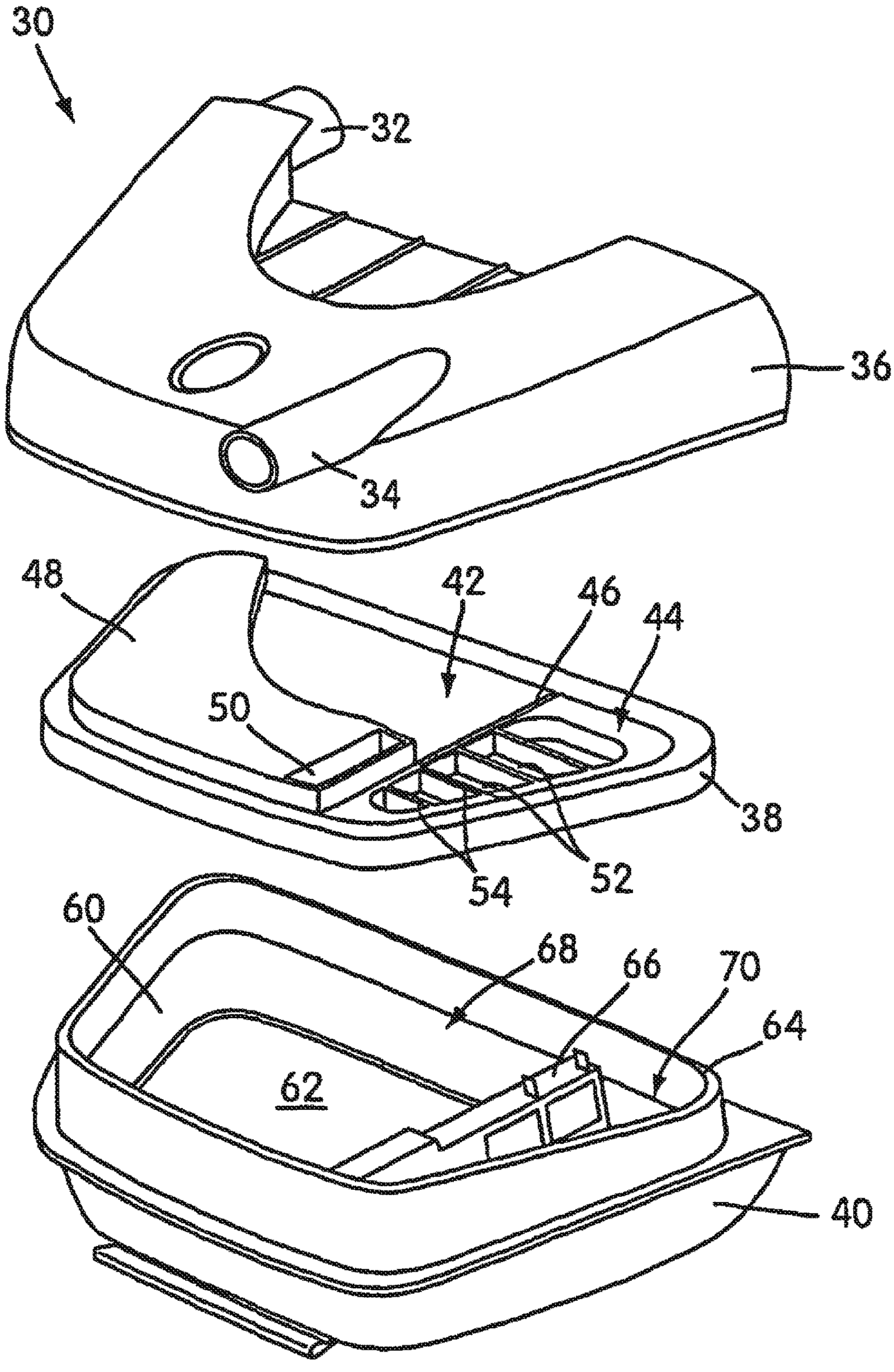


FIG. 7

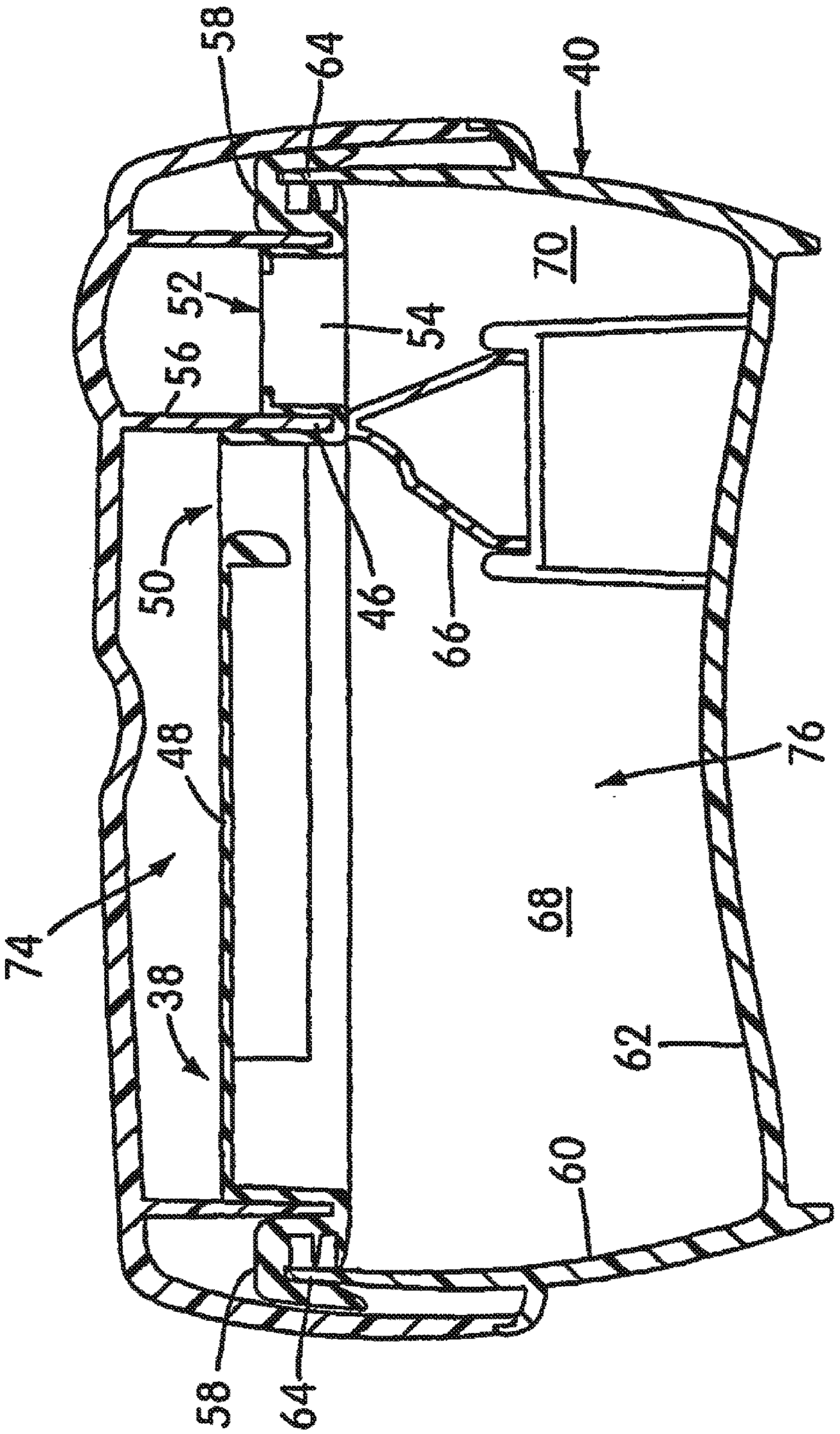


FIG. 8

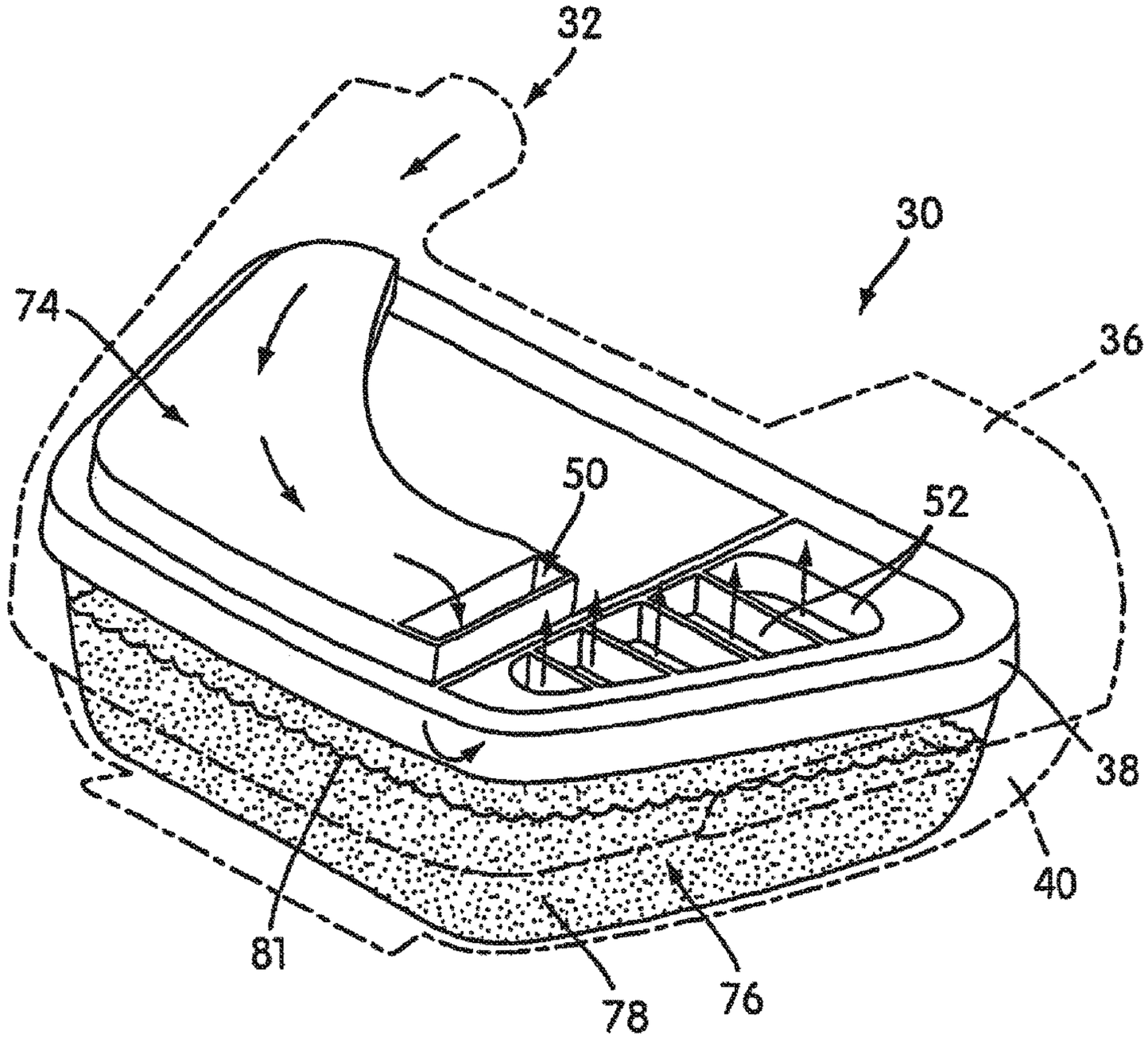


FIG. 9

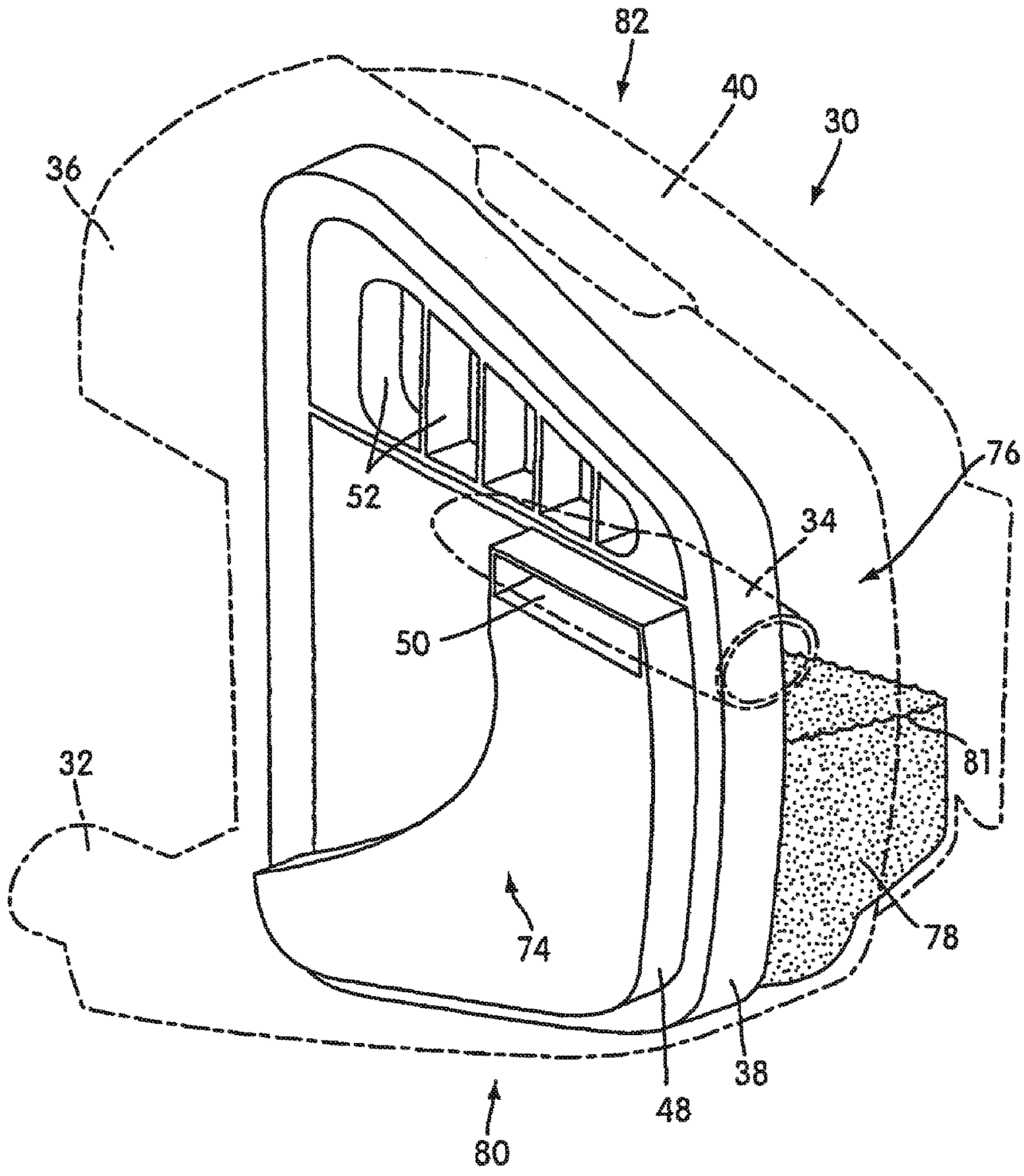


FIG. 10

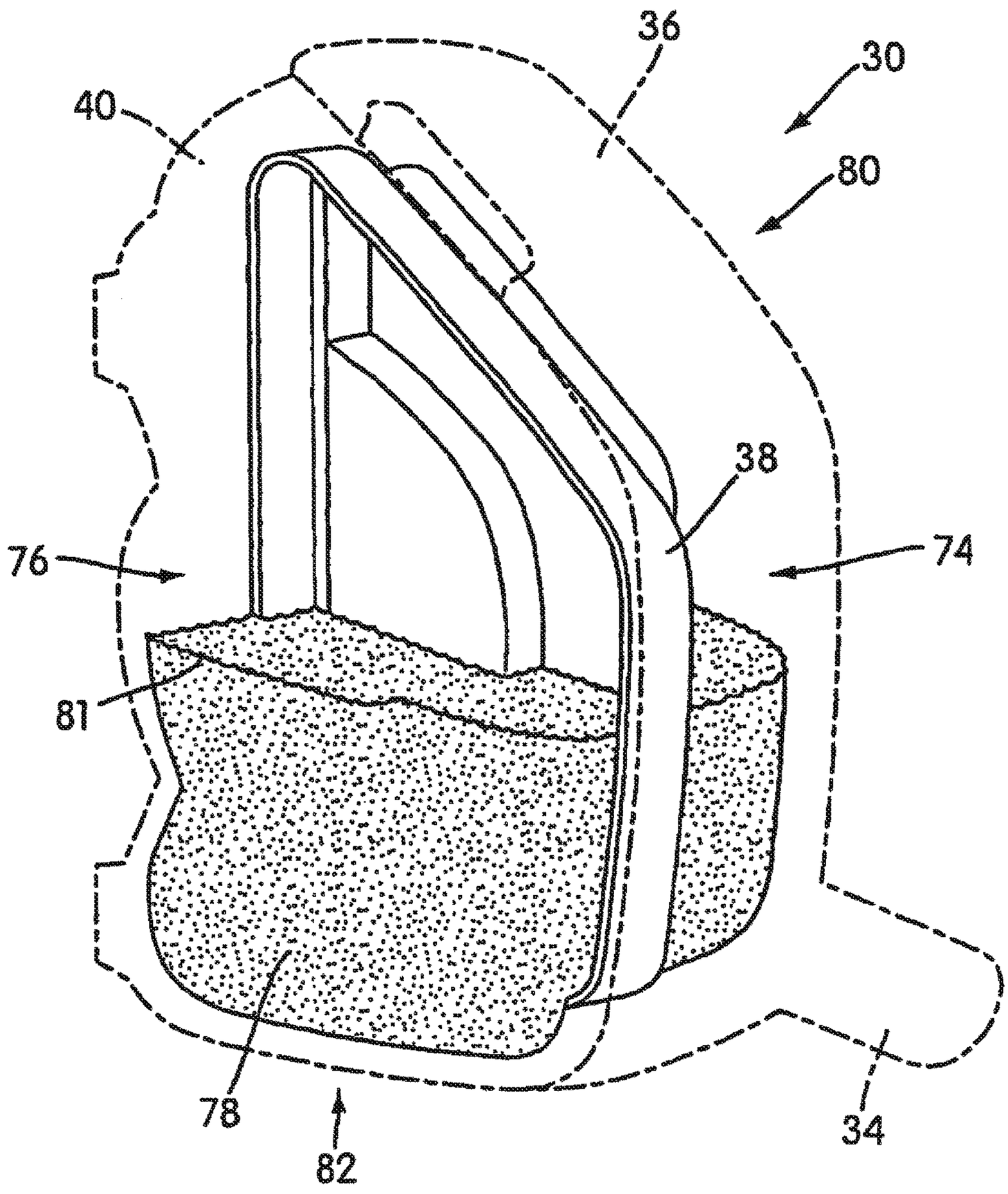


FIG. 11

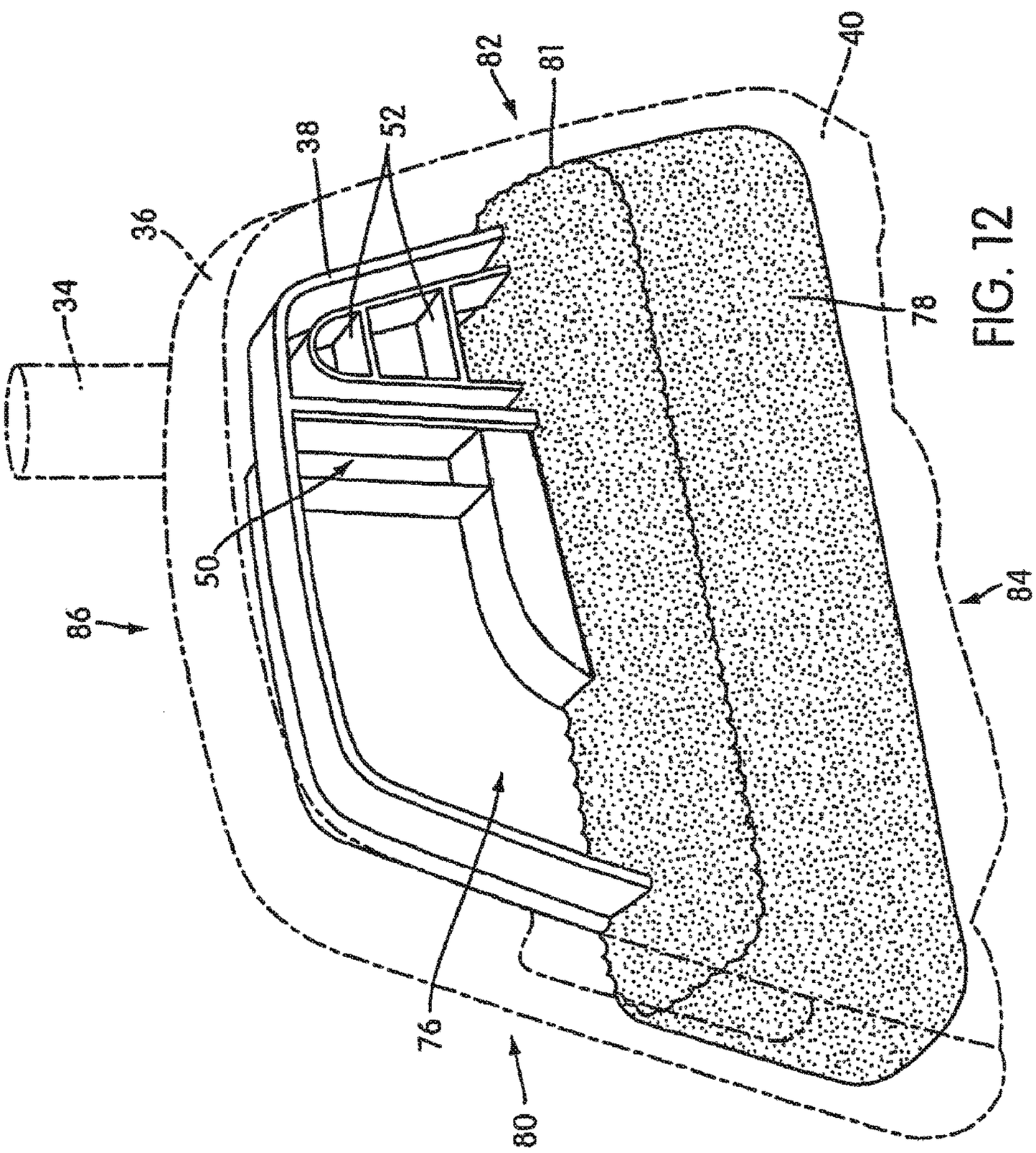


FIG. 12

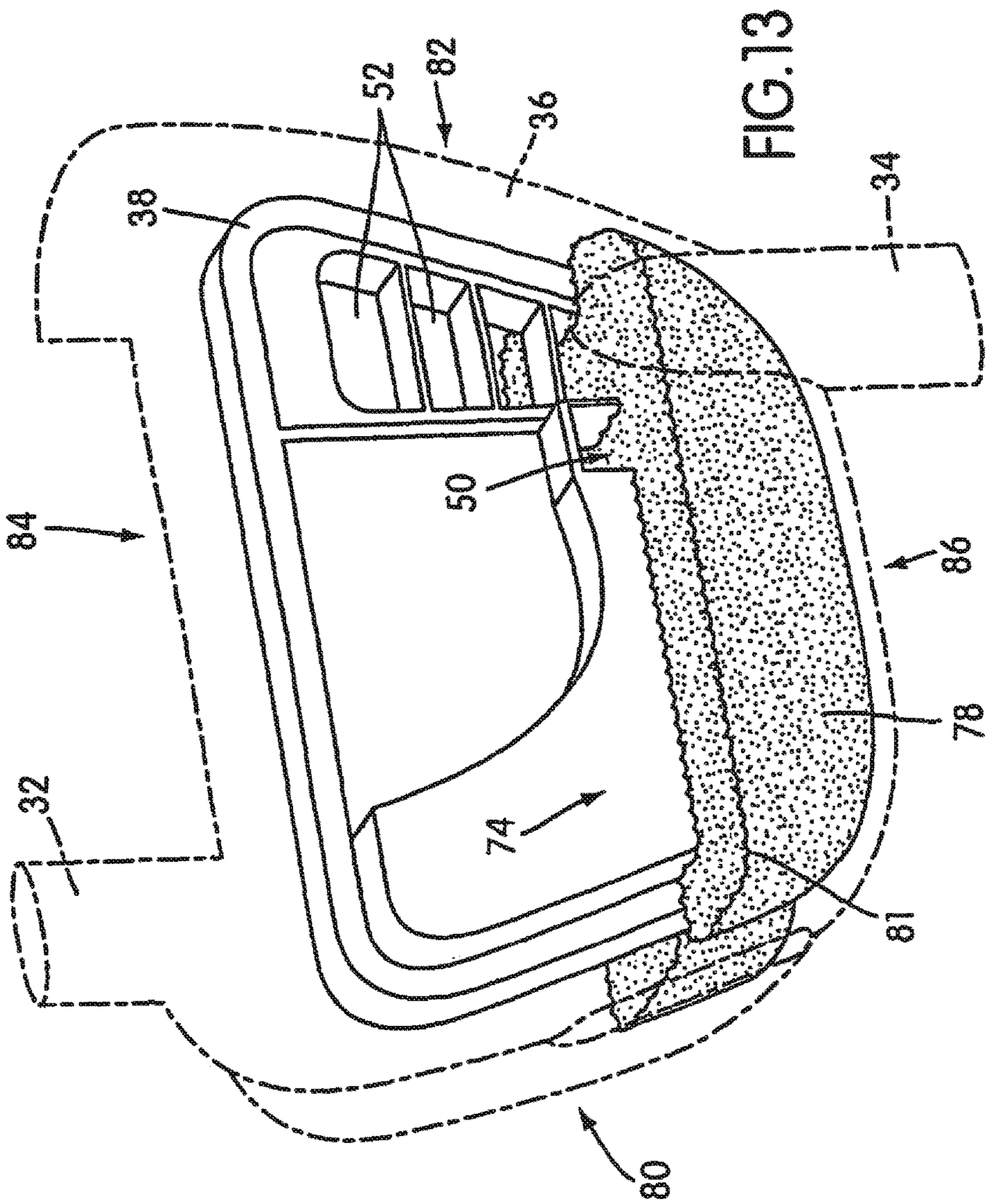


FIG. 13

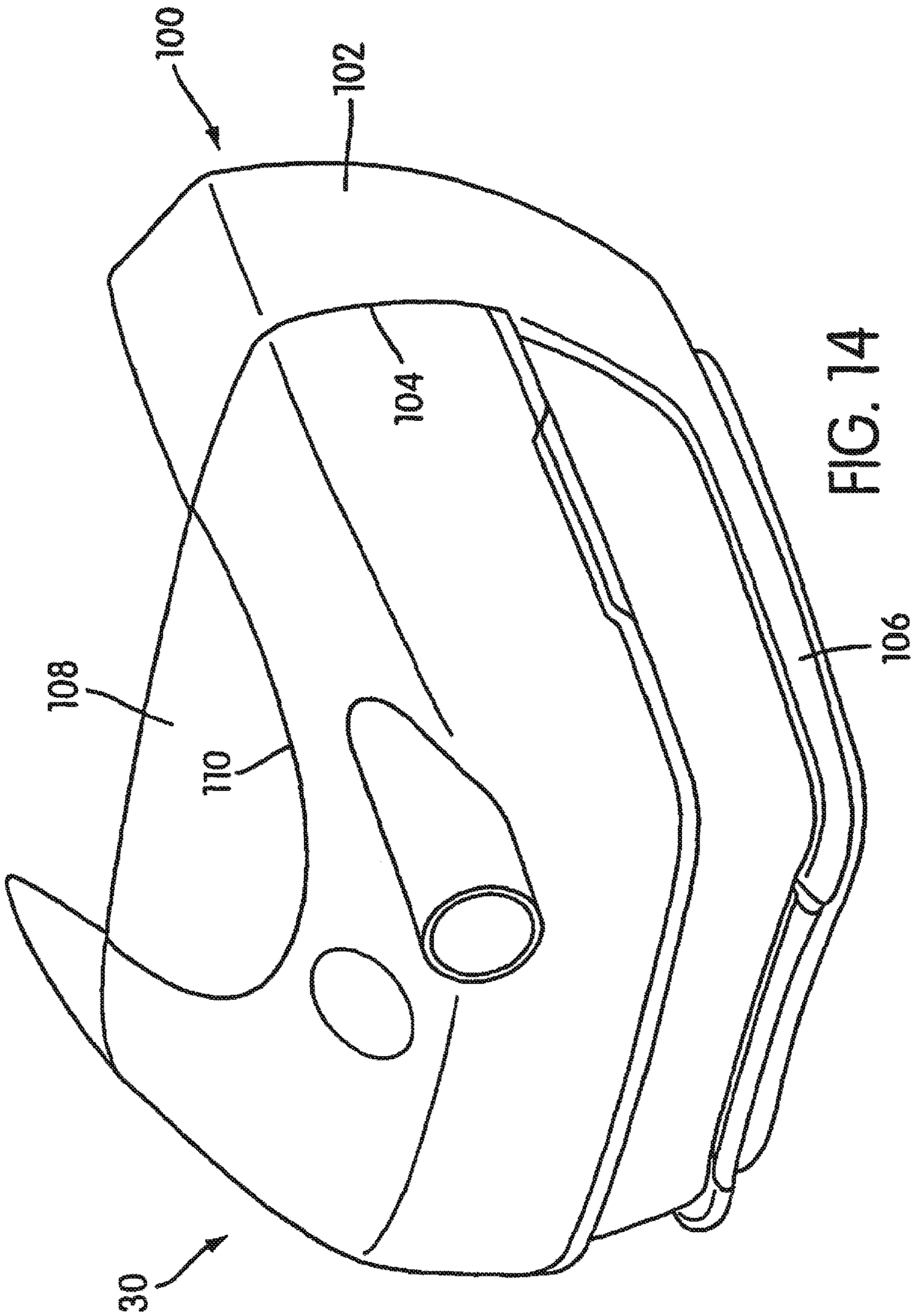


FIG. 14

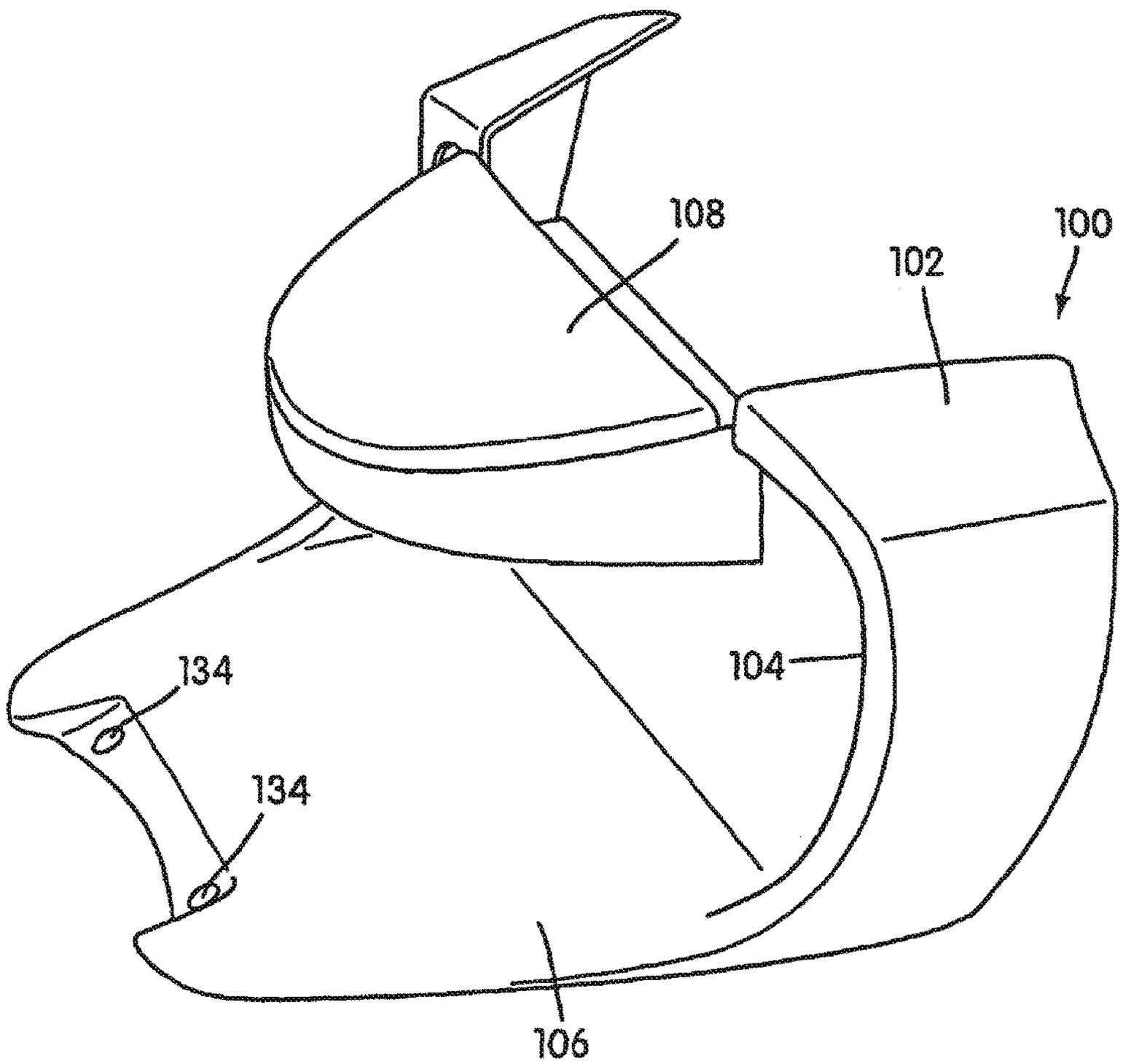


FIG. 15

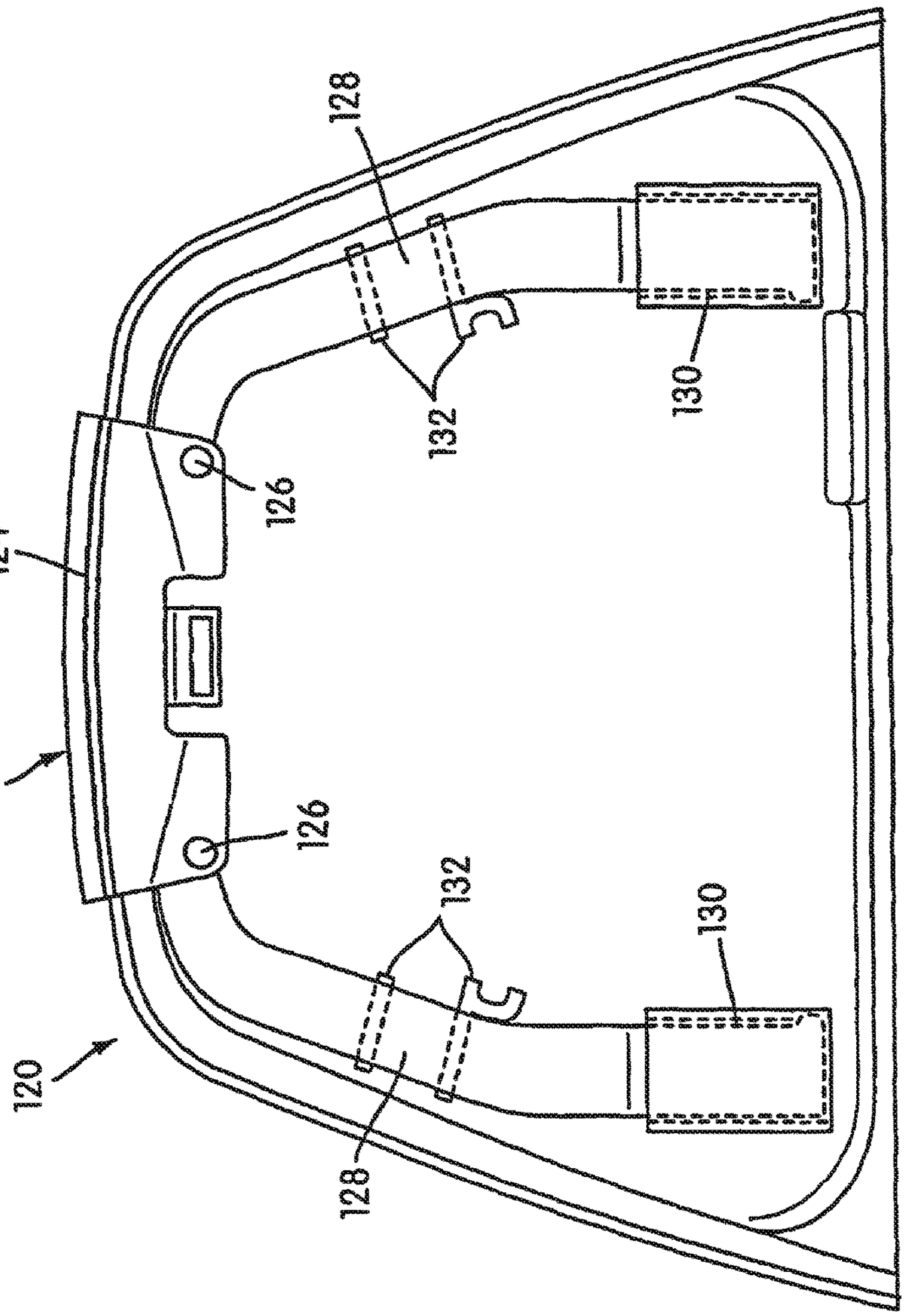


FIG. 16

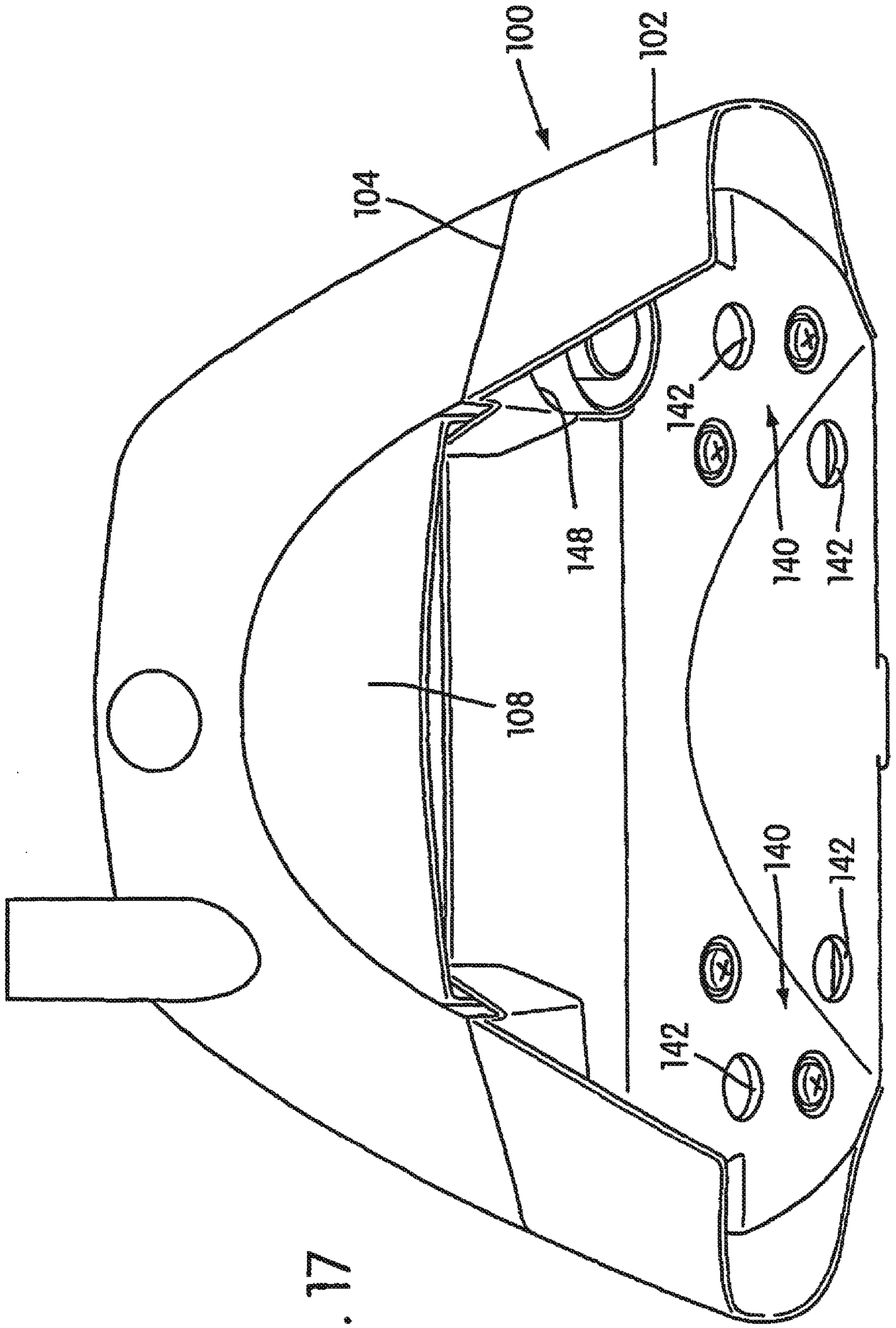


FIG. 17

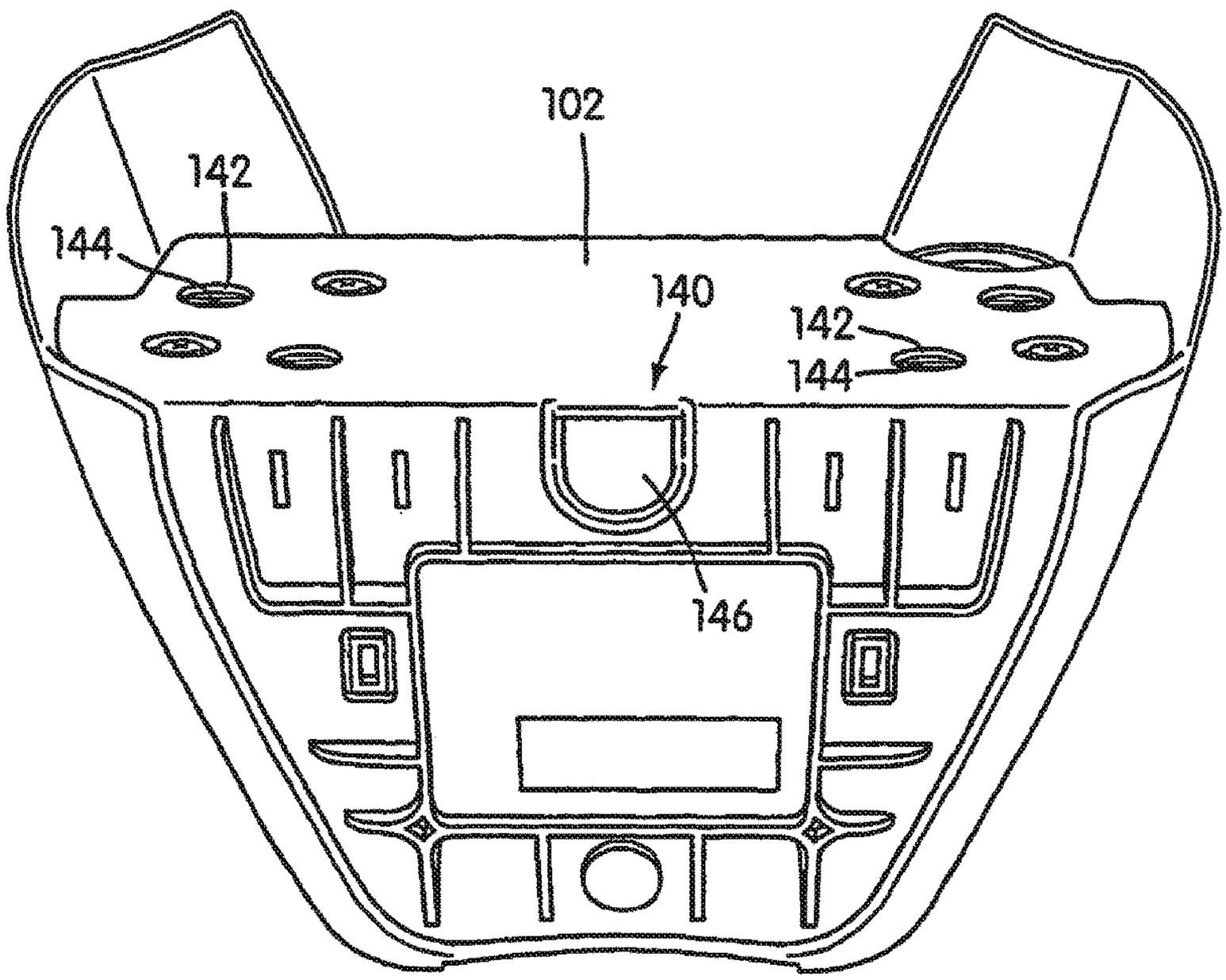


FIG. 18

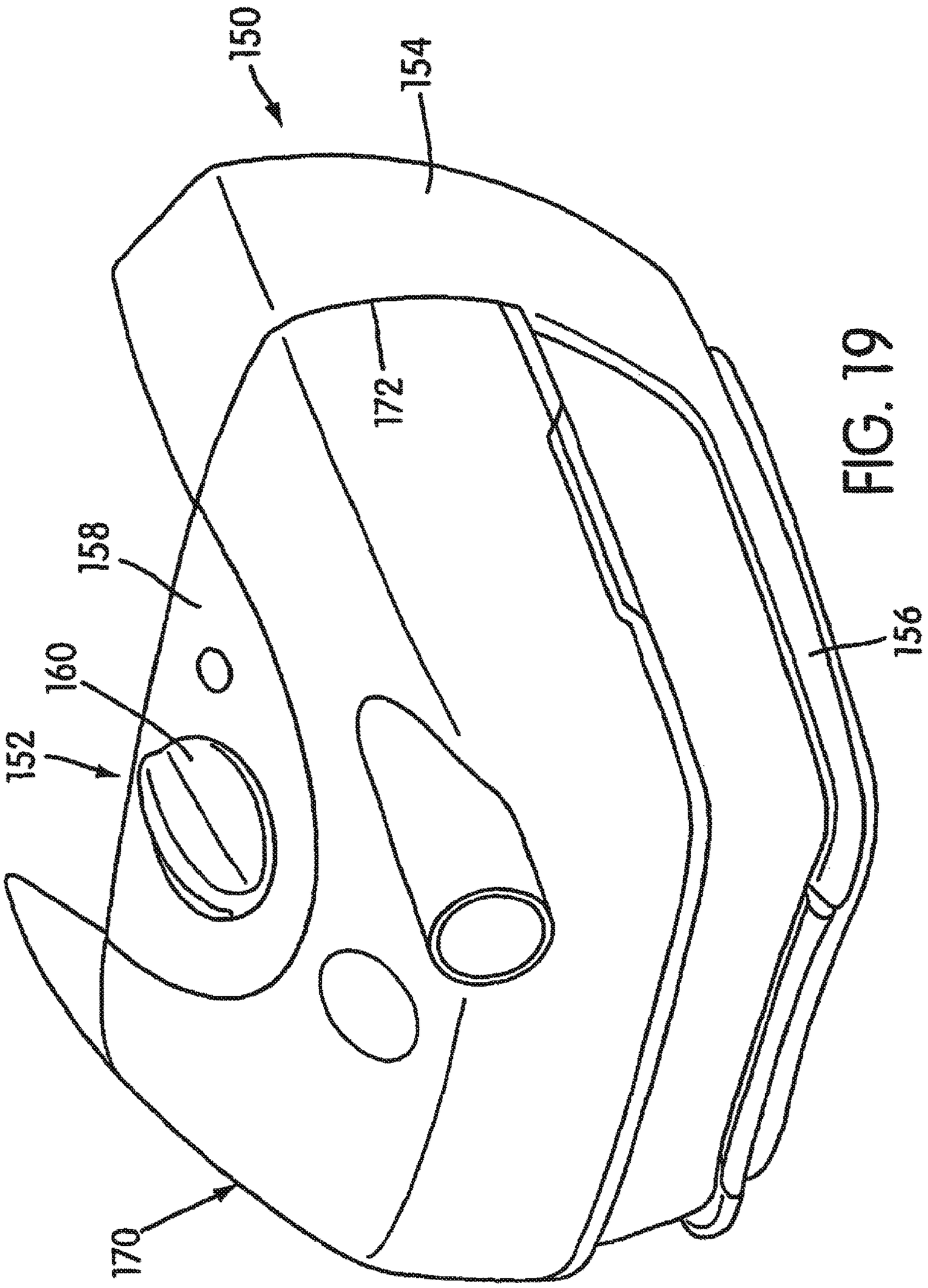


FIG. 19

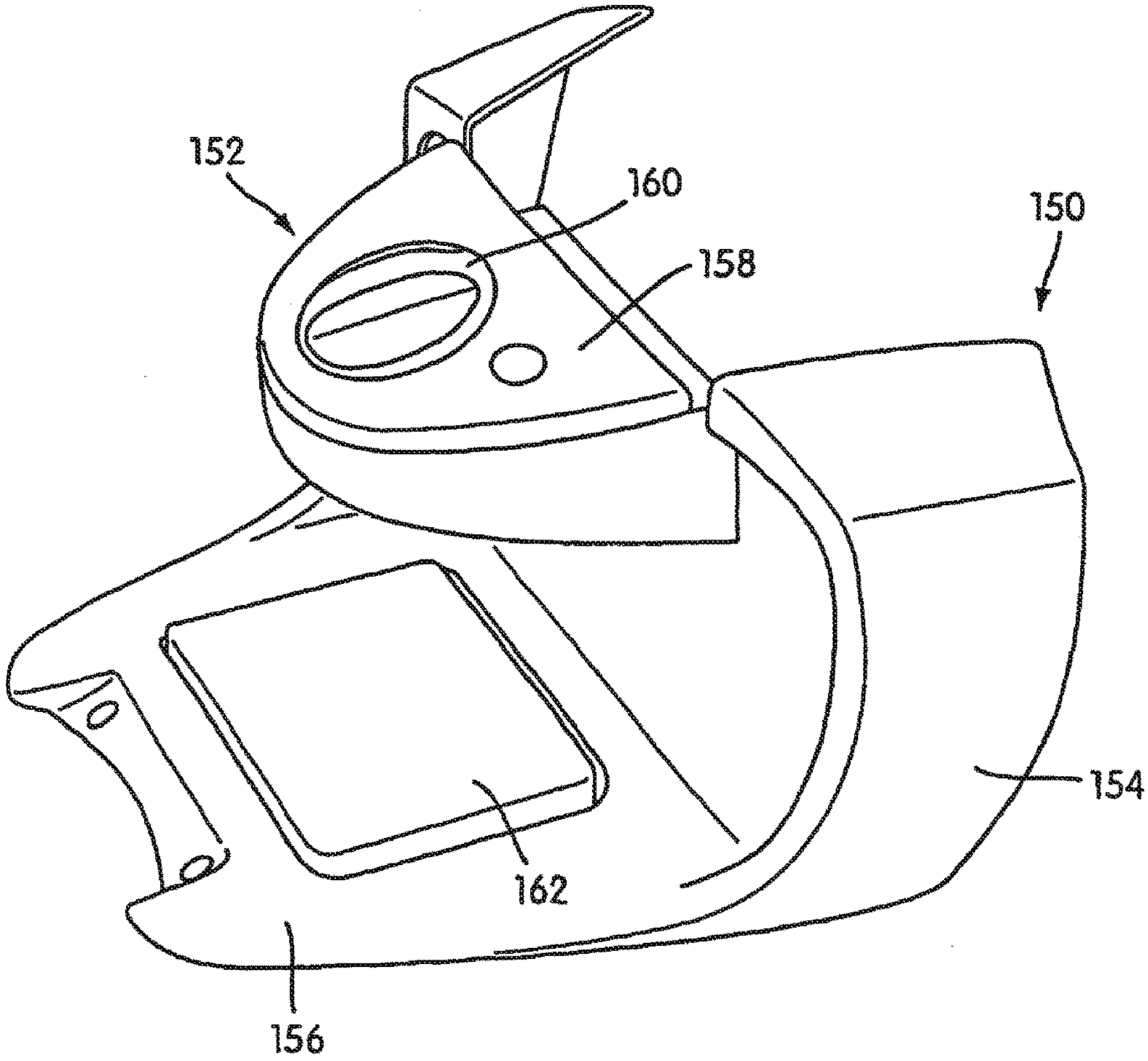


FIG. 20

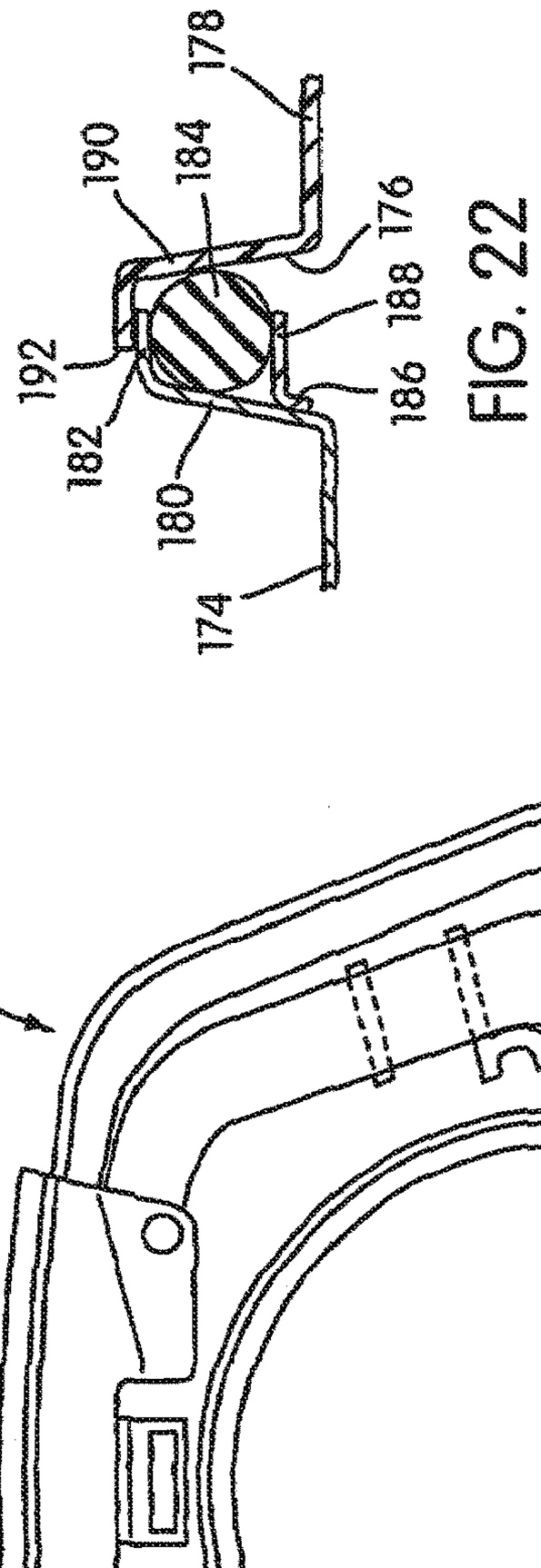


FIG. 22

FIG. 21

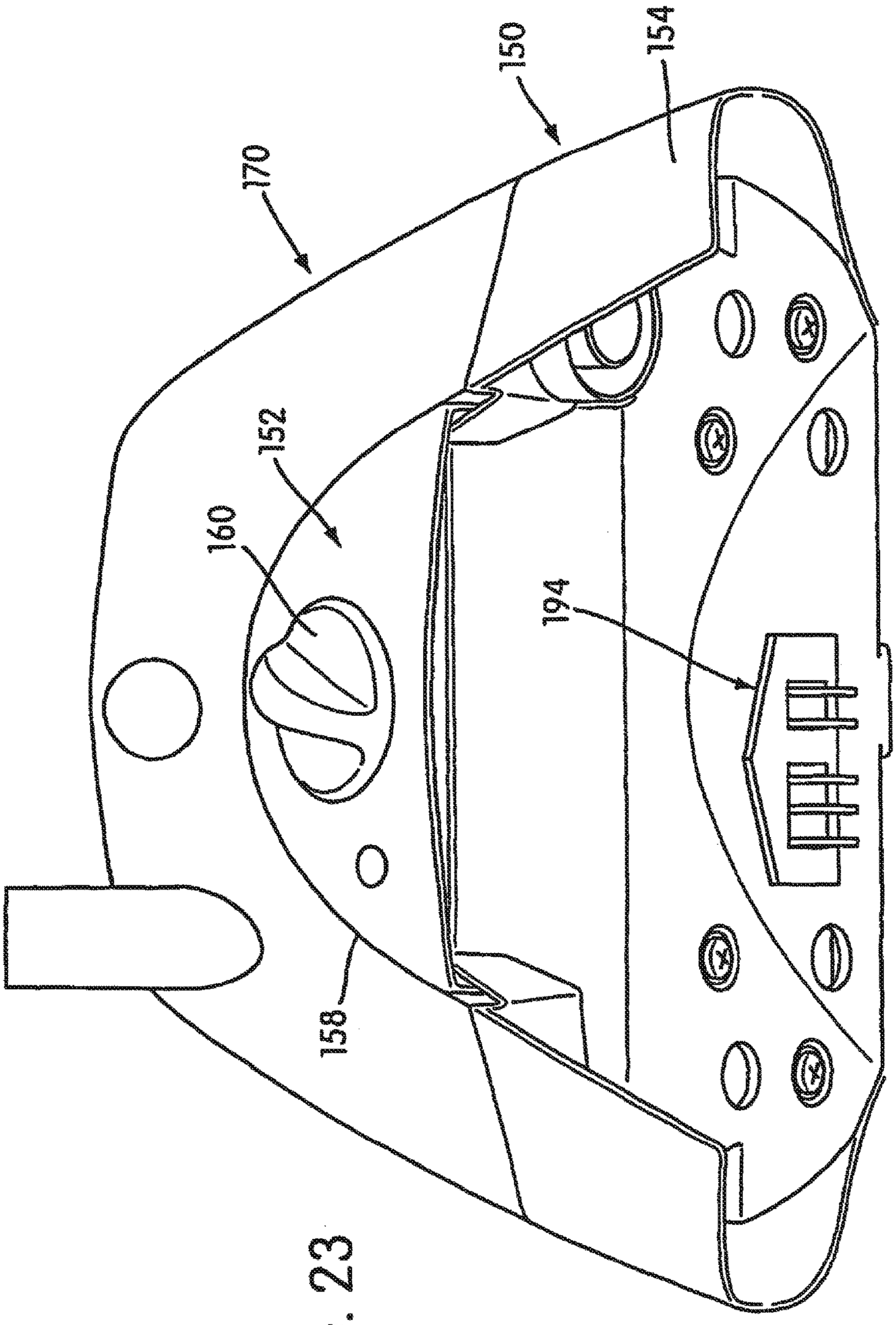


FIG. 23

HUMIDIFIER WITH STRUCTURE TO PREVENT BACKFLOW OF LIQUID THROUGH THE HUMIDIFIER INLET

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation *reissue of Ser. No. 13/944,960, filed Aug. 23, 2013, which is a continuation reissue of Ser. No. 13/100,783, now U.S. Pat. No. Re. 44,453, which is an application for reissue of U.S. Pat. No. 7,614, 398, filed as Ser. No. 11/181,807 filed Jul. 15, 2005, which is a continuation* of Ser. No. 10/467,382, filed 7 Aug. 2003, now U.S. Pat. No. 6,935,337, which is the US national phase of international application PCT/AU02/00155 filed 14 Feb. 2002, which designated the United States, and claims the benefit of Australia Application Nos. PR3117, filed Feb. 16, 2001, and PR 7288, filed Aug. 27, 2001, each of which is incorporated herein by reference in its entirety.

The present application claims priority to Australian Provisional Applications PR3117, filed on Feb. 16, 2001 and PR7288, filed on Aug. 27, 2001, the specifications and drawings of which are incorporated by reference in their entireties.

The present invention relates to a humidifier for use with an apparatus for supplying breathable gas such as those used for Non-invasive Positive Pressure Ventilation (NIPPV) or Continuous Positive Airway Pressure (CPAP).

An apparatus for NIPPV or CPAP typically comprises a blower whose output is connected to a patient interface, such as a mask, via an air delivery conduit. Some patients find NIPPV or CPAP more comfortable when provided with humidified air. To this end, manufacturers often supply humidifiers which may be attached in the air circuit between the blower outlet and the patient interface. Humidifiers typically include a water reservoir and are configured such that ambient air from the blower entering the humidifier collects moisture through contact with the water, before continuing on to the patient interface.

