A seam area, and a method of making a seam for an industrial fabric, provide for first and second fold lines oriented in the CD of the fabric. Each fold line comprises a set of land areas configured to define a set of holes, and the land areas of each set are constructed and arranged such that when the fabric is folded along the fold lines and the fold lines are aligned with each other, each folded land area of each set is offset from the folded land areas of the other set, and aligned with and receivable by an opposing hole of the other set to form a channel to receive a fastening means. The seams provide the benefits of simple, accurate and economical construction, strength, consistency with adjacent fabric surfaces, and thus reduced marking of sheets carried by the fabrics.
FIG. 3

PRIOR ART
FIG. 7
NONWOVEN SEAM FOR AN INDUSTRIAL FABRIC

FIELD OF THE INVENTION

[0001] The invention concerns a seam, and a method of making such seam, for joining the opposing ends of an industrial fabric such as a papermaker’s fabric to render it endless. It is particularly concerned with a seam for use in an endless industrial fabric which seam is comprised of intermeshing indentations and land areas located at each of the two opposing fabric ends. The land areas at one of the ends are shaped to intermesh with the indentations at the second opposing end, when the fabric ends are brought together, and vice versa; a pintle or coil, or similar joining means inserted between the fabric layers at the seam region is used to close the seam.

BACKGROUND OF THE INVENTION

[0002] A variety of materials are used as precursors from which finished industrial fabrics such as papermaker’s and similar filtration fabrics are made. Such precursors include flat woven or “endless” fabrics, for example, spiral-wound fabrics, nonwoven fabrics, and “endless woven” fabrics.

[0003] A “flat woven” fabric is one that is woven as a continuous length, the opposing ends of which must be joined in some manner so as to render the fabric endless. A spirally wound fabric is one that has been formed by helically or spirally winding a narrow strip of a flat woven or nonwoven fabric in successive abutting turns which are bonded together so as to build up a desired cohesive length and width of fabric, to form “multi-axial” fabrics (such as described by Best et al. in U.S. Pat. No. 5,268,076 and by Rexfelt et al. in U.S. Pat. No. 5,360,656).

Nonwoven fabrics are constructed of nonwoven materials such as extruded mesh and entangled butts which together with other nonwoven or woven materials may be incorporated into hybrid fabrics, or used on their own. “Endless woven” fabrics are formed by a weaving process which results in a belt that is continuous, similar to an open-ended sock or tube, and then folded in the cross-machine direction into a flat fabric, the ends of which can then be brought together and joined in a seam.

[0004] All of these fabrics are essentially intermediate stages of the final endless fabric product, which might be, for example, a press felt or dryer fabric for a papermaking machine, or a filtration or other conveying fabric. In all or nearly all cases, the seams of this invention are formed in a fabric which still requires further processing before it is ready for its intended end use.

[0005] As used herein, the term “industrial fabric” refers to fabrics which are woven or non-woven, or “hybrid”, i.e., a combination of woven and non-woven, and which are intended for use in dewatering, drainage or other liquid filtration, for papermaking applications and the like. Such woven, non-woven and combination fabrics comprise a mesh or similar material, and may contain a fibrous batt.

[0006] These known fabrics do not initially contain a seam and one must be created to provide for their installation on the machines for which they are intended. Because it is usually preferred that the seam present as little a discontinuity in fabric properties as possible, particularly to avoid sheet-maring, the fabric construction must be opened, either by cutting or disassembly, in order to create a suitable seam. Methods and apparatus for doing this are well known. In fabrics having a woven construction (such as flat woven, endless woven fabrics and certain spirally wound fabrics which include a woven fabric component, as described above), yarns in the machine direction (MD) yarn system(s) can be used to form the seam, for example by the removal of yarns in the cross-machine direction (CD) yarn system, to leave MD yarn loops at each end of the fabric, which can then be joined by suitable means. Methods of forming seams in these types of fabrics have been well described in the prior art, for example Lee in U.S. Pat. No. 6,000,441 and U.S. Pat. No. 6,079,454.

[0007] It has also been suggested in U.S. Pat. No. 6,811,849 (Best) that for seamsing the adjacent lateral edges of the narrow strips of a spirally wound fabric in the machine direction, an uneven lateral edge “following a meandering course” can be provided to the fabric. The meanders can be aligned between adjacent edges, to interlock the alternating projections, and the edges then seamed in a conventional manner, by stitching or taping along the seam line over the projections.

