March 31, 1959 T. HINDLE 2,879,580

FLEXIBLE HINGES

Filed March 9, 1956 4 Sheets-Sheet 1

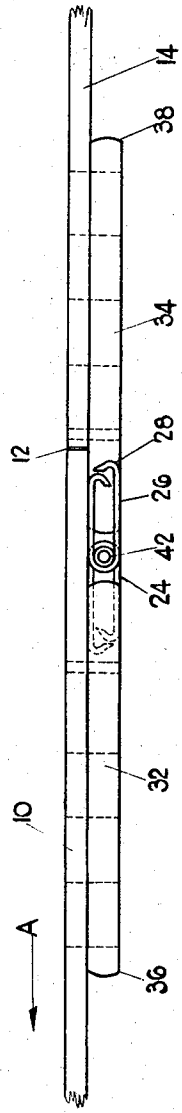

FIG. 1.

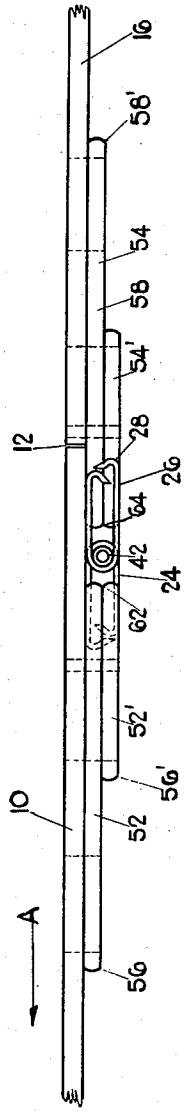

FIG. 2.

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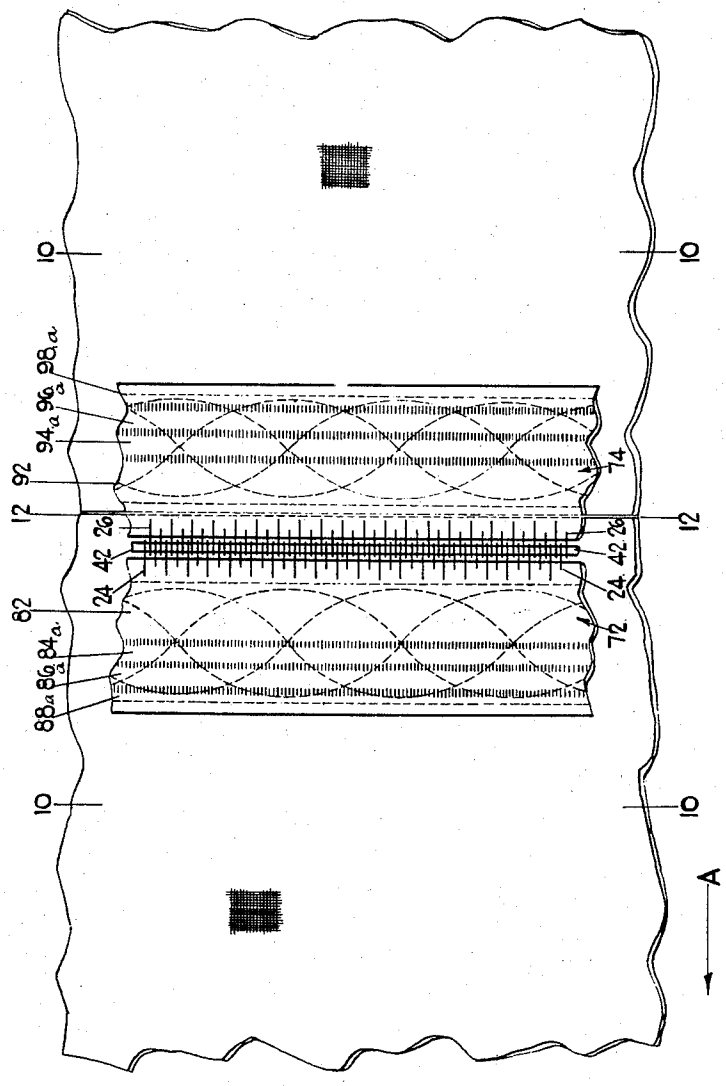

FIG. 3.