Typically, the blower and humidifier are separate components connected via a flexible conduit. An air delivery conduit connects the humidifier outlet to a patient interface mask. Alternatively, the blower and humidifier may be rigidly-connected together. Air from the blower outlet passes into the humidifier inlet where it is humidified and then passes to the air delivery conduit. A potential problem with either arrangement is that if the humidifier is tilted relative to its normal orientation, water may run or spill from the humidifier into the blower outlet which may damage the electrical circuits of the blower and potentially cause infection control problems.

It is one aspect of the present invention to substantially overcome or at least ameliorate the prior art disadvantages.

It is another aspect to provide a humidifier for a CPAP apparatus that is adapted to substantially prevent liquid contained thereto from undesirably exiting an inlet of the humidifier.

It is another aspect to provide a humidifier that is capable of directly connecting to a CPAP apparatus.

It is another aspect to provide a humidifier that has an inlet that is directly connectable with a CPAP apparatus to effectively eliminate a supply tube.

It is another aspect to provide a humidifier that is capable of heating the liquid contained therein.

One embodiment of the present invention includes an apparatus for humidifying breathable gas including a humidifier body configured to retain a body of liquid therein, an inlet communicated with an interior of the humidifier body and connectable to a blower outlet, and an outlet communicated with the interior of the humidifier body and connectable to a patient supply conduit. The interior of the humidifier is arranged such that liquid from the body of liquid is prevented from exiting the humidifier body through the inlet thereof when the humidifier body is rotated from a working, upright orientation.

In this manner, the liquid is substantially prevented from entering the blower outlet and possibly damaging the blower.

It is contemplated that the apparatus may also include a first chamber having an inlet and an outlet, the first chamber inlet preferably being connectable to a blower outlet, a second chamber having an inlet preferably connected to the first chamber outlet, and an outlet preferably connectable to the patient supply conduit, the second chamber preferably having the carrying capacity for the body of liquid. The first chamber inlet and outlet and volumes of the first and second chambers may be adapted such that, when the humidifier is disposed in the working upright orientation, the body of liquid is contained in the second chamber and, in other relative positions of the humidifier, the body of liquid is retained in at least one of the second chamber and the first and second chambers at a level therewithin below a level of the first chamber inlet.

