

DISPOSABLE GARMENTS

5 This disclosure relates generally to the field of disposable garments and in particular, though not exclusively, to elastic constructions which may be used along openings of disposable garments to provide a form-fitting closure, such as along a person's waist, leg, ankle, neck or wrist.

10 The term "disposable garments" as used herein refers to those types of articles intended to be worn by persons, including infants and adults, which are designed for single use or temporary use and are meant to be disposed of after being used once instead of being laundered or dry cleaned
15 for re-use. Some examples of disposable garments within this general type are disposable diapers; adult incontinence garments; hospital garments such as surgical gowns, caps and booties or shoe covers; single use garments intended to be worn by patients in a hospital such as disposable pajamas
20 and gowns; and various other types of garments, such as laboratory coats, disposable shower caps, etc. Single use or disposable garments are most usually made of lightweight film or sheet material such as thermoplastic films, nonwoven

5 sheets of thermoplastic or cellulosic fibers, papers, coated
films or papers and various composites of one or more of
these types of materials. The materials used for disposable
garments are distinguishable from textiles that are used to
make a sewn garment or article intended for long term use
and subject to repeated laundering or drycleaning. Further,
disposable garments must generally be manufactured using
techniques such as die-cutting, heat sealing, sonic sealing,
adhesive bonding, etc., instead of the sewing methods custom-
arily employed to produce textile garments.

Many disposable garments employ some form of elasticized
body-encircling opening in order to provide a form-fitting
closure with part of a person's body. For example, a dispos-
able diaper will often have elasticized leg openings in
order to reduce leakage around an infant's legs, or sometimes
an elasticized waist opening; a gown or coat-like disposable
garment will often have elasticized wrist openings to provide
a snug fit about a person's wrists; disposable booties or
shoe covers may have an elasticized ankle encircling portion;
and a disposable cap may have an elasticized opening to fit
about a person's head.

The prior art techniques of which we are aware most
generally used to provide elasticized openings for disposable
garments are typified by patents relating to disposable
diapers, particularly U. S. patents 3,860,003,

4,050,462 and 4,325,372. The disposable diapers of these patents are three-layer composite structures comprising a liquid permeable bodyside liner, a liquid impermeable outer cover and an absorbent batt sandwiched between the liner and the cover. In order to provide elasticized leg openings, a strip of elastomeric material is included in the garments along the portions thereof which define the leg openings. The manner in which the elastomeric strips are incorporated in these garments involves joining the elastomeric strip to one layer of the garment, either the liner or the cover, intermittently bonding portions of one surface of the elastomeric strip to one layer or the other, and spacing the elastomeric strip from the edge of the garment at the leg openings. The techniques of forming elasticized openings in disposable garments disclosed in these patents are also typical of other prior art constructions. These techniques result in a disposable diaper having elasticized leg openings that have a ruffled or gathered appearance. This style of elasticised leg opening, while acceptable for disposable diapers, would be unacceptable or undesirable for various other types of disposable garments; also, elasticized leg openings for disposable diapers having a different appearance than the typical prior art constructions would be advantageous. Viewed from one broad aspect there is herein disclosed a disposable garment of the type including an outer

- marginal portion of material and an interior marginal portion of material along a part of the garment intended to fit along a wearer's body and an elastic element joined thereto to provide an elasticised opening for
- 5 the garment, wherein
- (1) the elastic element includes an exterior surface joined to the outer marginal portion of material along the opening and an inner surface joined to the interior marginal portion of material along the opening;
- 10 (2) the outer edges of the elastic element, the outer marginal portion of material and the interior marginal portion of material are substantially coincident:
- (3) the outer marginal portion of material is selected from the class consisting of (a) composite webs having
- 15 an outer layer of nonwoven fibrous material and an inner layer of plastic material, the inner layer being in contact with the exterior surface of the elastic element, (b) nonwoven webs of synthetic or natural fibres, or (c) plastic films,
- 20 (i) the outer marginal portion having a thickness in the range of 0.19 mm to 1.1 mm when a composite web, in the range of 0.13 mm to 0.76 mm when a nonwoven web, and in the range of 0.0076 mm to 0.05 mm when a plastic film,
- 25 (ii) the outer marginal portion having a flexural

rigidity in the range of 0.01 to 0.1 cm-g
when a composite web or nonwoven web and in
the range of 0.002 to 0.008 cm-g when a plastic
film;

- 5 (4) the exterior surface of the elastic element and the
outer marginal portion are in contact along an interface
and joined together along a plurality of bond points
disposed along the entire interface, the bond points
being spaced in the direction of elongation of the
10 elastic element and transversely thereof, and

(a) when the material of the outer marginal
portion is a composite web, the area of each
bond point is 0.05 to 3 mm², the distance
between neighbouring bond points in the direction
15 of elongation of the elastic element prior to
joinder of the elastic element to the outer
marginal portion is 0.5 to 4 mm, and the total
area of the bond points is 5 to 40% of the area
of said interface,

20 (b) when the material of the outer marginal
portion is a nonwoven web, the area of each bond
point is 0.05 to 3 mm², the distance between
neighbouring bond points in the direction of
elongation of the elastic element prior to
25 joinder of the elastic element to the outer

marginal portion is 0.25 to 4 mm, and the total area of the bond points is 5 to 50% of the area of said interface,

(c) when the material of the outer marginal portion is a plastic film, the area of each bond point is 0.05 to 1.5 mm², the distance between neighbouring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.05 to 2 mm, and the total area of the bond points is 20 to 80% of the area of said interface;

(5) wherein the elastic element is joined along the bond points when in an elongated condition and remains joined only to the bond points when in a retracted condition to provide an elasticized opening characterised by micro-ribbing of the outer marginal portion of material between the bond points.

