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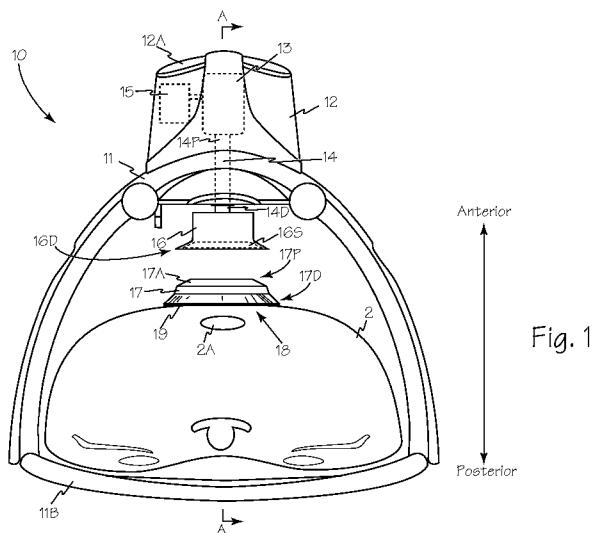
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(54) Title: MECHANICAL CHEST COMPRESSION PLUNGER ADAPTER AND COMPRESSION PAD



(57) Abstract: A plunger adapter and a detachable compression pad for piston driven chest compression devices optimizes the application of chest compressions to a fixed location on a patient's chest. The detachable compression pad may be removably secured to the patient above the patient's sternum to ensure that the compression pressure from the piston through the piston adapter is applied to a fixed location on the patient's chest. As the plunger and plunger adapter retract from the chest, the compression pad remains fixed to the patient's chest, and as the plunger and plunger adapter extend from the chest compression unit for subsequent compression strokes, the distal end of the plunger adapter reengages the compression pad to apply compression to a fixed location on the patient's chest.

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Mechanical Chest Compression Plunger Adapter and Compression PadField of the Inventions

[0001] The inventions described below relate to the field of emergency medical devices and methods and more specifically to methods and device to optimize the resuscitation of cardiac arrest patients.

Background of the Inventions

[0002] According to the American Heart Association nearly 383,000 out-of-hospital sudden cardiac arrests occur annually in the United States. These patients may be saved by the timely application of life saving measures such as Cardiopulmonary resuscitation (CPR).

[0003] CPR is a well-known and valuable method of first aid used to resuscitate people who have suffered from cardiac arrest. CPR requires repetitive chest compressions to squeeze the heart and the thoracic cavity to pump blood through the body. Artificial respiration, such as mouth-to-mouth breathing or a bag mask device, is used to supply air to the lungs. When a first aid provider performs manual chest compression effectively, blood flow in the body is about 25% to 30% of normal blood flow. However, even experienced paramedics cannot maintain adequate chest compressions for more than a few minutes. Hightower, et al., Decay In Quality Of Chest Compressions Over Time, 26 Ann. Emerg. Med. 300 (Sep. 1995). Thus, CPR is not often successful at sustaining or reviving the patient. Nevertheless, if chest compressions could be adequately maintained, then cardiac arrest victims could be sustained for extended periods of time. Occasional reports of extended chest compression efforts (45 to 90

minutes) have been reported, with the victims eventually being saved by coronary bypass surgery. See Tovar, et al., Successful Myocardial Revascularization and Neurologic Recovery, 22 Texas Heart J. 271 (1995).

[0004] In efforts to provide better blood flow and increase the effectiveness of bystander resuscitation efforts, various mechanical devices have been proposed for performing AUTOMATED CHEST COMPRESSIONS. In one variation of such devices, a belt is placed around the patient's chest and the belt is used to effect chest compressions. Our own patents, Mollenauer, et al., Resuscitation Device having a Motor Driven Belt to Constrict/Compress the Chest, U.S. Patent 6,142,962 (Nov. 7, 2000); Sherman, et al., CPR Assist Device with Pressure Bladder Feedback, U.S. Patent 6,616,620 (Sep. 9, 2003); Sherman, et al., Modular CPR Assist Device, U.S. Patent 6,066,106 (May 23, 2000); and Sherman, et al., Modular CPR Assist Device, U.S. Patent 6,398,745 (Jun. 4, 2002), and our application 09/866,377 filed on May 25, 2001, show chest compression devices that compress a patient's chest with a belt. Various other mechanisms may be used to tighten the belt, including the mechanisms shown in Lach, et al., Resuscitation Method and Device, U.S. Patent 4,774,160 (Sep. 13, 1988) and in Kelly, et al., Chest Compression Device for Cardiac Arrest, U.S. Patent 5,738,637 (Apr. 14, 1998).

[0005] Piston based chest compression systems are illustrated in Nilsson, et al., CPR Device and Method, U.S. Patent Publication 2010/0185127 (Jul. 22, 2010), Sebelius, et al., Support Structure, U.S. Patent Publication 2009/0260637 (Oct. 22, 2009), Sebelius, et al., Rigid Support Structure on Two Legs for CPR, U.S. Patent 7,569,021 (Aug. 4, 2009), Steen, Systems and Procedures for Treating Cardiac Arrest, U.S. Patent 7,226,427 (Jun. 5, 2007) and King, Gas-Driven Chest Compression Device, U.S. Patent Publication 2010/0004572 (Jan. 7, 2010) all of which are hereby incorporated by reference.

[0006] As mechanical compressions are performed by piston based chest compression systems, the compression pads may shift position relative to the patient and the effectiveness of the automated chest compressions are diminished. The repeated extension and retraction of the piston often results in the piston and compression cup moving or "walking" up the patient's chest toward the neck or moving down toward the patient's abdomen.

Summary

[0007] The devices and methods described below provide for a plunger adapter and a detachable compression pad for piston driven chest compression devices that maintain the compression force in the proper position on the patient's chest. The detachable compression pad is removably secured to the patient above the patient's sternum to ensure that the compression pressure from the piston through the piston adapter is applied to a fixed location on the patient's chest. As the piston and piston adapter retract from the chest, the compression pad remains fixed to the patient's chest, and as the piston and piston adapter extend from the chest compression unit, the distal end of the plunger adapter reengages the compression pad to apply compression to the patient's chest at the same location above the patient's sternum as the previous compressions.