A volume of the second chamber may be larger than a volume of the first chamber.

The first chamber may be located substantially above the second chamber in the working upright orientation of the apparatus.

The first chamber inlet and outlet may be located adjacent opposing sections of the first chamber.

The second chamber outlet may be located closer to the first chamber outlet than the first chamber inlet.

At least a portion of a base of the second chamber may be made of a heat conducting material.

The heat conductive portion may be in the form of a metallic cap which covers an opening of the base.

The apparatus may also include a top cover, a base, and a divider disposed between the top cover and base, wherein the base defines a receptacle formed therewithin, which preferably retains the body of liquid in the working orientation of the apparatus.

The top cover and the divider together may define the first chamber and the receptacle and the divider together form the second chamber.

The first chamber inlet and the second chamber outlet may be formed in the top cover and is the first chamber outlet and the second chamber inlet may be formed in the divider, the first chamber outlet and the second chamber inlet may be defined by a single aperture in the divider which communicates the first and second chambers.

The divider may define first and second sections, the first section together with the top cover preferably defining the first chamber.

The divider may include a plurality of apertures, separated by ribs, which may provide fluid communication from the second chamber to the second chamber outlet formed in the top cover.

The top cover and the base may be formed from a relatively rigid polymer material and the divider may be formed from a relatively resilient material.

The first chamber inlet may be connected to a blower outlet, the first chamber outlet may be connected to the second chamber inlet, the second chamber outlet may be connected to the patient supply conduit, and a portion of the second chamber below and behind the second chamber inlet may define a volume thereof greater than a volume of the body of liquid.

A portion of the second chamber between the first chamber inlet and the second chamber inlet and below the second chamber inlet may define a volume thereof greater than the volume of the body of liquid.

Portions of the first chamber and second chamber between the first chamber inlet and the second chamber outlet may define a volume thereof greater than the volume of the body of liquid.