[0008] However, in endless fabrics which are comprised entirely of nonwoven materials, including but not limited to batt, extruded mesh, extruded nonwovens and film, there is no machine direction (MD) oriented yarn system from which seaming loops can be derived and joined in a seam. It will be appreciated that seam formation in most known industrial fabrics is a difficult and time consuming process which adds considerably to the cost of the fabric.

[0009] It is suggested in WO 2005/042836 (Sayers) to provide a seam for a nonwoven fabric comprising a series of layers of a perforated film material which are laminated together. A seam may be formed in the fabric ends by cutting so as to castellate these ends to provide loops for interdigitation. The seam can be reinforced by adding a pre-preg comprising of a woven body, or a unidirectional yarn array, or a fine fabric such as an aramid woven cloth. However, the disclosure is very general and speculative in nature and provides no specifics as to how this might be done.

[0010] U.S. Pat. No. 3,323,226 (Beaumont et al.), to which reference is made in the WO 2005/042836 document, describes a dryer fabric which is comprised of one or more sheets of a nonwoven polymeric material such as polyethylene terephthalate. The fabric is rendered endless either by ultrasonically welding the opposed ends (which is preferred) or, optionally, folding them back on themselves and securing them in place using transverse rows of stitching. The folds are then notched to provide loops which can be interleaved with those at the opposite end to thereby join the fabric together to form an endless construction.

[0011] Neither reference teaches the provision of holes to a fabric while under tension prior to removal from the loom or frame for folding. Further, neither reference teaches any method of providing for the formation of a seam in a spirally wound or other endless woven fabric. In particular neither reference discloses a method whereby two sets of holes are cut at fold line locations, which in the case of endless fabrics will be equidistant from one another, such that in all cases when the fabric is folded, it can be joined by intermeshing the land areas of each folded end with the opposing holes of the other end.

[0012] Published application DE 43 13 356 (Wild), discloses a method of connecting the opposite ends of a pressed film strip such as a belt, in which the ends of the flat film are folded over and fixed, preferably with an adhesive compound, and punched to create flaps. The flaps of one end can be
aligned with the recesses of the other end, and a connecting rod installed through the flaps. However, the application is directed only at “film” of the type comprising a single layer such as a metal or plastic foil or sheet.

[0013] It is thus desirable to provide a simple non-marking seam in these endless fabrics and other industrial fabrics, and a method of making such seam, which seam would be easily and reliably joined on the machine to render the fabric endless thereon.

[0014] The seams of this invention are especially suited for use in industrial fabrics which are made entirely or in part from nonwoven components, but may also find application in both endless and flat woven fabrics. Further, the seams of this invention are especially well suited for use in industrial fabrics that are assembled by means of the spiral winding process as described above.

[0015] The seams of this invention are created by first forming two straight rows of holes across the width (CD) of an endless fabric tube in order to form eventual seam loops. The holes may be round, square, rectangular or any other suitable shape. The two rows are parallel and equidistant from one another, and are oriented so as to be perpendicular to the MD. For example, an endless belt having a continuous peripheral length of 100 ft. (30.48 m) would have rows punched out at the 50 (15.24 m) and 100 ft. (30.48 m) marks. In the simplest case, the holes are substantially identical in configuration, are spaced apart equidistantly in a straight line, and each hole is rectangular in shape, and is preferably a square. Alternatively, the holes in a specific row need not be identical in configuration, but can be varied according to factors based on the materials of construction and the intended end use, provided that each hole of one row corresponds to the configuration of the opposing land area of the other row. It is simplest to form these holes while the fabric is under tension, such as while it is mounted on an assembly frame or heatsetting frame.

[0016] After the holes are formed in the fabric by suitable means (e.g., cutting, die punching, welding, precision ultrasonic, microwave, laser or any other appropriate means), the fabric tube is collapsed on itself by folding so that the rows of holes are at each of the opposing ends of the now double layer fabric. The fold lines are located in the CD of the fabric, along the center line of the holes at each of the two fabric ends, such that land areas and indentations are formed at the folded edges, the land areas being that portion of the fabric that is between the holes, and the indentations being “half” of the holes. The two folded ends of the fabric can then be brought together and the folded land areas from each end, which are in the form of loops, are intermeshed with the new half-size holes from the opposite end, so that the loops are aligned, alternating from each end of the fabric, to form a seam line. A sewing wire such as a pin can then easily be inserted along the seam line, through the aligned loops. One or more rows of stitching, or other suitable stabilizing means, can be added parallel and close to the loop ends of the fabric to help maintain the loop alignment, hold the sewing wire in place and complete the seam.

