

[54] **PNEUMATIC APPARATUS FOR HOLDING THE POSTURE OF PARALYZED, DISEASED, DISABLED OR WOUNDED PERSONS**

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[51] Int. Cl. **A61f 5/04**

[58] Field of Search..... **128/87, DIG. 20, 1; 2/2.1 R, 2.1 A, DIG. 3**

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[57] ABSTRACT

The apparatus according to this invention comprises essentially a pair of trousers, or an overall of special, lightweight and high-resistance material, retained on the wearer's body by suitable means such as suspenders, belts, trouser-straps, et cetera, provided with zip fasteners and adjustable through suitable means such as lacing, these trousers having incorporated therein a plurality of separate flexible inflatable tubes adapted, when inflated, to impart to the various portions involved the desired rigidity permitting of holding the proper posture or position.

12 Claims, 5 Drawing Figures

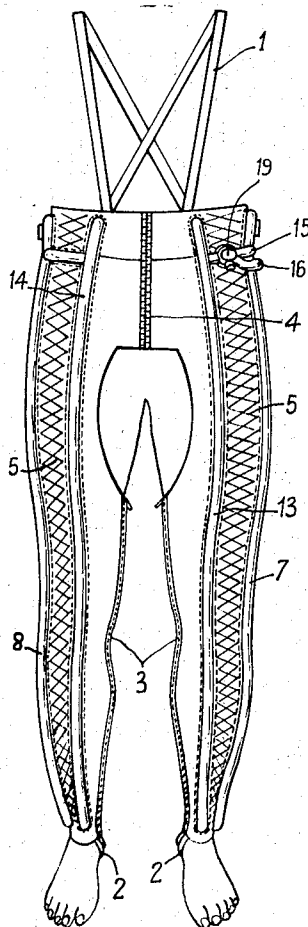


Fig:1

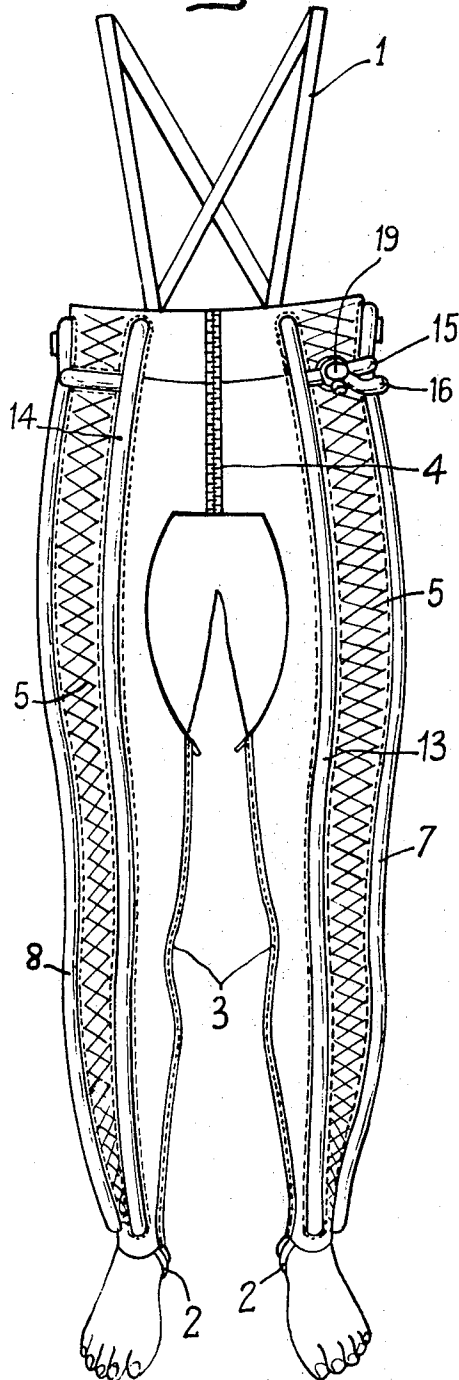
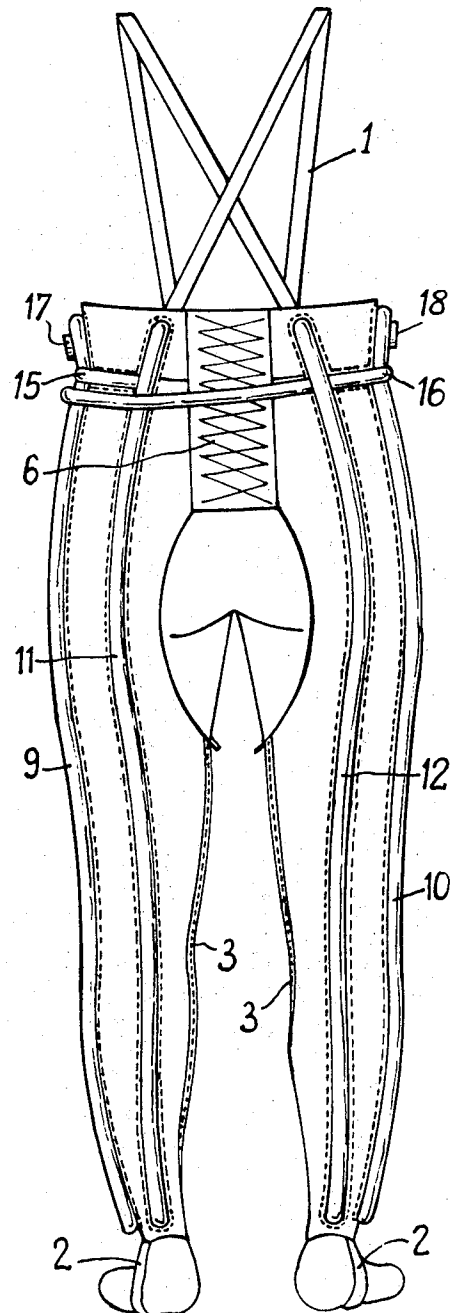