Therefore at least in preferred forms the elasticized form-fitting closures for use with disposable garments provide a tailored look to the garments instead of the

ruffled or gathered opening typical of prior constructions. This allows the production of disposable garments that have more attractive looking elasticized openings. The construction can be employed with disposable
5 diapers for example, but it is also suitable for other types of disposable garments such as panties, gowns, booties, shoe covers and the like, and results in a more presentable appearance that may enhance or increase the use of disposable garments.

10 Some embodiments of the above broad aspects will now be described by way of example with reference to the accompanying drawings in which:-

Fig. 1 is a front perspective view of a disposable panty incorporating elasticized leg and waist openings
15 according to one embodiment;

Fig. 2 is a side perspective view of the disposable panty of Fig. 1;

Fig. 3 is a sectional view of the side seam construction of the panty of Fig. 1;

20 Fig. 4 is a sectional view of the elasticized waist band of the panty of Fig. 1;

Fig. 5 is a sectional view of an elasticized leg band of the panty of Fig. 1;

Fig. 6 is a sectional view of an elasticized opening of
25 an alternate construction of a disposable garment;

Fig. 7 is a perspective view of a marginal portion of the disposable panty of Fig. 1;

Fig. 8 is a sectional view illustrating the joinder of the elastic element to the disposable garment of Fig. 1 during the manufacture of the garment when the elastic element is in an extended condition;

Fig. 9 is a sectional view along the same plane as Fig. 8 illustrating the elastic element in its retracted condition in the finished garment;

Fig. 10 is a front perspective view of an exterior portion of the disposable panty of Fig. 1 depicting an elasticized opening when the elastic element is in its retracted condition;

Fig. 11 is a photomicrograph at 13.2X of one type of material suitable for use in a disposable garment, shown in plan view;

Fig. 12 is a photomicrograph at 13.2X of the material of Fig. 11 in cross-section with an elastic element joined thereto, shown in its extended condition;

Fig. 13 is a photomicrograph plan view at 13.2X of the structure illustrated in Fig. 12 with the elastic element in its retracted condition;

Fig. 14 is a photomicrograph at 13.2X of the structure of Fig. 13 illustrated in cross-section;

Fig. 14a is a photomicrograph at 2X illustrating the front view of the structure of Figs. 13 and 14;

Figs. 15, 15a, 16, 17, 18, 18a, 19, 20, 21 and 22 are schematic diagrams of various sections of a disposable garment as referred to in part (c) of the following description.

Fig. 23 is a sectional view of a disposable garment having a second embodiment of an elasticized opening; and

Fig. 24 is a sectional view of a disposable garment having a third embodiment of an elasticized opening.

(a) Figs. 1-10.

Figs. 1 and 2 illustrate, in front and side perspective views respectively, a disposable panty 10 including an elasticized waist band 11 and elasticized leg bands 12 and 13.

The panty 10 has a front panel 14 and rear panel 15 joined together along side seams 16 to form a completed garment. The panty 10 can be made, for example, from a single flat blank cut to the appropriate configuration and folded along crotch portion 17 between the leg openings or from separate front and rear panels seamed together along the crotch portion.

The front panel 14 and rear panel 15 of the panty are of the same construction and each includes (referring now to Figs. 4 and 5) a bodyside liner 20 and an outer cover 21. An absorbent batt 22 is positioned between the liner 20 and cover 21 and may be secured to either the liner or the cover, or both, by any suitable means well known in the art such as lines or dots of adhesive, pressure sensitive tapes, sonic seals, heat seals, etc., or the batt may be enclosed by but not secured to the liner or the cover.

As shown in Fig. 3, the side seams 16 are formed by seaming together contacting portions of the outer cover 21 by any suitable means well known in the art, such as sonic sealing, adhesive bonding, heat sealing, adhesive coated tapes, etc. This leaves a narrow fin inside the garment, which can be made relatively narrow such as about 1/16 to 1/2 inch (0.16 to 1.27 cm) wide so as to minimize the amount of the seam located along the interior of the garment. Any suitable side seam construction can be used in a disposable garment including an elasticized portion according to the present invention.

The present invention is concerned with the construction of elasticized openings in a disposable garment such as at the waist and legs of the disposable panty 10. The sectional view of Fig. 4 illustrates the construction along the waist band 11 of the panty 10, and the sectional view of Fig. 5 illustrates the construction along the leg bands 12 and 13.

As illustrated in these two drawings, the outer cover 21 of the panty is a two-layer sheet material having an outer layer 23 of fibrous nonwoven material and an inner layer 24 of plastic material; this is a particularly-preferred material for use with the elastic construction of the present invention in a disposable panty and is more fully described in the co-pending application of William M. Heran et al entitled Disposable Underpants, such as Infant's Training Pants and the Like filed on the same date herewith, U.S. Serial No. 690351 and assigned to the assignee of this application.

