United States Patent [19]

Spielberg

[11] **3,859,989**

[45] **Jan. 14, 1975**

[54] **THERAPEUTIC CUFF**

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[21] Appl. No.: **332,703**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 321,313, Jan. 5, 1973, abandoned.

[52] **U.S. Cl.** ..... **128/24 R,** 128/64

[51] **Int. Cl.** **A61h 1/00**

[58] **Field of Search** ..... 128/24 R, DIG. 20, 60, 128/64, 297, 299, 38–40

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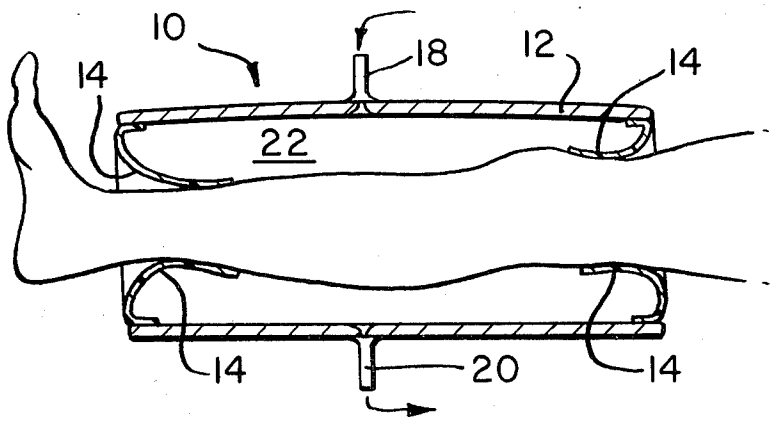
Primary Examiner—Lawrence W. Trapp
Attorney, Agent, or Firm—Cesari & McKenna

[57] **ABSTRACT**

A pressure cuff for medical therapeutic purposes is formed from a single walled, fluid impervious casing which is sealed to the body of a patient by one or more flexible, body-conforming, adherent flaps of thin film sheet material. Valves in the casing provide direct access to the body portion to be treated and allow maintenance of a controlled atmosphere around the body portion. A modification allows the use of both positive and negative pressures.