Fig. 2



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Fig. 3

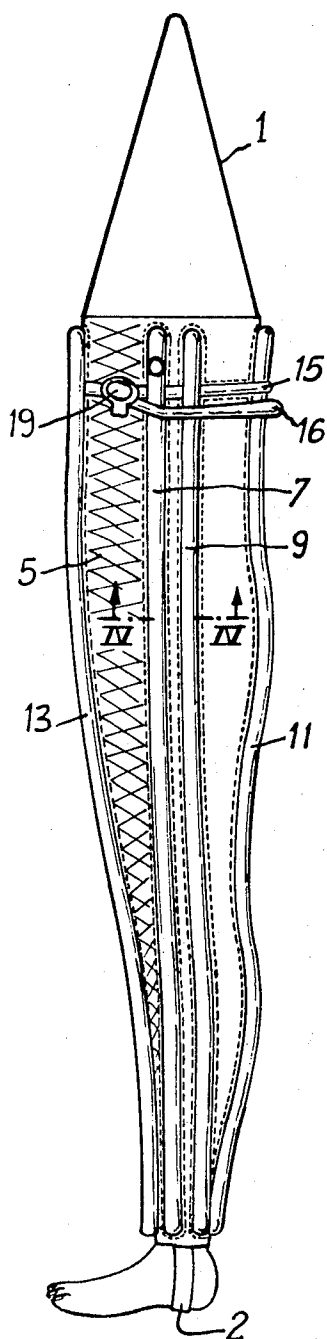


Fig. 4

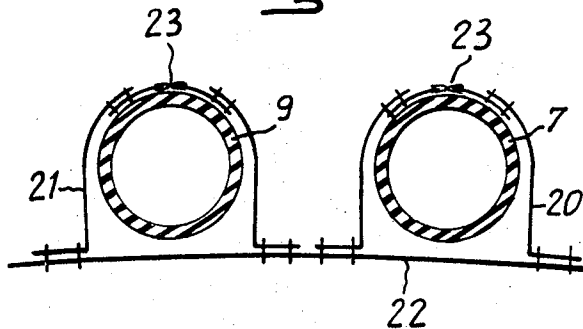
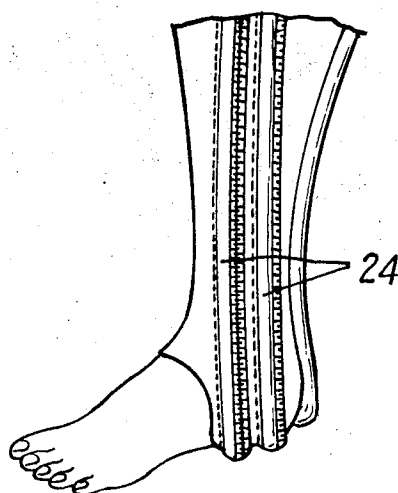


Fig. 5



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PNEUMATIC APPARATUS FOR HOLDING THE POSTURE OF PARALYZED, DISEASED, DISABLED OR WOUNDED PERSONS

BACKGROUND OF THE INVENTION

This application is a continuation of my application Ser. No. 172,617 filed Aug. 18, 1971.

This invention relates in general to pneumatic apparatus for holding the posture of paralyzed, diseased, disabled or wounded persons, that is, an apparatus adapted, when inflated, to hold and support in a nearly rigid manner one portion of the wearer's body, for the purpose of either permitting a particular desired posture or attitude, by acting as a stiffening element, or absorbing one fraction of the efforts likely to be exerted on the skeleton and to cause the rupture of a fragile bone thereof, or alternately for permitting the re-education of an injured person after a fracture.

BRIEF DESCRIPTION OF THE PRIOR ART

The apparatus according to this invention are intended more particularly for holding the body of a patient suffering from a paralysis of the lower limbs, in order to assist him when walking. Conventional apparatus aiming at this specific result are made in general of metal and leather, thus implying considerable and permanent weight and rigidity which, in most instances, are difficult to bear by the patient, thus limiting the time during which they can be used, and also the amplitude of the permissible movements. Moreover, a fall with conventional apparatus may cause severe wounds and thus a considerable fraction of the safety characteristic of those apparatus is eliminated, this also applying to the self-confidence absolutely necessary for re-educating the patient. Besides, any change in volume, due either to a momentary oedema or to a loss of body weight, are not compensated under any circumstances with those conventional apparatus.

