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(54) CHEST DRAIN CONNECTOR

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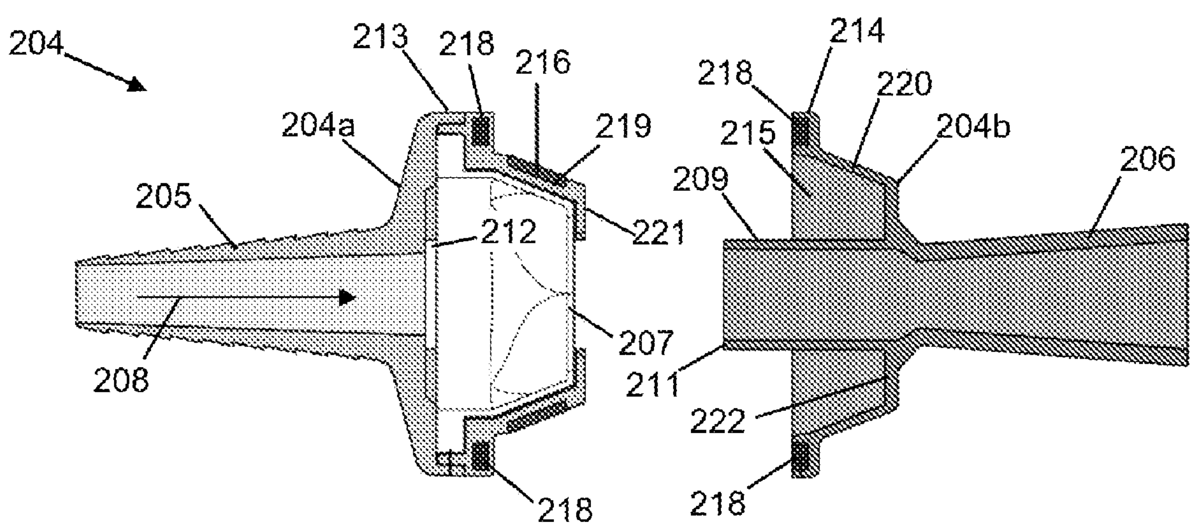
(57) **ABSTRACT**

A breakaway chest drain connector, which includes a first part having an inlet for connecting to an upstream portion of a chest drain tube, a one-way valve and a first flange surrounding the one-way valve; and a second part having an outlet for connecting to a downstream portion of the chest tube, a second flange and a hollow protrusion, the second flange surrounding the hollow protrusion. The second part is connectable to the first part by securing the first flange to the second flange such that the hollow protrusion passes through the one-way valve to form an uninterrupted fluid flow passage from the inlet through the hollow protrusion and the outlet along a longitudinal axis of the connector. The first and second flanges are separable by applying a longitudinal separation force above a defined threshold separation force.