12 Claims, 20 Drawing Figures



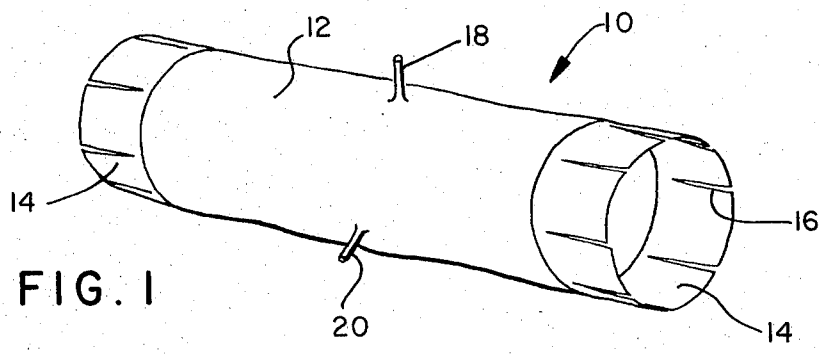


FIG. 1

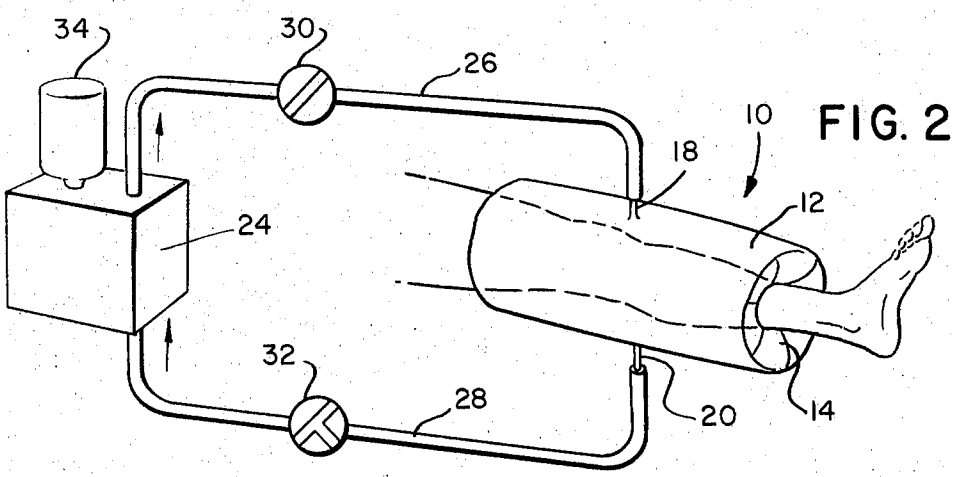


FIG. 2

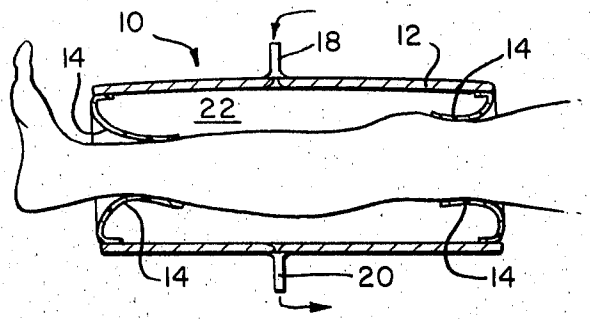


FIG. 3

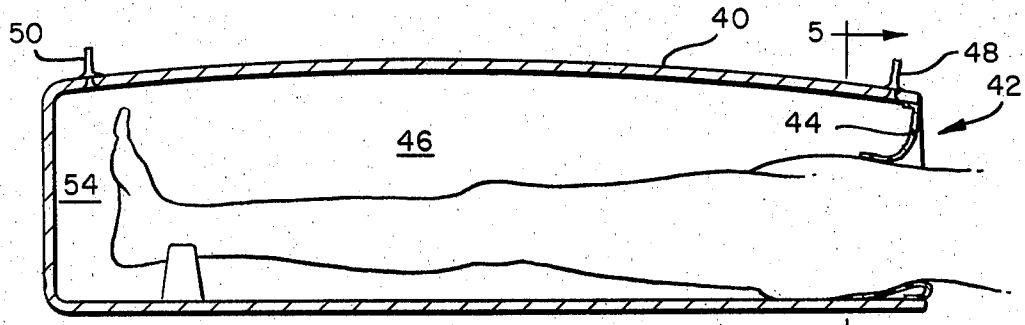


FIG. 4

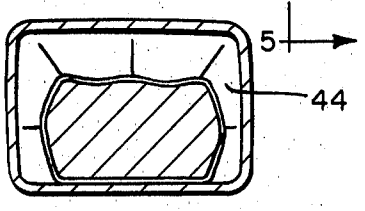


FIG. 5

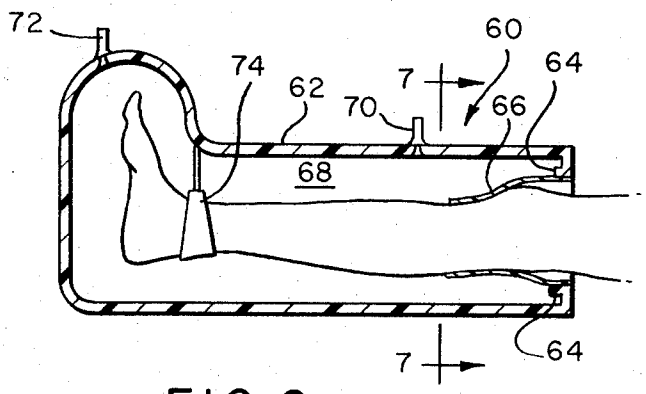


FIG. 6

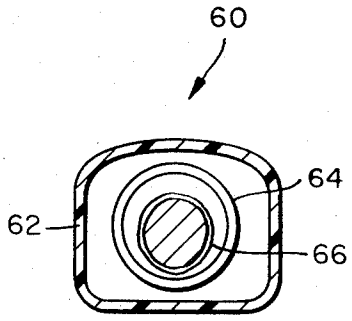


FIG. 7

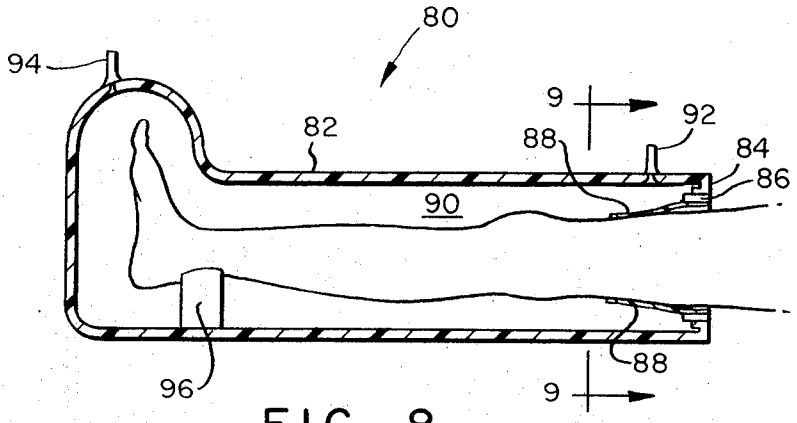


FIG. 8