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FLEXIBLE HINGES

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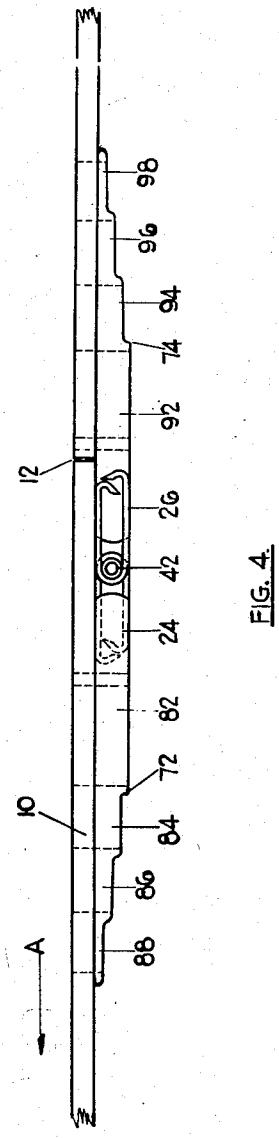

FIG. 4.

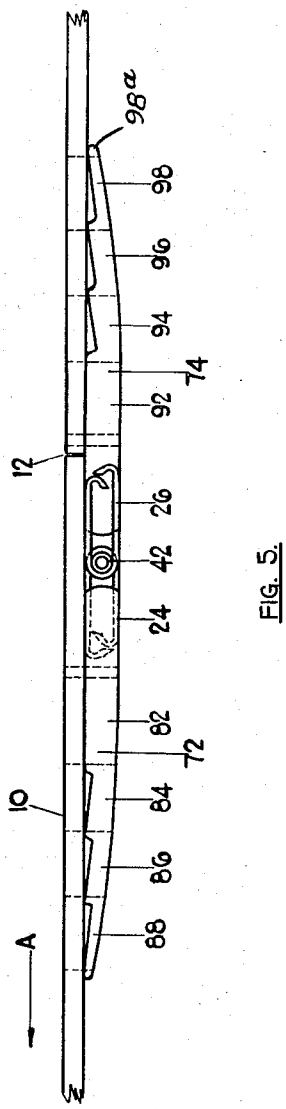

FIG. 5.

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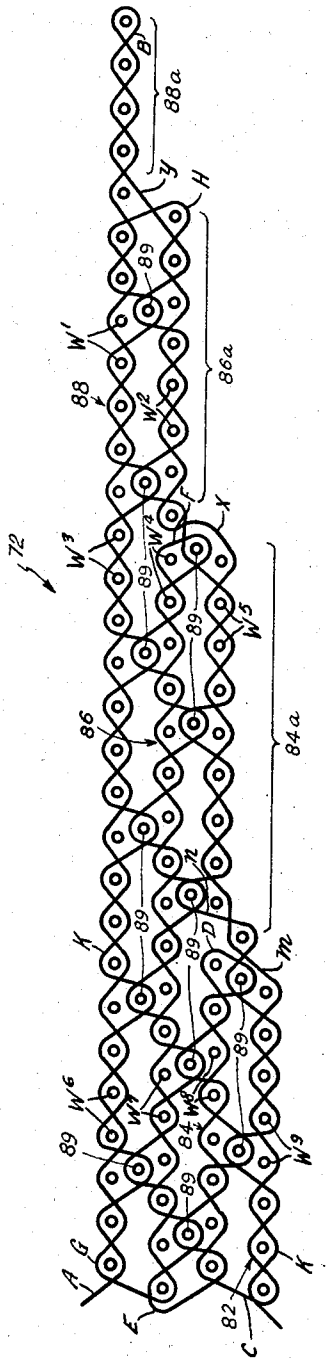

FIG. 6.

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United States Patent Office 2,879,580 Patented Mar. 31, 1959

2,879,580

FLEXIBLE HINGES

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Application March 9, 1956, Serial No. 570,555

Claims priority, application Great Britain December 7, 1956

12 Claims. (Cl. 28—78)

This invention relates to flexible hinges such as are employed for belts, such as conveyor belts, power transmission belts, or, in particular, for paper-makers' dryer felts.

In the art of paper-making on a Fourdrinier paper-machine, after the paper fibres have been formed into a coherent sheet at the "wet end" of the machine, the sheet is delivered to the "dry end" for movement over steam-heated cylinders, whereby the paper is consolidated and dried. The sheet is held in intimate contact with the hot cylinders by means of "dryer felts" which are frequently of great length and width and are extremely costly. Such felts are ordinarily manufactured entirely of cotton, or of a combination of cotton and asbestos, or of a combination of cotton and synthetic fibres or filaments, or of a combination of cotton, asbestos and synthetic fibres or filaments, or entirely of synthetic fibres. Most dryer felts are woven flat and the ends joined to form an endless structure after the felt has been positioned over the drying cylinders and felt rolls of that section of the paper-machine which the felt is to clothe. It is obviously desirable to make the joint which is known in the paper-making art as a seam both secure and flexible, and one which may be quickly made to save time in fitting.