Another embodiment of the present invention includes a CPAP apparatus including an apparatus for humidifying breathable gas as described above.

Another embodiment of the present invention includes a humidifier for a CPAP apparatus having a humidifier body defining a fluid reservoir and a fluid passage therein. The humidifier body has first and second chambers with a dividing member therebetween. The dividing member includes an orifice therethrough to communicate the first and second chambers with one another. Air from a blower (not shown) arrives in the first chamber via a first chamber inlet and departs from the second chamber via a second chamber outlet. The fluid passage includes the inlet, outlet, the orifice, and, at least, portions of the first and second chambers. The humidifier is designed to carry a body of liquid having a maximum volume, V_{max}. In a working orientation of the humidifier, the liquid body lies in a bottom portion of the second chamber. With respect to the working orientation of the humidifier the orifice lies forward of and to the side of the inlet. The first and second chambers are configured such that a volume of a first portion of the second chamber, which lies directly beneath the fist chamber, is greater than V_{max}. Additionally, the volume of a second portion of the second chamber, which is disposed to the side of the first chamber, is greater than V_{max}. Furthermore, the volume of a portion of the second chamber forward of the inlet plus a portion of the first chamber forward of the inlet is greater than V_{max}. Additionally, the volume of a portion of the second chamber to the side of the inlet plus a portion of the first chamber to the side of the inlet is greater than V_{max}.

Yet another embodiment of the present invention includes a humidifier for a CPAP apparatus having first and second chambers, wherein an inlet to the humidifier is communicated with the first chamber, an outlet from the humidifier is communicated with the second chamber, and the first and second chambers are intercommunicated via an orifice extending therebetween. The inlet and orifice are arranged relative to one another such that a level of a volume of liquid present within the humidifier is below at least one of the inlet and orifice for any orientation of the humidifier.

Although certain embodiments of the invention are illustrated and described herein as having certain features, one skilled in the art would recognize that alternative embodiments of the invention could be provided based on at least one or more features, either individually or in combination, of the illustrated and described embodiments.

