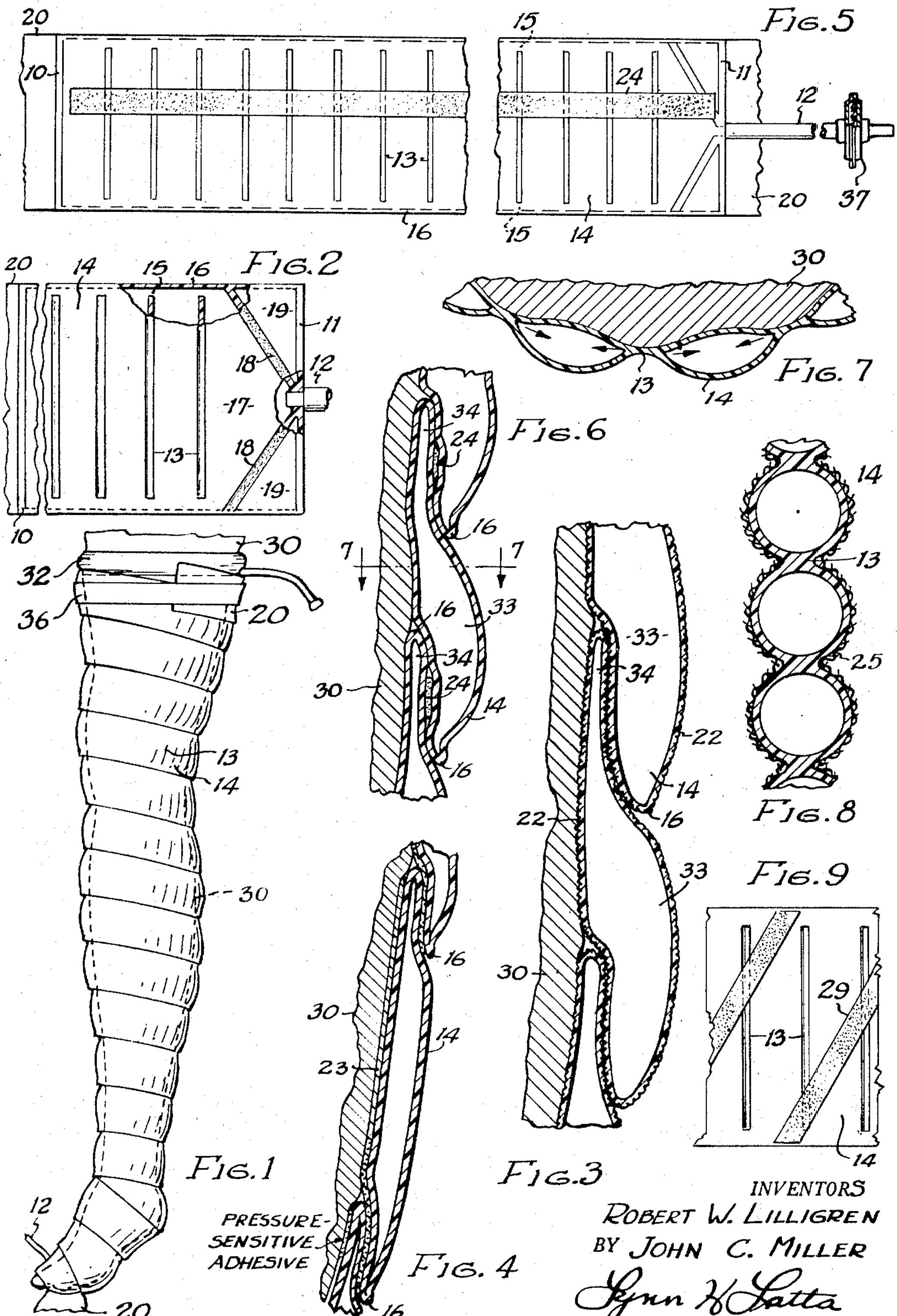
July 8, 1969 R. W. LILLIGREN ET AL 3,454,010

SURGICAL BANDAGE, CONSTRICTIVE DEVICE, AND INFLATABLE MEANS

Filed May 8, 1967



INVENTORS
ROBERT W. LILLIGREN
JOHN C. MILLER

BY Lynn H. Latta
ATTORNEY

3,454,010

SURGICAL BANDAGE, CONSTRICTIVE DEVICE, AND INFLATABLE MEANS

Robert W. Lilligren, 3109 Palos Verdes Drive N., Palos Verdes Estates, Calif. 90274, and John Clifton Miller, 1105 Shasta, Vallejo, Calif. 94590

Filed May 8, 1967, Ser. No. 636,744
Int. Cl. A61m *1/00;* A61b *17/12;* A61h *1/00*
U.S. Cl. 128—327 9 Claims

ABSTRACT OF THE DISCLOSURE

A surgical bandage, for preoperative treatment of a limb, utilizes pneumatic pressure to compress the blood and lymphatic vessels and to express the normal fluids from the limb below a previously placed tourniquet and prior to its inflation. These in turn provide a "dry" surgical field. A second use for the device is to reduce the volume of the vascular tree by multiple limb compression in the immediate treatment of shock.