[0017] The holes in the endless fabric tube can be created by any suitable means depending on the material of manufacture of the fabric. For example, a cutting wheel can be run across the fabric while the fabric is still on the manufacturing heatsetting frame and is under tension. The cutting wheel may be heated to heat-seal any frayed yarn ends or other loose pieces of material. Alternatively, the holes may be punched out with hot rods or a heated die punch. Alternatively, the holes can be created in the ends of the multilayer fabric following its removal from the frame upon which it has been manufactured or assembled. In this method, the fabric is either folded and “half” holes (for example “U” shaped cut-outs) formed at each of the two folded ends to create the seaming loops and indentations, or the two rows of holes are punched through the fabric at two locations equidistant from one another and the fabric folded subsequently, provided that steps are taken to resolve the practical difficulties in maintaining tension and alignment of the full fabric when it is off the frame. The optimum shape of the holes will depend on the physical characteristics required for the seam for the intended end use of the fabric. For example, a substantially circular or elliptical shape will result in some open areas when the looped land areas are fitted together, which may cause problems in certain fabric applications, in which case the preferred configuration may be a rectangle or square, with slightly rounded corners; however, where such open areas would not create problems in the specific intended end use of the fabric, circular holes may be the simplest to create. The frequency of the holes and loops, as well as their size, will ideally be optimized for the intended end use of the fabric. It is generally desired that the physical properties of the fabric at the seam area be more or less the same as throughout the fabric although this may be less important in some applications. This will generally require that the dimensions of the holes and the land areas are substantially uniform across the CD of the fabric.

[0018] Further, the teachings of the invention can also be used to create coupling loops to which can be attached additional seaming elements, such as those described in U.S. Pat. No. 6,328,079 to Zils, or seaming coils, or other seam finishing means.

[0019] Although the invention has been described as being particularly suitable for use in endless fabrics, it can also be used on a flat woven fabric, for example by folding back a strip across each end of the fabric onto itself, applying one or more rows of stitching or a similar securing means, and then creating holes along the folded edge to create the seaming loops. The periphery of the holes can readily be heat sealed to prevent stray yarns from coming loose.

[0020] The seams of the present invention are thus suitable for use in nonwoven, hybrid (i.e. those containing both nonwoven and woven components) and woven fabrics, including spirally wound fabrics. Although they have been described in the context of papermaking fabrics, including press felt base fabrics, assembled press fabrics and dryer fabrics, the seams of the invention are not so restricted and may have applicability in a wide range of industrial fabrics.

[0021] The invention therefore seeks to provide a seam area for an industrial fabric, the fabric having a machine direction and a cross-machine direction, the seam area comprising a first and second fold line each oriented in the cross-machine direction, wherein

(a) the first fold line comprises a first set of land areas configured to define a first set of holes;
(b) the second fold line comprises a second set of land areas configured to define a second set of holes;
(c) the land areas of each set are constructed and arranged such that when the fabric is folded along the fold lines and the fold lines are aligned with each other, each folded land area of each set is
offset from the folded land areas of the other set and
(ii) aligned with and receivable by an opposing hole of the other set to form a channel to receive a fastening means.

The invention further seeks to provide a method of making a seam in an industrial fabric having a machine direction and a cross-machine direction, comprising the steps of:

a. forming a first set of holes each centred along a first fold line oriented in the cross-machine direction in the fabric, each hole being spaced apart from adjacent holes by a land area of a first set;
b. forming a second set of holes each centred along a second fold line oriented in the cross-machine direction in the fabric, each hole of the second set being spaced apart from adjacent holes by a land area, wherein the configuration of the second set of holes along the second fold line corresponds to the land areas of the first set, and the configuration of the first set of holes along the first fold line corresponds to the land areas of the second set;
c. folding the fabric at the first fold line;
d. folding the fabric at the second fold line;
e. intermeshing the first set of holes with the second set of land areas and the second set of holes with the first set of land areas to form a channel across the fabric in the cross-machine direction; and
f. inserting a fastening means in the channel.

The seam area and the method of making a seam can be for an endless construction industrial fabric, being an endless woven fabric, an endless nonwoven fabric, or a spiral wound fabric, in which case the first and second fold lines are equidistant from each other in the machine direction.

Alternatively, the seam area and the method of making a seam can be for an industrial fabric selected from flat woven and flat nonwoven, in which case the first and second fold lines are proximate each end of the fabric.