As shown in Fig. 4, an elastic element 25 is joined along its first or exterior surface 26 to a marginal portion of layer 24 of the outer cover 21 of the disposable panty 10 and joined along its opposite second or inner surface 27 to a marginal portion of the bodyside liner 20 of the garment. Referring back to Figs. 1 and 2, the elastic element 25 extends entirely around the waist band 11 of the panty 10; thus, there will be a portion of elastic element 25 joined as shown in Fig. 4 to the marginal portion of the front panel 14 which extends about part of the waist band 11 and another portion of the elastic element 25 joined to a marginal portion of the rear panel 15 of the panty which extends about the balance of the waist band 11. Similarly, referring now to Fig 5, an elastic element 30 extends about the circumference of the leg opening 12 and has its first or exterior surface 31 joined to the inner layer 24 of a marginal

portion of the outer cover 21 about the leg opening and its second or inner surface 32 joined to a marginal portion of the bodyside liner 20 about a leg opening. A similar elastic element extends about the leg opening 13 in the same manner.

5 Referring again to Figs. 1 and 2, an elastic element 30 extends about the circumference of each leg band 12 and 13.

Figs. 4 and 5 illustrate a first important characteristic of the present invention according to which the elastic element 25 is joined to both the bodyside liner 20 and outer
10 cover 21 of the disposable panty about the waist band 11; similarly, the elastic element 30 is joined to both the liner 20 and outer cover 21 of the panty about each of the leg openings 12 and 13.

Figs. 4 and 5 further illustrate a second important
15 characteristic of the present invention according to which the outer edge of the elastic element 25 is coincident with the outer edges of the bodyside liner 20 and outer cover 21, which relationship is denoted by the line A-A in Fig. 4. Similarly, the outer edge of the elastic element 30 is
20 coincident with the outer edges of the bodyside liner and outer cover 21 about each of the leg openings 12 and 13, which relationship is indicated by the line A-A in Fig. 5. Thus, the outermost edge of neither the liner 20 or cover 21 extends beyond the outermost edge of the elastic element
25 along the waist band or the leg bands of the disposable panty 10. The outer edges of these several elements can be

made coincident during manufacture of the garment by simultaneously cutting through the outer cover, elastic element and bodyside liner or by appropriately registering cutting of the outer cover and liner relative to the outer edge of
5 the elastic element.

The sectional view of Fig. 6 illustrates an alternate construction for a disposable garment incorporating the above two features of the present invention in a disposable garment which has a single layer 40 at an opening that is,
10 elasticized. In this version, an elastic element 41 has its first or exterior surface 42 joined to the layer 40 about the opening. The layer 40 is folded over the elastic element 41 and the second or inner surface 43 of the elastic element is joined to the folded-over portion 40a of the layer 40.
15 This drawing illustrates an alternate form of the first mentioned characteristic of this invention, in that the elastic element 41 is joined to a layer of garment material along both of its surfaces 42 and 43, with the layer on one side of the elastic element comprising a folded-over portion
20 of the same layer that is joined to the other surface of the elastic element. As to the second characteristic, the outer edge of the elastic element 41 is not strictly coincident with the outermost edge of the layer 40 since the bight portion 40b thereof is folded about the outer edge of the
25 elastic element 41. The bight portion 40b of the layer 40 is to be adjacent the outer edge of the elastic element of

41. Thus, for the purposes of the present invention, and as used in the claims, the term "substantially coincident" with respect to the outer edges of an elastic element and the layer or layers of the garment to which it is joined is defined to include structures as illustrated in Figs. 4 and 5 in which the edges of the layers of the garment and the elastic element are exactly coincident and also the structure as illustrated in Fig. 6 in which the difference between the outer edge of the elastic element and a folded layer to which it is joined differ by no more than the thickness of the layer to which the elastic element is joined. The outer edges of these several elements can be made substantially coincident when a garment is manufactured by folding as described or by appropriately registering the cutting of an outer cover and a liner relative to the outer edge of an elastic element. The folded edge construction as shown in Fig. 6 is suitable for disposable garments such as gowns, caps, booties and the like that do not require inner and outer layers as in the panty 10.

Figs. 7-10 illustrate a third important characteristic of the present invention. These drawings illustrate the elastic element 25 encircling the waist opening of the garment as shown in Fig. 1, it being understood that the joiner of the elastic elements 30 and 41 in Figs. 5 and 6 will be the same so that the ensuing description is also applicable to these drawings.

Considering Fig. 7 first, the marginal portion of the outer cover 21 of the panty 10 to which the elastic element 25 is joined includes a plurality of closely-spaced bond points 50 extending about the entire circumference of the waistband 11 of the garment. As explained in detail below, the bond points 50 may comprise fused areas or embossments in the material of which the outer cover 21 is made; the bond points typically extend along the entire surface of the sheet from which the layer is made as suggested by the group of bond points 50a in Fig. 7, but it is important that the bond points 50 be formed at least along the marginal portion of the layer to which the elastic element 25 is joined. The elastic element 25 is joined to the garment when in an extended or stretched condition during manufacture of the panty 10, illustrated in the sectional view of Fig. 8. As shown in Fig. 8, each bond point 50 is spaced from its neighboring bond points in the direction of elongation of the elastic element by a discrete distance d_s . Neighboring bond points also are spaced from each other in the direction transverse to the direction of elongation of the elastic element. The elastic element 25 is joined to the bond points 50, and may or may not also be joined to the material of the outer cover 21 between the bond points when first attached thereto in a stretched condition during part of the manufacturing process. After manufacture of the panty 10 is completed, however, the elastic element 25 is allowed to

retract, which condition is illustrated in cross section in Fig. 9. When the elastic element 25 has retracted, it remains joined to the bond points 50 of the outer cover but it is not joined to the intervening sections of the outer cover between the bond points. The retraction of the elastic element 25 while remaining joined only to the bond points brings the bond points closer together, shown as distance d_r in Fig. 9, the distance d_r being less than d_s . This results in a micro-buckling or micro-ribbing of the outer cover 21 between the bond points, which condition is depicted in Fig. 9 by the curved sections or micro-ribbing of the outer cover between the bond points. Fig. 10 shows the exterior of the panty 10 along the waist band area to further illustrate the nature of its construction when the elastic element 25 is retracted. Very fine micro-buckling or micro-ribbing 51 of the outer cover 21 is illustrated in Fig. 10 which extends transversely of the elastic element 25.