BACKGROUND OF INVENTION

Heretofore it has been common surgical practice to tightly wrap a substantially nonstretchable bandage around a patient's limb in order to express fluids from the limb in preparation for surgery, reliance being placed upon the constant application of considerable tension to the bandage in order to wrap it tightly enough to drive out the fluids. This requires considerable muscular effort on the part of the surgeon and is quite time-consuming. It is also common practice to utilize tourniquets to inhibit the flow of blood in a limb that is being operated.

In the prior patented art, the patents to Ferrier, No. 2,699,165, and to Weinberg No. 2,781,041, disclose inflatable boots for treatment of vascular disorders in limbs by alternately subjecting the limb to fluid-energized compression and decompression. Such devices are of relatively complex and expensive construction and are designed to be reused repeatedly. They are not adapted for presurgery use.

The patent to Hoflinger discloses an inflatable boot for collecting blood at a selected point in the human body. This device is likewise of complex construction and not adapted for presurgery use. The patent to Koski et al., No. 2,943,859, discloses an inflatable arm-stiffening band which also is not suitable for presurgery use.

SUMMARY OF INVENTION

This invention provides a constrictive bandage which comprises a flat, ribbon-like tube of thin fluid-impervious material such as plastic film, having a series of fluid cells traversing it laterally and connected at opposite sides so as to provide a path of fluid-flow communication gradually progressing along the length of the bandage, whereby air or other gas injected into one end of the bandage, will progressively inflate the cells from one end of the bandage to the other. The cells are connected by ports of sufficient restriction to retard the progressive inflation of the cells sufficiently to automatically control the successive application of pressure to a limb that is helically wrapped with the bandage, in a manner such as to effect the gradual collapse of the limb's fluid vessels and the gradual driving of the fluid along the length of the limb, until the level of the tourniquet is reached and the distal limb cleared of blood and lymph.

The bandage is provided with means to effect attachment of successive turns of the bandage to one another, with the adherence being intensified as the bandage is inflated, the adherence being adequate to prevent the

opening of gaps between the turns of the bandage. The bandage is pre-sterilized and of inexpensive construction and thus disposable, being designed for use only once.

The object of the invention is to provide an inexpensive preoperative bandage which can be wrapped helically around a patient's limb without the necessity for pulling it tight during the wrapping, which, after being fully wrapped around the limb, will develop constrictive tension as the result of inflation thereof, which will thereby apply constrictive pressure to the limb commencing at one end of the wrapped bandage and progressing gradually to the other end of the bandage so as to drive the limb fluids out of the wrapped area, which can easily be pierced by the surgeon's scalpel after a tourniquet has been applied to the proximal or body end of the evacuated area to prevent return of fluids into the area, thus allowing the air to escape and collapsing the bandage, and which can be discarded when the operation is concluded. Sterility of the bandage eliminates the need for a portion of the usual sterile drapes and further reduces operative time and expense.

DESCRIPTION

This and other objects will become apparent in the following specifications and appended drawing, wherein:

FIG. 1 is a side view of a human leg wrapped in a bandage embodying the invention;

FIG. 2 is a plan view of an end portion of the bandage;

FIG. 3 is a cross-sectional view of several inflated turns of the bandage, as wrapped around a limb;

FIG. 4 is a cross-sectional view through a modified form of the bandage;

FIG. 5 is a fragmentary plan view of a bandage embodying another modified form of the invention;

FIG. 6 is a sectional view of several inflated turns of the bandage of FIG. 5;

FIG. 7 is a longitudinal sectional view of a portion of the bandage of FIG. 5, taken on line **7—7** of FIG. 6;

FIG. 8 is a fragmentary cross-sectional view of another modified form; and

FIG. 9 is a fragmentary cross-sectional view of another modified form.

