

[54] **ELASTIC GARMENT FOR IMPOSING
PRESSURE ON UNDERLYING BODY
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Tenteris, both of Toledo, all of Ohio[73] Assignee: **Jobst Institute, Inc.**, Toledo, Ohio[22] Filed: **May 24, 1973**[21] Appl. No.: **363,400****Related U.S. Application Data**[63] Continuation of Ser. No. 99,214, Dec. 16, 1970,
abandoned.[52] U.S. Cl. **128/165, 2/240, 128/DIG. 15**[51] Int. Cl. **A61f 13/00**[58] Field of Search **128/165, 166, 156, 157;**
2/239, 240[56] **References Cited****UNITED STATES PATENTS**

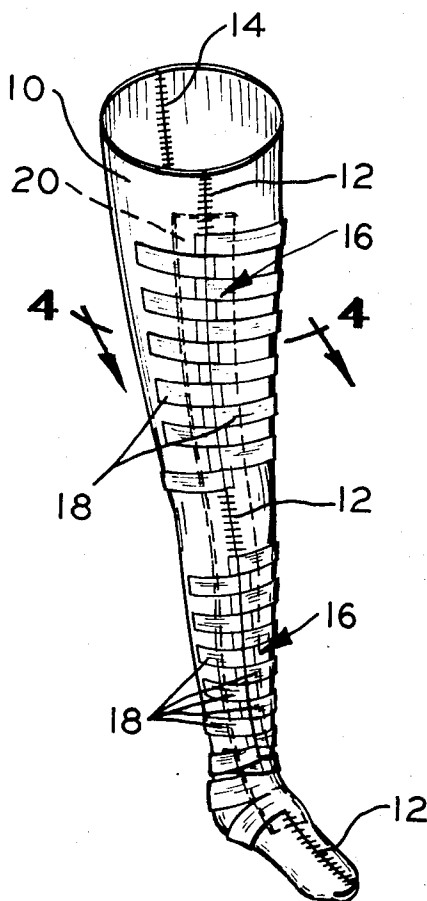
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Primary Examiner—Richard A. Gaudet*Assistant Examiner*—J. Yasko*Attorney, Agent, or Firm*—David H. Wilson[57] **ABSTRACT**

A garment for applying high pressures to an animal body is illustrated in a typical embodiment as a leg stocking having openings between circumferentially closed portions at the knee and the ends thereof. The openings allow relatively easy removal and application of the stocking which is stretchable in two directions giving movement lengthwise for flexing joints, and stretching circumferentially to apply a high pressure gradient to the leg over substantially the length of the stocking. The stocking is tailored to maintain the pressure gradient in the closed portions, and interdigitized cross links with fasteners operate independently on selected portions along the length of the openings to continue the gradient in this area upon closing the openings by overlapping the fasteners.