Preferably, the fastening means is a pintle. Alternatively, the fastening means comprises a seaming coil.

Preferably, the configuration of the holes is selected from substantially rectangular, substantially square, substantially circular and substantially elliptical, and preferably each hole has a width in the cross-machine direction along the respective fold line at least equal to a width in the cross-machine direction along the respective fold line of its opposing land.

Preferably, the holes are created by a method selected from punching, cutting, melting, ultrasonics and microwaving, and in addition the edges of the holes can be heat sealed.

The invention also seeks to provide an industrial fabric including the seam area as described above, the fabric preferably being formed by a method selected from endless weaving, flat woven, flat nonwoven and spiral winding.

The industrial fabric can be a papermaker's fabric, preferably a press felt, or a filtration fabric. The industrial fabric can comprise at least one nonwoven component, or can be constructed without any woven component.

DETAILED DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the drawings, in which

FIG. 1 is a perspective view of a spiral wound fabric of the prior art, before folding;

FIG. 2 is a perspective partial view of the fabric of FIG. 1 after folding and before joining of the folded ends to form a seam;

FIG. 3 is a perspective view of the fabric of FIG. 1 after joining of the seam;

FIG. 4 is a perspective partial view of an end of a woven fabric of the prior art, including seaming loops;

FIG. 5 is a perspective view of a spiral wound fabric of a first embodiment of the invention, before folding;

FIG. 6 is a perspective partial view of the fabric of FIG. 5 after folding and before joining of the folded ends to form a seam;

FIG. 7 is a perspective view of the fabric of FIG. 5 after joining of the seam;

FIG. 8 is a perspective view of an endless woven or nonwoven fabric of a second embodiment of the invention before folding; and

FIG. 9 is a perspective partial view of one end of a flat woven fabric of a third embodiment of the invention.

FIGS. 1 to 4 show a seaming method of the prior art in relation to a spirally wound industrial fabric. Referring first to FIG. 1, fabric 10 is in the form of an endless tube, being comprised of a series of helically wound turns of a narrow fabric strip 11. Each turn of the strip 11 is laid in close proximity to the one previously laid down so that a bond 12 can be effected along the length of the fabric strip. The CD of the fabric 10 is shown by the arrow A and the MD by the arrow B. The fabric 10 includes a woven component or array of parallel MD oriented yarns which are shown exposed for seaming at two equidistant regions, each group of exposed yarn portions being referred to as a "lease," and shown here as leases 13 and 14. The leases 13 and 14 are prepared by carefully cutting the fabric along its interior and exterior sides at the location where the seam is to be formed, and then stripping out all of the CD yarns and any other extraneous or undesired materials to leave the exposed MD yarns as shown at 13 and 14. A notional fold line 20a, 20b is provided along the length (i.e. in the CD) of the leases 13 and 14 respectively.

In FIG. 2, the fabric 10 is shown after folding at the leases 13, 14 along the respective fold lines 20a, 20b, and is collapsed upon itself as a double layer structure. These folds allow the exposed portions of the MD oriented yarns at the leases 13, 14 to form loops 22, which are separated by spaces 24, and extend beyond the woven edges 21a, 21b. Referring to FIG. 3, the edges 21a and 21b are brought into proximity, so that the loops 22 of each end of the folded fabric 10 can be interdigitated to form a seam 26, which is secured by insertion of a pintle 28 across the fabric width through the interdigitated loops 22.

FIG. 4 shows a portion of one end of an endless woven fabric of the prior art, in which the MD yarns 18 form seaming loops 42, which are separated by spaces 43 and extending beyond the edge formed by the CD yarns 16. In this prior art construction, it is necessary to carefully interweave the CD yarns 16 so as to maintain the seaming loops 42 in an orthogonal relationship, to allow insertion of the pintle (not shown). Depending on the weave pattern and size of the fabric, this can be an extremely time consuming process.

Referring now to FIG. 5, a spirally wound industrial fabric 30 is shown as prepared for seaming according to the teachings of the present invention. Fabric 30 is an endless tube similar to fabric 10 shown in FIG. 1, being comprised of a series of helically wound turns of a woven or nonwoven narrow fabric strip 11, each turn of which is laid in close
proximity to the fabric turn previously laid down so that a bond 12 can be created along the length of the fabric strip to hold the strips together. Two rows of holes 34 are created in the fabric 30, the holes 34 having their centres along one of two fold lines 40a and 40b, which are oriented in the CD, as indicated by arrow A, and equidistant from one another in the MD. Adjacent holes 34 are separated from one another by land areas 35. The rows of holes 34 are configured so that on formation of the eventual seam, the holes of the two rows are mutually offset, such that each land area 35 of one row is aligned with an opposing hole 34 of the other row. The eventual machine side surface of the fabric is shown as 31, and the sheet side surface as 32.