(b) Figs. 11-14a.

The photomicrographs of Figs. 11-14a provide further elucidation of the joinder of an elastic element to a disposable garment in accordance with this invention.

Fig. 11 is a 13.2X enlargement of a portion of material for the outer cover 21 which, as previously described is a two-layer composite structure consisting of an outer layer 23 of non-woven fibrous material and an inner layer 24 of plastic extrusion coated onto the fibrous outer layer 23.

The nonwoven fibrous outer layer 23 was thermally bonded so that the fibers thereof fused to one another to produce a series of bond points 50. The bond points 50 are smooth glass-like fused zones of the layer 23, whereas the remaining material of the layer between the bond points is relatively rough or fibrous in surface texture. Further, the bond points 50 are stiff or rigid, whereas the remaining material between the bond points is flexible. When the inner layer 24 of plastic material is extrusion coated onto the outer layer 23, the plastic material in molten form develops high adhesion to the bond points, and also adheres to the fibrous material between the bond points but usually at a lesser degree of adhesion, thereby resulting in an embossed composite web. The bond points are illustrated in Fig. 11 as being rectangular in shape, but they may have other configurations such as circular, triangular, hexagonal, etc. The distance between neighboring bond points 50 in the direction of elongation of an elastic element, generally circumferential relative to the opening which is to be elasticized, is identified as d_s in Fig. 11. It will be noted that the bond points 50 of Fig. 11 are arranged in alternating staggered rows, but again, other lineal arrangements of the bond points may be employed.

The photomicrograph of Fig. 12 illustrates the material of Fig. 11 in cross-section when an elastic element 25 is joined thereto in a stretched condition. Again, the distance

between bond points 50 is shown as d_s in Fig. 11

This photomicrograph represents an intermediate step in the manufacture of a disposable garment such as the panty 10 during which the elastic element is joined to the outer cover 21 and the liner 20 while in a stretched or elongated condition. In connection with the specific materials illustrated in Fig. 12, the elastic element 25 was stretched to an elongation of 50% when joined to the cover 21 and liner 20 in the manner illustrated.

10 The photomicrograph of Fig. 13 illustrates the material of Fig. 12 after the elastic element 25 has been allowed to retract and is a plan view similar to that of Fig. 11. As is evident from this photomicrograph, the bond points 50 have been drawn closer together due to the retraction of the elastic element 25. The photomicrograph of Fig. 13 is at 15 the same degree of magnification, 13.2X, as the photomicrograph of Fig. 11, and it can be seen that the distance d_r between the bond points after retraction of the elastic element is less than the distance d_s between the bond points 20 at the time the elastic element is initially joined to the layer 21 and liner 20.

The photomicrograph of Fig. 14 illustrates the material of Fig. 13 in cross-section. Again, it will be noted that the bond points 50 are closer to each other following retraction of the elastic element. Most clearly shown in this 25 figure, however, is the micro-buckling or micro-ribbing of

the outer layer 21 due to the retraction of elastic element 25. This results in the outer cover 21 having very fine striations or ribbing 51 in a direction transverse to the direction of retraction (and elongation) of the elastic element, best illustrated in Fig. 14a which is a photomicrograph front view at 2X of the material of Figs. 13 and 14. During retraction of the elastic element to the condition illustrated in Figs. 13-14a, the elastic element remains joined to the bond points 50 because of their smooth glass-like rigid structure, but the elastic element becomes disengaged from material of the outer cover between the bond points to which it may have been joined during the initial condition shown in Fig. 12; this is because the adhesion of the elastic element to the smooth rigid bond points is significantly higher than its adhesion to the rough flexible material between the bond points.

20 (c) Figs. 15-22

The following presents an explanation of the mechanism we believe provides the foregoing finely ribbed-like elasticized band for a disposable garment.

25 There are generally three phases to the mechanism as depicted in Figs. 15-22, which are shown two dimensionally bearing in mind that the mechanism occurs across the depth of the bond between the elastic element and outer cover bond in a similar manner. 30 With respect to the elements identified in Fig. 15-22:

w = width of the bond points 50;

d_s = length of outer cover 21 between bond points
when elastic element 25 is attached in stretched
condition;

5 l_s = length of stretched elastic element;

d_r = length of outer cover when elastic element is
contracted;

l_r = length of elastic element when retracted;

10 F_T = force required to hold elastic element in
position l_s ; and

t = thickness of outer cover.

In phase 1, illustrated in Fig. 15, the attachment
phase, the elastic element is stretched and attached to the
outer cover material (which is effectively in an unstretched
15 state). In phase 2, illustrated in Fig. 16, the buckling
failure phase, the elastic element is allowed to contract
which places a compressive load on the outer cover material
until it reaches its load carrying limit and fails by buck-
ling. In phase 3, Fig. 17, the retracted phase, the portion
20 of the elastic element between the bond points returns to
its original unstretched length while the outer cover material
effectively remains the same length but is in a buckled
condition between the bond points.