There have been many proposals in the prior art, such as Versoy et al. 2,397,710, to supply aviators with acceleration belts and stockings to prevent flow of blood into the lower extremities during high speed turns where the centrifugal force applied to the aviator often causes loss of consciousness. Such suits or accessories are tightly fitting so that blood flow is decreased under the foregoing circumstances. Such suits provide for flexibility of the knees so that the aviator can operate the controls, occupy a sitting position and in other respects be ambulatory.

It has also been proposed, Jobst 2,747,570 to provide garments with contour fitting properties about the lower extremities together with tubular members so disposed and arranged that upon inflation the compressive forces on the flesh are increased and upon release of pressure those forces are reduced. Thus by alternately increasing and decreasing the pressure, assistance is given in the circulation of fluids from and to the extremities. Such arrangements are beneficial where circulation has been impaired.

There have also been developed the so-called "space-suits" worn by the astronauts in outer space, the purpose being of course to apply the equivalent of atmospheric pressure to the body to prevent "bends" or otherwise exploding blood vessels which would result in quick loss of life.

Though tubular means have been included in many of the prior arrangements, none embodies the features essential to the instant invention which is an arrangement which makes life more bearable for persons dependent upon wheelchairs or other appliances due to impairment by disease, paralysis and even congenital defects of their lower extremities.

It is the essential object of this invention, applied to the problem set forth hereinabove, to utilize much lighter materials and co-ordinate a flexible holding of the joints with an efficient assistance to the walking movements. Now, so far as the applicant is aware, none of the apparatus proposed heretofore was capable of meeting these contradictory requirements and enabling the user or wearer to walk without any abnormal strain and keep the apparatus on him or herself all day long, in any desired positions, and without any inconvenience.