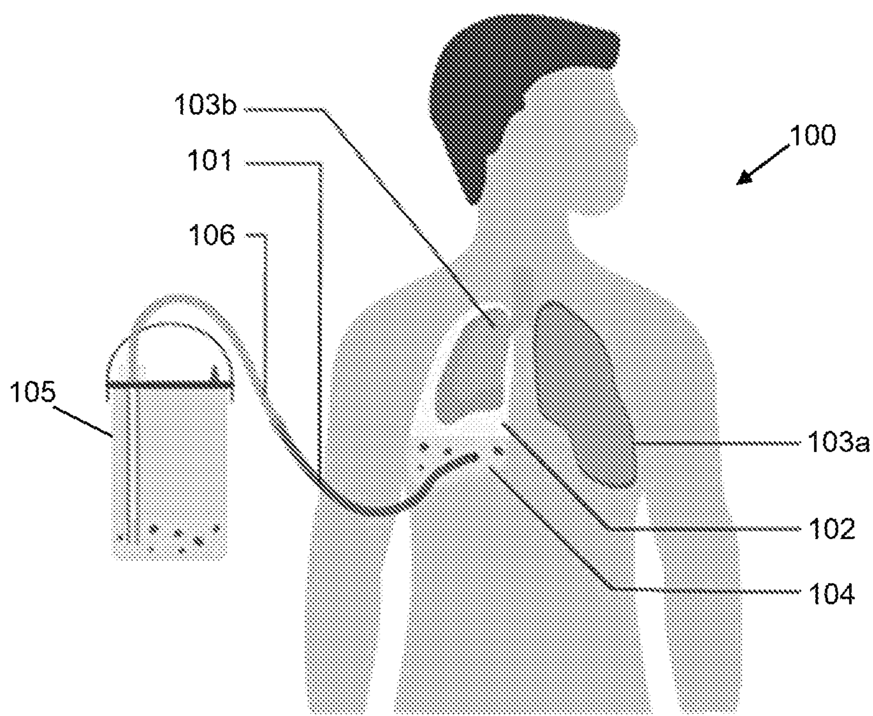


Fig. 1

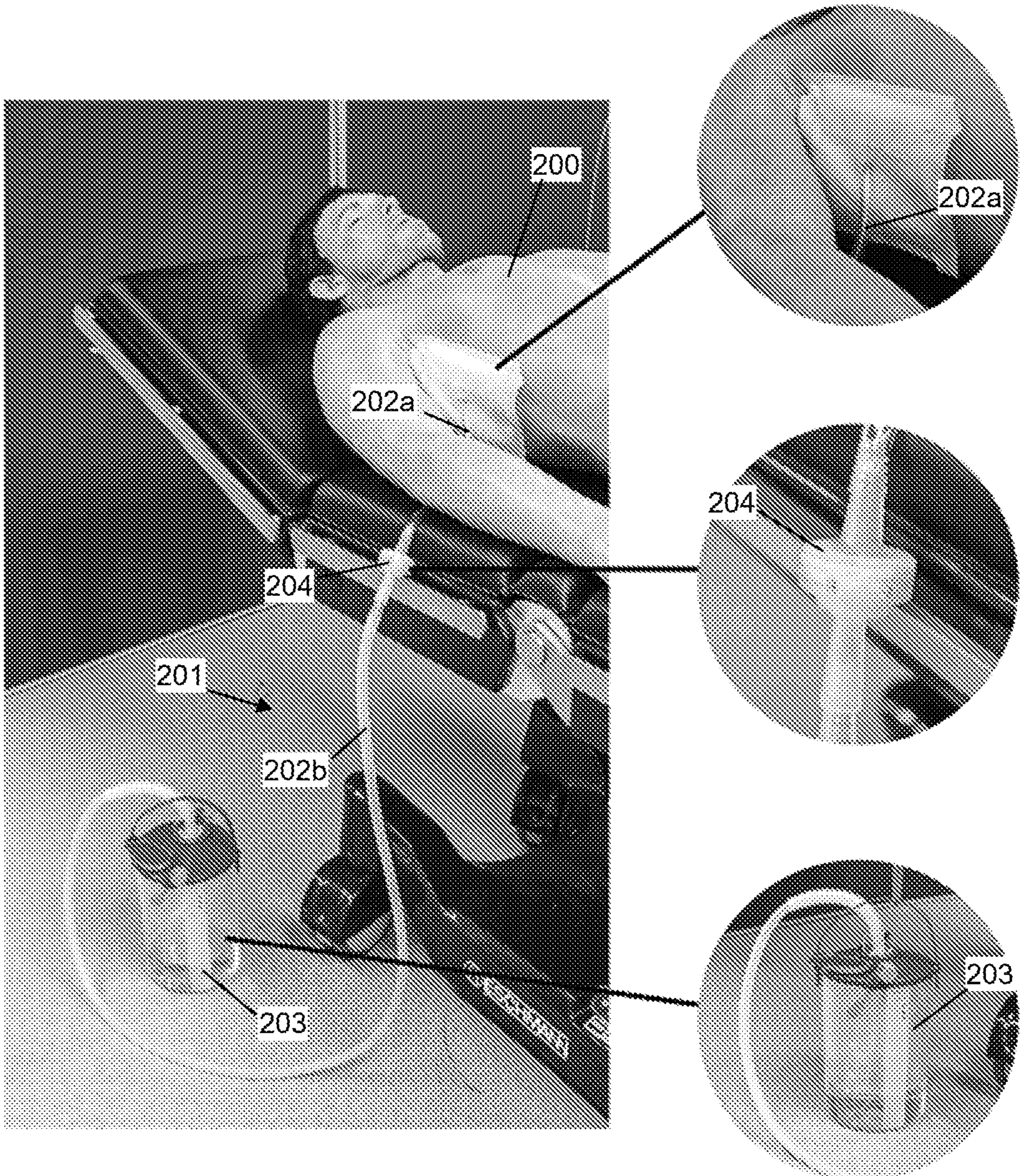


Fig. 2

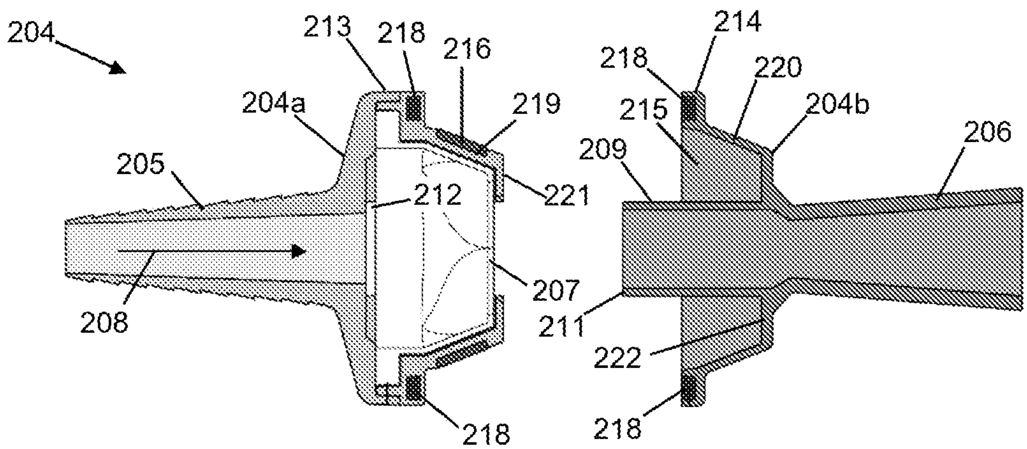
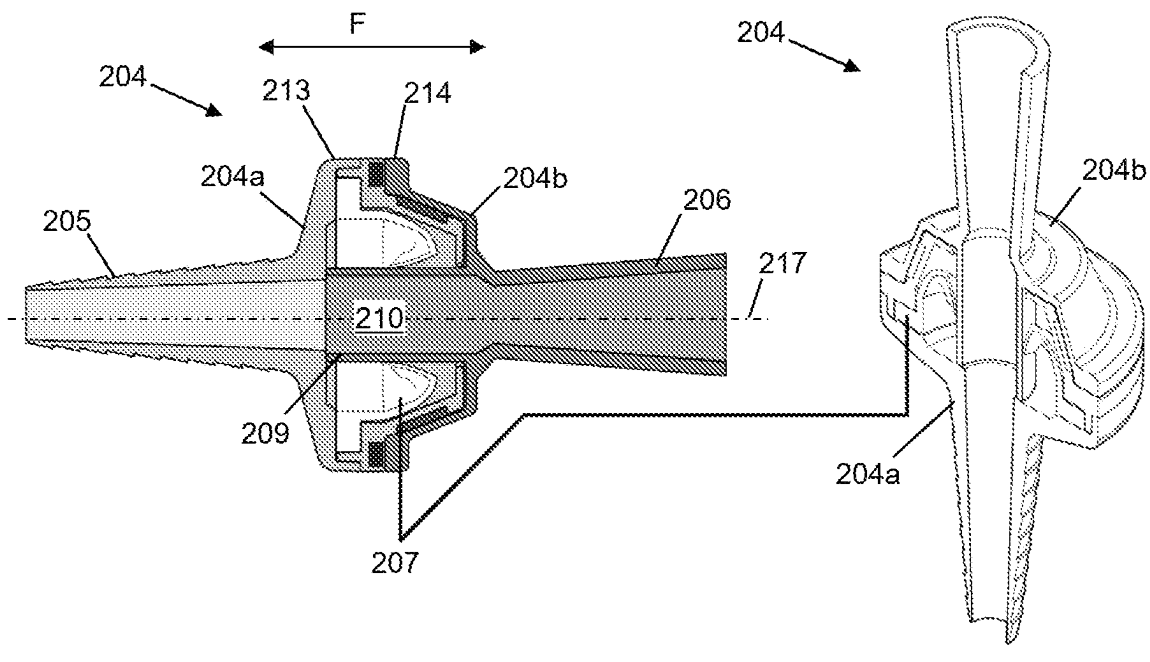

204
213
218
216
219
204a
205
212
221
208
207
218
214
218
220
215
204b
209
206
211
222
218

Fig. 3a


F
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213
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204a
204b
205
206
217
210
209
207
204
204b
204a

Fig. 3b

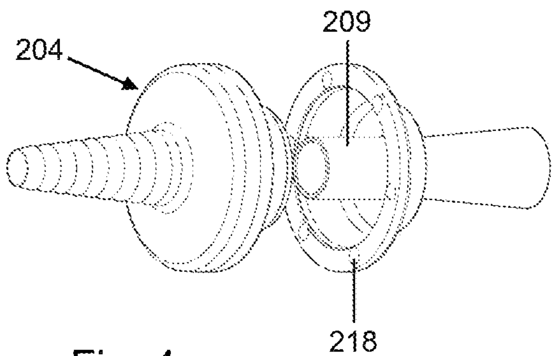


Fig. 4a

Valve Disconnected

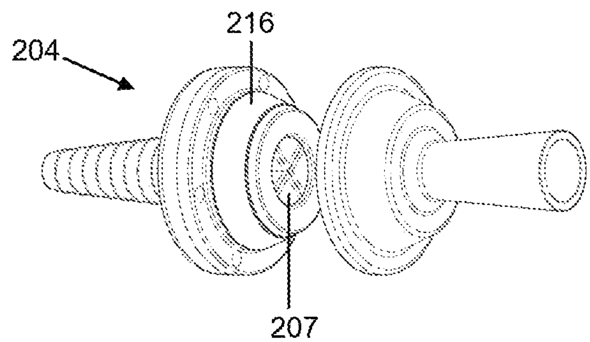
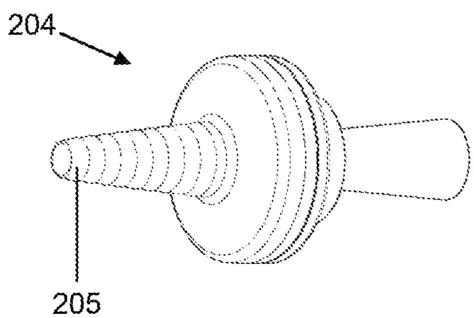