Numerous methods are employed to join the ends of the "dryer felts." The ends may be over-lapped and sewn, riveted or glued together. Alternatively, the ends may be brought together in butt joint and secured by means of a strip of felt or strong webbing sewn, riveted or glued to the underside of both ends of the felt at the joint, the actual ends of the felt being otherwise unattached. One of the most successful and expeditious methods of joining together the ends of a belt, including a paper-makers' dryer felt, is a form of flexible hinge known as a clipper belt-fastener, consisting of a plurality of regularly spaced wire clip elements adapted at one end to be clinched under mechanical pressure in the manner of a wire staple into the belt, and having hinge-like loops at the other end adapted to be interdigitated while a flexible pintle member to act as a hinge pin is threaded through them thus forming a flexible hinge. If such clips are applied directly to the ends of the felt itself, the hinged joint so formed is too insecure as the ends of the felt are "raw" or cut and do not have sufficient strength to withstand the tension applied during the normal running life of the felt on the paper-machine, so that the clips detach themselves from the end of the felt. For this reason, the metal clips have been first attached to one selvedge of strong webbing three to four inches wide, and a strip of this webbing with the clipper loops in position, has been securely attached by sewing to the underside of, and across each end of the felt. To ensure that the clips remain securely attached to the webbing and that the completed seam remains intact during the normal service life of the felt, a multi-ply webbing, preferably of four layers, is required. There is therefore produced a considerable "step" against the underside of the felt by the edge of such webbing away from the hinge pin. Now, a

drying section of a paper-making machine contains a number of rollers, known in the art as felt rolls, of relatively small diameter with which the underside of the continuously moving felt comes into contact. Each time the seam passes over a felt roll, there is a sharp impact of the leading edge of the webbing on the felt roll as the seam meets the roll, and a hammering effect is produced on a transverse strip of the felt immediately following the trailing edge of the webbing as the seam leaves the roll. These step effects are mechanically destructive and may occur many times per minute, the recurrence being dependent of course upon the speed of the paper-making machine and the number of felt rolls contained in the drying section over which the seam has to pass. As a result of such step effect, the leading edge of the leading webbing and a transverse strip of the felt itself immediately following the trailing webbing becomes more severely and more rapidly disintegrated than the body of the felt.

The webbing for the clips has to be of substantial thickness, usually 3 to 4 ply, for sufficient strength to carry the clips. The problem of the "step" effect aforesaid has been partly met by using two thinner superimposed pieces of webbing of different widths so as to divide the one original step into two smaller steps, one selvedge of each strip being coincident for receiving the clips. Nevertheless, it has been found in practice that the use of two strips of thinner webbing of different width, although an improvement on the use of a single thicker strip of webbing, is not wholly satisfactory. The leading edges of both the wider and narrower strips of the leading webbing are more rapidly worn than the rest of the webbing, and the "steps" between the two strips of trailing webbing and the wider strip of trailing webbing and the felt are still too great to avoid premature degradation of a transverse strip of the wider webbing and a transverse strip of the felt immediately following the wider webbing.

The principal object of this invention is to provide an improved means for jointing the ends of a "dryer" felt and includes an improved form of webbing which is firm enough and strong enough to hold securely the hinge clips and which is relatively free from the step effects of the webbing used heretofore in the construction of such flexible hinge joints.

According to the invention, means for securing a flexible hinge to the ends of a belt, such as a paper-makers' dryer felt, comprises a flexible hinge-clip receiving member of homogeneous character adapted to be attached transversely to the ends of the felt and having one edge adapted to receive and hold the clips, the member tapering in thickness towards the other edge to reduce the "step" effect thereat.

According to a preferred embodiment of the present invention, the member is in the form of webbing to which the clips are attached in the construction of a flexible hinge joint for use on a paper-maker's felt, and consists of a narrow woven fabric tapered in thickness so that the selvedge which receives the wire clips is of three or more layers and the other selvedge which faces towards the body of the felt is of one layer only.