The benefits of the present invention will be readily appreciated and understood from consideration of the following detailed description of embodiments of this invention, when taken with the accompanying drawings, wherein:

FIG. **1** is a schematic view of a humidifier according to one embodiment of the present invention in a working, upright orientation;

FIGS. **2-5** are schematic views of the humidifier shown in FIG. **1** in corresponding non-working, upright orientations;

FIG. **6** is a perspective view of a humidifier according to another embodiment of the present invention in a working, upright orientation;

FIG. **7**. Is an exploded perspective view of the humidifier shown in FIG. **6**;

FIG. **8** is a partial sectional view of the humidifier shown in FIG. **6**;

FIG. **9** is schematic view of the humidifier shown in FIG. **6** showing an air flow path through the humidifier;

FIGS. **10-13** are schematic views of the humidifier shown in FIG. **6** in corresponding non-working, upright orientations;

FIG. **14** is a perspective view of a humidifier and connecting structure according to another embodiment of the present invention;

FIG. **15** is a perspective view of the connecting structure shown in FIG. **14**;

FIG. **16** is a bottom plan view of the humidifier shown in FIG. **14**;

FIG. **17** is a rear perspective view of the humidifier and connecting, structure shown in FIG. **14**;

FIG. **18** is a bottom perspective view of the connecting structure shown in FIG, **14**;

FIG. **19** is a perspective view of a humidifier and heater according to another embodiment of the present invention;

FIG. **20** is a perspective view of the heater shown in FIG. **19**;

FIG. **21** is a bottom view of the humidifier shown in FIG. **19**;

FIG. **22** is a cross-sectional view taken along line **22-22** in FIG. **21**; and

FIG. **23** is a rear perspective view of the humidifier and heater shown in FIG. **19**.

FIG. **1** schematically illustrates one embodiment of the humidifier of the present invention, indicated at **10**. The humidifier **10** includes a humidifier body **12** defining a fluid reservoir and fluid passage therein. Additionally, there are two chambers **14**,**16** defined by the humidifier body **12** and a dividing member **18**. The dividing member **18** includes an orifice **20** therethrough to communicate the chambers **14**, **16** to one another. Air from a blower (not shown) arrives in the first chamber **16** via a first chamber inlet **22**. Air departs from the second chamber **14** via a second chamber outlet **24**. The fluid passage includes the inlet **22**, outlet **24**, the orifice **20**, and, at least, portions of the chambers **14**, **16**. The humidifier **10** is designed to carry a body of liquid **26** having a maximum volume, V_{max}.