[0008] Any suitable set of corresponding shapes may be provided in the plunger adapter and compression pad to minimize movement of the compression pad relative to the patient's chest and to optimize application of compressive force to the patient's chest. Complementary convex and concave shapes on the plunger adapter and the compression pad enable the plunger adapter and the compression pad to engage and focus the compression force to the patient's chest for each extension of the plunger. In a more detailed example,

the distal end of the plunger adapter may have a conical or frusto-conical socket and the compression pad may include a corresponding conical or frusto-conical portion or extension on the proximal end to engage the socket in the plunger adapter. The plunger adapter socket and the compression pad extension will adapt any round, ovoid or spherical shape to provide positive engagement while avoiding any rotational forces generated by the plunger about the long axis of the plunger. By securing the compression pad to the patient's chest, the application of compressive force is maintained in the selected location.

[0009] The compression pad is a generally incompressible pad configured to adapt to the shape of the patient's chest. The compression pad may be formed of one or more layers to optimize the application of CHEST COMPRESSIONS to the patient. The proximal or upper end of the compression pad is a generally hard convex portion or extension that may include a concave socket for engaging the plunger adapter. The central layer may be a flexible and incompressible layer to conform to the shape of the patient's chest. The lower or distal end of the compression pad may include one or more flexible cups for creating one or more areas of vacuum between the compression pad and the patient's chest.

[0010] Suitable engagement mechanisms may be included in the plunger and the plunger adapter to provide a preselected level of chest expansion force in addition to chest compression force. A magnet may be provided in the distal end of the plunger and a corresponding magnet or ferrous material may be included in the proximal end of the plunger adapter to provide a preselected retention force between the plunger and the plunger adapter. The retention force is selected to provide some expansion force to the patient's chest between compressions without applying enough expansion force to the patient's chest to tear the patient's skin or underlying

tissue. Similarly an electromagnet may be provided in distal end of the plunger to provide an adjustable level of retention force, or to provide timed release of the plunger adapter from the plunger.

Brief Description of the Drawings

[0011] Figure 1 is a front view of a piston driven chest compression device with a detachable plunger adapter and compression pad and a cross section of a patient's chest showing landmark skeletal structures.

[0012] Figure 2 is a cross section of the chest compression device of Figure 1 taken along A-A with an alternate plunger adapter and compression pad.

[0013] Figure 3 is a side view of a plunger adapter and compression pad.

[0014] Figure 4 is an end view of the distal end of a plunger adapter with a frusto-conical socket.

[0015] Figure 5 is an end view of the proximal end of a compression pad with an extension corresponding to the frusto-conical socket of the plunger adapter of Figure 4.

[0016] Figure 6 is a side view of an alternate plunger adapter and compression pad.

[0017] Figure 7 is an end view of the distal end of the plunger adapter of Figure 6.

[0018] Figure 8 is an end view of the proximal end of a compression pad with an extension corresponding to the plunger adapter of Figure 6.

[0019] Figure 9 is a side view of an octagonal plunger adapter and compression pad.

[0020] Figure 10 is an end view of the distal end of the plunger adapter of Figure 9.

[0021] Figure 11 is an end view of the proximal end of a compression pad with an extension corresponding to the plunger adapter of Figure 9.

[0022] Figure 12 is a perspective view of a mechanical chest compression device engaging a patient with an electrode assembly and a compression monitor puck.

[0023] Figure 13 is a close up perspective of the electrode assembly and compression monitor puck of Figure 12.

[0024] Figure 14 is a side view of a plunger adapter configured to engage a compression monitor puck.

Detailed Description of the Inventions

[0025] In Figure 1, mechanical chest compression device 10 is oriented to apply compressions to the chest 2 of patient 1. Chest compression device 10 includes support structure 11 and backboard 11B which supports and orients chest compression unit 12 apposing sternum 2A. Chest compression unit 12 includes any suitable drive means such as motor 13 which may be a reversible electromotor, a linear actuator or the like. Plunger 14 has a distal end 14D and a proximal end 14P, and proximal end 14P of the plunger is operably coupled to motor 13. Distal end 14D of the plunger extends from and withdraws into the housing upon operation of motor 13. A motor control unit such as controller 15 is operably connected to motor 13 and includes a microprocessor to control the operation of the motor and the plunger. Plunger adapter 16 is secured to the distal end of the plunger and compression pad 17 removably engages the plunger adapter.

[0026] Distal end 16D of plunger adapter 16 is sized and shaped to avoid injury to a patient if plunger 14 is extended

to contact the patient without a compression pad between the plunger adapter and the patient. Distal end 16D of plunger adapter 16 includes a socket 16S that is sized and shaped to engage a correspondingly shaped element on a compression pad which may be called a key, a portion or an extension such as extension 17A on proximal end 17P of compression pad 17. Compression pad extension 17A operates as a locator pin or key for preventing the locator bushing, plunger adapter 16, and chest compression unit 12 from changing the point of application of compression force on the patient or "walking" across the patients chest.

[0027] In use, compression pad 17 is removably secured to the patient's chest at force application location **18**, which is in a superior position relative to sternal notch 2N as illustrated in Figure 2. Compression pad 17 may be secured to the patient with any suitable biocompatible tape or adhesive such as adhesive **19**. The mechanical chest compression device 10 is oriented around the patient's chest 2 with chest compression unit 12 apposing compression pad 17. Plunger 14 is extended to confirm proper siting of compression pad 17 on the patient and to confirm mating and orientation of plunger adapter 16 with compression pad 17 and compression pad extension 17A with socket 16S. Upon confirmation of proper alignment and orientation, controller 15 is instructed, through any suitable interface such as interface 12A, to perform cyclic compressions and decompressions for CPR.

[0028] As illustrated in Figure 2, plunger adapter **24** is configured with a generally cylindrical shape. Compression pad **25** includes a corresponding cylindrical shaped socket **26** in proximal end 25P of compression pad 25. In configurations with the plunger adapter operating as the male component in the plunger adapter/compression pad interface, the plunger adapter should be sized such that the force per unit area

applied by the plunger adapter, if applied directly to the patient's chest, does not damage the patient.

[0029] The combination of plunger adapter and compression pad may be sized along the anterior-posterior axis to enable a chest compression unit with a fixed length plunger with a fixed extension length to accommodate patients with different anterior-posterior dimensions.

[0030] In Figures 3, 4 and 5, plunger adapter 30 has a height or anterior posterior dimension 30D and compression pad 31 has a height or anterior posterior dimension 31D. Plunger adapter 30 is removably secured to plunger 32 using any suitable technique such as mating threads, keyed slots, locator pin or pins, friction engagement or other. The height of a plunger adapter and the height of a compression pad may be individually selected to conform to the anterior posterior dimensions of a patient and the length and extension capability of a plunger and compression unit. Compression pad 31 includes extensions such as extension 33 sized to engage a comparably sized socket such as socket 34 in any suitable plunger adapter such as plunger adapter 30. The inner surfaces, surface 34A and surface 34B, of a plunger adapter socket such as socket 34 may include an adhesive or coating such as adhesive layer 35 with a preselected level of adhesion to maintain a limited engagement between a plunger adapter, such as adapter 30, and a compression pad such as compression pad 31, to produce a preselected level of decompression during each retraction of the plunger while performing automated chest compressions with minimal damage to the patient. Adhesive layer 35 may also be applied to compression pad surfaces 33A and or 33B.