The invention as applied to the so-called "seam" of paper-makers' dryer felts is now described in greater detail with reference to the accompanying drawings wherein:

Figure 1 is a vertical section longitudinally of a felt at the clip-type hinge seam, showing the known use of webbing of uniform weft-ways cross-section;

Figure 2 is a vertical section longitudinally of a felt at the clip-type hinge seam showing the known use at each end of the felt of two pieces of webbing of different widths;

Figure 3 is a plan view of a portion of a paper-makers' dryer felt at the clip-type hinge seam showing one example of a novel tapered thickness webbing with which the clips are engaged and made in accordance with the present invention;

Figure 4 is a vertical section longitudinally of a felt at the clip-type hinge seam showing the novel tapered thickness webbing of Fig. 3 in weft-ways cross-section;

Figure 5 shows an alternative method of stitching the novel tapered webbing to the ends of the felt;

Figure 6 is a diagrammatic illustration of one weave structure of tapered webbing made in accordance with the present invention and shown as a formal section through a straight warp.

A flexible hinged seam as illustrated in Fig. 1 is made by inserting wire clips **24** and **26** at regularly spaced intervals along one selvedge of each of two strips **32** and **34** of four-layer homogeneously woven webbing. One strip of such webbing with the clips attached is stitched to the underside of each end of the felt **10** in such a manner that when the two sets of clips are engaged (interdigitated) to provide a continuous passage through the eyes, the ends of the felt form a closely-butted joint **12** just beyond the longer clinching parts **28** of one set of clips **26**. The flexible hinge seam is completed by the introduction of a flexible pintle member **42** through the interleaved eyes of the clips.

With a flexible hinge joint seam so constructed, when the felt is run on the paper machine in the direction indicated by the arrow A, excessive mechanical degradation occurs along the leading edge **36** of the webbing **32** and across the whole width of the felt at **14**, immediately behind the trailing edge **38** of the webbing **34**. This excessive degradation occurs, as previously explained, because of the depth of the "step" at **36** and **38** between the underside of the felt and the strips of the webbing.

A flexible hinge seam as illustrated in Fig. 2 is made by stitching together two superimposed pieces of webbing **52** and **52'**, of different widths, the selvedges **62** thereof being in registration. Similar superimposed pieces of webbing **54** and **54'** are stitched together with registering selvedges **64**, and wire hinge clips **24** and **26** are inserted at regularly spaced intervals along each of the registering selvedges **62** and **64**. The webbing with the clips attached is stitched to the underside of each end of the felt **10** and the joint is completed in the same manner as previously described by the insertion of a flexible hinge pin. When a felt with a flexible hinge seam so constructed is run on a paper machine in the direction indicated by the arrow A, in spite of the fact that there are two "steps" between the felt and the outer layer of webbing, these steps will cause premature degradation at the leading webbing selvedges **56** and **56'**, to the trailing webbing **54** at that portion **58** immediately following webbing **54'**, and across the whole width of the felt at that portion **16** immediately following the trailing edge **58'** of the webbing **54**.

The flexible hinge seam illustrated in Figs. 3, 4 and 5 is made according to one example of the invention with tapered thickness webbing. One construction of such webbing, embodying the present invention, is shown and described, solely by way of example and without intended limitation, in Fig. 6 and is such that as shown in these figures, one piece of webbing **72** is so constructed that, for approximately one-sixth of its width from one selvedge it has a single layer section **88***a*, this being followed by a two-layer section **86***a*, then a three-layer section **84***a*, and the remainder **82** of the webbing, representing approximately one-half of the total width, has a four-layer construction. The other piece of webbing **74** has a similar tapered cross-section in which sections **92**, **94***a*, **96***a* and **98***a* are of four, three, two and one layer constructions, respectively. Wire hinge clips **24** and **26** are inserted at regularly spaced intervals along each of the selvedges of the four-layer sections **82** and **92** of the strips of webbing **72** and **74**. The two strips of webbing with the clips attached are stitched to the underside of each end of the felt **10** and the flexible hinge seam is completed in a manner similar to that described earlier above. As illustrated in Fig. 4 the hinge seam is made with the "steps" of the webbing facing outwards, whereas as illustrated in Fig. 5, the hinge seam is made with the "steps" of the webbing facing inwards, i.e. towards the underside of the felt. Both methods of construction are satisfactory.