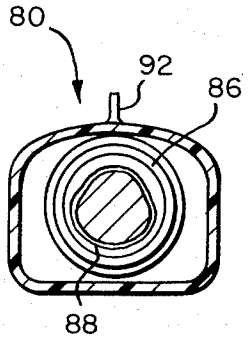


FIG. 9

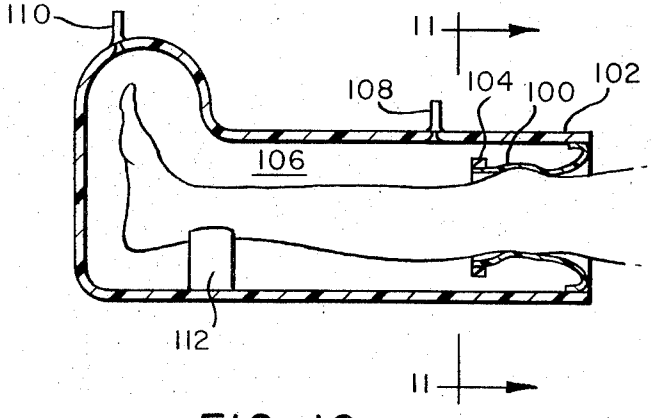


FIG. 10

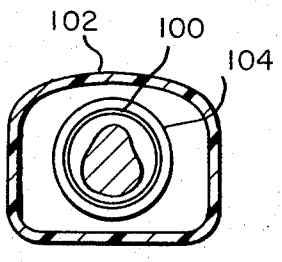


FIG. 11

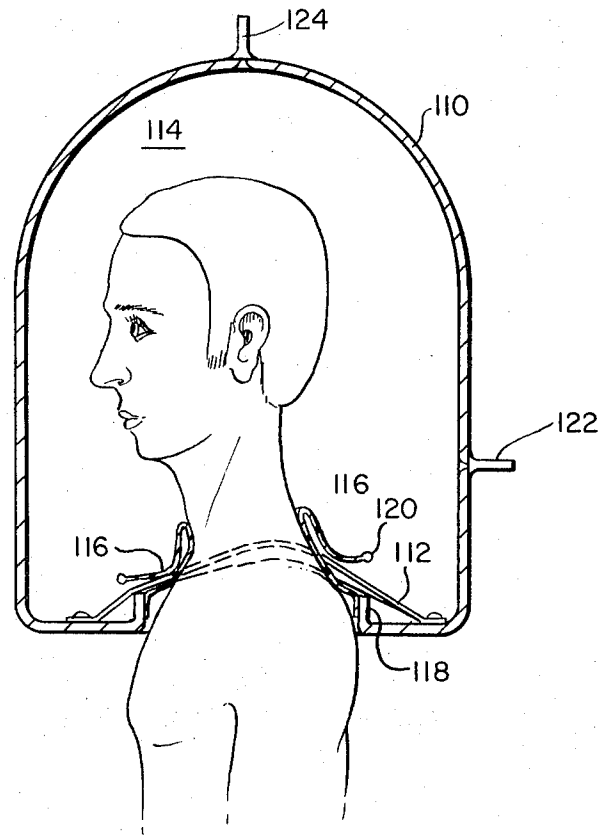


FIG. 12

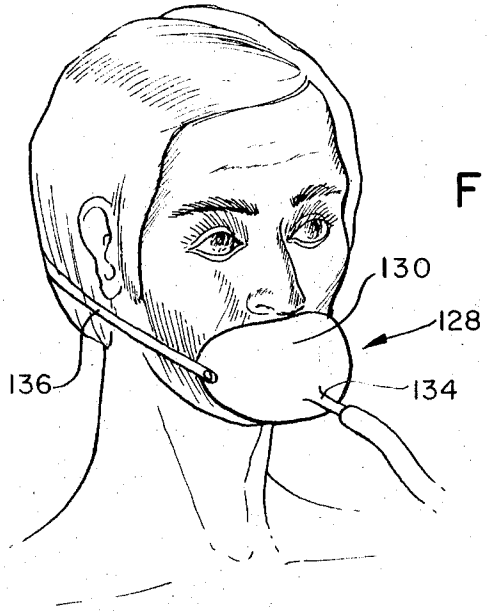


FIG. 13

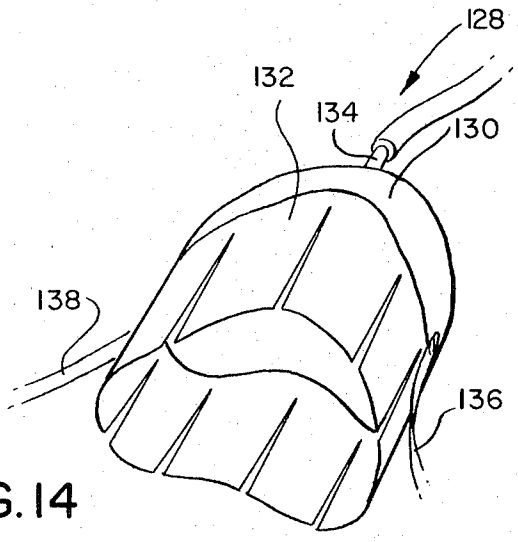


FIG. 14

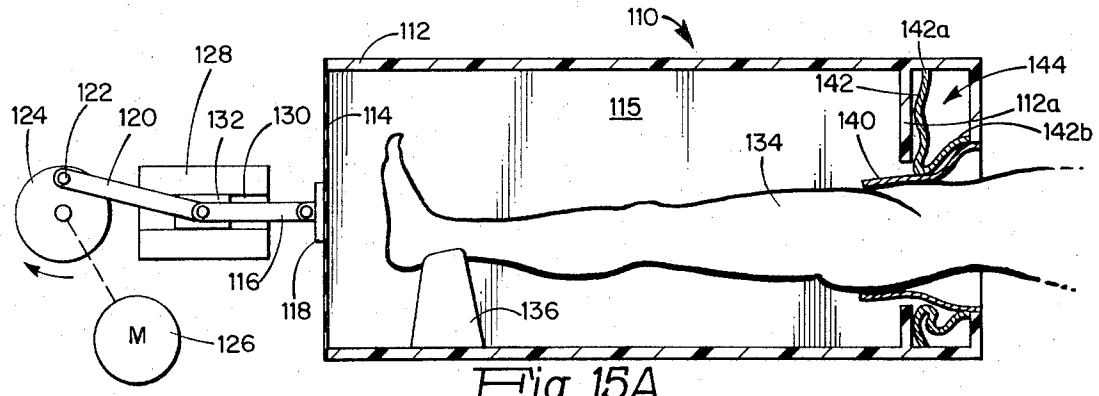


Fig. 15A.

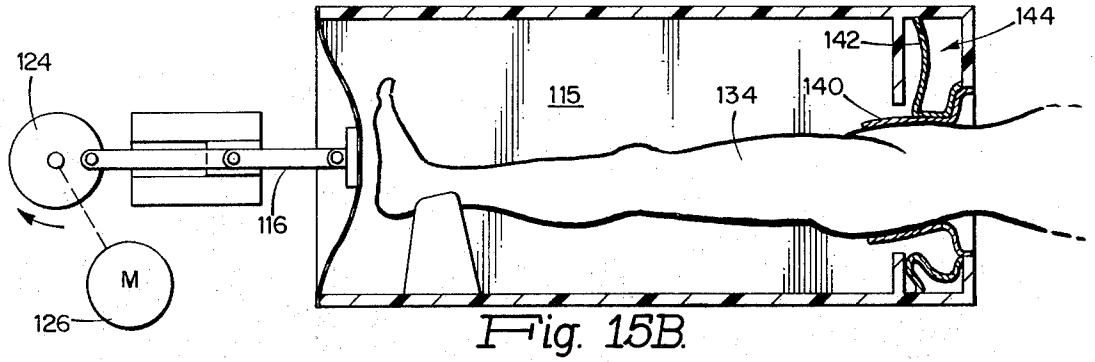


Fig. 15B.

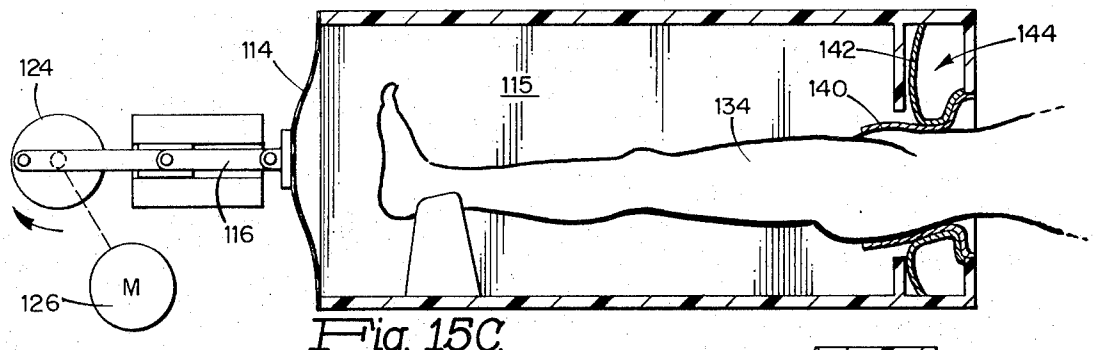


Fig. 15C.