[0031] Compression pad 31 is a generally incompressible pad configured to adapt to the shape of the patient's chest. A compression pad such as compression pad 31 may be formed of

one or more layers such as first layer 31A and second layer 31B to optimize the application of compressive force to the patient. The proximal or upper end of the compression pad is a generally hard extension or socket such as extension layer 33 for engaging the plunger adapter. The first or central layer, layer 31A may be a flexible and incompressible layer to conform to the shape of the patient's chest. The lower or distal end, second layer 31B, of the compression pad is flexible and generally incompressible to adapt to the shape of the patient's chest and may include one or more flexible cups for creating one or more areas of vacuum between the compression pad and the patient's chest.

[0032] Suitable engagement mechanisms may be included in the plunger and the plunger adapter to provide a preselected level of chest expansion force in addition to chest compression force. A magnet may be provided in the distal end of the plunger and a corresponding magnet or ferrous material may be included in the proximal end of the plunger adapter to provide a preselected retention force between the plunger and the plunger adapter. The retention force is selected to provide some expansion force to the patient's chest between compressions without applying enough expansion force to the patient's chest to tear the patient's skin or underlying tissue. Similarly an electromagnet may be provided in distal end of the plunger to provide an adjustable level of retention force, or to provide timed release of the plunger adapter from the plunger.

[0033] As illustrated in Figures 6, 7 and 8, plunger adapter 40 includes socket 41 that is sized and dimensioned to engage extension 42 of compression pad 43. Compression pad 43 may be removably secured to the chest of a patient as discussed above. To generate a predetermined decompression force 44 during the retraction of plunger 45, magnets such as adapter magnet 40M and compression magnet 43M may be included

in plunger adapter 40 and compression pad 43 to provide the predetermined retention force, such as force of attraction or magnetic force 46, to hold compression pad 43 to plunger adapter 40 until the predetermined decompression force is exceeded. The predetermined level of decompression force is selected to be at a level below which, the chest tissue at force application location 18 will not be damaged before compression pad 43 releases from plunger adapter 40. Any other suitable technique for providing a predetermined level of retention force 46 may be used such as electromagnetic attraction, frictional engagement or others. Any other suitable cooperative configurations of socket and extension may be used.

[0034] Referring now to Figures 9, 10 and 11, plunger adapter 50, and compression pad 51 may adopt any suitable shape. Here, distal end 50D of plunger adapter 50 is octagonal although any suitable regular or irregular shape may be used. Distal end 50D includes socket 52 to engage proximal end 51P of compression pad 51. The distal end of compression pad 51, end 51D, may adopt any suitable shape regardless of the shape of the key on proximal end 51P. Here, proximal end 51P is keyed as a hexagon to conform to the shape of socket 52.

[0035] Patient 1 illustrated in Figure 12 has electrode assembly 56 secured to chest 2. Mechanical chest compression device 57 is oriented to apply compressions to the chest of patient 1. Compression pad 56 includes chest compression monitor 58 used to provide feedback for manual CPR which is illustrated in greater detail in Figure 13. The chest compression monitor is provided to detect compression depth and or rate according to Halperin, CPR Chest Compression Monitor, U.S. Patent 6,390,996 issued May 21, 2002 incorporated herein by reference.

[0036] Plunger adapter **59** is sized and shaped to accommodate socket **62** which engages chest compression monitor or puck **58** as illustrated in Figure 14. Chest compression monitors may also be separate and stand-alone from a compression pad and are known in the art as a puck. Stand-alone pucks may be adhered to the patient's chest, using adhesive **60** at the desired location **61**, for providing feedback for therapeutic chest compressions. An appropriately sized and shaped plunger adapter having a suitably sized and shaped socket **62** may be connected to the plunger of mechanical chest compression device **57** to prevent chest compression device from wandering, walking or otherwise providing chest compressions away from the desired location as discussed above. The plunger adapter is keyed to the size and shape of the puck and may be provided to accommodate pucks or chest compression monitors from any suitable manufacturer operating with any suitable sensor technology or combination of sensors such as accelerometers and or force sensors.

[0037] While the preferred embodiments of the devices and methods have been described in reference to the environment in which they were developed, they are merely illustrative of the principles of the inventions. The elements of the various embodiments may be incorporated into each of the other species to obtain the benefits of those elements in combination with such other species, and the various beneficial features may be employed in embodiments alone or in combination with each other. Other embodiments and configurations may be devised without departing from the spirit of the inventions and the scope of the appended claims.

We claim:

1. An automated chest compression device comprising:
 - a mounting structure;
 - a chest compression unit including a reversible electromotor, a plunger having a distal end and a proximal end, the proximal end of the plunger operably coupled to the reversible electromotor, the distal end of the plunger extending from and withdrawing into the housing, the chest compression unit secured to the mounting structure to engage a patient and perform chest compressions;
 - an electromotor control unit operably connected to the motor and including a microprocessor to control the electromotor and the plunger;
 - a plunger adapter secured to the distal end of the plunger; and
 - a compression pad removably engaging the plunger adapter.
2. The automated chest compression device of claim 1 wherein the plunger adapter and the compression pad include complimentary concave and convex elements, respectively, to removably engage the plunger adapter with the compression pad.
3. The automated chest compression device of claim 1 wherein the plunger adapter comprises:
 - a generally cylindrical adapter with a proximal end and a distal end, the proximal end removably engaging the distal end of the plunger, the distal end of the adapter having a frustoconical socket for engaging the compression pad; and

wherein the compression pad further comprises a frustoconical extension for removably engaging the frustoconical socket of the plunger adapter.

4. The automated chest compression device of claim 1 wherein the plunger adapter comprises:

a generally cylindrical adapter with a proximal end and a distal end, the proximal end removably engaging the distal end of the plunger, the distal end of the adapter for engaging the compression pad; and

wherein the compression pad further comprises a generally cylindrical socket for removably engaging the distal end of the plunger adapter.

5. The automated chest compression device of claim 1 wherein the plunger adapter and the compression pad further comprise:

means for generating a predetermined retention force between the plunger adapter and the compression pad.