6 Claims, 5 Drawing Figures

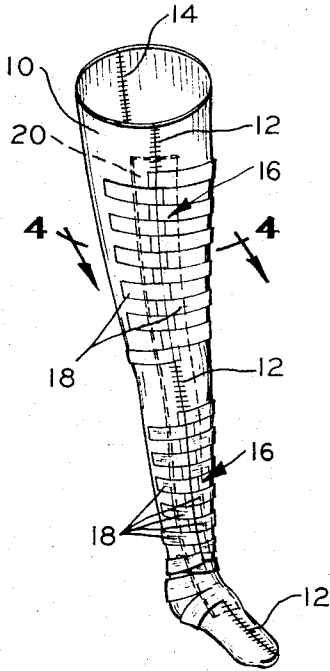


FIG. 1

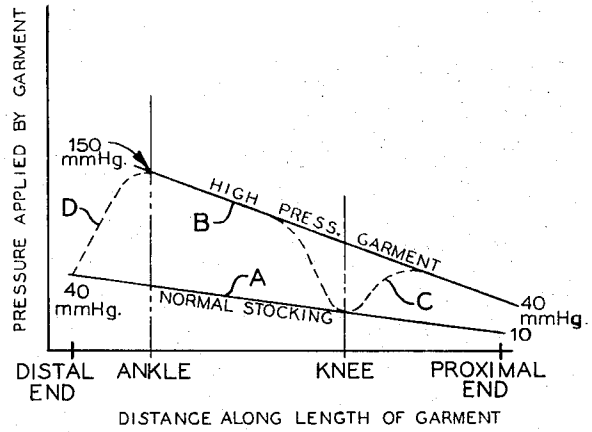


FIG. 2

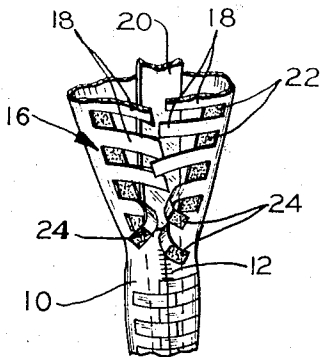


FIG. 3

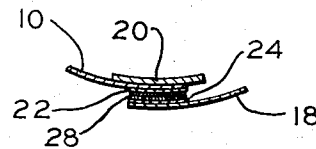


FIG. 4

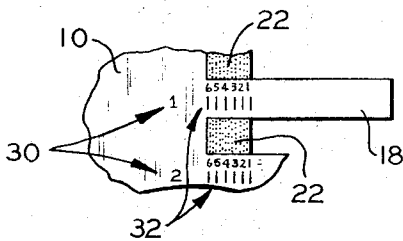


FIG. 5

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ELASTIC GARMENT FOR IMPOSING PRESSURE ON UNDERLYING BODY REGIONS

This is a continuation of application Ser. No. 99,214, filed Dec. 16, 1970, now abandoned.

BACKGROUND OF THE INVENTION

Heretofore pressure stockings capable of maintaining a pressure gradient which increases toward the distal end of a limb encompassed by the stocking have been produced. Such a pressure gradient aids the return of blood to the heart and reduces accumulation of lymph fluid. The pressure stockings of the prior art feature a design having its circumference closed by a permanently sewn seam over the entire length wherein the cross-sectional circumference of the stocking, relative to the cross-sectional circumference of the limb decreases toward the distal end to develop a greater pressure on the surface of the limb at points more remote from the body. A stocking structure of the above type is described in U.S. Pat. No. 2,574,873 issued to C. Jobst — Nov. 13, 1951.

In certain extreme cases of massive lymphedema the above stocking was incapable of applying the required pressure which was two to three times the pressure of the above sewn seam pressure stocking. When the pressure applying capabilities of the sewn seam stocking were increased to the proper magnitude, it was found that the wearer could no longer don the stocking. Alternatively, garments with openings along the seams to facilitate application and removal were tried in an effort to achieve the requisite pressure and facilitate donning. Laced seams tended to slip and thereby equalize the pressure over the length of the garment. Thus, in practice, the pressure gradient could not be accurately established and over a reasonable period of wear, the gradient was dissipated by slippage of the laces. In addition, the lace inhibited longitudinal stretching and resulted in creep of the garment against the surface of the covered limb toward the distal end thereof, thereby chafing the patient. When other closure or fastening means were employed, the results were similar due to the continuous nature of the structure supporting the fasteners inhibiting longitudinal stretching of the garment.

Burn treatments have been developed wherein during the advanced healing process the application of pressure of about 5 to 10 m.m. of Hg inhibits scarring characterized by excessive re-growth of tissue in the injured area. Where body regions are to be healed as in the case of the human torso pressures imposed by enveloping tubular constraining structures can be developed only with rather substantial forces in view of the broad areas involved. Application of elastic constraining tubular garments, where sufficient tension is applied to achieve the desired pressure, has been difficult since burn scar tissue is particularly sensitive and vulnerable to shear forces. Further, when a constraining garment is mounted over burn scar tissue and the patient permitted to move, shear forces should be minimized, wrinkles in the garment due to gathering of material should be avoided, shifting of the garment as by twisting or creeping, should not occur, and chafing of the underlying tissue by the garment or pads which it constrains should be minimized.