Referring now to the drawing in detail and in particular to FIGS. 1–3, we have shown therein, as an example of one form in which the invention may be embodied, a bandage constructed from a flat tube of thin heat-sealable plastic film material such as polyethylene tubing, the ends of which are closed, as by seams **10** and **11** consisting of transverse bands of heat-sealing. An inflation fitting **12**, including suitable means (e.g., valve or clamp) for closing it after inflation, is secured in the sealed end seam **11**, with its inner end communicating with the interior of the tube at that end.

The tube is divided by transverse seams **13** of heat-sealed junction between the tubing walls into a series of transverse air cells **14** which are interconnected along the sides of the bandage by constricted ports **15** formed as short spaces between the ends of heat-sealed bands **13** and the side folds **16** of the tubing.

The first cell, **17**, communciating with fitting **12**, may be triangular, defined between the first transverse band **13** and diagonal bands **18** spreading outwardly from fitting **12**.

The external surface of the tubing material is provided with a nonslipping surface such that the successive turns of wrapping will adhere to one another sufficiently to prevent separation of the turns when inflated. The nonslipping surface may be a roughened (pitted or pebbled or grained) surface in the tubing wall, as at **22**, or it may be a layer of pressure-sensitive adhesive **23** (FIG. 4) applied to one face of the bandage and adapted to adhere to the other face of an adjacent turn in the wrapped bandage, or it may be a strip **24** of pressure-sensitive adhesive (FIG. 5) extending longitudinally along one face of the bandage in a position to engage and adhere to the overlapped area of an adjacent turn, as in FIG. 6, or it may be a covering of gauze **25** (FIG. 8) on the outer or both faces of the tubing, secured thereto by the heat-sealing of bands **13** (the heat softened tubing material adhering to the gauze during heat-sealing).

In the use of the bandage to prepare a limb (e.g., a patient's leg **30**) for surgery, it is wrapped around the limb in successive helical turns, as illustrated in FIG. 1, with successive turns overlapping to a substantial extent (e.g., in the range between a substantially 50% overlap as shown in FIG. 3 and a substantially 33⅓% overlap as shown in FIG. 6).

Where a pressure sensitive adhesive covering one face of the bandage is utilized as in FIG. 4, the overlap may be as small as approximately 20%, as shown in FIG. 4, or somewhat less, so long as it is adequate to provide continuous air-cell coverage along the length of the limb, with a portion of the inflated area of one turn overlapping that of a previous turn as shown. In this construction, the adhesive may be permitted to directly contact the patient's skin and to hold the turns in their proper positions by adherence to the skin. The adhesive employed in such instance is of mild adherence, easily stripped away from the skin without injurious pulling. FIG. 4 shows the bandage in uninflated condition.

As shown in FIG. 9, the adhesive may be applied in diagonal stripes **29**.

The bandage in each instance is wrapped around the limb under just sufficient tension to place the turns in snug overlapping contact and without any slack along the length of the bandage. The beginning end of the bandage is held in place by an assistant until secured by successive turns. When wrapping is completed, the end (e.g., strap portion **20**) is secured, as by pinning or by wrapping a band of surgical adhesive tape around the end turn of the bandage or by use of tie strings or other equivalent securing means, or at the user's discretion, by hand pressure until inflation of the device and the tourniquet is completed.

The bandage is then inflated by applying an air pressure hose or other compressed gas supply device to fitting **12**, so as to force compressed air or other gas into that end of the bandage. The air will flow into the first cell **17** and from that cell through the constricted ports **15** into successive cells **14** along the length of the bandage, travelling helically around the limb and progressively compressing the limb with hoop tension such as to gradually drive the limb fluids toward the patient's body (the air injection being effected at the end of the bandage nearest the limb extremity). As each successive turn of the bandage is inflated, its constrictive pressure will be somewhat greater in its central area **33** than in the area **34** of its margin which is covered by an uninflated turn, but as the latter turn is inflated, it will apply compression to such marginal area of the previous turn, thus bringing the pressure thereof up to the maximum in the inflated preceding turns. The net result is a creeping wave of constriction of which the front is of somewhat lower intensity than the maximum pressure which is developed in the fully inflated turns following the front. This avoids any trapping of fluids in the limb in areas that have been passed by the compression wave.

Inflation may be effected by use of an air hose, or by carbon dioxide from a CO_2 cartridge or from a "Kidde-Tourniquet," or by gas pressure from a Zimmer "Inflatomatic" tourniquet, or other suitable source of pressurized gas, whether air, CO_2, freon, nitrogen, helium or other gas. The same source of gas pressure may be used to inflate both the bandage and the tourniquet **32**.