6. The automated chest compression device of claim 5 wherein the means for generating a predetermined retention force further comprise:

an adhesive layer.

7. The automated chest compression device of claim 5 wherein the means for generating a predetermined retention force further comprise:

a plunger adapter magnet; and

a compression pad magnet.

8. A method of performing chest compression on a patient comprising the steps:

providing a mounting structure surrounding the patient's chest;

securing a chest compression unit on the mounting structure apposing the patient's sternum, the chest compression unit including a reversible electromotor, a plunger having a distal end and a proximal end, the proximal end of the plunger operably coupled to the reversible electromotor, the distal end of the plunger extending from and withdrawing into the housing to perform chest compression on the patient;

providing an electromotor control unit operably connected to the motor and including a microprocessor to control the electromotor and the plunger;

providing a plunger adapter secured to the distal end of the plunger; and

securing a compression pad over the sternum of a patient, the compression pad removably engaging the plunger adapter;

initiating chest compressions through the electromotor control unit.

9. The method of claim 8 wherein the plunger adapter comprises:

a generally cylindrical adapter with a proximal end and a distal end, the proximal end removably engaging the distal end of the plunger, the distal end of the plunger adapter having a frustoconical socket for engaging the compression pad; and

wherein the compression pad further comprises a frustoconical extension for removably engaging the distal end of the plunger adapter.

10. The method of claim 8 wherein the plunger adapter comprises:

a generally cylindrical plunger adapter with a proximal end and a distal end, the proximal end removably engaging the distal end of the plunger, the distal end of the plunger adapter for engaging the compression pad; and

wherein the compression pad further comprises a generally cylindrical socket for removably engaging the distal end of the plunger adapter.

11. An improved chest compression device of the type with a chest compression unit, a mounting device for mounting the chest compression unit on a patient, the chest compression unit comprising a housing, a plunger having a distal end and a proximal end, the proximal end of the plunger disposed in the housing, a reversible electromotor, a mechanical device connected from the motor to the proximal end of the plunger for driving the plunger in a reciprocating manner with respect to the housing and for translating rotational motion of the motor to linear motion of the plunger, an electromotor control unit connected to the motor and including a microprocessor, a first monitor operable for monitoring the position of the plunger in respect of the housing, a second monitor operable for monitoring the position of the plunger in respect of the mechanical device for translating rotational motion to linear motion or the rotor, the positions monitored by the first and second monitors being communicated to the electromotor control unit, wherein the improvement comprises:

a plunger adapter secured to the distal end of the plunger; and

a compression pad removably engaging the plunger adapter.

12. The automated chest compression device of claim 11 wherein the plunger adapter and the compression pad include complimentary concave and convex elements to removably engage the plunger adapter with the compression pad.

13. The automated chest compression device of claim 11 wherein the plunger adapter comprises:

a generally cylindrical adapter with a proximal end and a distal end, the proximal end removably engaging the distal end of the plunger, the distal end of the adapter having a frustoconical socket for engaging the compression pad; and

wherein the compression cup further comprises a frustoconical extension for removably engaging the frustoconical socket of the plunger adapter.

14. The automated chest compression device of claim 11 wherein the plunger adapter comprises:

a generally cylindrical adapter with a proximal end and a distal end, the proximal end removably engaging the distal end of the plunger, the distal end of the adapter for engaging the compression pad; and

wherein the compression pad further comprises a generally cylindrical socket for removably engaging the distal end of the plunger adapter.

15. The automated chest compression device of claim 11 wherein the plunger adapter and the compression pad further comprise:

means for generating a predetermined retention force between the plunger adapter and the compression pad.

16. The automated chest compression device of claim 15 wherein the means for generating a predetermined retention force further comprise:

an adhesive layer.

17. The automated chest compression device of claim 15 wherein the means for generating a predetermined retention force further comprise:

a plunger adapter magnet; and

a compression pad magnet.

18. The automated chest compression device of claim 2 further comprising:

a compression monitor secured to the patient at a preselected force application location; and

wherein the concave element in the plunger adapter is a socket sized to engage the compression monitor during cyclic chest compressions.

19. The automated chest compression device of claim 18 further comprising:

a electrode assembly secured to the patient corresponding to the preselected force application location; and the compression monitor is removably secured to the electrode assembly.

20. A piston based chest compression device for compressing the chest of a patient comprising:

a support structure;

a chest compression unit apposing the patient's chest, the chest compression unit including a motor, a plunger having a distal end and a proximal end, the proximal

end of the plunger operably coupled to the motor, the distal end of the plunger extending from and withdrawing into the compression unit to perform cyclic chest compressions at a preselected force application location;

a microprocessor to control the motor and the plunger; and

a plunger adapter having a proximal end and a distal end, the proximal end secured to the distal end of the plunger, the distal end having a concave socket sized and dimensioned to engage a compression monitor puck.