In a working orientation represented in FIG. **1**, the liquid body **26** lies in a bottom portion of the second chamber **14**. With respect to the orientation of the humidifier **10** depicted in FIG. **1**, e.g., the orifice **20** lies forward of and to the side of the first chamber inlet **22** (e.g., at a diagonally opposite end of the chamber **16**). As shown, the volume of a first portion **14**A of the second chamber **14**, which lies directly beneath the first chamber **16**, is greater than V_{max} due to its relatively increased height. Additionally, the volume of a

second portion **14**B of the second chamber **14**, which is disposed to the side of the first chamber **16**, is greater than V_{max}. Furthermore, the volume of a portion of the second chamber **14** forward of the inlet **22** plus a portion of the first chamber **16** forward of the inlet **22** is greater than V_{max}. Additionally, the volume of a portion of the second chamber **14** to the side of the inlet **22** plus a portion of the first chamber **16** to the side of the inlet **22** is greater than V_{max}. Hence, in order to minimize the volume of the humidifier **10**, the first chamber inlet **22** is positioned as far to one side of the humidifier body **12** and as far rearward of the humidifier body **12** as possible.

The embodiment of the humidifier **10** shown in FIGS. **1-5** is configured to prevent liquid from the liquid body **26** from exiting through the inlet **22** thereof, such as when inadvertently rotated from an upright, normal working position (generally illustrated in FIG. **1**). For this reason, it is preferable for the humidifier **10** to be capable of being rotated from the upright, working position by about 120° without allowing liquid to exit from the inlet **22**. It is more preferable for the humidifier **10** to be capable of being rotated from the upright, working position by about 80°-110° without allowing liquid to exit from the inlet **22**. It is contemplated that for the embodiment of the humidifier **10** shown in FIG. **1**, it may be especially preferable for the humidifier **10** to be capable of being rotated from the upright, working position by about 90° without allowing liquid to exit from the inlet **22**, since the humidifier **10** is readily able to be placed on one side thereof due to the substantially fiat, normal sides thereof. However, of course, it may be desirable for the humidifier **10** to be capable of being rotated more or less than 90°, depending on the particular configuration of the humidifier **10**. It is noted that while the humidifier **10** is designed to prevent liquid from exiting the inlet thereof when inadvertently oriented in other than the upright working position, it may be possible to purposefully enable liquid to exit from the inlet, such as by jostling or rapidly and/or repeatedly rotating the humidifier **10**. In situations wherein it is highly undesirable for liquid to exit the inlet of the humidifier, the configuration (e.g., volume) of the chambers, size and placement of the inlet and outlet, and size and placement of the aperture intercommunicating the chambers may be altered from the illustrated embodiment to decrease the possibility of liquid exiting the inlet of the humidifier.

As shown in FIG. **2**, the arrangement of the chambers **14**, **16**, inlet **22**, and outlet **24** means that, if the humidifier **10** is rotated in a clockwise direction by up to 90° about axis α, then the liquid body **26** will accumulate in the second portion **14**B of the second chamber **14** and a portion of the first chamber **16** adjacent the outlet **24**. In this situation, liquid of the liquid body **26** may run out of the outlet **24**, but will not run out of the inlet **22** back into the blower.

Similarly, as shown in FIG. **3**, if the humidifier **10** is rotated in a counter-clockwise direction (relative to the position illustrated in FIG. **1**) by up to 90° about axis α, then the liquid body **26** will accumulate in the first portion **14**A of the second chamber **14**, but will not spill over orifice **20** into the first chamber **16**.

As shown in FIG. **4**, if the humidifier **10** is rotated in a clockwise direction (relative to the position illustrated in FIG. **1**) up to 90° about axis β, then the liquid body **26** will accumulate in a rearward portion of the second chamber **14** but will not spill over orifice **20** into the first chamber **16**.

As shown in FIG. **5**, if the humidifier **10** is rotated in a counter-clockwise direction (relative to the position illustrated in FIG. **1**) up to 90° about axis β, then the liquid body **26** will accumulate in forward portions of the first and second chambers **14**, **16** and will not spill back through first chamber inlet **22**. Furthermore, liquid of the liquid body **26** will drain out of the humidifier **10** through second chamber outlet **24**.

In the embodiment illustrated in FIGS. **1-5**, the humidifier **10** has an exterior shape that is generally rectangular and the humidifier **10**. As illustrated, the inlet **22** is positioned to correspond to a blower outlet being on the upper left-hand side when viewed from the front in an upright position. Therefore the humidifier inlet **22** is positioned at the back of the humidifier **10** on the upper left-hand side, when viewed from the front in an upright position. The humidifier outlet **24** lies on the front upper right-hand side, when viewed from the front in an upright position. However, it is, of course, possible for the inlet and outlet to be repositioned corresponding to the position of the blower outlet.

For each of the orientations of the humidifier **10** shown in FIGS. **1-5**, the level of the liquid body **26** is always below the level of at least one of the inlet **22** and orifice **20** intercommunicating the first and second chambers **16**, **14**. In this manner, in a case wherein the inlet **22** is disposed below the level of the liquid body **26** (such as in orientations illustrated in FIGS. **3** and **4**), the orifice **20** is disposed above the level of the liquid body **26**, which prevents liquid from flowing therethrough and exiting the inlet **22**. Conversely, in a case wherein the orifice **20** is disposed-below the level of the liquid body **26** (such as in orientations illustrated in FIGS. **2** and **5**), the inlet **22** is disposed above the level of the liquid body **26**. Accordingly, liquid may flow through the orifice **20**, but is prevented from exiting through the inlet **22**.

FIG. **6** shows another embodiment of a humidifier **30** according to the present invention. The humidifier **30** includes an inlet **32** and an outlet **34**, both of which are communicated with an interior of the humidifier **30**. The interior of the humidifier **30** defines a reservoir for a body of liquid and a fluid passage. The fluid passage is communicated to each of the inlet **32** and outlet **34** and is configured such that fluid (e.g., breathable gas at an elevated pressure) flowing therethrough is exposed to the body of liquid. Additionally, the humidifier **30** is adapted for detachable connection to an NIPPV or CPAP apparatus (not shown) which includes a blower. When connected, the output of the blower is attached to the inlet **32**. Air from the blower enters the inlet **32**, flows through the fluid passage, and collects moisture through contact with the liquid body, before continuing on to the outlet **34** and then to the patient.

It is also contemplated that the humidifier **30** may include an additional internal passage to allow monitoring of the CPAP pressure without degrading signal strength or necessitating relatively large correction factors due to signal attenuation within the humidifier, such as described in co-pending Applications incorporated above, as well as co-pending Application No. WO 02/066107, entitled "Air Pressure Signal Monitoring in Apparatus for Treating Sleep Disordered Breathing", filed on even date herewith and hereby incorporated by reference in its entirety.

As shown in FIG. **7**, the humidifier **30** includes a top cover **36**, a gasket **38**, and a base **40**. The gasket **38** is disposed between the top cover **36** and base **40**, which are secured together via sliding clips **72**. (See FIG. **6**.) Of course, other suitable fastening arrangements and constructions are possible. For example, the top cover **36** and base **40** may be formed with snap-fit or other cooperating constructions. Alternatively, other types of mechanical fasteners may be utilized. It is contemplated that the top cover **36** may be formed from a relatively rigid polymer material, such as

polysulfone (for example, grade UDEL P1700, manufactured by BP Amoco Polymers), and includes the inlet **32** and the outlet **34**. The gasket **38** may be formed from a relatively resilient material, such as silicone rubber (for example, SILASTIC 94595-IIC, manufactured by Dow Corning) and is divided into first and second sections **42** and **44** by a channel structure **46**. The first section **42** includes a raised portion **48** having a first aperture **50** extending vertically therethrough. The second section **44** includes a plurality of second apertures **52** extending vertically therethrough and being separated from one another by ribs **54**. The top cover **36** may also include a divider wall structure **56** (FIG. **8**) which corresponds to and is received within the channel structure **46** of the gasket **38**. The gasket **38** includes a sealing flange **58** formed about a periphery thereof. The base **40** may be formed from the same or similar rigid polymer material as the top cover **36** and may include a receptacle **60** formed therewithin, a bottom portion **62**, and side walls **64** extending upwardly from the bottom portion **62**. The base **40** may also include a removable bridge structure **66**, which divides the receptacle **60** into two sections **68** and **70**, which correspond to the sections **[22]** *42* and **[24]** *44* of the gasket **38**.

As shown in FIG. **8**, to assemble the humidifier **30**, the gasket **38** is attached the base **40**. The flange **58** of the gasket **38** forms a sealing engagement with an upper edge portion of the side walls **64** of the base **40**. The top cover **36** is then attached to the base **40** via sliding clips **72** (FIG. **6**) on opposite sides of the humidifier **30**, such that the top cover **36** covers and seals with the gasket **38**. The removable bridge structure **66** vertically supports an intermediate portion of the gasket **38**. As shown, a downwardly facing surface of the channel structure **46** of the gasket **38** engages an upwardly facing surface of the bridge structure **66**. When assembled, the gasket first section **42**, the top cover **36**, and the divider wall structure of the top cover **36** together form a first chamber **74**. The receptacle **60** of the base **40** together with the gasket **38** form a second chamber **76**. The first chamber **74** is thus located above the second chamber **76** and the volume of the second chamber **76** is larger than the volume of the first chamber **74**. The first and second chambers **74**, **76** are in communication with one another via the first aperture **50** within the gasket **38**. The second chamber **76** is in communication with the outlet **34** via the second apertures **52** within the gasket **38**.

In use, a predetermined maximum volume of liquid is poured into the receptacle **60** of the base **40** after removing the top cover **36** and the sealing gasket **38** from the base **40**. The top cover **36** and the sealing gasket **38** are then reattached to the base **40**. As shown in FIG. **9**, a body of liquid **78** is held in the second chamber **76** when the humidifier **10** is in the upright working orientation of the humidifier **30**. Breathable gas from the blower enters the inlet **32** and travels through the first chamber **74** and into the first aperture **50**. The gas passes through the aperture **50** and enters the second chamber **76** where it is humidified by contact with the body of liquid **78**, before exiting through apertures **52** in the gasket **38**, and then out through outlet **34** (FIG. **6**).

In the working upright orientation of the humidifier **30**, as shown in FIG. **9**, a liquid level, indicated at **81**, of the body of liquid **78** is below the aperture **50**. Thus, liquid from the body of liquid **78** cannot exit via the inlet **32** and there is no risk of damaging the electronic components of the NIPPV or CPAP apparatus. The body of liquid **78**, however, will be displaced in the humidifier **30** according to the orientation of the humidifier **30**. Accordingly, the humidifier **30** is configured to substantially prevent liquid of the body of liquid **78** from exiting through the inlet **32** in non-upright orientations to avoid damage to the NIPPV or CPAP apparatus connected to the humidifier **30**.

Similarly as with the embodiment illustrated in FIGS. **1-5**, the embodiment of the humidifier **30** shown in FIGS. **6-13** is configured to prevent liquid from the liquid body **78** from exiting through the inlet **32** thereof, such as when inadvertently rotated from an upright normal working position (generally illustrated in FIG. **6**). For this reason, it is preferable for the humidifier **30** to be capable of being rotated from the upright, working position by about 120° without allowing liquid to exit from the inlet **32**. It is more preferable for the humidifier **30** to be capable of being rotated from the upright, working position by about 80°-110° without allowing liquid to exit from the inlet **32**. It may be especially preferable for the humidifier **30** to be capable of being rotated from the upright, working position by about 90° without allowing liquid to exit from the inlet **32**. However, of course, it may be desirable for the humidifier **30** to be capable of being rotated more or less than 90°. It is noted that while the humidifier **30** is designed to prevent liquid from exiting the inlet thereof when inadvertently oriented in other than the upright working position, it may be possible to purposefully enable liquid to exit from the inlet, such as by jostling or rapidly and or repeatedly rotating the humidifier **30**. In situations wherein it is highly undesirable for liquid to exit the inlet of the humidifier, the configuration (e.g., volume) of the chambers, size and placement of the inlet and outlet, and size and placement of the aperture intercommunicating the chambers may be altered from the illustrated embodiment to decrease the possibility of liquid exiting the inlet of the humidifier.

For each of the orientations of the humidifier **30** shown in FIGS. **10-13**, the level of the liquid body **78** is always below the level of at least one of the inlet **32** and aperture **50** intercommunicating the first and second chambers **74**, **76**. In this manner, in a case wherein the inlet **32** is disposed below the level of the liquid body **78** (such as in orientations illustrated in FIGS. **10** and **12**), the aperture **50** is disposed above the level of the liquid body **78**, which prevents liquid from flowing therethrough and exiting the inlet **32**. Conversely, in a case wherein the aperture **50** is disposed below the level of the liquid body **78** (such as in orientations illustrated in FIGS. **11** and **13**), the inlet **32** is disposed above the level of the liquid body **78**. Accordingly, liquid may flow through the aperture **50**, but is prevented from exiting through the inlet **32**.

In FIG. **10**, the humidifier **30** is rotated to an angle about 90° from the working upright orientation, such that a side **80** thereof corresponding to the side of the humidifier **30** adjacent the inlet **32**, is oriented below a side **82** thereof corresponding to the side of the humidifier **30** adjacent the outlet **34**. Because the raised portion **48** of the gasket **38** increases the volume of the second chamber **76**, the body of liquid **78** remains only in the second chamber **76** and the level **81** of the liquid body **78** remains below the first aperture **50**. Thus, the liquid will not exit through the inlet **32**.

In FIG. **11**, the humidifier **30** is rotated to an angle about 90° from the working upright orientation, such that the side **82** is below the side **80** (i.e., flipped 180° from the orientation illustrated in FIG. **11**). As the level **81** of the body of liquid **78** is above (at least initially) the apertures **52**, liquid will pass therethrough and exit the outlet **34**. However, since the level **81** of the liquid body **78** is below the inlet **32**, liquid will not exit through the inlet **32**. Liquid exiting through the

outlet **34** is generally acceptable as there is not generally a risk in damaging the NIPPV or CPAP apparatus.

In FIG. **12**, the humidifier **30** is rotated to an angle about 90° from the working upright orientation, such that a rear side thereof indicated at **84**, corresponding to the side at which the inlet **32** is located, is below a forward side thereof indicated at **86**, corresponding to the side at which the outlet **34** is located. As shown, the body of liquid **78** remains substantially in the second chamber **76** and the level **81** of the liquid body **78** remains below the first aperture **50**. Thus, water cannot exit through the inlet **32**.