SUMMARY OF THE INVENTION

This invention relates to pressure or compressive type health garments for animal bodies, and more particularly, to garments capable of exerting pressures two to four times those available in known pressure type garments, which can be readily drawn over the body to be encased. The garment has the ability to maintain a pressure gradient on a body along the length thereof and is also capable of providing pressure relief at predetermined regions.

Typical of a garment having the above features is a stocking for supporting a leg consisting of elastic material stretchable in two directions to allow flexure of joints by longitudinal stretching, and radial pressure by circumferential stretching. The stocking encases the leg by virtue of circumferentially enclosed ends between which an opening or openings extend, closable by independently operable fasteners after the leg is inserted through the enclosed end. The pressure gradient over the length of the stocking is established by tailoring the stocking to a circumferential dimension progressively decreasing from the proximal toward the distal end in greater ratio than that of the leg to be encased. Open portions of the stockings are closed by the fasteners which can be positioned to provide the desired circumferential constrictive force.

This type garment is capable of exerting higher pressures than stockings known in the prior art. Both closed and open seam portions as well as the garment material are of a nature which allows longitudinal stretching to give freedom for joint flexure where required. Material for the garment can be tailored to provide a pressure gradient over the entire stocking length, and the open seam is articulated longitudinally by independent fasteners which can maintain pressure levels in portions of the garment adjacent the fastener to continue the pressure gradient over the length of the open portions. Fasteners having graded indices may be employed to enable a predetermined pressure to be applied in a selected region by merely placing the fastener adjacent the proper index. The opening renders the garment easily donnable by the wearer. The capability of adjusting the pressure of predetermined portions of the stocking material along the length of the opening allows gradual pressure gradients to be developed thereby militating against wrinkling of the garment and accompanying surface chafing and sores on the encased body.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a leg stocking in accordance with the concept disclosed;

FIG. 2 is a diagram illustrating pressure gradients and magnitude of pressures involved for a normal stocking by curve A, a high pressure garment by curve B, and modifications of the garment curve B in curves C and D to obtain a leg stocking;

FIG. 3 is a fragmentary perspective view of the stocking of FIG. 1 with the upper seam opened to expose both a liner and fastener engaging elements;

FIG. 4 is an enlarged fragmentary cross sectional view taken along line 4—4 of FIG. 1; and

FIG. 5 is an enlarged fragmentary elevational view of the fasteners, illustrating the graduated indices thereon.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, FIG. 1 illustrates an embodiment of a pressure type garment for use at pressures higher than those obtainable with exclusively sewn seam stockings. A garment of the type illustrated will be referred to, for convenience, as a "high pressure garment" and the sewn seam stocking as a "normal stocking." The high pressure garment is illustrated in the form of a leg stocking for supporting the thigh, calf, ankle and instep portions of a leg. The stocking material 10 is an elastic fabric stretchable in the longitudinal and circumferential directions. The circumference of the stockings is enclosed at the top, knee and foot by the sewn seam 12. The sewn seam 12 is fabricated by a multiple thread process which maintains the stretchability of the stocking material 10 where the seam is formed, particularly in the longitudinal direction. Typical of the sewn seams 12 and 14 illustrated is a seam by a Wilcox and Gibbs five-needle sewing machine, which seam is known in the trade as a "flatlock seam." Where the encased body does not have a smooth contour, an additional seam in the region where changes in contour occur, may be introduced as illustrated by the rear sewn seam 14. Location of seams is not limited to the positions in FIG. 1. Seams are located as required by the contour of the garment and their utility for the wearer.