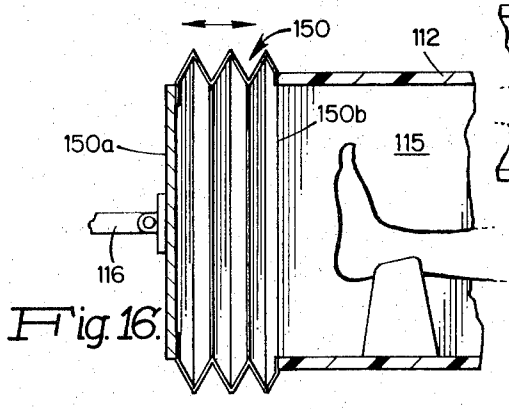


Fig. 16.

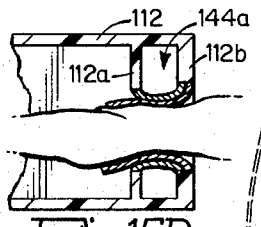


Fig. 15D.

Fig. 17.

THERAPEUTIC CUFF

This application is a continuation-in-part of my abandoned U.S. Patent Application Ser. No. 321,313, filed Jan 5, 1973.

BACKGROUND OF THE INVENTION

A. Field of the Invention

The invention relates to a pressure cuff, and comprises a single walled pressure cuff with flexible, body conforming, adherent flaps of thin sheet material forming a fluid-type seal between the cuff wall and the body portion to which the cuff is connected.

B. Prior Art

Patients confined to bed for extended periods of time are highly susceptible to blood pooling in the lower extremities which frequently leads to the formation of blood clots in the veins. To alleviate this, techniques have been developed for cyclically applying pressure to the lower extremities to assist the venous return to the heart and thereby eliminate the pooling which leads to clotting. See, for example, U.S. Pat. No. 3,391,692 which issued to me on July 9, 1968.

The cuff used in that technique is double-walled, the inner and outer walls forming a fluid-impermeable chamber between them. This cuff is placed around the body portion to be treated, and the chamber is alternately expanded and contracted in a cyclical manner to pump the blood in the extremities back toward the heart. A travelling wave is set up by the pumping cycle to thereby establish a preferential direction for blood travel.

This cuff is highly beneficial in patient treatment, but it does have certain disadvantages. Thus, the inner wall of such a cuff is in essentially continuous contact with the body surface being treated, and can cause skin irritation if applied for extended periods of time. Further, moisture builds up at the skin surface under the cuff, thus causing further patient discomfort over extended treatment intervals. Of course, when medication is to be applied to the body portion being treated, or when it is to be inspected, the cuff must be removed. And whenever the body portion to be treated has surface lesions such as caused by a wound or a burn which would be aggravated by direct cuff contact or which would cause severe patient discomfort on such contact, the cuff cannot be used at all.

BRIEF DESCRIPTION OF THE INVENTION

A. Objects of the Invention

Accordingly, it is an object of the invention to provide an improved pressure cuff.

Further, it is an object of the invention to provide a pressure cuff characterized by minimal body contact surface.

A further object of the invention is to provide a pressure cuff which avoids moisture build-up at the skin surface.

Still another object of the invention is to provide a pressure cuff which allows the application of medication while maintaining pressure on the part being treated.

A further object is to provide a pressure cuff which facilitates direct inspection of the body portion being treated.

Yet another object of the invention is to provide a pressure cuff which allows the maintenance of a controlled environment of the body surface being treated.

Still another object of the invention is to provide a cuff for local hyperbaric treatment for cutaneous lesions such as burns.

Still a further object of the invention is to provide a cuff which can sustain both positive and negative pressures.

B. Summary of the Invention

As used herein, the term "pressure cuff" denotes a shell or casing for application over a body portion and having sealing means forming a pressurizable chamber between the casing and the body surface within the casing.

In accordance with the invention, I form a pressure cuff from a single-walled casing of limited resilience having one or more flaps of a thin, flexible, body-conforming, adherent sheet material connected to the ends thereof and forming a seal between the casing and a body portion to be treated. The casing, as well as the end flaps, are fluid-tight, and, when properly positioned around the body portion to be treated, form a chamber surrounding the body surface. A fluid such as air or other gas is admitted into, and vented from, this chamber by means of one or more valves extending through the casing wall. These valves are connected, respectively, to a fluid source and a fluid sink. For example, one of the valves, serving as an inlet valve, may be connected to a pump for pressurizing the chamber from a fluid source, with the other valve, serving as an outlet valve, being connected in the return line of the pump or alternatively being vented to the atmosphere.

With the pressure cuff of the present invention, the body portion being treated is substantially free of contact with the casing and thus there is no surface irritation engendered as the casing is periodically pumped. The only direct contact is with the sealing flaps and these are highly conformable to the body shape so as to cause minimal discomfort. This is especially advantageous for patients having wounds or skin lesions on the body portion which is to be pressure treated. Further, the moisture which forms at the body surface is continually purged during the pumping, and a further source of patient discomfort is thus eliminated. Moreover, the temperature of the pumping fluid can be regulated to the degree desired to best accomodate patient comfort and promote healing. Indeed, medication in desired amounts and at the desired intervals may be introduced at the chamber by means of the pumping system and this medication is brought into direct contact with the body surface being treated.