In the first phase, Fig. 15, the elastic element is
25 elongated by the application of an external force and joined
to the bond points 50 of the outer cover during the manufac-
ture of a garment. Fig. 15a is a free body diagram illustrat-
ing the force applied to the elastic element to stretch it

to length " L_s ", at which length the elastic element is joined to the bond points. The force required to hold an elastic element at a stretched length " L_s " can be determined as a function of its stretched length minus its retracted length " L_r ". This relationship for linear springs is Hooke's Law:

$$(Eq. 1) \quad F = K(L_2 - L_1)$$

With reference to Fig. 15a:

$$(Eq. 2) \quad F_T = K_E(L_s - L_r)$$

Where " K_E " is the slope of the line between the displacement ($L_s - L_r$) and " F_T " the force developed upon stretching the elastic element from retracted length " L_r " to stretched length " L_s ". The elastic element may not behave as a linear spring but the force can be determined empirically as a function " K_E " of the displacement. " K_E " will represent the spring constant for the elastic element, which is assumed to generally remain constant as the change in length of the elastic element increases. At any stretched length " l " of the elastic element, the force " F_E " in the elastic element is:

$$(Eq. 3) \quad F_E = K_E (l - l_r).$$

The relationship of equation 3 shows that a higher spring constant and/or a higher elongation will result in a higher force " F_E ".

Fig. 18 is a free body diagram illustrating the forces on the composite structure at any phase. In Fig. 18, " F " is

any external force applied to the elastic element, " F_E " is the force in the elastic element at any length, and " F_m " is the force applied to the outer cover through the bond points by the elastic element. To be in static equilibrium, the
5 sum of the forces must be equal to zero, therefore:

$$(Eq. 4) \quad F + F_m = F_E$$

These forces vary in the three phases as follows:

- (1) in phase 1, $F = F_T$, $F_m = 0$, and $F_E = F_T$.
- (2) in phase 2, assuming the force F_T is no longer
10 applied to the elastic element, $F = 0$, and $F_m = F_E$.
- (3) in phase 3, F , F_m and F_E are all effectively 0, disregarding any minor residual forces in the elements.

In order to reach phase 2, the beginning of buckling failure,
15 the force " F_E " must be at least sufficiently large to generate force " F_m " equal to the critical load of the outer cover material; to reach phase 3, the force " F_E " must be greater than this critical load.

In phase 2, the outer cover material appears as an
20 eccentrically loaded column with a compressive force F_m located at a distance of $t/2$ from the neutral axis of the column, where " t " is the thickness of the outer cover material as shown in Fig. 18a. If we consider that $t/2$ is a very small value, we can approximate the column as one basically
25 loaded at its neutral axis. The general equation for the

critical load at which buckling occurs in this case can be found in STANDARD Handbook for Mechanical Engineers, Sixth Edition, page 5-54 as:

$$(Eq. 5) \quad P_{cr} = \frac{n \pi^2 E I}{l^2} = \frac{n \pi^2 E A}{\left(\frac{l}{r}\right)^2}$$

5 Where:

- P_{cr} = load at which the column buckles (fails);
- n = coefficient which depends on end support conditions;
- E = material modulus of elasticity;
- I = least moment of inertia of material cross section;
- 10 A = cross sectional area of material;
- r = least radius of gyration of material;
- l = length of column between supports.

Considering a rectangular cross section of the material with thickness "t" and unit depth "b" as shown in Fig. 19 we have
15 the following:

$$I = \frac{b t^3}{12}, \quad A = tb, \text{ and } r^2 = \frac{I}{A} = \frac{t^2}{12}$$

(NOTE: To have buckling in the direction of the least radius of gyration, t is less than b.) Substituting these values into equation 5, the critical elastic force to cause
20 the material to buckle is:

$$(Eq. 6) \quad F_m = \left(\frac{n \pi^2 b}{12} \right) \left(\frac{t^3 E}{l^2} \right)$$

In any column, either concentrically or eccentrically loaded, that fails by buckling, a point in the loading is reached

where the column failure is not dependent on the eccentricity of the load at all. At this point, the values are again only dependent on "E", "l" and "t". See Mechanical Design and Systems Handbook, 1964 McGraw-Hill, Inc., pages 15-32 to

5 15-34.

Substituting specific values into equation 6, we can determine the maximum force required to buckle a column of a specific material under a consistent end loading configuration as follows:

10 (Eq. 7)
$$F_m = Q \frac{Et^3}{d_s^2}$$

In this equation, Q is a constant that includes the coefficient "n" for the end support conditions, depth of the material and numerical constants of integration. The value of Q can be determined empirically as has been done for
15 specific cases, as in the Gordon-Rankins formula for structural main members with a ratio of l/r between 120 and 200. (See Mechanical Design reference above.)

From equation 7, it can be seen that for any given depth "b" of the column, the critical elastic force is
20 directly proportional to the cube of the thickness "t" and the modulus of elasticity of the material "E" and inversely proportional to the square of the length of the column "d_s".

In Fig. 17, the unrestricted elastic element is shown in its retracted or unloaded length "l_r". The outer cover
25 21 is at length "d_r". At this point, the outer cover 21 is

not supporting any loading from the elastic element and has not retracted. Therefore,

$$(Eq. 8) \quad d_r \doteq d_s \doteq l_s$$

An estimate of the height of the buckle may be made by

5 assuming a triangular shape for the retracted layer 21. The amplitude "a" can be obtained from the Pythagorean Theorem using a right triangle with sides $l_r/2$, $d_r/2$ and the relationship of l_s to d_r as in equation 8:

$$(Eq. 9) \quad \left(\frac{l_s}{2}\right)^2 = \left(\frac{l_r}{2}\right)^2 + a^2$$

10 $(Eq. 10) \quad a = \frac{1}{2} \sqrt{l_s^2 - l_r^2}$

Note that the amplitude can never be greater than 1/2 the stretched length because for this to be true, the retracted length would have to be zero.