The leg stocking is formed in a manner similar to the stocking illustrated in U.S. Pat. No. 2,574,873 issued to C. Jobst — Nov. 13, 1951, which discloses a stocking "having variation in radial pressure at different points in the length of the stocking so as to secure just the required amount for assisting circulation without danger of strangulation." The graduation in the pressure results in a pressure gradient generally as illustrated by curve A of FIG. 2. The ideal pressure gradient for a high pressure garment is illustrated by curve B. While pressure levels vary with the wearer's needs, a pressure gradient in a normal stocking of 10 to 40 m.m. Hg is practical and usable. In a high pressure garment, the range would be 40 to 150 m.m. Hg, approaching four times the level of the normal stocking.

The high pressure garment stocking material 10 has a modulus of elasticity of two to four times that of the fabric of a normal stocking. Typically, powernet or bobbiset materials can be used as the stocking material 10.

Openings 16 on the front of the leg stocking between the sewn seams 12 are illustrated in FIG. 1 as closed by tabs 18. When the tabs 18 are unfastened, the openings 16 give the leg stocking clearance to pass over the leg to be encased. FIG. 3 illustrates the tabs 18 in more detail and reveals an inner liner 20 which may be used between the skin surface and the openings 16 to afford the wearer comfort from the edges of the openings 16. The liner is depicted by hidden lines in FIG. 1, and can be inserted as an independent element or attached to the knee portion of the leg stocking. The tabs 18 above the sewn seam 12 at the knee are illustrated in a non-engaged position in FIG. 3. Tabs 18 are extensions of the stocking material 10 and, therefore, are stretchable both in the longitudinal and circumferential directions. They are distributed over the length of the openings 16 with adjacent tabs 18 extending from opposite sides of the openings 16. Extension of tabs 18 as integral por-

tions of the stocking body from opposite sides of the openings 16 in an alternating pattern enables the tabs 18 to be interdigitated when lapped over the openings 16 which have been pulled closed. The alternating extension of tabs 18 from opposite sides of openings 16 decrease the tendency of a garment to twist and reduces oblique friction forces on the skin of the enclosed body which causes abrasion and chafing.

Advantageously, the tabs 18 can be secured by fasteners made up of pads 22 and 24 having facings of fibrous entanglements 28, as illustrated in FIG. 4. Pads 22 each can be an array of loops on a fabric backing secured to the outer face of the body of the stocking in spaced positions with which the tabs 18 will register when drawn across the openings 16. In this manner the stocking material in the zones between pads 22 and forming the base regions of tabs 18 extending to the opposite side of opening 16 are of the same elastic character as the major body portions of the stocking. Pads 24 each can be an array of hooks on a fabric backing secured to the inner face of the tabs 18 near their ends. The mating portions 22 and 24 hold securely upon pressure engagement of the faces and can be manually peeled apart to render the openings 16 accessible. An example of the fasteners illustrated are those commercially available under the trademark "VELCRO." The fasteners have the advantage of infinite adjustment in the direction transverse of the stocking. Other types of fasteners could be used, for example, snaps, buttons or hooks. Since the tabs 18 are extensions of the stocking material 10, pulling each tab across an opening 16 to a predetermined point establishes the circumference for that portion of the leg stocking, thereby producing the desired constructive force and radial pressure. Due to the flexible nature of the stocking material 10, the tabs, being extensions of the stocking material 10, are independent of each other enabling that portion of the leg stocking attached to one cross link 18 to be stretched to a different circumferential dimension than the portion attached to an adjacent tab 18. The pressure gradient available in a tailored sewn seam is, therefore, also achieved in the portion of the leg stocking having tabs 18.