[0046] Referring to FIG. 6, the fabric 30 is shown after folding at the fold lines 40a, 40b, and is collapsed upon itself as a double layer structure. Along the fold lines 40a, 40b, the folded land areas 35 form loops which are separated by the spaces formed by, and one-half the original size of, the holes 34. Optionally, after folding of the fabric, one or more rows of stitching, shown here as 41a, 41b, can be provided at or proximate each seam area to secure the alignment, either before or after insertion of the pintle 36 (see FIG. 7).

[0047] FIG. 7 shows an assembled fabric 30 with the seam of this invention, in which the edges at the fold lines 40a, 40b (in FIG. 6) have been brought together, the land areas 35 of each end being intermeshed with the opposing holes 34 of the other end, to form a channel through which a securing means such as pintle 36 can be inserted so as to pass through all of the loops formed by land areas 35 to close the fabric 30. The interior surface of the finished fabric 30 is the machine side surface 31, and the exterior surface is the sheet side surface 32.

[0048] Referring to FIG. 8, an endless woven or nonwoven fabric 50, not being spirally wound, is shown as prepared for seaming according to the teachings of the invention. Two rows of holes 54 are provided having their centres along two fold lines 53a and 53b, which are oriented in the CD, as indicated by the arrow A, and are equidistant from one another in the MD. Adjacent holes 54 are separated from one another by land areas 55, and the holes 54 of one row are offset in relation to the land areas 54 of the other row, as described above in relation to FIG. 5. The eventual machine side surface of the fabric is shown as 51, and the sheet side surface as 52. After creation of the holes 54, the fabric 50 can be folded and the seam closed in the same manner as for the fabric 30 of FIG. 5.

[0049] FIG. 9 shows a flat woven or nonwoven fabric 60 prepared for seaming according to the teachings of the invention. A row of holes 64, having their centres along fold line 62, is created proximate each end of the fabric 60, parallel to the edge 63. When the fabric 60 is folded along the fold line 62, and the body of the fabric 60 adjacent to the edge 63 is secured in the position shown in FIG. 9, the land areas 65 of one end of the fabric 60 can be brought into opposing offset holes 64 of the other end (not shown) of the fabric 60, and secured by suitable means such as a pintle (not shown).

[0050] As discussed above, the holes can be of any suitable configuration, depending on the material of construction of the fabric and the intended end use. Suitable shapes include substantially circular, substantially elliptical, substantially rectangular or substantially square, with slightly rounded corners. Similarly, the selection of the size and frequency of the holes and land areas will be based on the same factors of materials of construction and intended end use.

[0051] In addition to direct seaming as described above, the teachings of the invention can be used to create coupling loops to which can be attached additional known seaming elements, seaming coils or other seam finishing means.

[0052] The teachings of the invention thus provide several important advantages over the methods and seams of the prior art.

[0053] Firstly, it is possible using the teachings of the invention to create a nearly invisible seam, in which the caliper and permeability in the seam area are substantially the same as in the remainder of the fabric. This provides a significant reduction or elimination of marking attributable to variations in these factors at or near the seam area.

[0054] Secondly, the teachings of the invention allow for a much higher land area across the fabric at the seam area than is feasible with known prior art seams and methods, thus providing strong seam loops and an increased resistance to seam failure.

[0055] Thirdly, the teachings of the invention provide for a seam and method which are fast, accurate and economical.

[0056] Fourthly, the teachings of this invention provide for a seam in a woven fabric, without the disadvantage of the known method in which the creation of MD yarn loops creates an interruption in the basic weave pattern by the removal of CD yarns to expose the MD yarns at the lease regions.

[0057] Fifthly, it is now possible to straightforwardly form a strong non-marking seam in a fabric that is comprised of nonwoven materials, such as extruded mesh, fibrous batt and the like.

[0058] Each of these advantages of the prior art methods, hitherto addressed by time-consuming and costly solutions, is avoided by the teachings of the invention.