Fig. 4b



Valve Connected

Fig. 4c

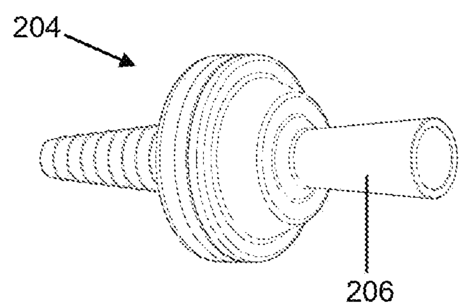


Fig. 4d

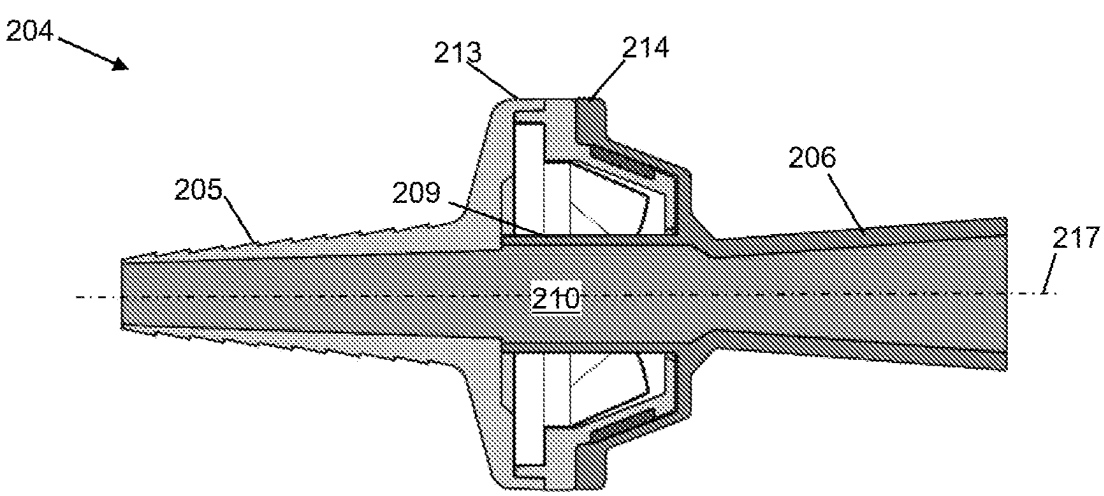


Fig. 5

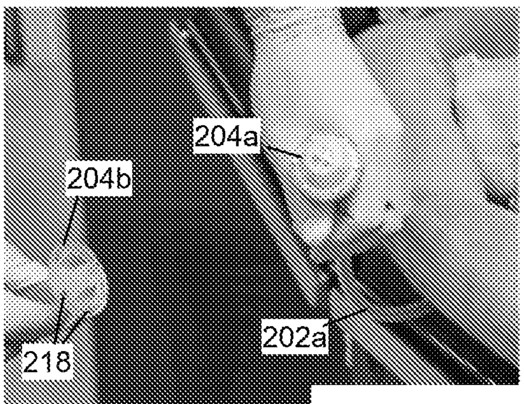


Fig. 6a

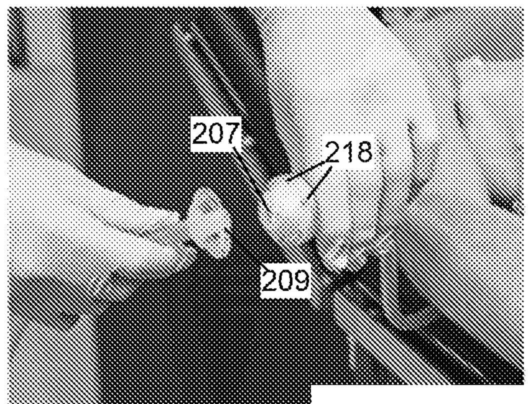


Fig. 6b

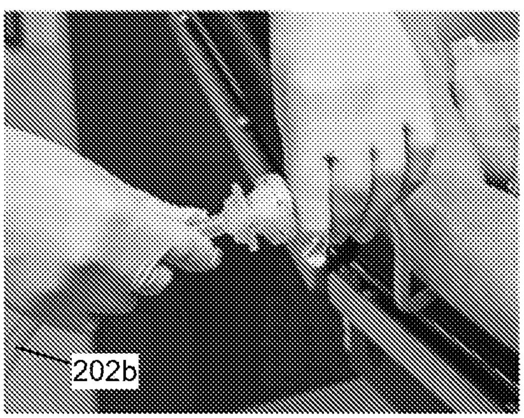


Fig. 6c

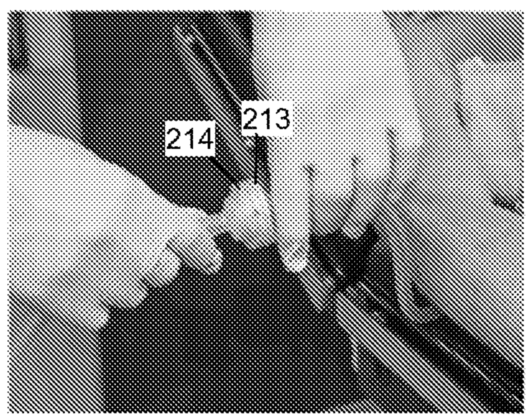


Fig. 6d

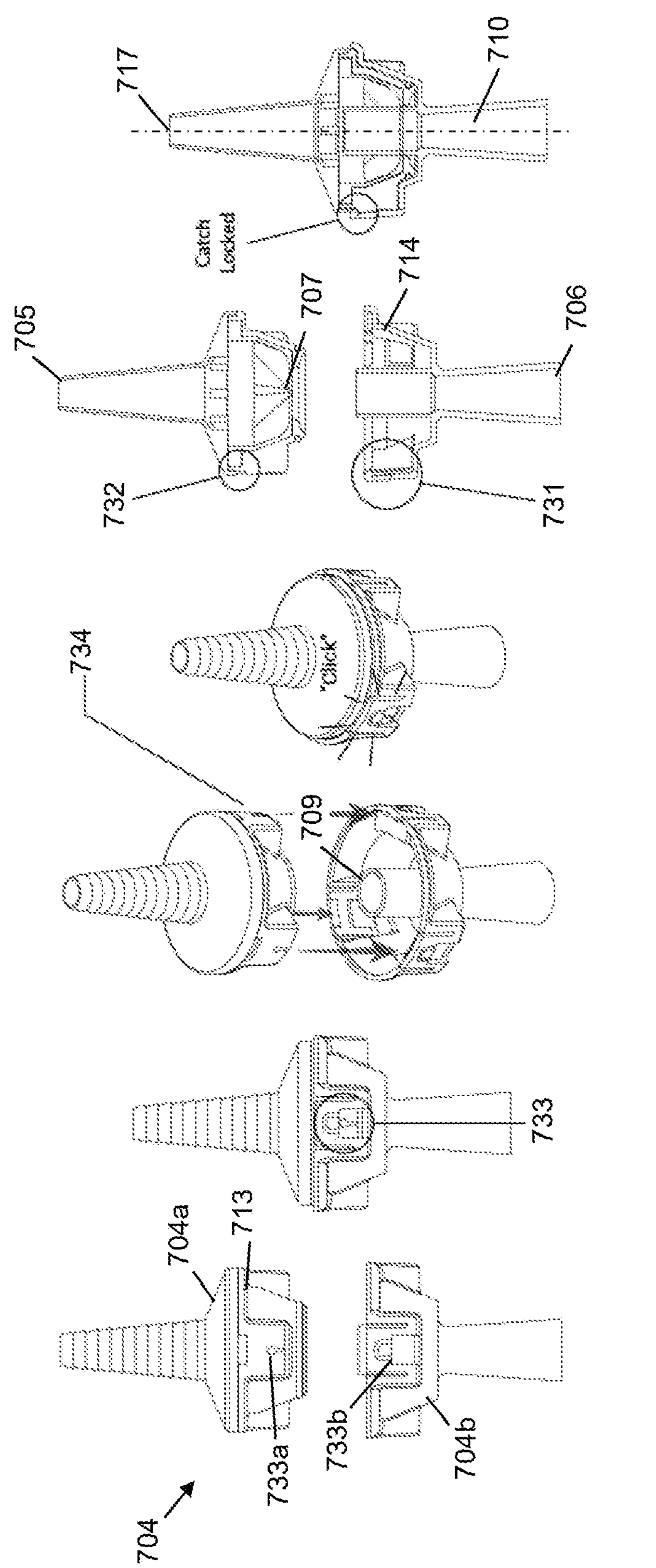


Fig. 7f

Fig. 7e

Fig. 7d

Fig. 7c

Fig. 7b

Fig. 7a

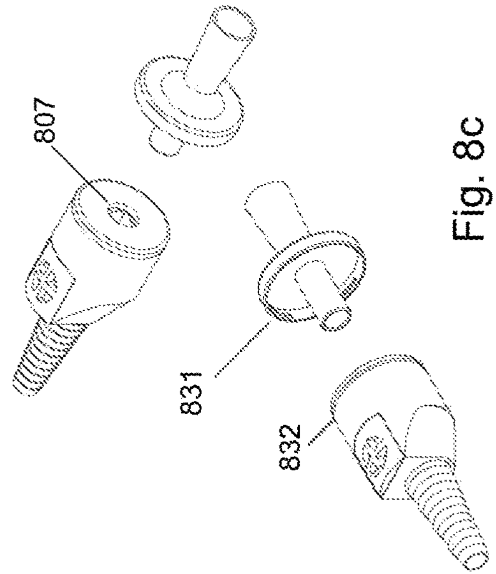


Fig. 8c

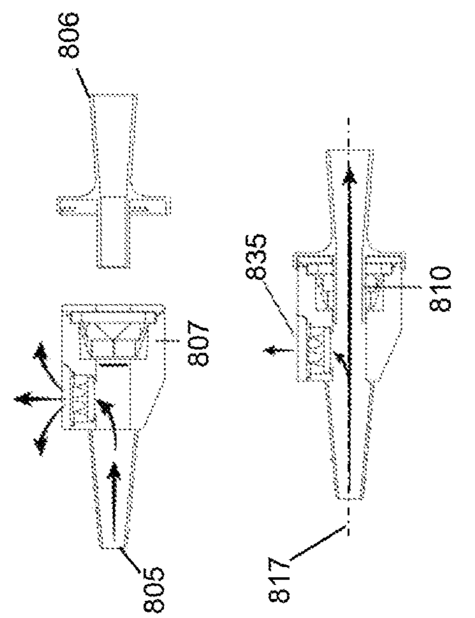


Fig. 8b

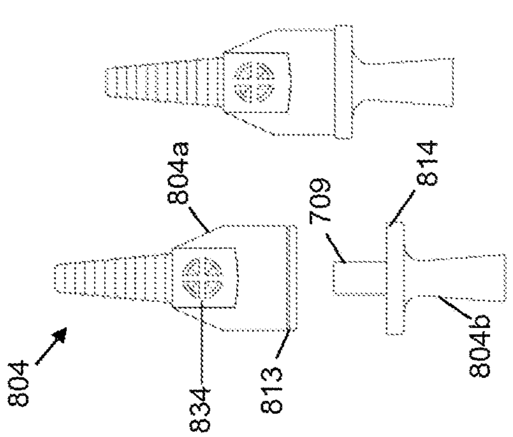


Fig. 8a

CHEST DRAIN CONNECTOR

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Application is a Section 371 National Stage Application of International Application No. PCT/GB2023/051851, filed Jul. 14, 2023, and published as WO 2024/013512 A1 on Jan. 18, 2024, in English, which claims priority to and the benefit of Great Britain Patent Application No. 2210372.5, filed Jul. 14, 2022, the contents of which are incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

[0002] The invention relates to a breakaway chest drain connector.

BACKGROUND

[0003] A chest drain, also known as a pleural or intercostal drain (ICD), is a medical tube inserted between the ribs into the space between the lung and internal chest wall (the pleural cavity).

[0004] Fluid, i.e. air and liquid, can leak into the space around the lung after infection or injury. This can be drained using a chest drain, allowing the lung to re-expand. It is estimated that world-wide over one million chest drains are inserted annually, with a minimum estimate of at least thirty thousand inserted within the UK each year.