The flexibility of the tabs 18 allows the pressure gradient applied by a leg stocking to be varied without abrupt pressure changes to give pressure relief to an area like the knee. FIG. 1 illustrates a sewn seam at the knee which is tailored to establish a pressure level of a normal stocking in the region of the knee to prevent strangulation at the knee. A transitional gradient from the higher pressures along the openings 16 through the lower pressures of the closed knee region of the garment can be tailored entirely in the open regions, entirely in the closed region, or partially in each of the contiguous regions. Strangulation would occur at the knee if the pressure level indicated by the ideal high pressure gradient, curve B of FIG. 2, was applied to the blood vessels at or near the surface of the area behind the knee. The dotted line curve C is indicative of the pressure relief afforded the knee and illustrates the smooth transition of the slope of the pressure gradient curves as the pressure falls to that of the normal stocking and then returns to the ideal gradient, curve B, for the high pressure garment. Similar relief is given to the foot and instep where pressures would otherwise exceed the tolerable comfort zone of the wearer. The highest pressures, therefore, exist at the ankle of the leg

stocking and, in practical applications, are as high as 150 m.m. Hg. The dotted line curve D of FIG. 2, illustrates the drop in pressure from the ankle to the instep and foot.

The degree of stretchability in the longitudinal direction and flexibility in achieving smooth pressure gradients in a high pressure garment increase with an increase in the number of tabs per unit length of garment opening 16 and is adjustable to the requirements of each case. Since the tab circumferentially stretches a select portion of the garment, the smooth transitions of pressure gradient can be achieved. Such transitions are especially useful where pressure relief is required for a region of the body. The tabs can be adjusted to optimize the transitions and minimize the tendency of the garment to wrinkle.

FIG. 5 illustrates a predetermined indexing system having longitudinal and transverse indices 30 and 32, respectively. The transverse index 32 is a guide for the amount of pressure to be applied by indicating how far the ends of the tabs 18 should be pulled past the opening 16, and the longitudinal index 30 locates the various portions of the stocking to which a select pressure is to be applied. The transverse indices 32 are placed in between the fastener pads 22, placing each adjacent its mating tab 18 when pulled to the closed position.

The preferred embodiment illustrates a leg stocking but could just as well have been any of numerous garments for any limb of an animal body and, further, for bodies other than limbs, such as corsets and the like, wherever a graduated degree of support is required. An infinite number of combinations of sewn seams 12 and openings 16 may be utilized as required by particular applications. A high pressure garment could be achieved without the use of any sewn seams employing the tabs 18 and fasteners 22 and 24.

Other embodiments of the garment include pressure bandages, particularly those requiring the development of high tension in the elastic material of the garment body such as is required for burn garments. Typically a burn vest can be employed for the treatment of burn scars in the torso. Such vests embrace the torso. They can be applied to the patient most conveniently if provided with an opening extending longitudinally of the tubular body which registers with the injured body region, as opening 16. The closure comprised of interdigitated cross links 18 of elastic material with adjacent cross links 18 extending from opposite sides of the openings enables such an opening to be closed in a manner to develop the necessary tension in the material of the garment body portion without imposing shear on the patient. In particular, the garment can be pre-tensioned before it is closed around the patient and then closed on the patient by imposing essentially only radial inwardly directed forces as it is brought into contact with the wound dressings. The balanced tension maintained across the closed opening by the interdigitated cross links extending from opposite sides of the openings avoids the usual localized pulling transverse of the opening as imposed by most prior art closure structures where tension is developed from but one side. Further, while the individual tabs and the garment body were stressed before being closed they do afford a means of localized adjustment. By employing discrete tabs or extensions 18 of elastic material on each side of the garment opening 16 spaced apart at least the width of interdigitated extensions and provid-

ing individual securing means individually secured on the face of the main body of the garment as the Velcro pads 22, the usual constraints against longitudinal elasticity of the garment are avoided in that a region of the body material, unconstrained by securing means, is available between each extension securing pad 22. A zipper closure or a Velcro strip parallel to the opening and secured to the body portion does not provide this longitudinal elasticity. As a result, movement of the patient is accommodated in small increments over the enclosed body portion without imposing sheer longitudinal of the garment opening and without developing the gathered and thus wrinkled area typical of those prior art closures.