When a felt with a flexible hinge seam with tapered thickness webbing in accordance with the present invention is incorporated is run on a paper-making machine in the direction indicated by the arrow A, the "steps" from the felt to the thickest portions of the strips of webbing are less sharply defined and relatively so shallow that localised degradation to any part of either strip of webbing or to that part of the felt immediately following extension **98***a* of the trailing webbing **98** is substantially reduced or eliminated. Furthermore, because the hinge clips have been inserted into the selvedges of the four-layer portions of the webbing, they are as securely held as if the whole of the webbing were of uniform four-layer construction.

One example of weave for a suitable tapered thickness webbing for a flexible hinge seam according to the present invention is illustrated in Fig. 6 in which the weave structure is shown as a formal section through a straight warp. The webbing is 3 inches wide and consists of four layers, respectively a first layer **88** comprises a section **88***a* approximately one-half inch wide, measured inwardly from one selvage edge, the part **88***a* being a single layer fabric comprising the parallel warps W; a second layer **86** having a section **84***a* which underlies a part of the layer **88** to form therewith a two-layer fabric approximately one-half inch wide wherein the warps W^1, W^2 are in superposed planes; a third layer **84** having a section **84***a* which underlies parts of the layers **88** and **86** to form therewith a three-layer fabric approximately one-half inch wide wherein the warps W^3, W^4 and W^5 are superposed planes; and finally, a fourth layer **82** which underlies parts of layers **88**, **86** and **84** to provide a four-layer fabric approximately one and one-half inches wide wherein the warps W^6, W^7, W^8 and W^9 are in supperposed planes. The construction is of plain weave, the layers being bound together by means of binder warp threads **89**, and the picking order of the weft threads is chosen so as to produce a firm, smooth main selvedge to the four-layer section **82**. Since the warps run lengthwise of the "seam" and provide the anchorage for the spring clips, the warps must necessarily be heavy and this means that the wefts must be sharply bent in interweaving with the warps. However, the wefts which extend transversely of the webbing (and thus lengthwise of the felt) must collectively carry the load imposed by the pull of the felt and thus it is essential that each individual layer of the multi-ply fabric consists, in major part, of wefts interwoven with the warps of a single layer only, in order that the fabric may provide as nearly as possible maximum resistance to transverse elongation.

The weave structure as shown in Fig. 6 is such that in the upper and lower warp planes certain wefts, for instance those indicated at K, extend without deflection from the respective warp planes. The major portions at least of the respective warp planes and the binder warps **89** are so located that those stitching wefts *m*, *n*, *x*, *y*, etc. which pass from one warp plane to the next at the shoulders (where each thicker portion of the fabric joins the next adjacent thinner portion) extend diagonally so that the angle at each step, where one ply is offset from the next, is substantially less than a right angle. It will be evident that, at the shoulder where a thicker portion joins the adjacent thinner portion, the warps and wefts are so interwoven as to provide a nonraveling

quasi-selvage devoid of loose yarn ends. Inspection of Fig. 6, which diagrammatically depicts the result of a single weaving cycle, shows that eight picks of filling or weft are introduced during each such cycle. The pick which begins at the point designated A and which extends transversely to the right, as seen in Fig. 6, is hereinafter referred to as the first pick. Study of Fig. 6 shows that this first pick interweaves with all of the warps of the upper or top layer of warps and also at regular intervals interweaves with binder warps **89**.

The second pick, which commences at the point indicated by the letter B, and which is woven in while the shuttle travels to the left, interweave with all of the warps of the fabric section **88***a*; but, at a point *y*, this second pick leaves the top layer and begins to interweave with warps of the second layer and continues to interweave with all of the warps of the second layer which are comprised in the fabric section **86***a* and at intervals also interweaves with binding warps **89** located between the first and second layers. Then, at the point *x*, the second pick leaves the second layer of warps and begins to interweave with warps of the third layer, continuing to interweave with all of the warps of the third layer comprised in the fabric section **84***a* and, at recurrent intervals also interweaves with binder warps **89** located between the second and third layers; then, at the point *n* this second pick leaves the warps of the third layer and begins to interweave with warps of the fourth or bottom layer, continuing to interweave with the warps of the fourth layer and at intervals also intervening with binder warps **89** located between the third and fourth layers.

The third pick which commences at the point C and, traveling toward the right, interweaves with all of the warps of the third layer to the left of the fabric section **84***a* and at regular intervals interweaves with binder warps **89** between the layers **3** and **4**.