The stretched length of the elastic element can be
15 referred to as a proportion of the original unstretched length. This proportion is the elongation "e" expressed in general terms of stretched length L_s and retracted length L_r .

$$(Eq. 11) \quad e = \frac{L_s - L_r}{L_r}, \text{ or } \%e = \frac{L_s - L_r}{L_r} \times 100$$

20 Also:

$$(Eq. 12) \quad L_s = L_r (e+1)$$

$$(Eq. 13) \quad L_r = \frac{L_s}{(e+1)}$$

Substituting equation 13 into equation 10 using the specific lengths l_s and l_r :

(Eq. 14)
$$\alpha = \frac{1}{2} l_s \sqrt{1 - \frac{1}{(e+1)^2}}$$

These values only consider the amount of the outer cover and elastic element composite between the bond points. To determine the total composite retraction, we must consider the amount of bonded area. Figs. 21 and 22 show the distances including the length of the bond when the bond remains under tension in the retracted state. The following equations are based on Figs. 21 and 22 and equation 13:

(Eq. 15)
$$x_s = l_s + w = (x_s - w) + w$$

(Eq. 16)
$$x_r = l_r + w = ((x_s - w)/(e + 1)) + w$$

The elongation "S" of the composite is now a ratio of x_s to x_r as follows:

15 (Eq. 17)
$$S = \frac{x_s - x_r}{x_r}, \text{ which can be rewritten as}$$

(Eq. 18)
$$S = \frac{e(x_s - w)}{x_s + we}$$

Let the ratio of "w" to the total length " x_s " be defined as the ratio "Y" of the bonded area to the unbonded area.

(Eq. 19)
$$Y = w/x_s$$

20 Substituting this back into equation 18:

(Eq. 20)
$$S = \frac{e(1-Y)}{1+Ye}$$

Equation 20 shows that the elongation of the composite is only related to the initial elongation "e" of the elastic element and the ratio "Y" of the bonded area to the unbonded area.

It should be noted that the bond between the elastic element and the outer cover must be strong enough to maintain the force that is still over the bond points in phase 3.

This force is, from equations 2 and 13:

5 (Eq. 21)
$$F = \frac{K_e w e}{e + 1}$$

(d) Materials.

A disposable garment having one or more elasticized body-encircling openings in accordance with this invention can be made of various materials suitable for the manufacturing techniques typically employed to produce such garments and appropriate to the end use intended for the garment. Garments such as disposable gowns, booties, caps may be made of a single layer of material (which can have two or more strata) whereas garments such as the disposable panty 10 described herein, infant diapers and adult incontinence garments may have several layers each selected for a specific functionality.

For example, the bodyside liner 20 or interior panel of the disposable panty 10 can be any flexible porous sheet which passes fluids therethrough to be absorbed in the absorbent batt 18, and other types of disposable garments may include a bodyside liner for the same purpose. The liner may comprise a nonwoven web or sheet of polyolefin fibers, such as polypropylene or polyethylene; a web of polyester fibers; a web of spun bonded polypropylene, polyethylene or polyester fibers; a web of rayon fibers; a

bonded carded web of synthetic or natural fibers, and the like. The liner may also comprise a plastic film which is perforated to obtain the desired degree of moisture perviousness, or an expanded plastic webbing material or a scrim material. The liner preferably is made of a material which will feel soft and comfortable against the skin of an infant or adult.

An absorbent batt when included in a disposable garment, such as the absorbent batt 22 of the disposable panty 10, may comprise any suitable material capable of absorbing and retaining waste fluids that pass through the bodyside liner. The absorbent batt may comprise cellulosic material such as an air-formed batt of wood pulp fibers, commonly known as "fluff", which may include a heat fusible binder; a batt of melt blown fibers, such as of polypropylene, polyethylene, polyester and the like; a bonded carded web of synthetic or cellulosic fibrous materials; a composite of melt blown fibers of polypropylene, polyethylene, polyester or the like mixed with pulp fibers; or a blend of fluff with staple textile fibers such as rayon and the like. The batt may comprise one or more layers or combinations of the foregoing materials. In addition, the batt may include compounds added to increase its absorbency.

The exterior panel of a composite disposable garment, such as the outer cover 21 of the panty 10 and similar constructions, or the material of a single layer disposable

garment such as a gown, bootie, cap, etc., can be of various types of materials including a plurality of closely-spaced bond points at least along the marginal portion(s) to which an elastic element is to be joined as described herein. The

5 following types of materials are suitable for this purpose:

(1) Composite webs having an outer layer of nonwoven fibrous material and an inner layer of plastic material. Materials suitable for the outer layer (such as the layer 23 of the outer cover 21 of the panty 10) include a spun-bonded nonwoven
10 web of synthetic fibers such as polypropylene, polyethylene or polyester fibers; a nonwoven web of cellulosic fibers, textile fibers such as rayon fibers, cotton and the like, or a blend of cellulosic and textile fibers; a spun-bonded nonwoven web of synthetic fibers such as polypropylene,
15 polyethylene or polyester fibers mixed with cellulosic, pulp or textile fibers; or melt blown thermoplastic fibers, such as macrofibers or microfibers, of polypropylene, polyethylene, polyester or other thermoplastic materials or mixtures of such thermoplastic fibers with cellulosic, pulp or textile
20 fibers. Suitable plastic materials for the inner layer (such as the inner layer 24 of the outer cover 21 of the panty 10) include polyolefin polymers such as polyethylene or polypropylene; polyolefin copolymers such as ethylene vinyl acetate, ethylene methyl acrylate or ethylene ethyl
25 acrylate; polyvinyl chloride; or nylon. For many types of disposable garments, the inner layer is to provide a moisture

barrier or liquid imperviousness. The plastic inner layer can be extrusion coated onto a web of the outer layer material, or the plastic inner layer may be a pre-formed web laminated to a web of the outer layer material such as by
5 heat and pressure, sonic sealing, adhesive bonding etc. The bond points can be formed in a composite web by embossing with a suitable roll using heat and pressure as appropriate, or by other techniques capable of forming smooth fused bond points as previously described. The bond points may be
10 located along the interior surface of the web or may be spaced slightly within the thickness of the web.

(2) Nonwoven webs of synthetic and/or natural fibers.

Suitable materials include a spun-bonded nonwoven web of synthetic fibers such as polypropylene, polyethylene or
15 polyester fibers; a nonwoven web of cellulosic fibers, textile fibers such as rayon fibers, cotton and the like, or a blend of cellulosic and textile fibers; a spun-bonded nonwoven web of synthetic fibers such as polypropylene, polyethylene or polyester fibers mixed with cellulosic, pulp
20 or textile fibers; or melt blown thermoplastic fibers, such as macrofibers or microfibers, of polypropylene, polyethylene, polyester or other thermoplastic materials or mixtures of such thermoplastic fibers with cellulosic, pulp or textile fibers. The bond points can be formed in nonwoven webs of
25 this type by the same techniques as described above in connection with composite webs.

(3) Plastic film, which may comprise single layer films of plastic material or multiple layer films of two or more similar or dissimilar plastic materials formed by lamination, extrusion coating or coextrusion of appropriate plastics.

5 Suitable plastic materials include polyolefin polymers such as polyethylene or polypropylene; polyolefin copolymers such as ethylene vinyl acetate, ethylene methyl acrylate or ethylene ethyl acrylate; polyvinyl chloride; or nylon. The bond points can be formed in plastic films by embossing
10 under heat and pressure with a roll having a suitable surface pattern or by extruding plastic films onto a chill roll having a patterned surface texture to form the bond points. The bond points should project slightly from the innermost surface of the film to which an elastic element is to be
15 joined.

Any suitable elastomeric material can be employed for the elastic element in the practice of this invention that exhibits an elongation (defined as in Equation 11 above) at least in the range of 5% to 300%, preferably in the range of
20 25% to 200%. Also, the material of the elastic element should have a spring constant (K in equation 1, or K_E in equation 2 of part (c) above) such that the elastic element can develop a force (F_E in equation 3 of part (c) above) when elongated and joined to the garment large enough to
25 result in buckling of the outer cover material between bond points when the elastic element retracts. However, the force

developed by elongation of the elastic element when a garment is worn by a person should not be so high as to cause discomfort to the person or undue restriction of the part of a person's body in contact with the elasticized portion of the garment. We have found that material for the elastic element with a spring constant in the range of 10 to 30 gms/cm, preferably 15 to 22 gms/cm, is suitable for disposable garments such as infant's training pants constructed in accordance with the present invention. However, the spring constant can vary from these limits, depending upon the end use for a specific disposable garment. Various commercially available materials can be used, such as natural rubber, butyl rubber or other synthetic rubbers, urethane elastomeric material such as that available from B. F. Goodrich Company under the trademark TUFTANE, and elastomeric material available from the H. B. Fuller Company under the tradename FULLASTIC. The latter material (see e. g. U. S. patent 4,418,123) is based upon thermoplastic elastomeric copolymers of the A-B-A type such as those available from Shell Chemical under the trademark KRATON which have a rubbery midblock such as butadiene or isoprene and polystyrene end blocks, and is especially useful because it is a self-adhesive material and can be applied to the outer layer of a disposable garment without additional adhesive between the elastic element and the layers. The elastic element can be applied to the garment by any suitable means including adhesive

bonding, heat sealing or sonic bonding, whichever is appropriate to the specific material selected for the elastic means.

(e) Physical Parameters.

5 It is an important feature of these embodiments that the outer layer or exterior panel of a disposable garment to which an elastic element is joined has several characteristics in order to obtain the micro-ribbing or micro-buckling condition described above.

10 As stated previously, at least the marginal portion of the outer layer is to have a plurality of closely-spaced bond points along its inner surface to which the elastic element is joined. There is to be a continuous array of the bond points along the entire marginal portion, which can be
15 in either a regular or irregular pattern. Further, it is important that each bond point has a specified area and is spaced from its neighboring bond points in the direction of elongation of the elastic means at a specified distance. The bond point area and spacing will, however, vary with the
20 type of material employed for the exterior panel. The numerical ranges for these parameters of the exterior panel materials are as follows:

(1) For composite webs, as defined in part (d), each bond point should have an area in the range of 0.05 to 3 mm^2 ,
25 preferably 0.09 to 0.56 mm^2 and most preferably 0.15 to 0.30 mm^2 . The distance between bond points in the direction of

elongation of the elastic element prior to joinder of the elastic element should be in the range of 0.5 to 4 mm, preferably 0.9 mm to 1.5 mm and most preferably 1.1 to 1.3 mm.