It is significant that the opening of the garment is closed without the closure means imposing any components of force longitudinal of the opening. The elastic cross links or extensions 18 extend across the opening 16 generally perpendicularly to the margins of the opening through all of the range of forces imposed. Prior art lacings impose longitudinal forces on the opening margins and garment portions in their vicinity by virtue of the runs of the laces parallel to the opening or inclined from a perpendicular to the opening. As the prior art garments with lace closures are subject to body movement the lacings tend to shorten the garment along the length of the opening, gather the material of the garment body along the opening, wrinkle the garment and impose shearing stress on the tissue enclosed.

From the above it will be appreciated that certain features of the garment construction offers advantages in applications other than those involving pressure gradients as where uniform pressure with minimized shearing stress is desired for burn garments. Such burn garments frequently are required to develop substantial force in order to produce the requisite pressure over the large areas to which they are applied.

In the case of the pressure gradient stocking, the garment is one capable of exerting pressures two to three times that of a normal stocking and capable of establishing a pressure gradient upon a body. The garment, sewn seams and tab closed openings are stretchable longitudinally to eliminate garment creep relative to the surface of the body encased. Pressure relief can be given to regions of the enclosed body requiring it, and smooth transitions of pressure gradient militate against chafing. The pressure relief prevents strangulation and affords the wearer comfort as well as joint flexibility. The garment openings render the garment easily donnable and the opening fasteners are securable manually. Fasteners of the type illustrated are infinitely adjustable and especially adaptable to indexing systems. The tabs allow subsequent adjustment of pressure levels upon the wearer's improved or worsened condition.

What is claimed is:

1. A leg stocking comprising a main body portion including thigh, knee, calf, ankle, instep and foot portions of generally tubular shape and of flexible material which is longitudinally and circumferentially elastic having a front seam circumferentially closed at the top, knee, instep and foot, the remaining portions of said front seam being openings; a plurality of adjustable fastening means extending laterally across said openings and spaced along the length of said main body portion, whereby regions intermediate said spaced fastening means afford longitudinal elasticity to said garment

along the margins of said openings; said main body portion at the knee, instep and foot portions being formed to impose a pressure gradient on the body regions to which it is applied by gradations in the ratio of the circumference of the body region to the circumference of the garment region in registry therewith, whereby said closed tubular length imposes an inward directed radial pressure on the body region which is greater at one end thereof than at the other end, and being tailored to relieve pressure on the portion of the body encased thereby, whereby the pressure relief is accomplished by a smooth transition with said fastening means adjustable to give a gradual change in pressure gradient from the openings in said main body portion to the knee, instep and foot portions; said fastening means including lateral extensions of said material extending from both sides of the openings with said extensions on one side interdigitating with said extensions on the other side; a liner between the margins of said openings and said leg; pressure indicating indices for said extensions; and a second seam to facilitate tailoring that portion of said main body portion requiring a substantial change in contour to conform to the leg.

2. A garment for supporting an articulated region of animal bodies comprising:

a main body portion of flexible, elastic material of generally tubular shape including a closed tubular length encompassing said articulated animal body region, said body portion including said tubular length being formed to impose a pressure gradient on the animal body region to which the garment is applied by gradations in the ratio of the circumference of the animal body region to the circumference of the garment body region in registry therewith whereby said closed tubular length imposes an inward directed radial pressure on the articulated region which is greater at one end thereof than at the other end, and is gradually reduced along said length intermediate the ends of said length to level less than at the low pressure end of said length by the decrease in the ratio of the circumference of the intermediate portion to the circumference of the animal body region enclosed thereby below the ratio of the low pressure end of said length, said body portion having at least one opening extending along the length thereof extending from said closed tubular length and having margins for said opening generally paralleling the longitudinal axis of said tubular shape; a second closed tubular length adjacent one end of said main body portion and spaced from said first mentioned closed tubular length by said opening extending along the length thereof; said second closed tubular length having a terminal portion extending to said one end of said main body portion in which the ratio of the circumference of the terminal portion to the circumference of the animal body region enclosed thereby is progressively reduced along the longitudinal dimension of said main body portion toward said end whereby inward directed radial pressure on the enclosed body region is progressively reduced toward said end; and

a plurality of adjustable fastening means extending laterally across the opening and spaced along the length of said main body portion, whereby regions intermediate said spaced fastening means afford longitudinal elasticity to said garment along said

opening margins, said fastening means being capable of adjustably establishing gradations of radial pressures on the animal body along the length thereof.