1-25. (canceled)

26. A seam area for a fibrous industrial fabric, the fabric having a machine direction and a cross-machine direction, the seam area comprising a first and second fold line each oriented in the cross-machine direction wherein

(a) the first fold line comprises a first set of land areas configured to define a first set of holes;
(b) the second fold line comprises a second set of land areas configured to define a second set of holes;
(c) the land areas of each set are constructed and arranged such that when the fabric is folded along the fold lines and the fold lines are aligned with each other, each folded land area of each set is
(i) offset from the folded land areas of the other set and
(ii) aligned with and receivable by an opposing hole of the other set to form a channel to receive a fastening element.

27. A seam area for a fibrous industrial fabric according to claim 26, wherein the fabric is an endless construction fabric and the first and second fold lines are equidistant from each other in the machine direction.

28. A seam area for fibrous industrial fabric according to claim 26, wherein the fabric is selected from flat woven and flat nonwoven and the first and second fold lines are proximate each end of the fabric.

29. A seam according to claim 26, wherein the fastening element is a pintle.

30. A seam area according to claim 26, wherein the fastening element comprises a seaming coil.
31. A seam area according to claim 26, wherein the configuration of the holes is selected from substantially rectangular, substantially square, substantially circular and substantially elliptical.

32. A seam area according to claim 26, wherein each of the holes has a width in the cross-machine direction along the respective fold line at least equal to a width in the cross-machine direction along the respective fold line of its opposing land.

33. A seam area according to claim 26, wherein the holes are created by a method selected from punching, cutting, melting, ultrasonics and microwaving.

34. A seam area according to claim 26, wherein the edges of the holes are heat sealed.

35. A fibrous industrial fabric including a seam area according to claim 26.

36. A fibrous industrial fabric according to claim 26, wherein the fabric is formed by a method selected from endless weaving, flat woven, flat nonwoven, a combination of flat woven and flat nonwoven, and spiral winding.

37. A fibrous industrial fabric according to claim 26, wherein the fabric is a papermaker’s fabric.

38. A fibrous industrial fabric according to claim 35, wherein the fabric is a press felt.

39. A fibrous industrial fabric according to claim 37, wherein the fabric is a filtration fabric.

40. A fibrous industrial fabric according to claim 35, further comprising at least one nonwoven component.

41. A fibrous industrial fabric according to claim 35, which does not include any woven component.

42. A method of making a seam in an industrial fabric having a machine direction and a cross-machine direction, comprising the steps of:

(a) forming a first set of holes each centered along a first fold line oriented in the cross-machine direction in the fabric, each of the holes being spaced apart from an adjacent one of the holes by a land area of a first set;

(b) forming a second set of holes each centered along a second fold line oriented in the cross-machine direction in the fabric, each of the holes of the second set being spaced apart from adjacent one of the holes by a land area, wherein the configuration of the second set of holes along the second fold line corresponds to the land areas of the first set, and the configuration of the first set of holes along the first fold line corresponds to the land areas of the second set;

(c) folding the fabric at the first fold line;

(d) folding the fabric at the second fold line;

(e) intermeshing the first set of holes with the second set of land areas and the second set of holes with the first set of land areas to form a channel across the fabric in the cross-machine direction; and

(f) inserting a fastening element in the channel.

43. The method according to claim 42, wherein the fabric is an endless construction fabric and the first and second fold lines are equidistant from each other in the machine direction.

44. The method of claim 42, wherein the fabric is selected from flat woven, flat nonwoven and a combination thereof, and the first and second fold lines are proximate to each end of the fabric.

45. The method of claim 42, wherein the fastening element is a pintle.

46. The method of claim 42, wherein the fastening element comprises a seaming coil.

47. The method of claim 42, wherein the holes are formed with a configuration selected from substantially rectangular, substantially square, substantially circular and substantially elliptical.

48. The method of claim 42, wherein each of the holes is formed with a width in the cross-machine direction along the respective fold line at least equal to a width in the cross-machine direction along the respective fold line of an opposing one of the lands.

49. The method of claim 42, wherein the holes are formed by a method selected from punching, cutting, melting, ultrasonics and microwaving.

50. The method of claim 42, wherein steps (a) and (b) further include heat sealing the edges of the holes.

51. The method of claim 42, wherein step (c) forms a first upper and lower fabric layer adjacent the first fold line, and step (d) forms a second upper and lower fabric layer adjacent the second fold line, and after step (d) forms a second upper and lower fabric layer adjacent the second fold line, and after step (d), the method further includes step (d.1) comprising stitching the first upper and lower fabric layers together proximate the first fold line, and stitching the second upper and lower fabric layers together proximate the second fold line.