SUMMARY OF THE INVENTION

The apparatus according to this invention comprises essentially a pair of trousers, or an overall of special, lightweight and high-resistance material, retained on the wearer's body by suitable means such as suspenders, belts, trouser-straps, et cetera, provided with zip fasteners and adjustable through suitable means such as lacings, these trousers having incorporated therein a plurality of separate flexible inflatable tubes adapted, when inflated, to impart to the various portions involved the desired rigidity permitting of holding the proper posture or position.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to afford a clearer understanding of this invention, a typical form of embodiment thereof will now be described in detail, together with a modified form of embodiment, the apparatus illustrated being intended for holding a person upright and also to assist the wearer when walking or attempting to walk, notably in the case of paralyzed, disabled, wounded persons, notably those having fragile bones. In the drawings:

FIGS. 1, 2 and 3 are a front view, a rear view and a side view respectively of the pants or overalls according to this invention for holding the lower limbs;

FIG. 4 is a detail section showing the incorporation of juxtaposed inflatable tubes in the apparatus, and

FIG. 5 is a fragmentary view of a modified form of embodiment suitable for protecting and assisting a diseased person having fragile bones.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The overalls or garment elements illustrated in FIGS. 1 to 3 of the drawings in the form of close-fitting trousers are held in position by suspenders 1 and trouser-straps 2 adapted to pass under the wearer's feet. A pair of zip fasteners 3 extend along the two legs, thus permitting the easy and quick putting on of the apparatus, and an abdominal fastener 4 is provided for completing the donning operation. Lacings 5 are also provided along the two legs for compensating the changes in volume of the wearer's limbs while permitting an adjustment affording the best possible fit to the contour of each limb without interfering with the blood circulation under any circumstances; if desired, this fitting may be completed by a back lacing 6.

The overalls illustrated are intended for supporting a set of flexible inflatable tubes, adapted when inflated to become sufficiently rigid. In the example illustrated, which should not be construed as limiting the scope of the invention, but corresponds to a position appearing as a preferable one, each leg comprises four substantially parallel vertical tubes designated by the reference numerals 7, 9, 11 and 13 for the left-hand leg and 8, 10, 12 and 14 for the right-hand leg. The lateral tubes 7, 8, 9 and 10 disposed externally of the legs and extending upwards along the two sides of the pelvis, up to the waistband, are intended for firmly holding or locking the joints of the hips and knees. The rear tubes 11, 12 act partially like the major gluteal muscles, which are the largest and most powerful muscles of the human body, and also as extensors for the thigh in relation to the pelvis. These tubes are also provided for holding or locking the hip and knee joints. The front tubes 13 and 14 are intended for flexibility holding the legs while promoting a slight recurvatum of the knees; they act somewhat as substitutes for the quadriceps, i.e., the muscle extending the leg in alignment with the thigh.

Another pair of tubes 15 and 16 are provided around the waist for interconnecting all the aforesaid tubes, tube 15 being connected to the left-hand tubes 7, 9, 11 and 13, and tube 16 to the right-hand tubes 8, 10, 12 and 14.

A pair of valves 17, 18 controlled by means of an airtap 19 connected to a source of fluid under pressure are provided for supplying this fluid to the left-hand and right-hand tubes, respectively, while permitting the separate inflation thereof (for example, when changing from the sitting to the standing position), or the simultaneous inflation (for instance for walking). By turning the tap 19 in one or the other direction, the wearer can inflate the desired leg and take a bearing on this leg for beginning to stand up, whereafter the second leg is inflated for standing completely (for example, when the wearer wishes to get up from an armchair). The valves 17 and 18, when actuated by the user, permit of draining the tubes of one or the other leg or to reduce the pressure therein, for example, in order to perform movements likely to be counteracted by an excessive inflation, for instance, for getting into or out from a car.

The source of fluid under pressure consists of a cartridge (not shown) secured to the garment, but in recreation rooms, it is more convenient to provide a permanent source to which several patients can be linked up. This permanent source may consist, for instance, of a bottle considerably larger than a cartridge, whether on board a car or in a private house.