FIG. **13** illustrates when the humidifier **30** is tilted to an angle about 90° from the working upright orientation, such that the forward side **86** is below the rear side **84**. As shown, the body of liquid **78** is disposed within forward portions of the first and second chambers **74**, **76**. As the level **81** of the body of liquid **78** is at least initially above the level of the aperture **50**, liquid will flow through the aperture **50** into the first chamber **74**. However, since the inlet **32** is disposed above the level of the body of liquid **78** in this orientation, no liquid exits through the inlet **34**.

The humidifier **30** thus ensures that the body of liquid **78** is disposed in one of (a) only the second chamber **76**, or (b) portions of the first and second chambers **74**, **76** at a level below the inlet **32**, to prevent liquid from exiting through the inlet **32** at orientations of the humidifier **30** up to an angle of about 90° from the working upright orientation. In the illustrated embodiment, a number of features of the humidifier **30** contribute to ensuing this function. These include relive positions of the inlet **32** and first aperture **50**. More particularly, the inlet **32** and first aperture **50** are located on opposing ends of the first chamber **74**. Also, the volume of the second chamber **76** is larger than the volume of the first chamber **74**, which is assisted by the raised portion **48** of the gasket **38** so that liquid displaced from the first chamber **74** may be accommodated within the second chamber **76** without overflow through aperture **50**. Furthermore, the outlet **34** is located closer to the first aperture **50** than the inlet **32**, which assists in ensuing that liquid will exit via the outlet **34**, rather than though the inlet **32**.

The humidifier **30** therefore substantially prevents or reduces the risk of water exiting through the inlet **32**, which may damage the NIPPV or CPAP apparatus, when the humidifier **30** is in other orientations up to an angle of about 90° from its working upright orientation.

It is contemplated that the humidifier **30** may be used as a retrofit or add-on component for a CPAP apparatus. To facilitate this usage, it may be preferable to provide a connecting structure **100** that is configured to connect between the CPAP apparatus and humidifier **30**. As shown in FIGS. **14** and **15**, the connecting structure **100** includes a housing **102**, which provides a generally horizontally extending receptacle **104** within which the humidifier **30** may be disposed. The housing **102** provides a base portion **106** that is configured to support the humidifier **310** thereon and a retaining portion **108** configured to secure the humidifier **30** in position. As shown in FIG. **16**, the retaining portion **108** extends generally parallel to the base portion **106** and is spaced above the base portion **106**. Referring back to FIG. **14**, the humidifier **30** may be formed with a recess **110** that is open and of a complimentary shape to receive the retaining portion **108** therein.

To facilitate connection of the humidifier **30** to the connecting strut **100**, it is contemplated that another embodiment of a humidifier, indicated at **120** in FIG. **16**, may include a securing mechanism **122**. As shown, the securing mechanism **122** includes a resiliently biased pull member **124** that includes one or more locking lugs **126** extending generally downwardly therefrom. The pull member **124** is disposed at a forward end (assuming the rearward end of the humidifier **120** is adjacent the connecting structure **100**) of the humidifier **120** and is resiliently biased by a pair of resilient legs **128**. Rearward portions of the legs **128** are relatively securely retained within corresponding pocket structures **130** provided on a bottom side of the humidifier **120**. Ribs **132** extend is downwardly from the bottom side of the humidifier **120** and engage an intermediary portion of the legs **128** to define a space between the resilient legs **128** and the bottom side of the humidifier **120**. In this manner, the pull member **124** is biased generally downwardly by the resilient legs **128**, but may be manually moved (e.g., pulled) upward against a resilient bias of the legs **128**.

As shown in FIG. **15**, a forward portion of the base portion **106** includes generally upwardly open lug receiving recesses **134** within which the lugs **126** may be disposed when the humidifier **120** is disposed within the receptacle **104**. As the humidifier **120** is inserted within receptacle **104**, the legs **128** resiliently bias the legs **126** into recesses **134**. The lugs **126** and recesses **134** thereby secure the humidifier **120** within the receptacle **104**. To remove the humidifier **120** from the receptacle **104**, the pull member **124** is pulled upwardly to withdraw the lugs **126** from the recesses **134**. The humidifier **120** may then be pulled generally horizontally out of the receptacle **104**.

FIG. **17** shows a rearward side of the connecting structure **100**. The rearward side of the connecting structure **100** provides a retaining mechanism **140** to secure the connecting structure **100** to the CPAP apparatus. It is contemplated that the retaining mechanism **140** may include a series of apertures **142** within the rearward portion of the housing **102**. The apertures **142** may receive therein, for example, prongs or tabs (not shown) provided by the CPAP apparatus. As shown in FIG. **18**, within each aperture **142**, a locking member **144** may be provided that is resiliently biased toward a position that partially encloses the respective aperture **142**. As also shown in FIG. **18**, a button structure **146** may be coupled to the locking members **144**, such that manual movement of the button structure **146** moves the locking members **144** out of their biased positions to substantially fully open the apertures **142**. It is contemplated that the tabs or prongs on the CPAP apparatus are provided with a groove therein such that when positioned within the apertures **142**, the locking members **144** engage within respective grooves to thereby securely and detachably retain the connecting structure **100** to the CPAP apparatus.

Referring back to FIG. **17**, the housing **102** of the connecting structure **100** may be provided with an opening **148** that allows the inlet of the humidifier to extend therethrough so as to be connected to the CPAP apparatus.

In certain circumstances, it may be desirable to provide heated humid air to the respirator mask. Accordingly, another embodiment of the connecting structure, indicated at **150** in is FIG. **19**, may include a heater **152**. The connecting structure **150** may include a housing **154**, which provides a base portion **156** and retaining portion **158**, similar to the housing **102** described above. As shown in FIG. **19**, the retaining portion **158** may include a controller such as a knob or other selecting device **160** thereon to control a heat setting of the heater **152**. It is also contemplated that the controller **160** may include a display device, such as an LCD screen.

As shown in FIG. **20**, the base portion **156** may include a heating element **162** thereon. The heating element **162** may be in the form of a substantially flat plate-like resistance

heater, which heat generated thereby may be directly controlled by the controller **160**. As shown in FIG. **19**, another embodiment of the humidifier is indicated at **170**. The humidifier **170** is disposed within a receptacle **172** provided by the housing **154**. It is contemplated that the humidifier **170** has the same basic construction as the humidifiers **10** and **120** described above. However, it is contemplated that the humidifier **170** may include a heating plate **174** (also referred to as a metallic cap) to facilitate heating of the liquid contained therein. In particular, an opening **176** is provided within a bottom wall **178** of the humidifier **170**. The heating plate **174** is shaped to fit within the opening **176**, as shown in FIG. **21**. As shown in more detail in FIG. **22**, the heating plate **174** includes an upstanding peripheral wall **180** which includes an outwardly extending peripheral lip **182**. A resilient seal member **184** is disposed about an outer periphery of the peripheral wall **180** in contact with the peripheral lip **182**. A ring-like retaining member **186** may be press-lit onto the peripheral wall **180** to retain the seal **184** in position on the peripheral wall **180**. The retaining member **186** includes an outwardly extending flange structure **188**. The seal **184** is disposed between the peripheral lip **182** and flange structure **188**. It is contemplated that the retaining member **186** may be press fit onto the heating plate **174**, as described above, or may be formed in one piece therewith. The bottom wall **178** of the humidifier **170** is formed with an annular upstanding flange **190** which receives the heating plate **174**. It is contemplated that the flange **190** may be slightly tapered inwardly in the upward direction to ease insertion of the heating plate **174**. As shown, the flange **190** may include a generally horizontally extending lip structure **192** that vertically retains the heating plate **174**.

Referring to FIG. **19**, with the humidifier **170** in position within the receptacle **172**, a bottom surface of the heating plate **174** is in contact with an upper surface of the heating element **162**. In this manner, a heat generated by the heating element **162** is conducively transferred to the heating plate **174**. The liquid within the humidifier **170** is exposed to an upper surface of the heating plate **174** and conducts heat therefrom. It is contemplated that a temperature of the liquid within the humidifier **170** may be controlled by manipulation of the controller **160**.

It is also contemplated that the heating element **162** may be upwardly resiliently biased to ensure adequate contact between the heating element **162** and the heating plate **174**.

As shown in Ha **23**, a rearward portion of the connecting suture **150** may include a plurality of generally outwardly extending contact elements **194**. It is contemplated that the contact element **194** may communicate with a power supply within the CPAP apparatus and/or a controller and/or sensors. In this manner, power may be delivered to the heater **152** directly from the CPAP apparatus. Additionally, a controller within the CPAP apparatus itself may control the heater **152**. Furthermore, it is contemplated that sensors within the CPAP apparatus may monitor a heat output of the heater **152**. Moreover, it may be possible for a CPAP apparatus to automatically adjust a heat output of the heater **152** based on a measured temperature thereof or of the water within the humidifier or of the breathable air exiting the humidifier.

The invention claimed is:

[1. A humidifier assembly for a CPAP apparatus, comprising

a humidifier including

a base configured to retain a body of liquid therein, at least a portion of the base being constructed of a heat conducting material,

a top cover, and

a seal disposed between the top cover and the base; and

a connecting structure configured to connect between the CPAP apparatus and humidifier and allow communication of an outlet of the CPAP apparatus with the inlet of the humidifier, the connecting structure including

a housing providing a base portion to support the humidifier thereon, and

a retaining mechanism configured to secure the connecting structure to the CPAP apparatus,

wherein the base portion includes a heating element in contact with the heat conducting material of the base of the humidifier.**]**

[2. A humidifier assembly according to claim **1**, wherein the top cover defines both an inlet and an outlet communicated with an interior of the base, the inlet configured to receive pressurized breathable gas and the outlet configured to deliver the pressurized breathable gas with added humidity.**]**

[3. A humidifier assembly according to claim **1**, wherein the connecting structure includes a control knob to control a heat setting of the heating element.**]**

[4. A humidifier assembly according to claim **1**, wherein the connecting structure includes contact elements that communicate with a power supply within the CPAP apparatus.**]**

[5. A humidifier assembly according to claim **1**, wherein the connecting structure is configured to allow removable attachment of the CPAP apparatus to the humidifier.**]**

[6. A humidifier assembly according to claim **1**, wherein the heat conducting material is a metallic material.**]**

[7. A CPAP apparatus including a humidifier assembly according to claim **1**.**]**

8. A humidifier, comprising:

a humidifier body configured to retain liquid, the humidifier body comprising:

a rear portion having a humidifier body inlet adapted to receive a flow of pressurized breathable gas, the inlet configured to direct the flow of pressurized breathable gas into the humidifier body in a substantially horizontal direction when the humidifier is in an upright operating position;

a top cover having a humidifier body outlet adapted to deliver the flow of pressurized breathable gas with added humidity;

a base detachably fastened to the top cover with at least a first clip, the base having a heat conducting plate and forming a liquid receptacle for the liquid; and

a vertically extending passage to direct gas from the inlet towards liquid in the liquid receptacle of the base, the vertically extending passage having at least a portion with closed shape as seen in cross-section,

wherein if the humidifier body is rotated from the upright, operating position to each of a plurality of non-upright positions, the liquid in the humidifier body remains below the inlet.

9. The humidifier of claim 8, wherein the rear portion of the humidifier body includes an external retaining portion recess positioned, configured and dimensioned to at least partly receive a horizontally extending retaining portion of a connecting structure.

10. The humidifier of claim 8, wherein the humidifier body has a gas introduction chamber and a gas humidification chamber connected to the gas introduction chamber by the passage.

11. The humidifier of claim 10, wherein the top cover includes an internal divider wall, depending from a top

inner surface of the top cover, to divide the gas introduction chamber from the humidification chamber.

12. The humidifier of claim 8, further comprising a second clip to detachably fasten the top cover and the base, wherein the top cover and the base are snap-fit together.

13. The humidifier of claim 8, wherein the closed shape of the passage is substantially rectangular.

14. The humidifier of claim 8, wherein the passage receives the entirety of the flow of pressurized breathable gas before the gas is directed to the liquid receptacle.

15. The humidifier of claim 8, further comprising a seal between the heat conducting plate and the base.

16. The humidifier of claim 15, wherein the humidifier body further comprises a seal between the base and the top cover.

17. The humidifier of claim 8, wherein the heat conducting plate comprises metal.

18. The humidifier of claim 17, wherein the heat conducting plate is circular.

19. The humidifier of claim 8, wherein the top cover is formed of a transparent material.

20. The humidifier of claim 18, wherein the base is formed of a transparent material.

21. The humidifier of claim 8, wherein the top cover and the base are snap-fit together.

22. The humidifier of claim 8, wherein:

the rear portion of the humidifier body includes an external retaining portion recess positioned, configured and dimensioned to at least partly receive a horizontally extending retaining portion of a connecting structure,

the humidifier body has a gas introduction chamber and a gas humidifier chamber connected to the gas introduction chamber by the passage,

the top cover includes an internal divider wall, depending from a top inner surface of the top cover, to divide the gas introduction chamber and the gas humidification chamber,

the passage receives the entirety of the gas before the gas is directed to the liquid receptacle,

the humidifier further comprises a first seal between the heat conducting plate and the base, and further comprises a second seal between the base and the top cover,

the heat conducting plate is formed of metal,

the top cover and base comprise transparent material, and

a shape of the heat conducting plate is different than a shape of the base of the humidifier body, and the heat conducting plate covers only a portion of the base.

23. The humidifier of claim 8, wherein:

the humidifier body has a pair of resiliently biased lugs adapted to be disposed within corresponding recesses to secure the humidifier in place relative to a CPAP apparatus,

the humidifier body has a gas introduction chamber and a gas humidifier chamber connected to the gas introduction chamber by the passage,

the passage receives all of the gas before the gas is directed from the gas introduction chamber to the gas humidifier chamber and the liquid receptacle, and

the humidifier further comprises a seal between the base and the top cover.