[0005] Chest drains are usually held in place by being stitched to the chest skin. However, in some cases chest drains can be accidentally moved or pulled out, which can be painful for the patient as well as being dangerous due to the possibility of air re-entering the patient and collapsing the lung again, as well as an increased risk of infection. Whenever a chest drain is pulled out it must be replaced, resulting in more discomfort for the patient, after which the patient must have another X-ray to ensure that the chest tube is correctly located. This all results in additional burdens on the patient and on treatment time and costs.

[0006] Sutures can reduce the chance of the chest tube being pulled out, but there is still around a 7% chance of accidental removal. A balloon ICD may be used to more securely fasten the chest drain in the patient, but if dislodged this can result in a larger hole at the point of incision, requiring further repair and risk of adverse events. Portable chest drains may reduce the risk of removal, but tend to have smaller capacities and are not suitable for when a chest drain needs to be kept in for a prolonged period to drain large amounts of fluid.

[0007] Drain displacement affects both Seldinger chest drains (smaller, 12-14 French gauge drains inserted using a needle and guidewire system) as well as larger 24-32 French gauge drains that require a surgical incision for insertion of the tube. Regardless of the size used, most drains have a one-way valve incorporated into the collecting system. The most common system used is a bottle with a water trap, which allows fluid to drain from the chest whilst preventing air from re-entering. The bottle must be positioned lower than the patient's chest to allow gravity to drain the pleural cavity. This requires long tubing connecting the drain to the bottle, which can easily become caught and dislodged when moving a patient, resulting in the chest drain itself coming under tension.