FIG. 4 illustrates by way of example the arrangement comprising a pair of inflatable tubes 7, 9 in corresponding sheaths 20, 21 incorporated in the overall and sewn, for instance, to the material 22 thereof; each sheath advantageously comprises a quick-action fastener 23, for example, of the zip type, extending longitudinally to permit the access to the inner tube in case of inspection, maintenance, repair or replacement thereof.

As shown, each of the sheaths 20 and 21, of the high-resistance flexible material is stitched to the high-resistance flexible material which forms part of the contour fitting of the device to the person in need of it. The major portion of the circumferential wall of each sheath is separate from the enclosing means 22. The external sheaths which accommodate the inflatable tubes

or bladders 7 and 9 permit limited expansion of the bladders upon inflation, but without significant shortening of the distance between the left and right hand stitching of each sheath. In other words, the length of each circumferential wall of each tubular enclosure which is separate from the enclosing means 22 is greater than the length thereof common to the enclosing means so as to permit inflation of the tubular enclosures 21 outwardly of the enclosing means 22 in avoidance of a development of any substantial compressive forces radially of the enclosed limb. As each tubular enclosure is inflated, as by its bladder forming a gas impervious wall-structure, it expands and then prevents further expansion of the bladder. As the pressure continues to rise, the sheath of each tubular enclosure is placed under tension in all directions, radially and longitudinally, because it fully encloses the bladder, the only access thereto being by way of the normally closed quick-action fasteners 23 and the manifold.

As earlier explained, the pressure of the fluid supplied to each inflatable tube or bladder determines the rigidity of the structure needed to lock in place the body joint it encloses. Thus, when a person has been sitting and desires to stand, it will be remembered that pressure will be applied to one leg so that it will be locked in place and will withstand bending moments imposed by the weight of the wearer. Thus, the person can rise from a chair on the one leg and thereafter inflate the tubes or bladders forming part of the sheath assembly associated with the other leg to rigidify it and thus permit the person to be ambulatory. It is obvious that the extent of pressure applied will depend upon the requirements of each person to which the device is adapted and for a child of light weight, the requirements will be very much lower than in the case of a heavy adult who would impose upon each of the leg structures moments quite high as compared to those imposed on the leg structure by a child.

In the modified form of embodiment illustrated in FIG. 5 and intended more particularly for a patient having fragile bones, the overall and the inflatable tubes, such as 24 may extend substantially down to floor level in order to provide a kind of semi-rigid bearing for relieving the bones of the lower limbs and thus avoiding any fracture thereof.

The above-described apparatus is adapted not only to lock the joints in a rather flexible manner, but also to provide an efficient assistance in the walking movement. Another advantageous feature of this apparatus is its extremely low weight, the facility of fitting and removing same to and from the patient's body, and, also, the fact that it is well tolerated by the cutaneous tissues, in that it will not cause any lesion, even after a prolonged use.

In addition, it imparts a great self-confidence to the diseased or wounded user, notably when the patient is confronted with difficulties such as stepping up and down curbs, steps, inclines, walking on slippery pavements, et cetera.

Of course, this invention should not be construed as being strictly limited to the assistance to the patient's lower limbs, for it can be used to advantage in the re-education of wounded patients suffering from any fractures, by wearing a garment element fitting properly to the body portion concerned, in a manner somewhat similar to that set forth hereinabove in connection with the lower limbs.

Although the present invention has been described with reference to preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the basic principle of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

What I claim is:

1. In a pneumatic apparatus for supporting a part of the body which is paralyzed, deformed, diseased, disabled or wounded comprising:

a garment of configuration for closely fitting at least said part of the body of a user requiring support and comprising flexible sheet material having longitudinal slits,

fastening means attached to said material for closing at least some of said slits;

adjusting means attached to said material for drawing together said material;

flexible inflatable tubes of material which limits the extent of expansion of the tubes and which are secured to and positioned longitudinally of and on the exterior of said garment;

means for inflating said tubes to a desired stiffness to support said part of the body of the user;

the improvement in which said inflatable tubes have circumferential wall-structure, the major portion of which is external and free from attachment to the material of said garment whereby when said tubes are fully inflated the common wall between the tubes and the garment is not significantly shortened and there is avoidance of development of compression forces radially inward of said garment which would impede blood circulation while imparting rigid support to the body.