A tourniquet **32**, previously applied around the limb, is then constricted (e.g., by inflation) so as to prevent any return flow of fluids into the bandaged limb. When

the tourniquet is constricted and secured, the surgeon proceeds with the surgery. Optionally, he may first unfasten the bandage and remove it from the limb, or he may simply cut through the bandage with his scalpel at the point where the incision is to be started. The severed turns of the bandage can then be allowed to drop away from the limb, and the uncut turns of the bandage can be retained in place to function as a surgical drape.

Where the bandage of FIGS. 5–7 is employed, it may be wrapped around the patient's limb with the strip of adhesive disposed on the outer face of the bandage on the covered side which is overlapped by a succeeding turn, or on the inner face of the covering side which overlaps a previous turn, so that the adhesive strip adheres to an adjacent turn of the bandage rather than to the patient's skin. Reliance is then placed on the bandage becoming, in effect, a continuous boot with the turns attached to one another. The same is true to a somewhat lesser extent in the bandage of FIG. 3, the roughened surfaces of the bandage clutching one another when pressed together by the air pressure in the inflated bandage, so as to establish non-slipping interengagement which is assisted by non-slipping engagement of the roughened surfaces of the exposed inner faces of the turns against the patient's skin.

Where the bandage of FIG. 8 is employed, the gauze surfaces will interlock with one another to provide non-slipping coupling of the successive turns, one to the other.

An important feature of operation of the bandage is the circumferential foreshortening which arises from the outward distention of the walls of cells **14** (FIG. 7) which tends to draw the seams **13** toward one another as indicated by the arrows. Since the bandage does not shift circumferentially, the seams **13** cannot actually be displaced, and the net effect is to build up hoop tension in the turns of bandage, which causes the constricting pressure to be applied along the full circumference of each turn, beneath the seams **13** as well as beneath the cells **14**.

The bandage can be produced in varying lengths for use on limbs of varying sizes. For unusually large limbs, several shorter bandages can be attached, end to end and inflated successively, the inflation of the second one being delayed until the first is completely inflated.

By way of illustration of one possible means of securing the tape at the end of the wrapping, a fastener tape is indicated at **36** in FIG. 1.

Inflation means **12** includes a hose of sufficient length to extend beyond the sterile field of operation, and includes a bacterial filter **37** which is positioned to fall outside said sterile field.

We claim:

1. A bandage for pre-surgery use in driving fluids from an area of a patient's limb to be operated, and for reduction of vascular tree volume in the immediate treatment of shock, when wrapped around the limb helically in successive turns, comprising:

- a length of generally flat tubing of thin plastic sheet material including:
  - longitudinally-spaced transverse seams defining within said tubing a plurality of gas cells,
  - each of said seams having at least one end thereof spaced from an adjacent side of the tubing to define a series of restrictetd ports interconnecting said cells,
  - means on at least one face of said bandage for engagement with the other face thereof in a succeeding turn of the wrapped bandage, such as to provide non-slipping attachment of successive turns to one another,
  - and means at one end of the bandage for injecting gas under pressure into the cell at that end, whereby to effect progressive inflation of successive turns of the wrapped bandage from one end to another so as to drive out fluids from the wrapped portion of the limb.

2. A bandage as defined in claim 1, wherein said tubing is of heat-sealable plastic material and said seams are heat-sealed strips of junction between the opposed tubing walls.

3. A bandage as defined in claim 2, wherein said tubing is of polyethylene material.

4. A bandage as defined in claim 1, wherein said restricted ports are provided at both sides of the bandage.

5. A bandage as defined in claim 1, wherein said nonslipping engagement means comprises a roughened surface on said tubing.

6. A bandage as defined in claim 1, wherein said nonslipping engagement means comprises a facing of pressure-sensitive adhesive on a face of said tubing.

7. A bandage as defined in claim 1, wherein said nonslipping engagement means comprises a longitudinal stripe of pressure-sensitive material on one face of said tubing, located nearer one side of the tubing than the other.

8. A bandage as defined in claim 1, wherein said nonslipping engagement means comprises a plurality of longitudinally spaced diagonal stripes of pressure-sensitive adhesive extending transversely of said tubing.

9. A bandage as defined in claim 1, wherein said nonslipping engagement means comprises a covering of gauze having portions thereof embedded in and thus attached to said seams.

References Cited

UNITED STATES PATENTS

2,044,691	6/1936	Hoflinger	128—327
2,272,481	2/1942	Rinkes et al.	
2,699,165	1/1955	Ferrier	128—60
3,164,152	1/1965	Nicoll	128—87

L. W. TRAPP, *Primary Examiner.*

U.S. Cl. X.R.

128—24, 299