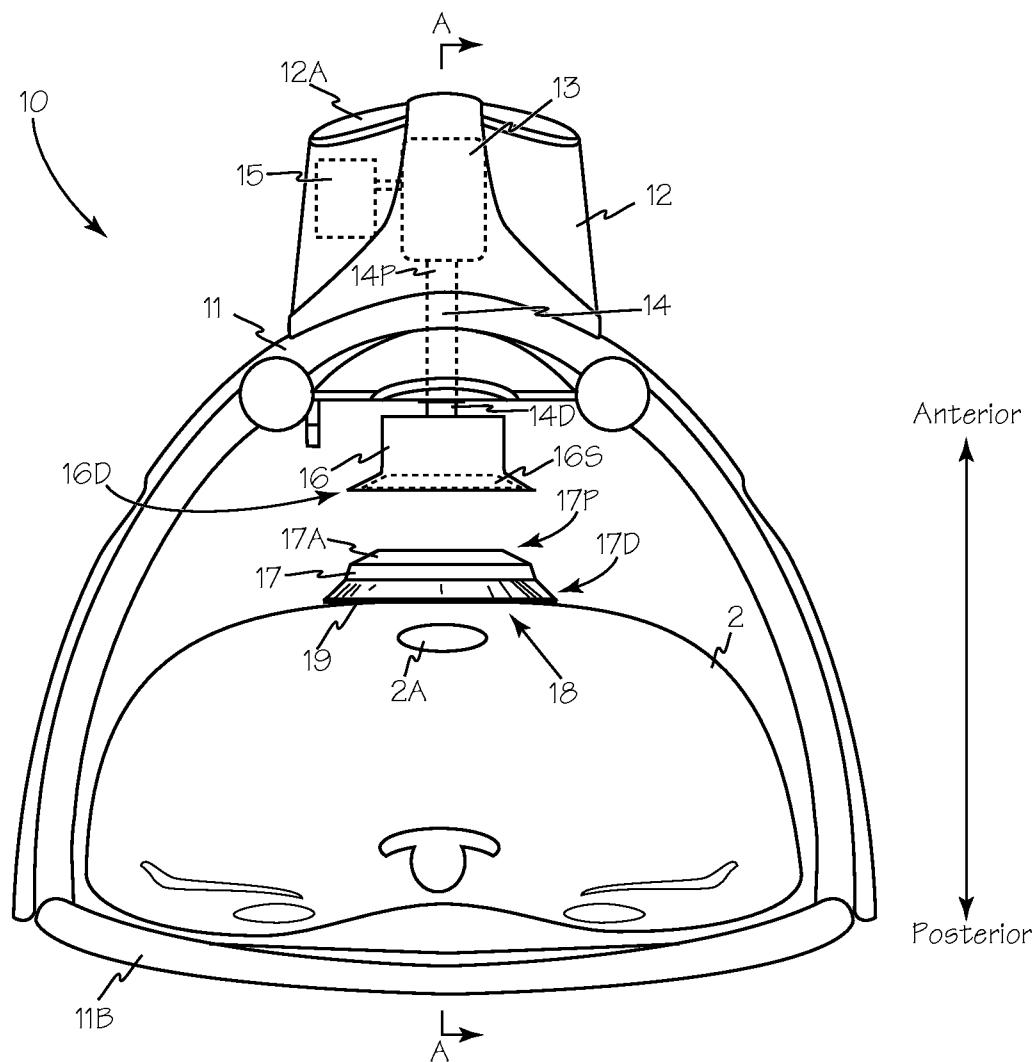


Fig. 1

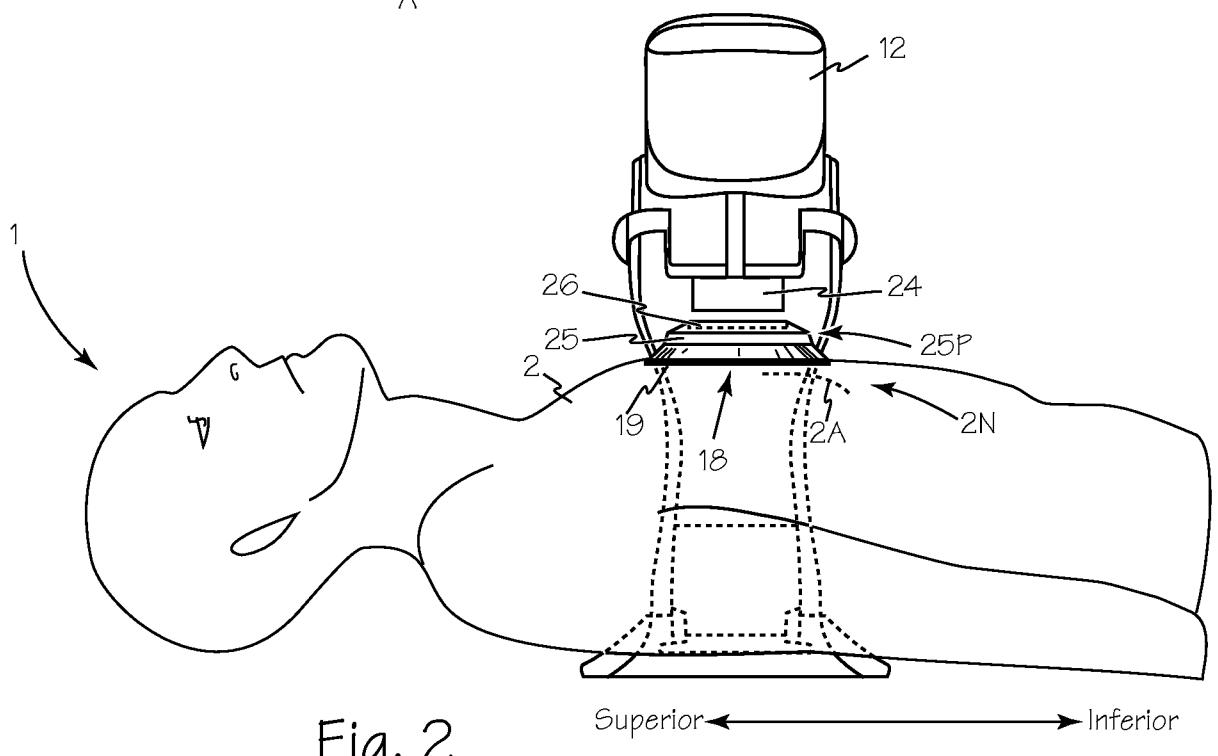


Fig. 2

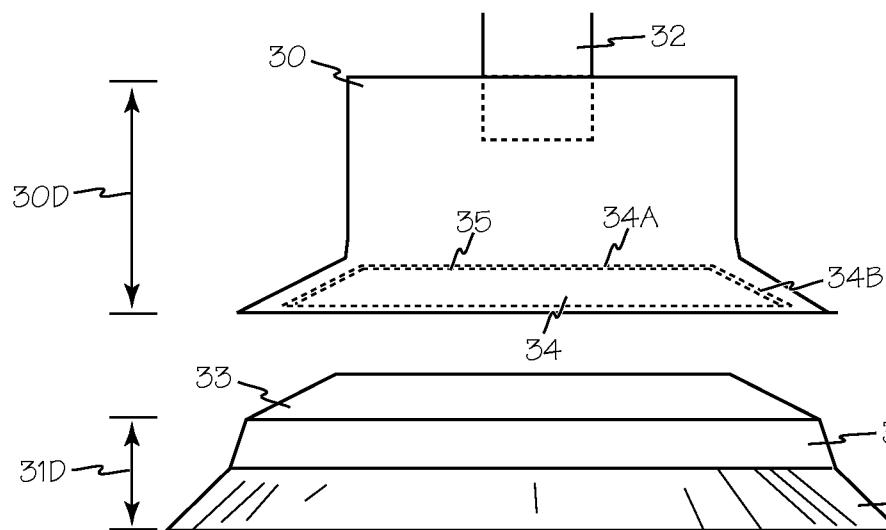


Fig. 3

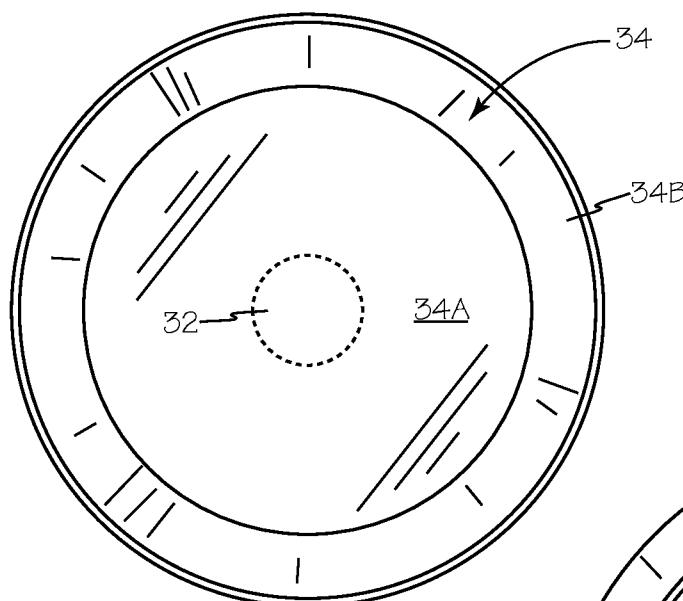


Fig. 4