2. Pneumatic apparatus as claimed in claim 1 wherein said garment has leg portions with slits extending the length of each leg portion and to the height of the pelvis portion of the garment and lacing extending through the material on each side of said leg portion and across pelvis portion.

3. Pneumatic apparatus as claimed in claim 2, wherein the lower ends of said leg portions include trouser-straps capable of extending under the user's feet.

4. Pneumatic apparatus as claimed in claim 2, wherein said tubes have lengthwise slits and fastening means attached to said tubes for opening and closing them.

5. Pneumatic apparatus as claimed in claim 3, wherein some of said tubes extend along said trouser-straps for lateral positioning thereof under the users' feet.

6. An orthopaedic garment for supporting a portion of the body comprising:

close-fitting trousers having at least one leg member formed from flexible lightweight sheet material and provided with longitudinal slits;

adjustable fastening means attached to said material for closing said slits; and

a plurality of elongated cylindrical inflatable tubes positioned longitudinally on the exterior of said material and having a limited extent of expansion;

said plurality of tubes, including tubes positioned to provide rigid support of the front and rear of said

leg member when inflated for substantially locking the knee joint of said leg member in an extended position;

said tubes having wall-structure, the major portion of which is external to said material forming said trousers whereby when said tubes are inflated there is avoidance of development of forces radially inward on the body which impede blood circulation.

7. Pneumatic means for making life more bearable for persons who are dependent upon wheelchairs or other appliances due to impairment by disease, paralysis or congenital defects of the lower extremities of their bodies, which comprises:

enclosing means including flexible lightweight material for close contour fitting from above the hip joint to at least the ankle of at least one lower extremity subject to said impairment,

bend-resisting means extending along the outer surface of said enclosing means from above the region of the hip joint to the region of the ankle comprising circumferential wall-structure forming a plurality of coextensive tubular enclosures some of which provide support in front of and behind the knee portion, said enclosures consisting of material closed throughout and at least in part separate from said enclosing means, and being limited in extent of expansion,

gas impervious wall-structure associated with said tubular enclosures,

said circumferential wall-structure separate from said enclosing means having a greater length than the length of said circumferential wall-structure common to said enclosing means so as to permit inflation of said tubular enclosures outwardly of said enclosing means in avoidance of development of compression forces impeding blood circulation radially of said enclosing means while imparting rigid support to the body, and

means for inflating said tubular enclosures to produce a combined stiffness of said tubular enclosures greater than any bending moment which can be produced upon them by the weight of the body thereby providing that degree of support which enables said persons to be ambulatory.

8. The pneumatic means of claim 7, in which a zip fastener extends from the crotch to the waist for securing together the upper portion of said enclosing means, and

zip fasteners extending from the crotch to each extremity to secure together each leg portion of said enclosing means.

9. The pneumatic means of claim 7, in which said enclosing means includes lacing structure extending from each leg portion up through and including the hip portion thereof, and lacing means for producing said contour fitting of said garment to the person being fitted.

10. The pneumatic means of claim 7, in which said bend-resisting means includes tubular enclosures extending from the remote end of each lower extremity upwardly to and including the hip portion and respectively located on the outermost portions of the leg structure intermediate the previously referred to tubular enclosures.

11. The pneumatic means of claim 7 in which there is included,

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valve structure for (1) selectively admitting air under pressure to the bend-resisting means associated with one leg portion to the exclusion of the bend-resisting means associated with the other leg portion, (2) jointly applying air pressure to all of said bend-resisting means, and (3) simultaneously releasing said air pressure to establish a lower pres-

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sure.

12. The pneumatic means of claim 7, in which each said gas-impervious wall-structure comprises a bladder, and normally closed zipper fasteners for each of said tubular enclosures which when open provide access to said bladders disposed therein.

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