The fourth pick, which commences at the point D, travels toward the left and interweaves with all of the warps of the third layer which are to the left of the fabric section **84***a* and, at recurrent intervals, also interweaves with binder warps **89** located between the second and third layers.

The fifth pick, which commences at the point E and travels toward the right, interweaves with all of the warps of the second layer which are to the left of the fabric section **86***a* and, at recurrent intervals, interweaves with binder warps **89** which are between the second and third layers.

The sixth pick, which begins at the point F and travels toward the left, interweaves with all of the warps of the second layer which are to the left of the fabric section **86***a* and, at recurrent intervals, interweaves also with binder warps **89** located between the first and second layers.

The seventh pick, which begins at the point G and travels toward the right, interweaves with all of the warps of the top layer which are to the left of fabric section **88***a*, but, does not interweave with any of the binder warps **89**.

The eighth pick, which begins at the point H and travels toward the right, interweaves with all of the warps of the second layer within the fabric section **86***a*, then leaves the warps of the second layer at the point *x* and interweaves with all of the warps of the third layer within the fabric section **84***a*, and then leaves the third layer, at the point *n*, and interweaves with all of the warps of the fourth layer which are to the left of the fabric section **84***a*, but nowhere interweaves with any of the binder warps **89**.

Thus, while the fabric might superficially appear to be a true multi-ply fabric, at least in those portions which are to the left of the fabric section **88***a*, it is, in reality, a multi-layer fabric (rather than a multi-ply fabric) to the left of the section **88***a*, since the constituent layers are not independent plies merely held together by stitching warps

or wefts as is customary in multi-ply fabrics, but is actually a unitary structure which cannot be separated into independent self-contained plies by the severance of any of its constituent yarns since certain, at least, of the wefts are essential elements of each of the several layers. To express this difference between the unitary fabric structure herein disclosed and a multi-ply fabric of customary type, the several layers of the present fabric are herein referred to as "quasi-plies." In weaving webbing in accordance with this example, there is total of 420 warp yarns each of 6s/2 (cotton counts) spun "Terylene" and 54 weft yarns per inch, each of 6s/5 spun "Terylene." This figure of the drawing is, of course, diagrammatic and shows fewer than the full number of warp threads and in consequence the dimensional proportions of width above given have had to be distorted in the drawing in order to show the weave.

It is to be understood that the invention is not limited to the above example. The webbing may be woven of cotton yarns, of synthetic yarns, of a combination of cotton yarns and synthetic yarns, of yarns produced from blends of cotton and synthetic fibers, or of yarns produced from blends of different synthetic fibres. In certain cases, a three-layer webbing, tapered to one layer, is sufficient, whereas in other cases, a five- or six-layer webbing, tapered in one-layer steps to one layer, is more satisfactory. Neither the total width of the webbing nor the widths of the various steps are critical and both may be varied without departing from the scope of the invention.

Whilst the tapered webbing as heretofore described is illustrated for use in making the hinge seam at the ends of paper-makers' dryer felts, it is obvious that it has characteristics which make it valuable for use in joining the ends of other endless belts, such as conveyor belts or power-transmitting belts.

It will be appreciated that one particular clip-type hinge construction for use with the novel tapered webbing has been described by way of example. Many modifications to the type of hinge may be made without departing from the scope of the invention of the use of a tapered webbing in the construction of a clip-type flexible hinge seam.

I claim:

1. Means for securing a flexible hinge to the ends of a belt such as a papermakers' dryer-felt thereby to form a seam, said means comprising a multi-ply woven fabric having selvages at its opposite edges and consisting of layers of warp elements of different widths and in overlapping arrangement producing zones of a progressively different number of plies in thickness, characterized in that the warp elements in each layer are interwoven with wefts in such a way that a portion, at least, of each layer forms a separate ply free from adjacent plies, while certain warps of each layer are bound at spaced intervals to warps of each adjacent layer by certain of the wefts, the fabric comprising four plies at one selvage and a single ply at its opposite selvage.

2. Means for securing a flexible hinge to the ends of a belt such as a papermakers' dryer-felt thereby to form a seam, said means comprising a multi-ply woven fabric having selvages at its opposite edges and consisting of layers of warp elements of different widths and in overlapping arrangement producing zones of a progressively different number of plies in thickness, characterized in that the warp elements in each layer are interwoven with wefts in such a way that a portion, at least, of each layer forms a separate ply free from adjacent plies, while certain warps of each layer are bound at spaced intervals to warps of each adjacent layer by certain of the wefts, the number of plies decreasing progressively from one selvage to the other, and at the edge of each narrower ply, wefts from the narrower ply extend diagonally toward and are interwoven with warps of the next adjacent ply.