24. The humidifier of claim 23, wherein the base and the top cover are snap fit to one another.

25. A CPAP system including a blower to generate the flow of pressurized breathable gas and the humidifier of claim 8.

26. A humidifier assembly, comprising:

the humidifier of claim 8; and

a connecting structure configured to connect between the humidifier and a CPAP apparatus without the need for an external tube or conduit extending between the CPAP apparatus and the connecting structure, the connecting structure comprising a housing defining a humidifier receptacle configured to horizontally receive the humidifier.

27. The humidifier assembly of claim 26, wherein the rear portion of the humidifier body includes an external retaining portion recess positioned, configured and dimensioned to at least partly receive a horizontally extending retaining portion of the connecting structure when the humidifier is fully inserted relative to the humidifier receptacle.

28. The humidifier assembly of claim 27, further comprising ribs between the recess and the horizontally extending retaining portion.

29. The humidifier assembly of claim 26, wherein the housing comprises a base portion configured to support the humidifier, and the humidifier assembly further comprises a securing mechanism that secures the humidifier in the housing with at least part of the humidifier being exposed.

30. The humidifier assembly of claim 29, wherein the base portion comprises a heating element configured to engage the heat conducting plate of the humidifier when the humidifier is retained in the housing.

31. The humidifier assembly of claim 30, wherein the heating element is resiliently biased into engagement with the heat conducting plate.

32. The humidifier assembly of claim 31, wherein the heating element is a flat plate-like resistance heater.

33. The humidifier assembly of claim 26, wherein the housing comprises contact elements configured to receive power from the CPAP apparatus.

34. The humidifier assembly of claim 33, wherein the housing comprises resiliently biased locking members on a side thereof that are configured to engage the CPAP apparatus to secure the connecting structure to the CPAP apparatus.

35. The humidifier assembly of claim 34, further comprising a release member configured to release the connecting structure from the CPAP apparatus.

36. The humidifier assembly of claim 35, wherein the release member is a button structure positioned on a lower portion of the housing.

37. The humidifier assembly of claim 36, wherein, when the humidifier body and the connecting structure as a unit are rotated from the upright, operating position, the liquid will drain through the humidifier body outlet before draining through the humidifier body inlet.

38. The humidifier assembly of claim 37, wherein the connecting structure includes an upstanding wall portion that extends in a vertical orientation, the humidifier having a rear wall that abuts or is proximate the upstanding wall portion when the humidifier is fully horizontally inserted relative to the connecting structure, wherein an opening of the connecting structure aligns with the inlet of the humidifier when the humidifier is fully inserted relative to the connecting structure, the opening being configured to allow communication of the flow of pressurized breathable gas from an outlet of the CPAP apparatus to the inlet of the humidifier.

39. The humidifier assembly of claim 36, wherein the connecting structure includes a movable button structure configured to allow manual release of the connecting structure from the CPAP apparatus.

40. A CPAP system including a blower to generate the flow of pressurized breathable gas and the humidifier assembly of claim 26.

41. The CPAP system of claim 40, wherein the CPAP apparatus includes a controller to control a heating element of the connecting structure, as well as at least one electrical connecting member to allow power supply from the CPAP apparatus to the connecting structure.

42. A humidifier, comprising:

a humidifier body configured to retain liquid, the humidifier body comprising:

a humidifier body inlet configured to receive a flow of pressurized breathable gas the humidifier body inlet being positioned on a rear side wall of the humidifier body;

a humidifier body outlet adapted to deliver the flow of pressurized breathable gas with added humidity;

a gas introduction chamber having a gas introduction chamber inlet and a gas introduction chamber outlet, the gas introduction chamber inlet being adapted to receive the flow of pressurized breathable gas from the humidifier body inlet;

a humidification chamber in communication with the gas introduction chamber and the humidifier body outlet, the humidification chamber having a bottom surface comprising heat conductive metallic material, and

a cover including the humidifier body outlet,

wherein:

the gas introduction chamber outlet serves as a humidification chamber inlet,

the gas introduction chamber and the humidification chamber are connected by a substantially vertically oriented transitional passage having a closed cross sectional shape configured to receive all of the flow of pressurized breathable gas before the gas is directed to the humidification chamber,

the gas introduction chamber inlet faces a substantially horizontal direction when the humidifier is in an upright, operating position,

the gas introduction chamber outlet is positioned above the liquid when the humidifier body retains the liquid and is in the upright, operating position, and

the gas introduction chamber and the humidification chamber are configured so that when the humidifier body is rotated around a horizontal axis parallel to the bottom surface of the humidifier chamber, in each of clockwise and counterclockwise directions, from the upright, operating position to a plurality of non-upright positions, liquid is prevented or discouraged from flowing from the humidification chamber and out through the humidifier body inlet.

43. The humidifier of claim 42, wherein a volume of the gas introduction chamber is smaller than a volume of the humidification chamber.

44. The humidifier of claim 43, wherein the non-upright positions include positions where the humidifier is inadvertently rotated about multiple horizontal axes.

45. The humidifier of claim 44, wherein the non-upright positions are those which occur when the humidifier is inadvertently rotated in both clockwise and counterclockwise orientations relative to the horizontal axes.

46. The humidifier of claim 44, wherein the horizontal axes include a first axis that runs from a front to a back of the humidifier body, and a second axis that runs from lateral side to lateral side of the humidifier body.

47. The humidifier of claim 42, wherein the humidifier body includes a top cover and a base that are snap-fit together.

48. The humidifier of claim 47, wherein the humidifier body further comprises a seal between the base and the top cover.

49. The humidifier of claim 48, further comprising a seal between the heat conducting plate and the base.

50. The humidifier of claim 48, wherein the top cover and base are formed of a transparent material.

51. The humidifier of claim 42, wherein the humidifier body includes a top cover, a base, and a pair of clips to detachably fasten the top cover and the base.

52. The humidifier of claim 42, further comprising a pair of resiliently biased lugs to secure the humidifier relative to a blower of a CPAP apparatus.

53. A humidifier assembly, comprising:

the humidifier of claim 42; and

a connecting structure configured to connect between the humidifier and a CPAP apparatus without the need for an external tube or conduit extending between the CPAP apparatus and the connecting structure, the connecting structure comprising a housing defining a receptacle configured to horizontally receive the humidifier.

54. The humidifier assembly of claim 53, wherein a rear portion of the humidifier body includes an external retaining portion recess positioned, configured and dimensioned to at least partly receive a horizontally extending retaining portion of the connecting structure.

55. The humidifier assembly of claim 54, further comprising ribs positioned adjacent the horizontally extending retaining portion.

56. The humidifier assembly of claim 53, wherein the housing comprises a base portion configured to support the humidifier, and the humidifier assembly further comprises a securing mechanism that secures the humidifier in the housing with at least part of the humidifier being exposed.

57. The humidifier assembly of claim 56, wherein the securing mechanism includes a resiliently biased member having a pair of locking lugs provided on the humidifier body, and the base portion includes lug receiving recesses in which the lugs may be releasably disposed.

58. The humidifier assembly of claim 56, wherein the base portion comprises a heating element configured to engage the heat conductive metallic material of the humidifier when the humidifier is retained in the housing.

59. The humidifier assembly of claim 58, wherein the heating element is resiliently biased into engagement with the heat conducting plate.

60. The humidifier assembly of claim 58, wherein the heating element is a flat plate-like resistance heater.

61. The humidifier assembly of claim 53, wherein the housing comprises contact elements configured to receive power from the CPAP apparatus.

62. The humidifier assembly of claim 61, wherein the housing comprises resiliently biased locking members on a side thereof that are configured to engage the CPAP apparatus to secure the connecting structure to the CPAP apparatus.

63. The humidifier assembly of claim 62, further comprising a release member configured to release the connecting structure from the CPAP apparatus.

64. The humidifier assembly of claim 63, wherein the release member is a button structure provided to a lower portion of the housing.

65. A CPAP system including a blower to generate a flow of pressurized breathable gas and the humidifier assembly of claim 53.

66. A CPAP system including a blower to generate a flow of pressurized breathable gas and the humidifier of claim 42.

67. A humidifier, comprising:

a humidifier body having a base and a top cover snap-fitted to the base, the base defining a liquid receptacle adapted to contain liquid, the base having a heat conducting plate;

an inlet adapted to receive a flow of pressurized breathable gas;

an outlet, downstream of the liquid receptacle, adapted to deliver the flow of pressurized breathable gas with added humidity; and

at least a first resiliently biased lug movable relative to the base, the first lug being biased in an extended position and manually movable against the resilient bias from the extended position to a retracted position,

wherein if the humidifier body is rotated from an upright, operating position to each of a plurality of non-upright positions, liquid in the humidifier body remains below the inlet.

68. The humidifier of claim 67, wherein a rear portion of the humidifier body includes an external retaining portion recess.

69. The humidifier of claim 67, wherein the humidifier body has a gas introduction chamber and a gas humidifier chamber connected to the gas introduction chamber by a vertically extending passage having at least a portion with closed shape as seen in cross-section.

70. The humidifier of claim 69, wherein the passage receives the entirety of the flow of pressurized breathable gas before the gas is directed to the liquid receptacle.

71. The humidifier of claim 67, wherein the humidifier body further comprises a seal between the base and the top cover.

72. The humidifier of claim 71, wherein the top cover and base comprise transparent material.

73. The humidifier of claim 67, wherein:

a rear portion of the humidifier body includes an external retaining portion recess,

the humidifier body has a gas introduction chamber and a gas humidifier chamber connected to the gas introduction chamber by a vertically extending passage having at least a portion with closed shape as seen in cross-section,

the passage receives all of the gas before the gas is directed to the liquid receptacle,

the heat conducting plate is formed of metal, and

the top cover and base comprise transparent material.

74. The humidifier of claim 73, further comprising a second lug, laterally spaced from the first lug and movable in unison with the first lug, wherein the first and second lugs are positioned to extend outwardly relative to the humidifier body.

75. A CPAP system including:

a CPAP apparatus having a blower to generate the flow of pressurized breathable gas; and

a humidifier receptacle to horizontally receive the humidifier of claim 67.

76. The CPAP system of claim 75, wherein a rear portion of the humidifier body includes an external retaining portion recess positioned, configured and dimensioned to at least partly receive a horizontally extending retaining portion associated with the humidifier receptacle when the humidifier is fully inserted relative to the humidifier receptacle, and

wherein the CPAP system further comprises at least a first lug receiving recess in which the first lug is a releasably disposed when the humidifier is fully inserted relative to the humidifier receptacle and the lug resiliently moves to the extended position.

77. The CPAP system of claim 76, further comprising ribs adjacent the horizontally extending retaining portion.

78. The CPAP system of claim 75, further comprising a heating element configured to engage the heat conducting plate of the humidifier when the humidifier is retained in the humidifier receptacle.

79. A CPAP system of claim 78, wherein the heating element is resiliently biased into engagement with the heat conducting plate.

80. The CPAP system of claim 79, wherein the heating element is a flat plate-like resistance heater.

81. The CPAP system of claim 75, further comprising a connecting structure having resiliently biased locking members on a side thereof that are configured to engage the CPAP apparatus to secure the connecting structure to the CPAP apparatus without the need for an external flexible hose or conduit, wherein the connecting structure includes the humidifier receptacle.

82. The CPAP system of claim 81, wherein the connecting structure comprises contact elements configured to receive power from the CPAP apparatus.

83. The CPAP system of claim 81, further comprising a release member configured to release the connecting structure from the CPAP apparatus.

84. The CPAP system of claim 83, wherein the release member is a button structure.

85. The CPAP system of claim 81, wherein, when the humidifier body and the connecting structure as a unit are rotated from the upright, operating position, liquid will drain through the outlet before draining through the inlet.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : RE46,571 E
APPLICATION NO. : 15/182919
DATED : October 17, 2017
INVENTOR(S) : Virr et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification

Please insert at Line 12 (approx.) in Column 1 as follows:
--Notice: More than one reissue application has been filed for the reissue of U.S. Patent No. 7,614,398. The reissue applications are U.S. Reissue Patent Application Serial No. 15/182,919 (the present application), filed on June 15, 2016, now U.S. Reissue Patent No. RE46,571 E, issued October 17, 2017, which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 13/944,960, filed on August 23, 2013, now U.S. Reissue Patent No. RE46,079 E, issued July 26, 2016, which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 13/100,783, filed on May 4, 2011, now U.S. Reissue Patent No. RE44,453 E, issued August 27, 2013.--

Signed and Sealed this
Fifth Day of June, 2018

Andrei Iancu
Director of the United States Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : RE46,571 E
APPLICATION NO. : 15/182919
DATED : October 17, 2017
INVENTOR(S) : Virr et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification

At Column 1, under the heading "CROSS REFERENCE TO RELATED APPLICATIONS," replace Lines 16-22 (approx.), with the following:

--NOTICE: More than one reissue application has been filed for the reissue of U.S. Patent No. 7,614,398 B2. The reissue applications are U.S. Reissue Patent Application No. 16/232,883, filed December 26, 2018, now U.S. Reissue Patent No. RE48,095 E, issued July 14, 2020, which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 16/231,286, filed on December 21, 2018, now U.S. Reissue Patent No. RE48,118 E, issued July 28, 2020, which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 15/706,811, filed on September 18, 2017, now U.S. Reissue Patent No. RE48,149, issued August 11, 2020, which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 15/182,919 (the present application), filed on June 15, 2016, now U.S. Reissue Patent No. RE46,571 E, issued October 17, 2017, which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 13/944,960, filed on August 23, 2013, now U.S. Reissue Patent No. RE46,079 E, issued July 26, 2016, which is a continuation reissue application of U.S. Reissue Patent Application Serial No. 13/100,783, filed on May 4, 2011, now U.S. Reissue Patent No. RE44,453 E, issued August 27, 2013, which is a reissue application of U.S. Patent Application No. 11/181,807, filed July 15, 2005, now U.S. Patent No. 7,614,398 B2, issued November 10, 2009, which is a continuation of U.S. Patent Application Serial No. 10/467,382, filed on August 7, 2003, now U.S. Patent No. 6,935,337 B2, issued August 30, 2005, which is the U.S. national phase--

This certificate supersedes the Certificate of Correction issued June 5, 2018.

Signed and Sealed this
Nineteenth Day of January, 2021

Andrei Iancu
Director of the United States Patent and Trademark Office