SUMMARY

[0008] According to a first aspect there is provided a chest drain connector comprising:

[0009] a first part having an inlet for connecting to an upstream portion of a chest drain tube, a one-way valve and a first flange surrounding the one-way valve;

[0010] a second part having an outlet for connecting to a downstream portion of the chest tube, a second flange and a hollow protrusion, the second flange surrounding the hollow protrusion,

[0011] wherein the second part is connectable to the first part by securing the first flange to the second flange such that the hollow protrusion passes through the one-way valve to form an uninterrupted fluid flow passage from the inlet through the hollow protrusion and the outlet along a longitudinal axis of the connector, the first and second flanges being separable by applying a longitudinal separation force above a defined threshold separation force.

[0012] The connection between the first and second flanges creates a weak point along the chest drain tube so that, if the tubing becomes caught, for example while a patient is being moved, the chest drain separates safely by separating the first and second parts. Once the connector has broken away, the one-way valve operates to allow fluid to pass through the first part of the connector while preventing air from entering. The chest drain can then be simply reconnected to the drainage bottle to continue draining the pleural cavity.

[0013] With the first and second parts connected to each other, the hollow protrusion of the second part passes through and bypasses the one-way valve, allowing free flow of fluids through the connector. When the first and second parts are separated from each other, the one-way valve in the first part closes and allows fluids to pass through the first part in only one direction, i.e. from the first part to the second part and, when in use, away from the patient. The hollow protrusion of the second part, when the second part is disconnected from the first part, is partially shrouded by the second flange, thereby reducing the possibility of contamination when the first and second parts are disconnected and then reconnected.

[0014] The one-way valve may be in the form of a slit valve, for example a cross-slit valve.

[0015] The chest drain connector may comprise a gasket configured to provide a fluid seal between the first and second parts when connected.

[0016] The first part may comprise a conical portion surrounding the one-way valve and the second part a conical portion surrounding the hollow protrusion, an outer surface of the conical portion of the first part configured to seal against an inner surface of the conical portion of the second part. The, or a, gasket may be provided on the outer surface of the conical portion of the first part and/or on the inner surface of the conical portion of the second part. The, or a, gasket may alternatively be provided on an outer end face of the conical portion of the first part and/or an inner end face of the conical portion of the second part.

[0017] Securing the first flange to the second flange allows the first and second parts to be separated with a defined separation force. In some examples, the first and/or second flange may comprise one or more magnets such that the first and second flanges are magnetically connectable to each other. In some examples, one or both of the first and second flanges comprise a plurality of magnets arranged around a periphery of the flange. The use of magnets allows for the separation force to be designed such that the first and second parts separate from each other if a force above a predefined threshold is applied. The threshold separation force may for example be above around 5N, for example above around 10N or between around 5N and 20N. The separation force should be sufficiently high to maintain connection of the first and second parts during normal use but allow the first and second parts to become separated without risking the chest drain tube becoming dislodged from the patient. The plurality of magnets may for example be neodymium iron boride magnets, which may have a diameter of between around 1 and 3 mm. A 1 mm diameter N42 grade neodymium based magnet can, for example achieve a separation force of around 0.2N, while a 3 mm diameter magnet can achieve a separation force of around 2N. The choice of type, size and number of magnets used can therefore enable a defined separation force to be achieved. An array of six 3 mm diameter magnets around each of the first and second flanges may for example provide for a separation force of around 12N.

[0018] In other examples, the first and second flanges may be connectable to each other using one or more releasable catches configured to separate if a longitudinal separation force above the predefined threshold is applied between the first and second parts and configured to allow the first and second parts to be reconnectable. Such releasable and reconnectable catches may for example have the form of flexible protrusions extending from the first and/or second flanges that provide a push fit connection between the first and second parts. Separation of the first and second parts may be achieved by pulling apart the connector along the longitudinal axis and the parts can be reconnected by pushing the parts together. The separation force using such releasable catches may be designed by design of the flexible protrusions.

[0019] The one or more releasable catches may comprise a catch on one of the first and second parts and a corresponding slot on the other of the first and second parts.

[0020] An advantage of using either magnets or flexible releasable catches is that a definite connection between the first and second parts can be felt by the user as the parts are assembled together, with a definite click provided when pushing the parts together so that the user is confident that the parts are secured.

[0021] The inlet of the first part may be configured to connect to the upstream portion of the chest drain tube by securing the inlet within the upstream portion of the chest drain tube. An outer surface of the inlet may have a tapered barbed shape.

[0022] The outlet of the second part may have a tapered inner surface for connecting to an outer surface of the downstream portion of the chest drain tube, for example to a barbed connector on the downstream portion of the chest drain tube. The outlet may alternatively have an outer surface with a tapered barbed shape for securing the outlet within the downstream portion of the chest drain tube.

[0023] The first part may comprise a pressure relief valve configured to allow fluid to escape from the first part above a preset pressure when the first and second parts are disconnected from each other.

[0024] According to a second aspect, there is provided a chest drain kit, comprising:

- **[0025]** a fluid collection vessel;
- **[0026]** a chest drain tube having an upstream portion for securing to a patient and a downstream portion for securing to the fluid collection vessel; and
- **[0027]** a chest drain connector according to the first aspect.

[0028] According to a third aspect there is provided a method of assembling a chest drain kit, the method comprising:

- **[0029]** providing a chest drain kit according to the second aspect;
- **[0030]** connecting the first part of the chest drain connector to the upstream portion of the chest drain tube;
- **[0031]** connecting the second part of the chest drain connector to the downstream portion of the chest drain tube;
- **[0032]** connecting the downstream portion of the chest drain tube to the fluid collection vessel; and
- **[0033]** connecting the first and second parts of the chest drain connector together.

[0034] The method may further comprise separating the chest drain connector by applying a longitudinal separation force above the defined threshold separation force.

[0035] The method may further comprise securing the upstream portion of the chest drain tube to a patient to drain fluid from the patient's pleural cavity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] The invention is described in further detail below by way of example and with reference to the accompanying drawings, in which:

[0037] FIG. **1** is a schematic diagram of a chest drain tube attached to a patient;

[0038] FIG. **2** is a photograph of a dummy patient with an installed chest drain tube, showing detailed views of a breakaway chest drain tube connector, bottle and sutured connection to the patient;

[0039] FIGS. **3***a* and **3***b* are cross-sectional diagrams of an example breakaway chest drain tube connector with first and second parts separated and connected;

[0040] FIGS. **4***a*-**4***d* are drawings of an example breakaway chest drain tube connector from different perspectives;

[0041] FIG. **5** is a cross-sectional drawing of an example breakaway chest drain tube connector;

[0042] FIGS. **6***a*-*d* are photographs illustrating a method of assembling an example breakaway chest drain tube connector;

[0043] FIGS. **7***a*-**7***f* are drawings of an alternative breakaway chest drain tube connector having a mechanical connection; and

[0044] FIGS. **8***a*-**8***c* are drawings of a further alternative breakaway chest drain tube connector having a pressure relief valve.

DETAILED DESCRIPTION

[0045] FIG. **1** illustrates a patient **100** with a chest tube **101** inserted into the pleural cavity **102** of one of the patient's lungs **103***a*, **103***b*, the lung **103***b* having collapsed. Fluid including air and liquid **104** is collecting in the pleural cavity **102** and needs to be drained. The chest tube **101** is secured to the patient **100** and extends into the pleural cavity **102** to enable the fluid to be drained through the tube **102** and into a collection vessel **105** via a collection tube **106**. As described in the background section above, a problem with this arrangement is that the chest tube **101** can become dislodged from the patient **100** if the patient is moved or rolls over, requiring the tube **101** to be reattached and creating injury as well as a risk of infection.