The wall of the casing, as noted above, is made from a material of limited resilience. For example, the casing may be formed from a cloth wall having an inner coating or lining of rubber or plastic to render the walls substantially fluid-impermeable; this construction is the type used in conventional blood pressure cuffs. Alternatively, the casing wall may be of a completely rigid material such as molded, hard plastic or even light metal such as aluminum. Preferably, however, whether rigid or of limited flexibility, the casing wall is advantageously formed from a translucent material which facilitates inspection of the body section without removing the pressure cuff, and one of the many plastics will thus frequently be found best.

The end flaps which form the seal between the casing and the body portion being treated are formed from a

thin, highly flexible, deformable, body conforming adherent sheet. Thin sheets of numerous materials, including various rubbers and plastics among others, have the desired body-conforming and body-adherent characteristics. The adherence may be primarily mechanical in nature (due to surface roughness and similar factors), or primarily physio-chemical in nature (e.g., electrostatic properties caused by molecular polarization) or both.

The thickness of each flap is of the order of a few mils (thousandths of an inch) to ensure snug conformity with the body section. The flaps, which are securely fastened to one end of the casing cuff, are of sufficient length to extend a few inches from the point of attachment and along the body surface.

Because of their body-conforming characteristic, the flaps form a seal with the body over a large area and thus do not create excessive localized and flow-restricting pressure such as may be created by an elastic type restrictive seal.

When the cuff is applied to a body portion, the flaps are folded inwardly of the casing and the chamber formed by the casing and the flaps is pressurized. The air pressure in the chamber pushes the free ends of the flaps both outwardly and against the body portion over their length; the frictional and/or electrostatic forces between the flaps and the surface of the body portion resist the outward thrust on the flaps and hold them and the casing snugly in place. When the chamber is thus inflated, the casing is held away from the body surface and thus does not chafe or otherwise irritate it.

Valves extending through the casing allow pressurization of the chamber. This pressurization may be cyclic, to assist venous return to the heart, or may be static, to provide hyperbaric treatment, as desired. A pumping source connected to the valves not only establishes the desired pressure and pressure cycle but also conditions the fluid (e.g., by removing moisture from it) and medicates it as desired.

As long as the cuff is to be used with pressures above atmospheric pressure a single sealing flap around the enclosed body portion is adequate. For a cuff which must accomodate both positive and negative pressures, however, a modified form of seal is provided. The modified seal has two parts, a first of which is identical to the single (positive-pressure) seal described above and a second of which is a negative pressure seal formed by a resilient sheet attached on all sides to the interior wall of the casing adjacent the body portion with which a seal is to be formed and forming a closed cell containing air or other expansible fluid. The cell normally contributes little, if anything, to sealing the cuff when the cuff is pressurized to a positive (above atmospheric) pressure, but expands and seals the cuff to the body portion it encloses when the cuff is evacuated to a negative (below atmospheric) pressure. For this purpose, the cell may be closed off at atmospheric pressure and will thus follow changes in applied pressure by expanding or contracting as the cuff pressure drops below, or rises above, atmospheric pressure.

DETAILED DESCRIPTION OF THE INVENTION

The foregoing and other and further objects and features of the invention will be more readily understood from the following detailed description, when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view in perspective of one form of cuff in accordance with the present invention and prior to its application to a body section;

FIG. 2 is a view in perspective of the cuff of FIG. 1 applied to a leg and having a pumping and fluid treatment system connected to it;

FIG. 3 is a vertical side sectional view of the cuff of FIG. 2 taken along the lines 3—3 of FIG. 2;

FIG. 4 is a side view of another sectional embodiment of my invention showing a single walled pressure cuff having only one open end;

FIG. 5 is an end sectional view taken along the lines 5—5 of FIG. 4;

FIG. 6 is a vertical side sectional view of another embodiment of the invention utilizing a rigid shell with internal support and showing an alternative construction for attaching the sealing flaps;

FIG. 7 is an end sectional view along the lines 7—7 of FIG. 6;

FIG. 8 is a vertical side sectional view of still another embodiment of the invention showing a further alternative construction for the end flaps;

FIG. 9 is an end sectional view along the lines 9—9 of FIG. 8;

FIG. 10 is a vertical side sectional view of still another embodiment of the invention showing yet another construction for attaching the end flaps;

FIG. 11 is an end sectional view along the lines 11—11 of FIG. 10;

FIG. 12 is a sketch of another form of cuff of the present invention with portions broken away for clarity, illustrating its use in providing hyperbaric treatment of the upper body, including the head;

FIG. 13 is a view in perspective of a mouth mask constructed in accordance with the present invention; and

FIG. 14 is a view in perspective of the mask in FIG. 12 as applied to the mouth of the patient.

FIG. 15A–C are side sectional views of an alternative cuff in accordance with the present invention which accomodates both positive and negative cuff pressure;

FIG. 15D is a side sectional view of an alternative embodiment of the cuff of FIGS. 15A–C.

FIG. 16 is a side sectional view of another embodiment of the cuff shown in FIG. 15; and

FIG. 17 is a side sectional view of still another embodiment of the cuff shown in FIG. 15.

In FIG. 1, one embodiment of a pressure cuff in accordance with the present invention that is especially useful for application to the lower extremities has a single-walled, outer cylindrical casing 10 to which are secured end flaps 12 and 14 respectively. The casing is preferably formed from a translucent plastic material such as vinyl, while the flaps 12 and 14 are formed from a thin, flexible, body conforming, adherent sheet of material such as rubber or a silica-filled vinyl sheet (the silica providing frictional properties). The length of the flaps in the longitudinal direction (i.e., in a direction parallel to the axis of the cylindrical cuff 10) should be of the order of 3 to 4 inches to provide sufficient sealing surface for contact with the body portion. Notches 16 may be formed around the periphery of the outer ends of the flaps 14 to assist in conforming the flaps to the smaller diameter of the body portion which they are to encompass. Valves 18 and 20 extend through the wall 12 to the interior of the cuff.