3. Means for securing a flexible hinge to the ends of a belt such as a paper-makers' dryer-felt comprising a strip of multi-ply woven fabric of the order of three and one-half inches in width and having selvages at its opposite edges, one selvage being relatively thicker than the other, the fabric comprising a plurality of warp planes within each of which warps are interwoven with wefts to form a ply or layer, certain wefts from each warp plane being stitched at intervals to wefts of the next adjacent plane by binder warps, the exposed ply at one face of the fabric being of greater width than the next adjacent ply and the latter being of greater width than the next ply and so on, the thicker selvage of the fabric providing a secure anchorage for the flexible hinge.

4. A hinge-securing member according to claim 3 wherein each of the warp plane layers comprises portions of single ply fabric in which the warps and wefts are interwoven in a plain weave, said portions being free from adjacent plies.

5. Means for securing a flexible hinge to the ends of a belt such as a paper-makers' dryer-felt thereby to provide a connection between said ends, said means comprising a strip of multi-ply woven fabric having selvage edges, one selvage edge being substantially thicker than the other, said fabric comprising a plurality of warp planes in each of which wefts are interwoven with warps to form a ply or layer, certain wefts diverging at intervals from one warp plane to the next and being stitched to wefts in the next adjacent warp plane, said warp planes, beginning at one face of the fabric, progressively diminishing in width, each warp plane comprising a portion at least in which the wefts are interwoven only with the warps in said plane to form a single ply fabric.

6. Means for securing a flexible hinge to the ends of a belt according to claim 5 wherein certain of those wefts which diverge from the warp plane at one face of the fabric pass in successive steps to and are interwoven with the warps of the warp plane at the opposite face of the fabric.

7. For use in anchoring an element of a flexible hinge to one end of a belt, such as a papermakers' dryer felt, a woven textile fabric having parallel selvages and wherein warps extend substantially parallel to the selvages, the fabric being thicker adjacent to one selvage than to the other, and progressively diminishing step-by-step, in thickness, from the thicker selvage toward the thinner selvage, with a shoulder, parallel to said selvages, at the junction of each thicker portion with the next adjacent thinner portion, the fabric being of unitary construction wherein warps and wefts are so interwoven as to form a non-raveling quasi-selvage at each of said shoulders.

8. A woven textile fabric, according to claim 7, wherein each of the thicker portions comprises warps disposed in parallel planes, with stitching wefts uniting warps in adjacent planes, certain of the stitching wefts being exposed at each of said shoulders to form, with adjacent warps, the non-raveling quasi-selvages.

9. A unitary woven fabric for use in anchoring a metallic hinge element to one end of a belt, such as a papermaker's dryer felt, said fabric having parallel selvage edges and having portions widthwise thereof which are of different thicknesses, said portions decreasing in thickness progressively step-by-step from one selvage toward the other, the fabric consisting of warp yarns and weft yarns so interwoven that at the junction of each thicker part with the next adjacent thinner part there is a sloping shoulder wherein the warps and wefts are interlocked to form a quasi-selvage.

10. For use in anchoring an element of a flexible hinge to one end of a belt such as a papermakers' dryer felt, a multi-layer woven fabric having parallel selvages and comprising a plurality of quasi-plies, successive plies progressively diminishing in width, one selvage of the fabric being thicker than the other selvage and comprising all the quasi-plies, each quasi-ply comprising warps parallel to the selvages of the fabric interwoven with wefts, and binder warps interposed between each pair of adjacent plies, at least one of the weft picks which is introduced during each cycle being interwoven with warps of each of said quasi-plies and with at least one binder warp located intermediate the edges of each respective quasi-ply.

11. A multi-layer fabric, according to claim 10, wherein, in each quasi-ply, one pick of weft is interwoven with all of the warps of said ply and at regular recurrent intervals with binder warps located between said quasi-ply and the next adjacent quasi-ply.

12. A multi-layer fabric, according to claim 10, wherein at least one of the weft picks, which is introduced during each cycle, is interwoven with warps adjacent to that edge of each quasi-ply, which is remote from the aforesaid thick selvage, to form a quasi-selvage parallel to said thick selvage.

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