3. A garment for supporting an articulated region of animal bodies comprising: a main body portion of flexible, elastic material of generally tubular shape including a closed tubular length encompassing said articulated animal body region, said body portion including said tubular length being formed to impose a pressure gradient on the animal body region to which the garment is applied by gradations in the ratio of the circumference of the animal body region to the circumference of the garment body region in registry therewith whereby said closed tubular length imposes an inward directed radial pressure on the articulated region which is greater at one end thereof than at the other end, said body portion having at least one opening extending along the length thereof from said closed tubular length and having margins for said opening generally paralleling the longitudinal axis of said tubular shape; and a plurality of adjustable fastening means extending laterally across said opening and spaced along the length of said main body portion, whereby regions intermediate said spaced fastening means afford longitudinal elasticity to said garment along said opening margins, said fastening means being adapted for adjustably establishing gradations of radial pressures on the animal body along the length thereof; said fastening means including a first set of extensions of flexible elastic material having a length extending across said opening from a first side to a second side of said main body portion; and said fastening means including a second set of extensions of flexible, elastic material having a length extending across said opening from a second side to a first side of said main body portion; said extensions of said first set being spaced apart along the margin of said opening a distance at least equal to the width of said extensions of said second set and said extensions of said second set each being aligned with the space between extensions of said first set and being spaced apart along the margin of said opening a distance at least equal to the width of said extensions of said first set whereby said extensions interdigitate and the extensions of each set engage the main body portion between the extensions of the opposed set to balance the forces imposed on the animal body region on the opposite sides of the opening and minimize the tendency of the garment to twist, to creep on and to chafe the animal body region.

4. A garment for imposing pressure upon regions of animal bodies comprising: a main body portion of flexible material of generally tubular shape for encompassing said animal body region, said material being elastic in the longitudinal and transverse dimensions of said tubular main body portion, said tubular main body portion having circumferences along its length which have a ratio to the circumference of the animal body region with which they are adapted to register whereby said tubular body imposes an inward directed radial pressure on the animal body region, said body portion having at least one opening extending longitudinally of the tubular shape and having margins for said opening; a plurality of fastening means extending across said opening generally perpendicularly to said margins and spaced along the length of said main body portion, whereby regions of said flexible, elastic material inter-

mediate said spaced fastening means afford longitudinal elasticity to said garment along said opening margins; said fastening means including a first set of extensions of flexible elastic material having a length extending across said opening from a first side to a second side of said main body portion; and said fastening means including a second set of extensions of flexible, elastic material having a length extending across said opening from said second side to said first side of said main body portion; said extensions of said first set being spaced apart along the margin of said opening a distance at least equal to the width of said extensions of said second set and said extensions of said second set each being aligned with the space between extensions of said first set and being spaced apart along the margin of said opening a distance at least equal to the width of said extensions of said first set whereby said extensions interdigitate and the extensions of each set engage the main body portion between the extensions of the opposed set to balance the forces imposed on the animal body region on the opposite sides of the opening and

minimize the tendency of the garment to twist, to creep on, and to chafe the animal body region.

5 5. A garment according to claim 4 including individual first securing means on the face most proximate said animal body of each of said extensions of said first and second set; and individual second securing means individually secured on the face of said main body portion remote from said animal body, said second securing means being adapted to securely engage with respective individual first securing means on extensions on the opposite side of said opening, said second securing means each being located on separate spaced areas of said main body portion on the first and second sides of said opening which are in an alignment with the space between adjacent extensions from said opening margins which is generally perpendicular to said opening margins.

10 6. A garment according to claim 5 wherein said first and second securing means are complementary area contact fasteners of the "Velcro" type.

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