[0046] FIG. **2** is a photograph of a dummy patient **200** with an example chest drain assembly **201** attached. The chest drain assembly **201** comprises a chest drain tube having an upstream portion **202***a* and a downstream portion **202***b*, the downstream portion **202***b* attached to a fluid collection vessel **203** and the upstream portion **202***a* sutured to the patient **200** and passing into the patient's pleural cavity. A breakaway chest drain connector **204** connects the upstream and downstream portions **202***a*, **202***b* of the chest drain tube. Detailed views of the upstream portion **202***a*, connector **204** and collection vessel **203** are shown alongside the main photograph. The chest drain assembly **201** may be provided as a chest drain kit, with the upstream and downstream portions **202***a*, **202***b* of the chest tube provided with the collection vessel **203** and a chest drain connector **204**.

[0047] FIG. **3** illustrates cross-sectional views of the example breakaway chest drain connector **204**, with the connector **204** shown separated in FIG. **3***a* and connected in FIG. **3***b*. The connector **204** comprises a first part **204***a* and a second part **204***b*. The first part **204***a* has an inlet **205** for connection to the upstream portion **202***a* of the chest drain tube. The second part **204***b* has an outlet **206** for connection to the downstream portion **202***b* of the chest drain tube. A one-way valve **207** in the first part **204***a* allows fluid to flow through the first part **204***a* in a downstream direction **208** when the first and second parts **204***a*, **204***b* are separated. A hollow protrusion **209** in the second part **204***b* is configured to pass through the one-way valve **207** when the first and second parts **204***a*, **204***b* are connected, as shown in FIG. **3***b*, thereby bypassing the one-way valve **207** and forming an uninterrupted flow passage **210** from the inlet **205** through the hollow protrusion **209** and the outlet **206** along a longitudinal axis **217** of the connector **204**. As illustrated in FIG. **3***b*, the one-way valve **207** is inverted by the hollow protrusion **209** when the first and second parts **204***a*, **204***b* of the connector are connected together. The one-way valve **207** therefore needs to be sufficiently flexible to invert, requiring the one-way valve **207** to be made from a flexible material such as a silicone rubber. As more clearly illustrated in FIG. **4***b*, the one-way valve **207** may be a cross-slit valve, i.e. with two transverse slits across the face of the valve **207**. This arrangement allows the valve to be more easily opened compared to a single slit valve, providing less resistance to the hollow protrusion **209** of the second part **204***b* being inserted when the connector is assembled.

[0048] With the first and second parts **204***a*, **204***b* connected, an upstream end **211** of the hollow protrusion **209** seals against a downstream end **212** of the inlet **205** to form the uninterrupted flow passage **210**. When connected to the upstream and downstream parts **202***a*, **202***b* of the chest tube, the connector **204** thereby provides little or no restriction to fluid flow between the patient at one end of the chest tube and the collection vessel at the other end, with the collection vessel providing a non-return valve, typically with a water trap as described above. However, when the connector **204** is separated, the one-way valve **207** closes so that the first part **204***a* prevents fluid (particularly air) from flowing upstream towards the patient but still allowing fluid to flow downstream through the first part **204***a* while the second part **204***b* is disconnected.

[0049] The first part **204***a* comprises a first flange **213** surrounding the one-way valve **207** and the second part **204***b* comprises a second flange **214** surrounding the hollow protrusion **209**. The first and second flanges **213**, **214** are arranged to secure the first and second parts **204***a*, **204***b* to each other when the connector **204** is connected, as shown in FIG. **3***b*. The second flange **214** defines a cavity **215** within which the one-way valve **207** is contained when the first and second parts **204***a*, **204***b* are connected. The first part **204***a* comprises a gasket **216** between the one-way valve **207** and the first flange **213**, which secures the one-way valve **207** to the first part **204***a* and provides a fluid seal around the one-way valve **207** when the first and second parts **204***a*, **204***b* are connected. In alternative examples a gasket may be provided on the second part **204***b* or may be provided on both parts **204***a*, **204***b*. In the illustrated example of FIGS. **3***a* and **3***b*, the gasket **216** is provided on an outer surface of a conical portion **219** of the first part **204***a* surrounding the one-way valve **207**. An inner surface of a corresponding conical portion **220** of the second part **204***b* is configured to seal against the outer surface of the conical portion **219** of the first part, with the gasket **216** providing a fluid seal between the parts **204***a*, **204***b*. In alternative examples, a gasket may be provided on the inner surface of the conical portion **220** of the second part. The conical portions **219**, **220** serve to allow the parts **204***a*, **204***b* to be more easily connected together, ensuring that the connection aligns the longitudinal axis **217** of the parts when connected. The conical portion **220** of the second part also serves to partially shroud the hollow protrusion **209** when the parts **204***a*, **204***b* are disconnected, reducing the possibility of contamination.

[0050] A gasket may also or alternatively be provided on an outer end face **221** of the conical portion **219** of the first part **204***a* and/or on an inner end face **222** of the conical portion **220** of the second part **204***b* to provide a fluid seal between the first and second parts **204***a*, **204***b* when the parts are connected.

[0051] An advantage of the second flange **214** surrounding the hollow protrusion **209** is that the hollow protrusion **209** is partially shrouded by the second flange **214** when the second part **204***b* is disconnected. This reduces the risk of contamination of the fluid passage through the second part **204***b* when the parts are disconnected.

[0052] With the first and second parts **204***a*, **204***b* connected, the first and second flanges **213**, **214** are secured together to maintain the connector **204** in the configuration shown in FIG. **3***b*, allowing free flow of fluid from the patient through the connector **204**. The connector **204** can be separated if a separation force F is applied along the longitudinal axis **217** of the connector **204** that is sufficient to break the connection between the flanges **213**, **214**, i.e. is above a defined threshold separation force.

[0053] The threshold separation force keeping the parts **204***a*, **204***b* together may be provided by a magnetic attraction between the first and second parts **204***a*, **204***b*. One or more magnets **218** on the first and/or second parts **204***a*, **204***b* may be provided to secure the first and second flanges **213**, **214** together. In some arrangements, magnets **218** may be provided in both parts **204***a*, **204***b*, with the magnets **218** being oriented to attract each other, i.e. with opposing poles facing each other upon bringing the flanges **213**, **214**

together. In other arrangements, one of the flanges **213**, **214** may comprise one or more magnets while the other flange comprises one or more corresponding ferritic portions. To increase the separation force while minimising weight and volume of the parts, multiple high strength magnets, such as neodymium iron boride magnets, may be used on each part **204***a*, **204***b*. In a particular example, multiple magnets provided on each part **204***a*, **204***b* together provide an attraction requiring a separation force of greater than around 10N. Other examples may require a different separation force threshold, for example greater than around 5N or between around 5N and 20N, which can be adjusted by adjusting the number and strength of magnets provided on each part **204***a*, **204***b*. The magnets **218** may be encased in plastic or embedded within the flange **213**, **214** to secure and shield the magnets.