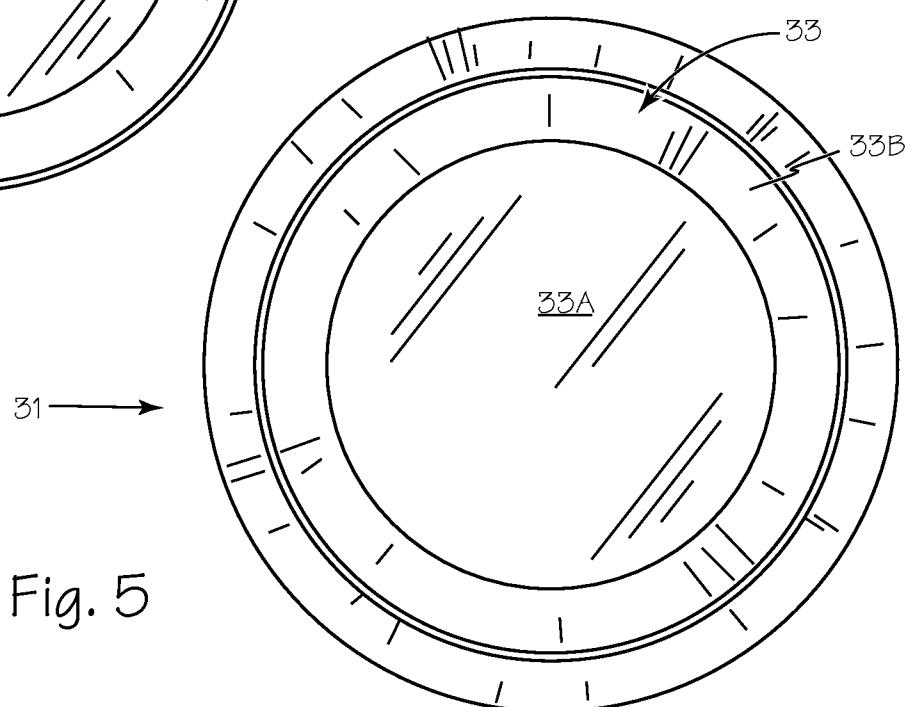


Fig. 5

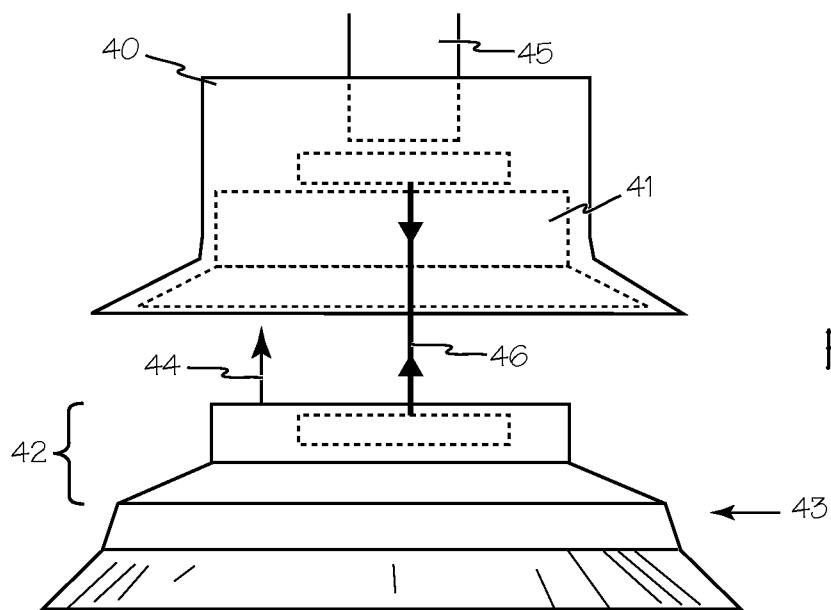


Fig. 6

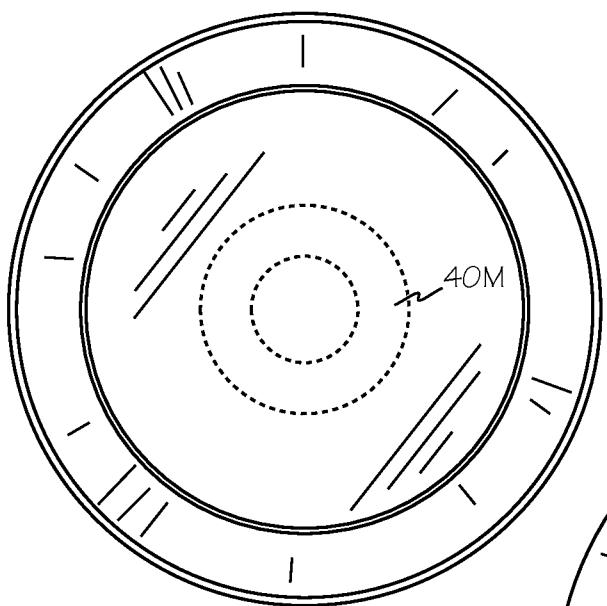


Fig. 7

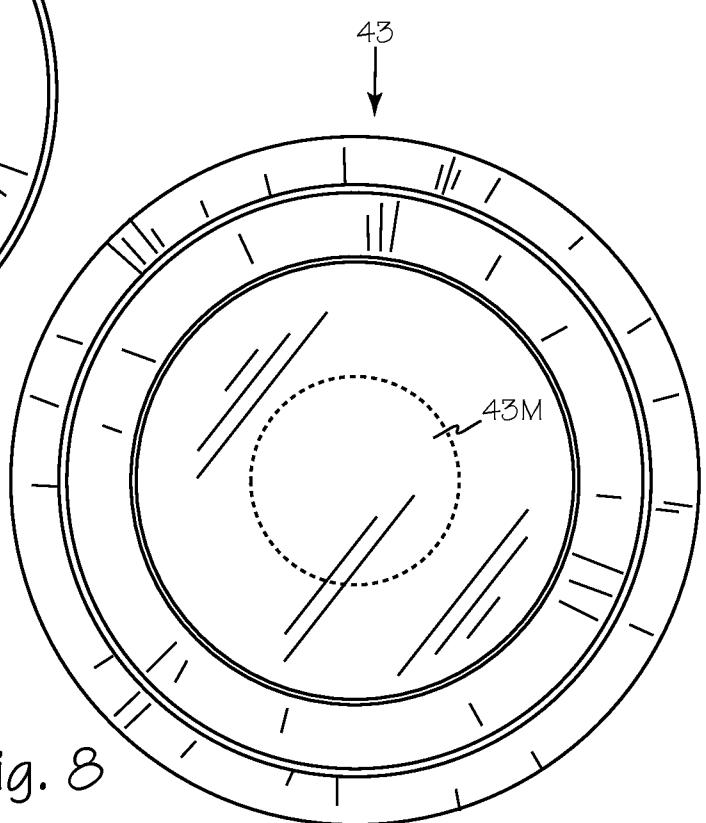
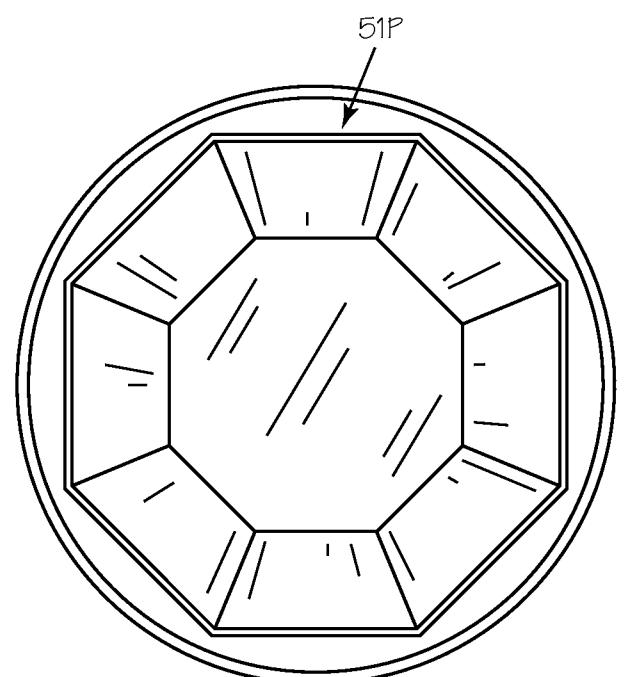