In FIG. 2, the cuff 10 of FIG. 1 is shown applied to the lower leg of a patent. The cuff completely encom-

passes a portion of the leg, and the flaps **14** are folded inwardly of the casing **12** and snugly fold around the leg within the cuff. The cuff forms a chamber **22** which is sealed fluid-tight by the flaps **14, 16** when the chamber is pressurized. Fluid is admitted to this chamber through valves **18** and **20** which are connected to a pumping source **24** through lines **26** and **28.** Valves **30** and **32** respectively, are positioned in these lines. When the valves **30** and **32** are closed, the pumping source **24** provides fluid under pressure to the interior of the cuff **10** in a closed loop from the source **24** through the valve **30** and line **26,** to the cuff **10,** thence back through the line **28** and valve **32** to the pumping source **22.** Valve **32** is a three position valve which may alternatively be positioned to vent the fluid from the casing **22.**

In addition to providing pressurized fluid to the cuff **10,** the pumping source **24** may condition the fluid it supplies. Thus, for example, the source **24** may contain moisture extraction apparatus (not shown) to remove excessive moisture from the fluid supply to the cuff. Alternatively, it may supply moisture to the body segment within the cuff when the moisture level is too low. Additionally, it may be connected to receive medication from a source **34** and apply it in controlled and timed amounts to the body segment in cuff **10.** Thus, the environment of the body segment within the cuff **10** may be precisely controlled.

FIG. **3** is a cross-section of the cuff **10** of FIG. **2.** As shown in FIG. **3,** those portions of the flap **14** nearest the casing **12** are bowed outwardly by the pressure within the cuff, while the ends of the flaps farthest from the casing are pushed against the body portions by the pressure within the cuff **10** and snugly conform to the body portion at the areas of contact. The snug adherence between the flaps **14** and the body portion prevent the flaps from being pushed completely out of the cuff. Thus, they form effective seals with the leg and allow pressurization of the chamber **22.**

In FIG. **4,** an alternative embodiment of the invention is shown in which the pressure cuff is formed from a rigid or semi-flexible casing **40** having only a single open end **42** sealed by a thin, flexible, circumferentially extending, body-conforming adherent flap **44** and forming a chamber **46** encompassing the leg. This form of pressure cuff is especially useful in counterpulsation treatment. Again, the flap **44** is several inches in length to allow sufficient surface contact area with the body portion to thereby form an effective seal. Valves **48** and **50** extending through the casing **40** provide a means of admitting fluid to the chamber **46** and discharging it from that chamber, respectively. A foot rest **52** is desirably provided to elevate the patient's leg but may be pushed out of the way if desired. The cuff is sufficiently large to enable the patient to move his legs to comfortable positions as desired. Note that both legs may be enclosed within the casing simultaneously so that both can be subjected to even pressure without squeezing them together.

Turning now to FIGS. **6** and **7,** the pressure cuff **60** shown there has a rigid casing **62** terminating at one end in an inwardly turned generally circular flange **64.** A thin, flexible, body-conforming, adherent flap of sheet material **66** is firmly secured to this flange, (for example, by adhesive or by thermoforming techniques) and extends inwardly several inches within the casing and in contact with the surface of the leg positioned within the casings **62.** The casing forms a chamber **68** which is sealed by the flaps **66** against fluid leakage. Pressurizing fluid is admitted to the chamber by means of a valve **70** and is discharged from the chamber by means of a valve **72.** A sling **74** may be attached to the casing for providing a rest for a limb within it.

In FIGS. **8** and **9,** a pressure cuff **80** has a casing **82** with a flanged, inwardly turned end wall portion **84** at one end thereof. A cylindrical ring **86** of dimensions somewhat larger than the maximum cross section of the body section being treated is attached to the end wall **84** and a thin, flexible, body conforming, adherent flap **88** connected to the ring **86.** Ring **86** lightly engages the limb positioned within it. Its purpose is to minimize any outward bowing of the flap **88** and thus this ring need not itself provide the sealing action, the latter being provided completely, or nearly completely, by the flap **88.** The casing **82** forms a chamber **90** which is sealed by flap **88.** The chamber is pressurized and depressurized by means of valves **92** and **94,** respectively. A foot rest **96** may be provided within the casing **82** for the patient's comfort.

In FIGS. **10** and **11,** a thin, flexible, circumferentially extending, body-conforming, adherent flap **100** extends between an end segment of a casing **102** and a cylindrical ring **104.** The ring **104** is of sufficient diameter to allow the body segment to be treated to be extended through it without discomfort, and it serves to anchor the flap **100** against outward bowing when the chamber **106** within the casing is pressurized. The ring **104** need not itself provide any sealing action and thus need not be pressed tightly against the body section. The casing **102** forms a pressure chamber **106** which is sealed by the flap **100.** Valves **108** and **110** are provided for pressurizing and depressurizing the chamber **106,** respectively. A rest **112** may be provided for comfort of the patient.

FIG. **12** shows a form of pressure cuff suitable for hyperbaric treatment of patients with respiratory problems. In this instance the cuff takes the form of a preferably rigid semi-cylindrical casing **110** with rounded top suspended on the shoulders of the patient by means of straps **112** and forming a pressure chamber **114.** The casing is, of course, preferably of a translucent meterial. A sealing flap **116** of thin, flexible, body-conforming, adherent material such as saran extends between in-turned edges **118** of casing **110** and a ring **120** of sufficient diameter of fit over the patient's head. The flap **116** is snugly engaged against the patient's chest when the chamber **114** is pressurized. Valves **122** and **124** allow chamber **114** to be pressurized and depressurized, respectively.

In FIG. **12** a mask **128** adapted to fit over a patient's mouth is shown. The mask has a generally oval cross-section and is formed from an outer semi-flexible or rigid casing **130** having a thin, flexible, body-conforming, adherent flap **132** attached to its rim. A pair of valves **134, 136** extend through the casing **130** for pressurizing and depressurizing the interior thereof when the casing is applied against the mouth of the patient. A pair of straps **136, 138** are also attached to the casing **130** for holding the casing against the mouth of the patient as shown in FIG. **14.** When the cuff is applied to the patient, the flap **132** is extended inwardly toward the housing **130.** When the interior of the housing is pressurized, the flap is pushed snugly against the patient's skin and forms a fluid tight seal with it.