[0054] In alternative examples, a threshold separation force may be achieved by securing the parts **204***a*, **204***b* together mechanically rather than magnetically. This may, for example, be achieved using one or more releasable catches that are configured to separate if a longitudinal separation force above a defined threshold force is applied. An advantage of using magnetic attraction, however, is that the threshold separation force can be reliably repeatable and the surfaces of the parts **204***a*, **204***b* are simpler to keep clean with less scope for contaminants.

[0055] The inlet **205** of the connector **204** as shown in FIGS. **3** and **4**, has an outer surface that has a tapered barbed shape, also known as a 'christmas tree' coupling, which enables the inlet **205** to be secured within the upstream portion of the chest drain tube. The outlet **206** of the connector **204** shown in FIGS. **3** and **4** has a tapered inner surface that enables an outer surface of the downstream portion of the chest drain tube to be secured within the outlet **206**. The outlet **206** may have an inverted 'christmas tree' form, i.e. with an inverse tapered barbed shape to that of the inlet **205**. Other alternative arrangements for the inlet **205** and outlet **206** may be provided for connection to the upstream and downstream portions of the chest drain tube.

[0056] FIG. **5** illustrates the chest drain connector **204** with the first and second parts **204***a*, **204***b* connected, forming an interrupted fluid flown channel **210** along a longitudinal axis from the inlet **205** through the hollow protrusion **209** and the outlet **206**. The first and second flanges **213**, **214** are connected together such that the hollow protrusion **209** passes through the one-way valve to form the uninterrupted flow passage **210**.

[0057] FIGS. **6***a-d* are a series of photographs illustrating a connector **204** being assembled from first and second parts **204***a*, **204***b*, either during installation of a chest drain kit or after disconnection of the connector **204** following movement of the patient. The first part **204***a* is connected to the upstream portion **202***a* of the chest drain tube and the second part **204***b* is connected to the downstream portion **202***b* of the chest drain tube. In FIG. **6***a* the parts **204***a*, **204***b* are separated from one another ready to be assembled. In FIGS. **6***b* the parts **204***a*, **204***b* are brought together and in FIG. **6***c* the hollow protrusion **209** of the second part is pushed though the one-way valve **207** of the first part until, in FIG. **6***d*, the parts **204***a*, **204***b* are brought into contact as the flanges **213**, **214** connect together, in this case using a corresponding plurality of magnets **218** around the periphery of each flange **213**, **214**. The chest drain is then ready for use, or continued use, with the connector **204** providing an uninterrupted flow passage from the upstream portion **202***a* to the downstream portion **202***b* through to a chest drain collection vessel connected to the end of the downstream portion **202***b*.

[0058] FIGS. **7***a* to **7***f* illustrate in a series of drawings an alternative example of a breakaway chest drain connector **704** having a first (or female) part **704***a* and a second (or male) part **704***b*. FIGS. **7***a* and **7***b* illustrate a front view of the connector **704**, with the first and second parts disconnected in FIG. **7***a* and connected in FIG. **7***b*. FIGS. **7***c* and **7***d* illustrate a **3/4** view of the connector **704**, with the first and second parts disconnected in FIG. **7***c* and connected in FIG. **7***d*. FIGS. **7***e* and **7***f* illustrate a section view of the connector **704**, with the first and second parts disconnected in FIG. **7***e* and connected in FIG. **7***f*.

[0059] As with the connector **204** described above, the first part **704***a* comprises an inlet **705** for connecting to an upstream portion of a chest drain tube, a one-way valve **707** and a first flange **713** surrounding the one-way valve **707**. The second part **704***b* comprises an outlet **706** for connecting to a downstream portion of the chest drain tube, a second flange **714** and a hollow protrusion **709**, the second flange **714** surrounding the hollow protrusion **709**. The second part **704***b* is connectable to the first part **704***a* by securing the first flange **713** to the second flange **714** such that the hollow protrusion **709** passes through the one-way valve **707** to form an uninterrupted fluid flow passage **710** from the inlet **705** through the hollow protrusion **709** and the outlet **706** along a longitudinal axis **717** of the connector **704**. The first and second flanges **713**, **714** are separable by applying a longitudinal separation force above a defined threshold separation force. In this example, the first and second flanges **713**, **714** are connectable to each other using one or more releasable catches configured to separate on applying a longitudinal separation force above the predefined separation force. In the illustrated example, a catch **731** is provided on the second part **704***b* that engages with a corresponding slot **732** in the first part **704***a*. The arrangement may be reversed, i.e. with the catch **731** on the first part **704***a* and the slot **732** in the second part. One or more guides **734** may also be provided to ensure that the first and second parts **704***a*, **704***b* align correctly.

[0060] As indicated in FIG. **7***d*, when the first and second parts **704***a*, **704***b* are engaged with each other, the catch **731** engages with the slot **732** to form a mechanical latch holding the parts together. When connected, the catch and slot engage with a click, assuring the user that the connector parts are properly engaged. This may be achieved using one or more live hinges, i.e. polymer parts that are configured to flex as the parts are engaged with each other to achieve the required mechanical latching effect.

[0061] A visual indicator **733** may be provided to indicate when the parts **704***a*, **704***b* are properly engaged with each other. In the example shown in FIGS. **7***a* and **7***b*, the visual indicator **733** is in the form of a representation of a padlock **733***b* on the second part **704***b*, to which a keyhole **733***a* is included once the first part **704***a* is properly engaged with the second part **704***b*. Other two-part representations may be provided that, when engaged together, provide a visual indicator that the parts are correctly engaged with each other. In a general aspect therefore, the first part **704***a* comprises a first portion **733***a* of a visual representation **733** and the second part **704***b* comprises a second portion **733***b* of the visual representation **733**, the visual representation **733** being assembled when the first and second parts are connected to each other.

[0062] FIGS. **8***a* to **8***c* illustrate in a series of drawings a further alternative example of a breakaway chest drain connector **804** having a first (or female) part **804***a* and a second (or male) part **804***b*. FIG. **8***a* illustrates a front view of the connector **804**, with the first and second parts connected and disconnected. FIG. **8***b* illustrates a sectional view of the connector **804** with the first and second parts connected and disconnected. FIG. **8***c* illustrate a perspective view of the connector **804**, with the first and second parts connected and disconnected.

[0063] As with the connectors **204** and **704** described above, the first part **804***a* comprises an inlet **805** for connecting to an upstream portion of a chest drain tube, a one-way valve **807** and a first flange **813** surrounding the one-way valve **807**. The second part **804***b* comprises an outlet **806** for connecting to a downstream portion of the chest tube, a second flange **814** and a hollow protrusion **809**, the second flange **814** surrounding the hollow protrusion **809**. The second part **804***b* is connectable to the first part **804***a* by securing the first flange **813** to the second flange **814** such that the hollow protrusion **809** passes through the one-way valve **807** to form an uninterrupted fluid flow passage **810** from the inlet **805** through the hollow protrusion **809** and the outlet **806** along a longitudinal axis **817** of the connector **804**. The first and second flanges **813**, **814** are separable by applying a longitudinal separation force above a defined threshold separation force.