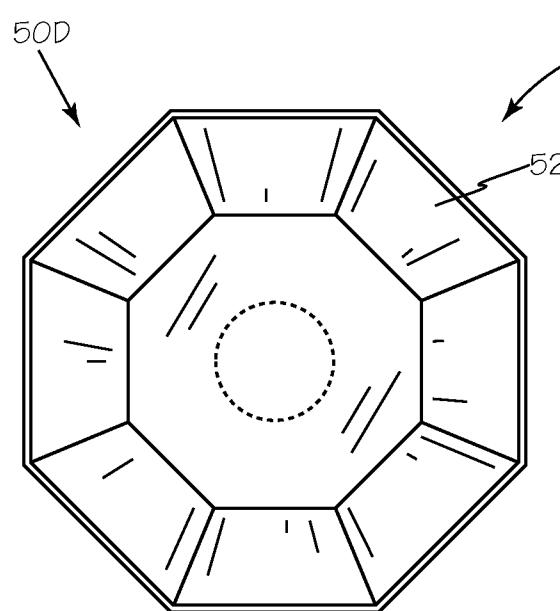
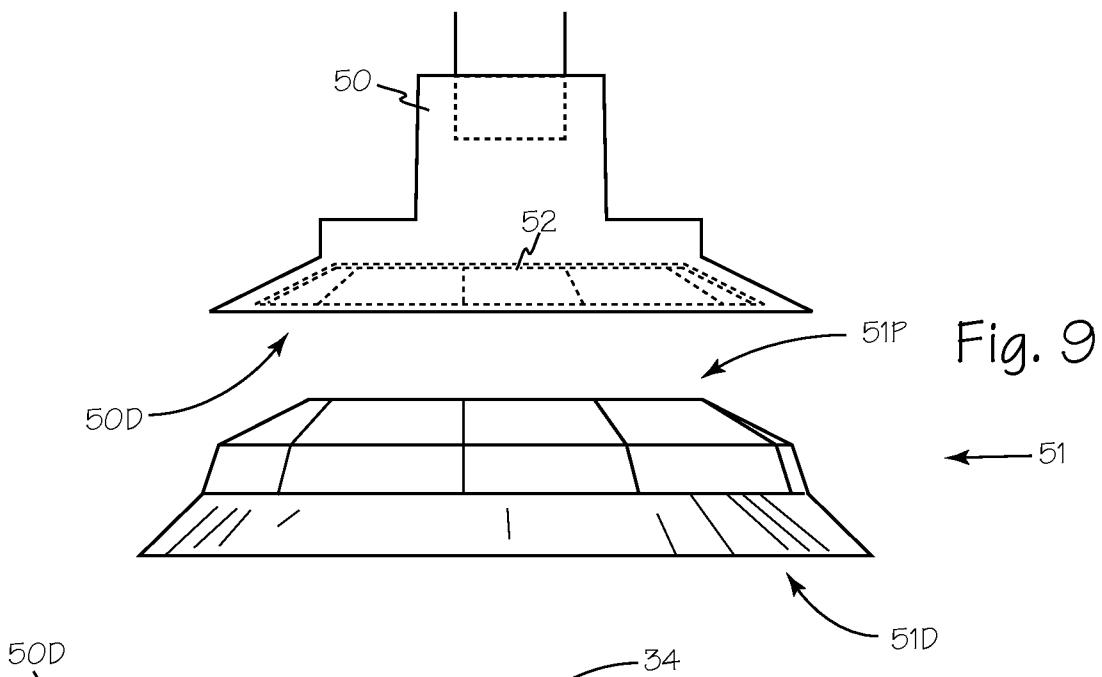
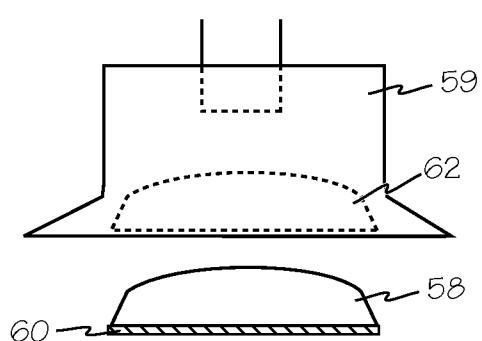
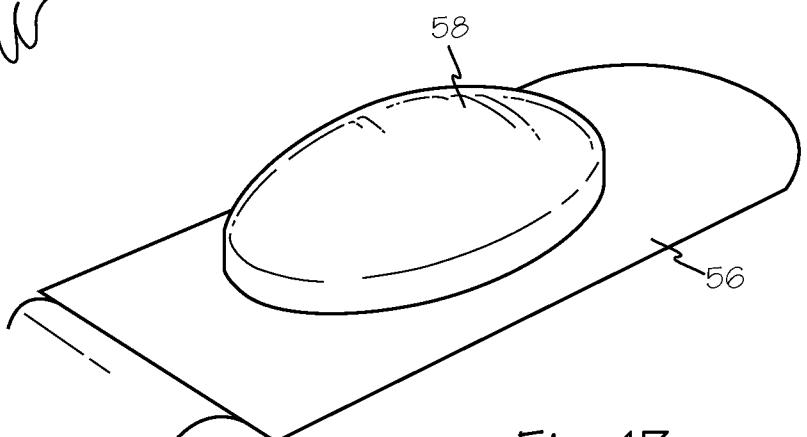
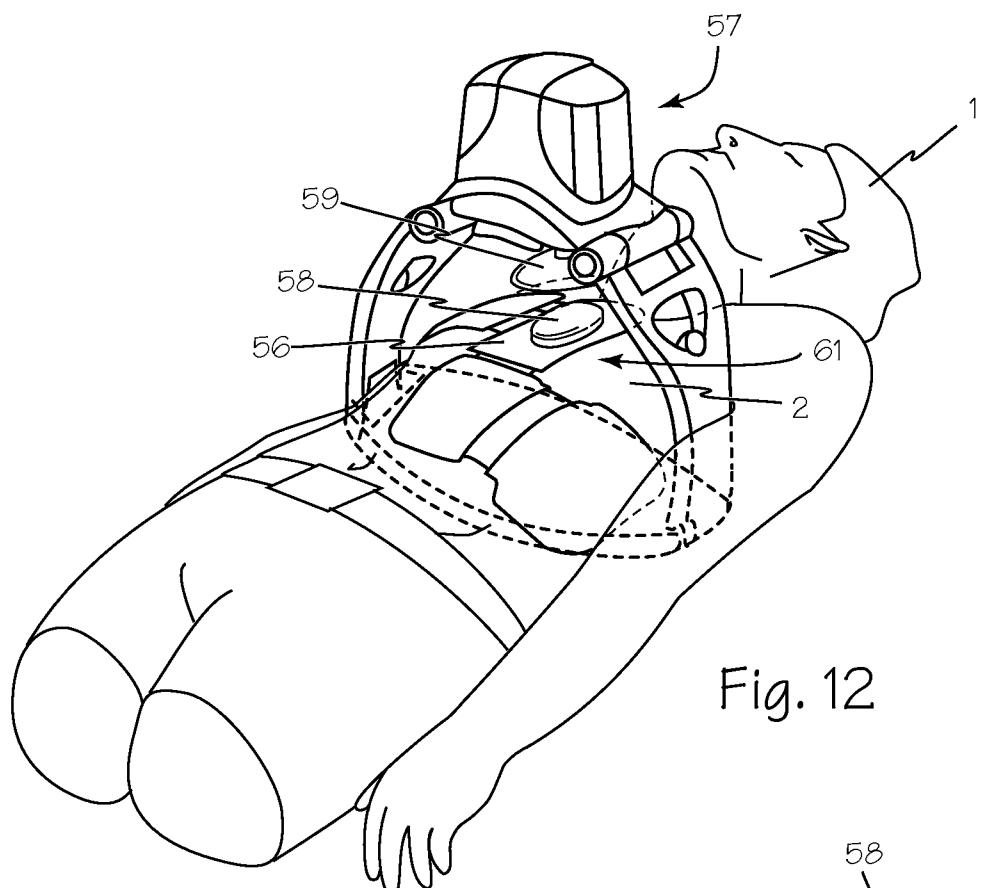