The pressure cuff may in the same manner be advantageously used in hyperbaric treatment of the eye, since it allows free eye movement beneath it. It also may beneficially be applied as an ostomy or stoma cover (as in a colostomy, urostomy or iliostomy, and contains gas release since it forms a tighter seal as the pressure increases.

In certain types of treatment it is desirable to provide for positive as well as negative pressures within the cuff. For example, in a type of therapy known as "counterpulsation" therapy, one cyclically and alternately applies positive and negative pressures to a body portion to assist the pumping action of the heart and thereby relieve strains on the heart caused by its normal pumping action. The cuff of the present invention is especially suited to this type of therapy since it offers greater comfort to the patient, and the patient may therefore be placed in it for treatment for extended periods of time without undue discomfort. However, in order to accommodate negative as well as positive pressures, the sealing flap illustrated and described in connection with FIGS. **1** through **14** must be modified.

Such a modified form of seal is shown in FIGS. **15A–15C**, together with a modified form of cuff which is especially suited to applying alternate positive and negative pressures to a patient. The particular type of cuff shown has a single open end and is specifically adapted to counterpulsation treatment, but it will be understoood that a cuff of the type shown in FIGS. **1–3** and open at both ends is equally well adapted to the modified seal now to be described. As shown in FIGS. **15A–15C**, a cuff **110** is formed from a relatively inflexible or even rigid casing **112** of sufficient size to confortably accommodate the body portion to be treated. One end of the casing **112** is closed by a resilient membrane **114** to form a chamber **115** interior to the casing. The membrane is connected to a shaft **116** through an adapter **118.** The adapter **118** is firmly attached to the membrane **114** and pivotally connects the shaft to the membrane. A crank arm **120** is pivotally connected to shaft **116** at one end thereof and is connected at the other end to a pin **122** on the outer perimeter of a wheel **124.** The wheel **124** is rotated by a motor **126.** A guide block **128** has a groove **130** in which a follower block **132** rides. The block **132** is connected to the pivot between arms **116** and **120.**

A body portion **134** such as the lower torso of a patient, is placed within the casing **112.** As was previously the case, a footrest **136** may be provided in the casing for the patient's comfort. A thin, flexible, body-conforming adherent flap **140** of sheet material having one edge firmly attached to an end **112***a* of the casing **112** is positioned to form a fluid-tight seal with the patient's body. The flap extends circumferentially around the patient's body as was the case in FIGS. **1** thorugh **14** to thereby form an airtight seal with it. A flexible, resilient flap **142** also extends circumferentially around the patient's body at the open end of the cuff **110.** It is sealed to the casing **112** at both its edges to form a closed cell **144** containing an expansible gas such as air. A wall **112***a* of the casing extends into the casing adjacent the flap **142.**

As illustrated in FIG. **15A**, the chamber **115** is initially at atmospheric pressure. For purposes of illustration, it will be assumed that the cell **144** was closed off under atmospheric pressure so that the pressure within the cell as illustrated in FIG. **15A** is also atmospheric. The flap **140** lies against the body and conforms lightly to its contour. The flap **142** rests lightly against the body at the upper portion thereof, but is drawh away from the body by its own weight at the lower portion thereof. In this position, the pressure in the chamber **115** is in equalibrium with the pressure outside this chamber and neither the flap **140** nor the flap **142** need provide any sealing action.

Turning now to FIG. **15B**, as the motor **126** turns the wheel **124,** the arm **116** moves to the right and drives the adapter **118** to the right. This moves the membrane **114** inwardly into the chamber **115** and diminishes the free volume of this chamber, thereby causing a pressure rise within it. The seal **140** conforms more snugly to the body portion which it encircles, and prevents escape of air from the chamber **115.** At the same time, the flap **142** has a net pressure exerted on it from the chamber **115** and thus the volume of the cell **144** diminishes, while the pressure inside the cell increases. No sealing action is provided by the flap **142** in this condition; instead the entire sealing is provided by the flap **140.**

As the motor **126** continues to rotate the wheel **124,** the shaft **116** reverses its motion and moves to the left, thus drawing the membrane **114** outwardly of the chamber **115.** This increases the effective volume of the chamber and thereby diminishes its pressure. When this occurs, air would normally move into the chamber **115** under the flap **140** and thereby break the seal otherwise provided by this flap. However, this is prevented by the seal **142** which, in response to the drop in pressure in chamber **115,** expands outwardly, thereby increasing the volume of chamber **144,** and diminishing its pressure. In expanding outwardly, it presses against the flap **140** and pushes this flap firmly against the body portion **134,** thus maintaining the effective seal between flap **140** and the body portion **134.** The wall **112***a* ensures that the flap **142** expands against the body surface. Thus, the chamber **115** can be dropped to a pressure below atmospheric (negative pressure), without leakage of air into it from the outside of the cuff.

As the pressure in the chamber is cycled between sub-atmospheric pressure and super-atmospheric pressure, therefore, the seals **142** and **140** alternately become effective to provide the desired sealing action. In no event, however, is the maximum sealing pressure greater than either atmospheric pressure or the maximum pressure in the chamber **115.** Further, this pressure is maintained over a substantial area and is not confined to a thin, ring-like section which may cause patient discomfort.

An alternative method of attaching flap **142** is shown in FIG. **15D.** there shown, one edge of this flap is attached directly to an inner edge of wall **112***a;* the opposite edge of this flap is attached to the rear wall **112***b* of the casing. The flap **142** forms closed chamber **144***a* with the walls **112***a* and **112***b.* This chamber expands and contracts in the manner described in connection with FIGS. **15A–C** to allow sealing of the open casing end under both positive and negative pressure conditions.