[0064] In this example, the first and second flanges **813**, **814** are connectable to each other using one or more releasable catches configured to separate on applying a longitudinal separation force above the predefined separation force. In the illustrated example, a catch **831** is provided on the second part **804***b* that engages with a corresponding slot or groove **832** in the first part **804***a*. The arrangement may be reversed, i.e. with the catch **831** on the first part **804***a* and the groove **832** in the second part. In this example, the relative rotational alignment of the first and second parts **804***a*, **804***b* is not relevant, so there is no need for a guide to ensure correct engagement of the first and second parts **804***a*, **804***b*.

[0065] When the first and second parts **804***a*, **804***b* are engaged with each other, the catch **831** engages with the groove **832** to form a mechanical latch holding the parts together. When connected, the catch **831** and slot **832** engage with a click, assuring the user that the connector parts **804***a*, **804***b* are properly engaged. This may be achieved through flexibility of the flange **814** on the second part **804***b*.

[0066] The connector **804** further comprises a pressure relief valve **834** in the first part **804***a*, which is a one-way valve that is configured to allow fluid to escape from the first part **804***a* above a preset pressure when the first and second parts **804***a*, **804***b* are disconnected from each other, as shown in FIG. **8***b*. This allows discharge of fluid from the first part **804***a* under pressure when the parts are disconnected, preventing an excessive pressure build-up. The pressure relief valve **834** is provided on a side of the first part **804***a* to not interfere with the flow passage **810** when the parts **804***a*, **804***b* are connected together. The pressure relieve valve **834** may also allow for discharge **835** from the connector **804** when the first and second parts **804***a*, **804***b* are connected to each other if the pressure in the flow passage **810** exceeds the preset pressure.

[0067] Other embodiments are intentionally within the scope of the invention, which is defined by the appended claims.

1. A chest drain connector comprising:

a first part having an inlet for connecting to an upstream portion of a chest drain tube, a one-way valve and a first flange surrounding the one-way valve;

a second part having an outlet for connecting to a downstream portion of the chest tube, a second flange and a hollow protrusion, the second flange surrounding the hollow protrusion,

wherein the second part is connectable to the first part by securing the first flange to the second flange such that the hollow protrusion passes through the one-way valve to form an uninterrupted fluid flow passage from the inlet through the hollow protrusion and the outlet along a longitudinal axis of the connector, the first and second flanges being separable by applying a longitudinal separation force above a defined threshold separation force,

wherein the one-way valve is a cross-slit valve that allows fluid to flow through the first part in a downstream direction while preventing air from entering the first part when the first and second parts are separated and is inverted by the hollow protrusion when the first and second parts of the connector are connected together.

2. (canceled)

3. (canceled)

4. The chest drain connector of claim **1** comprising a gasket configured to provide a fluid seal between the first and second parts when connected.

5. The chest drain connector of claim **4**, wherein the first part comprises a conical portion surrounding the one-way valve and the second part comprises a conical portion surrounding the hollow protrusion, an outer surface of the conical portion of the first part configured to seal against an inner surface of the conical portion of the second part.

6. The chest drain connector of claim **5**, wherein the gasket of provided on the outer surface of the conical portion of the first part and/or on the inner surface of the conical portion of the second part.

7. The chest drain connector of claim **5**, wherein the gasket is provided on an outer end face of the conical portion of the first part and/or an inner end face of the conical portion of the second part.

8. The chest drain connector of claim **1**, wherein an upstream end of the hollow protrusion seals against a downstream end of the inlet to provide the uninterrupted fluid flow passage when the first and second parts are connected.

9. The chest drain connector of claim **1** wherein the first and second flange comprises one or more magnets such that the first and second flanges are magnetically connectable to each other.

10. The chest drain connector of claim **9** wherein the first and second parts comprise a plurality of magnets arranged around a periphery of the flange.

11. The chest drain connector of claim **9**, wherein the one or more magnets are neodymium iron boride magnets.

12. The chest drain connector of claim **1** wherein the first and second flanges are connectable to each other using one or more releasable catches configured to separate on applying a longitudinal separation force above the predefined threshold separation force.

13. The chest drain connector of claim **12**, wherein the one or more releasable catches comprises a catch on one of the first and second parts and a corresponding slot on the other of the first and second parts.

14. The chest drain connector of claim **1**, wherein the threshold separation force is above 5N.

15. The chest drain connector of claim **14**, wherein the threshold separation force is between 5N and 20N.

16. (canceled)

17. The chest drain connector of claim **1** wherein an outer surface of the inlet has a tapered barbed shape.

18. The chest drain connector of claim **1**, wherein the outlet has a tapered inner surface for connecting to an outer surface of the downstream portion of the chest drain tube.

19. The chest drain connector of claim **1**, wherein the outlet has an outer surface with a tapered barbed shape for securing the outlet within the downstream portion of the chest drain tube.

20.

21. A chest drain kit, comprising:

a fluid collection vessel;

a chest drain tube having an upstream portion for securing to a patient and a downstream portion for securing to the fluid collection vessel; and

a chest drain connector comprising:

a first part having an inlet for connecting to an upstream portion of a chest drain tube, a one-way valve and a first flange surrounding the one-way valve;

a second part having an outlet for connecting to a downstream portion of the chest tube, a second flange and a hollow protrusion, the second flange surrounding the hollow protrusion,

wherein the second part is connectable to the first part by securing the first flange to the second flange such that the hollow protrusion passes through the one-way valve to form an uninterrupted fluid flow passage from the inlet through the hollow protrusion and the outlet along a longitudinal axis of the connector, the first and second flanges being separable by applying a longitudinal separation force above a defined threshold separation force,

wherein the one-way valve is a cross-slit valve that allows fluid to flow through the first part in a downstream direction while preventing air from entering the first part when the first and second parts are separated and is inverted by the hollow protrusion when the first and second parts of the connector are connected together.

22. A method of assembling a chest drain kit, the method comprising:

providing a chest drain kit comprising:

a fluid collection vessel;

a chest drain tube having an upstream portion for securing to a patient and a downstream portion for securing to the fluid collection vessel; and

a chest drain connector comprising:

a first part having an inlet for connecting to an upstream portion of a chest drain tube, a one-way valve and a first flange surrounding the one-way valve;

a second part having an outlet for connecting to a downstream portion of the chest tube, a second flange and a hollow protrusion, the second flange surrounding the hollow protrusion,

wherein the second part is connectable to the first part by securing the first flange to the second flange such that the hollow protrusion passes through the one-way valve to form an uninterrupted fluid flow passage from the inlet through the hollow protrusion and the outlet along a longitudinal axis of the connector, the first and second flanges being separable by applying a longitudinal separation force above a defined threshold separation force,

wherein the one-way valve is a cross-slit valve that allows fluid to flow through the first part in a downstream direction while preventing air from entering the first part when the first and second parts are separated and is inverted by the hollow protrusion when the first and second parts of the connector are connected together;

connecting the first part of the chest drain connector to the upstream portion of the chest drain tube;

connecting the second part of the chest drain connector to the downstream portion of the chest drain tube;

connecting the downstream portion of the chest drain tube to the fluid collection vessel; and

connecting the first and second parts of the chest drain connector together.

23. The method of claim **22**, further comprising separating the chest drain connector by applying a longitudinal separation force above the defined threshold separation force.

24. The method of claim **22**, further comprising securing the upstream portion of the chest drain tube to a patient to drain fluid from the patient's pleural cavity.

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