Fig. 8





INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/057509**A. CLASSIFICATION OF SUBJECT MATTER****A61H 31/00(2006.01)i, A62B 33/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61H 31/00; A62B 33/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords:chest, compression, electromotor, plunger, mounting structure, control unit, plunger adaptor, compression pad, monitor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010-0185127 A1 (NILSSON et al.) 22 July 2010 See abstract; paragraphs [0044], [0046], [0049]–[0051]; claim 1; and figures 1–5, 8–9.	1–7, 11–17
A		18–20
Y	US 2004-0116840 A1 (CANTRELL et al.) 17 June 2004 See abstract; paragraphs [0030]–[0031], [0035]–[0036], [0044]–[0045]; and figures 1–4.	1–7, 11–17
Y	US 2011-0201979 A1 (VOSS et al.) 18 August 2011 See abstract; paragraph [0042]; and figure 1.	5–7, 15–17
A	US 2010-0004571 A1 (NILSSON et al.) 7 January 2010 See abstract; paragraph [0045]; claims 21–22; and figure 1.	1–7, 11–20
A	US 7569021 B2 (SEBELIUS et al.) 4 August 2009 See abstract; column 7, lines 9–18, line 47 – column 8, line 11; and figures 6, 8.	1–7, 11–20

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 21 November 2013 (21.11.2013)	Date of mailing of the international search report 22 November 2013 (22.11.2013)
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	Authorized officer CHANG, Bong Ho Telephone No. +82-42-481-3353

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/US2013/057509**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: 8-10
because they relate to subject matter not required to be searched by this Authority, namely:
Claims 8-10 pertain to a method for treatment of the human body by therapy and thus relate to a subject matter which this ISA is not required to search, under Article 17(2)(a)(i) of the PCT and Rule 39.1(iv) of the Regulations under the PCT.
2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/057509

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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