It is, of course, possible to omit the sealing flap **140** entirely and instead use only the flap **142** which forms and expansible chamber. In such a case, the flap **142** must effectuate a seal under both positive and negative pressure conditions. This is accomplished by first plac-

ing the body portion to be treated in the casing with the chamber **144** formed by the flap **142** collapsed to permit this. This chamber is then pressurized to a pressure in excess of atmospheric pressure and of sufficient magnitude that it can maintain a seal with the body portion even when the chamber **115** is pressurized; it will thus also maintain a seal at or below atmospheric pressure. This type of seal may also replace the seal **14** shown in FIGS. **1–3.** However, this type of seal exerts pressure above atmospheric pressure at all times, and thus will in general not be as comfortable as the seals shown in FIGS. **1** and **15** which comprise an open flap with a free end (FIGS. **1–14**) and both an open flap with a free end and a closed flap forming an expansible chamber.

Various arrangements may also be used to provide the cyclic pressire for counterpulsation and other types of treatment. Two such alternatives are shown in FIGS. **16** and **17,** respectively. In FIG. **16,** the flexible membrane **114** is replaced with a bellows **150** which is fluid-tight sealed at an end **150***a* and which communicates with a chamber **115** at the other end **150***b*. As was the case with the membrane **114,** the bellows **150** is reciprocated by a rod **116** to alternately raise and lower the pressure in the chamber **115** by changing the effective volume as the rod **116** reciprocates.

In FIG. **17,** the casing **112** terminates in an enlarged segment **112***c* which is sealed fluid-tight by a correspondingly enlarged diaphragm **114***a*. This provides an enlarged chamber **115**A whose effective volume is changed as rod **116** is reciprocated. By providing a chamber **115**A of broad diameter but narrow width, the combined effective volume of chambers **115** and **115**A (and thus the fluid pressure in these chambers) can be changed quite rapidly and over a wide range.

From the foregoing, it will be seen that I have provided an improved pressure cuff. The cuff is single walled and is readily supported away from the surface of the body portion being treated so as to prevent the discomfort normally caused by frictional contact of the cuff with the patient. A simple yet effective seal is formed on the cuff by means of one or more flaps of a flexible, thin, body-conforming, adherent sheet of material which snugly conforms to the body portion when the interior of the casing is pressurized. The sealing force is distributed over a large area in this type of seal, and this eliminates any excessive localized sealing pressure which would otherwise impede blood circulation in a patient's body. The single walled casing allows direct access of the pressurizing fluid to the body surface and thus provides a convenient means for medicating this surface or otherwise controlling the atmosphere surrounding it. By utilizing a translucent material for the casing itself, continuous visual access to the surface being treated is provided.

The thickness of the sealing material is, of course, dependent on the material being used and the pressures to be applied, as well as the duration and repetition rate of the pressure application. In general, the seal must be thick enough to withstand the applied pressure and not distort excessively under it, and yet must be thin enough to snugly conform to the body section to which it is applied to thereby form a fluidtight seal. For plastic materials such as a vinyl, sheets of less than 0.005 inches thick will be found useful, while with other materials this thickness may be greater or less.

It may sometimes be found desirable to further improve both the adherent characteristics of the sealing material and its sealing ability by applying a small amount of viscous paste to the interface between the sealing flaps and the body portion. This is especially the case when the sealing material has poor (low) frictional characteristics.

It will be understood that the foregoing material is illustrative only and that various modifications may be made to the invention as described herein without departing from the spirit or the scope of the invention, the scope of the invention being defined in the claims.

Having illustrated and described my invention, I claim:

1. A therapeutic cuff for an animal body comprising

A. a relatively inflexible casing for positioning over a body portion and forming a chamber therewith,

B. at least one thin, flexible, body conforming, adherent, elongated sheet having a first end thereof circumferentially attached to said casing and having a second end thereof extending radially inwardly from said casing for engagement along a substantial area, intermediate said ends, with a body positioned within said casing to thereby form a circumferentially extending fluid tight sealing flap surrounding said body portion and isolating the interior of said chamber from the exterior thereof, the diameter of said flap at its ends and all portions therebetween being greater than that of the body portion it contacts whereby said flap exerts substantially no force of its own against said body portion,

C. means forming a circumferentially extending closed auxiliary chamber on an interior wall of said casing and having a deformable wall in contact with a surface of said flap opposite the surface in contact with said body portion, said chamber being pressurized to substantially atmospheric pressure to thereby exert minimal force against said flap and said body portion when the pressure within said casing is greater than atmospheric pressure and to exert a sealing force against said flap and body portion when the pressure in said chamber is less than atmospheric, and

D. means on said cuff for pressurizing said chamber.

2. A therapeutic cuff in accordance with claim **1** in which said sheet increasingly frictionally adheres to said body portion when said chamber is pressurized.

3. A therapeutic cuff in accordance with claim **1** in which said sheet is sufficiently thin to snugly conform to a body contour it engages and sufficiently thick to withstand rupture by the chamber pressure.

4. A therapeutic cuff in accordance with claim **3** in which said sheet is formed of rubber.

5. A therapeutic cuff in accordance with claim **3** in which said sheet is formed of plastic.

6. A therapeutic cuff in accordance with claim **3** in which said sheet is formed of a plastic that is treated to increase its frictional engagement with a body surface it contacts.

7. A therapeutic cuff in accordance with claim **3** in which a viscous paste is applied between the body-conforming sheet and the body portion to which it is to be sealed to thereby increase adherence between said body portion and said sheet and further increase the security of the seal.

8. A therapeutic cuff in accordance with claim 1 in which said casing is cylindrical in shape and is adapted to completely encompass said body portion.

9. A therapeutic cuff for an animal body, said cuff comprising

A. a casing for forming a hollow air chamber surrounding a body portion to be treated,

B. means for extending between said casing and said body portion for sealing said chamber fluid-tight; and

C. means forming a flexible wall in said casing and of substantially larger cross section than the chamber containing the body portion to be treated and movable inwardly and outwardly of said chamber to thereby change the pressure therein at a rate greater than that achievable by flexible walls of cross section comparable to that of the chamber containing the body portion to be treated.

10. A therapeutic cuff according to claim 9 in which said flexible wall comprises a resilient membrane diaphragm.

11. A therapeutic cuff according to claim 9 in which said flexible wall is in the form of a bellows.

12. A therapeutic cuff according to claim 9 which includes reciprocating means for moving said wall inwardly and outwardly of said chamber.

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