5 (2) For nonwoven webs, as defined in part (d), each bond point should have an area in the range of 0.05 to 3 mm², preferably 0.6 to 1.0 mm² and most preferably 0.7 to 0.85 mm². The distance between bond points in the direction of elongation of elastic element prior to joinder of the elastic
10 element should be in the range of 0.25 to 4 mm, preferably 0.25 to 3 mm and most preferably 0.5 to 2 mm.

(3) For plastic films, as defined in part (d), each bond point should have an area in the range of 0.05 to 1.5 mm², preferably 0.1 to 0.5 mm² and most preferably in the range
15 of 0.15 to 0.35 mm². The distance between bond points in the direction of elongation of the elastic element prior to joinder of the elastic element should be in the range of 0.05 to 2 mm, preferably 0.05 to 1 mm and most preferably 0.1 to 0.3 mm.

20 The bond points also should be spaced from one another transversely of the direction of elongation of the elastic element, but this spacing is not critical for the practice of the present invention and can vary within a wide range that may be less than or greater than the distance between
25 bond points in the direction of elongation of the elastic element as stated above. However, the bond points are to be

disposed along the entire interfacial contact area between the elastic element and the portion of the outer cover or external panel of the garment to which the elastic element is joined. Thus, with reference to Figs. 4 and 7, for

5 example, the bond points 50 are disposed along the entire area of the marginal portion of the outer cover 21 to which the first surface 26 of the elastic element 25 is joined.

Considering the area of each bond point and the spacing between bond points in the direction of elongation of the
10 elastic element within the ranges stated above,

and bearing in mind that the bond points are to be spaced from one another transversely of the direction of elongation of the elastic element, the bond points should cover a specified percentage of the surface area of the marginal

15 portion of the exterior panel to which the elastic element is joined; stated otherwise, the total area of the bond points should be a specified percentage of the area of the exterior surface (first surface 26) of the elastic element.

Thus, the total area of the bond points should be as follows:

20 (1) For composite webs, as defined in part (d), the bond points should cover from 5 to 40%, preferably 5 to 30% and most preferably 8 to 15%, of the interfacial contact area between the elastic element and the marginal portion of the outer cover to which the element is joined.

25 (2) For nonwoven webs, as defined in part (d), the bond points should cover from 5 to 50%, preferably 8 to 30% and

most preferably 11 to 20%, of the interfacial contact area between the elastic element and the marginal portion of the outer cover to which the element is joined.

(3) For plastic films, as defined in part (d), the bond
5 points should cover from 20 to 80%, preferably 35 to 75% and most preferably 50 to 60%, of the interfacial contact area between the elastic element and the marginal portion of the outer cover to which the element is joined.

Secondly, the flexural rigidity of the material of the
10 exterior panel is important. The construction of this invention is based upon an elastic element being joined to the bond points but not to the material between the bond points when in its retracted condition. In order for this structural relationship to be developed, it has been found
15 that the flexural rigidity of the material should be within a specified range, measured in accordance with Federal Test Method Std. No. 191, depending on the material used for the exterior panel:

(1) For composite webs, as defined in part (d), the flexural
20 rigidity should be in the range of 0.010 to 0.1 cm-g, preferably 0.02 to 0.08 cm-g and most preferably 0.03 cm-g to 0.055 cm-g.

(2) For nonwoven webs, as defined in part (d) the flexural
rigidity should be in the range of 0.01 to 0.1 cm-g, prefer-
25 ably 0.02 to 0.08 cm-g and most preferably in the range of 0.03 to 0.055 cm-g.

(3) For plastic films, as defined in part (d), the flexural rigidity should be in the range of 0.002 to 0.008 cm-g, preferably 0.0025 to 0.0075 cm-g and most preferably 0.003 to 0.006 cm-g.

- 5 In addition, the formation of the micro-ribbing or striations of the exterior layer between the bond points upon retraction of the elastic element as described above involves mechanical control of folding the material between the bond points by the force developed with the elastic
- 10 element. The thickness of the material affects the presence or absence of such folding or buckling and the degree of folding. The thickness of the material necessary to achieve this effect varies with the type of material used for the exterior layer, as follows:
- 15 (1) Composite webs, as defined in part (d), should be in the range of 0.0075 to 0.045 inches (0.19mm to 1.1mm) thick, preferably 0.009 to 0.020 inches (0.23 to 0.51mm) thick, and most preferably 0.011 to 0.015 inches (0.28 to 0.38mm) thick. These materials will generally have a basis weight in the
- 20 range of 15 to 90 g/m², most often in the range of 30 to 55 g/m².
- 25 (2) Nonwoven webs, as defined in part (d), should be in the range of 0.005 to 0.03 inches (0.13 to 0.76mm) thick, preferably 0.007 to 0.015 inches (0.18 to 0.38mm) thick, and most preferably in the range of 0.009 to 0.013 inches (0.23 to 0.33mm) thick. These materials will generally have a basis weight in the range of 10 to 50 g/m², most often in the range of 15 to 30 g/m².

(3) Plastic films, as defined in part (d), should be in the range of 0.0003 to 0.006 inches (0.0076 to 0.15mm) thick, preferably 0.0003 to 0.002 inches (0.0076 to 0.05mm) thick, most preferably in the range of 0.0005 to 0.001 inches (0.013 to 0.025mm) thick.

5 To summarize, the (1) bond point area and spacing, (2) flexural rigidity, and (3) thickness of the exterior layer to which an elastic element is joined should be within the ranges stated above in order to produce an elasticized body-encircling opening in a disposable garment in accordance
10 with the present invention and these characteristics are regarded as critical parameters for the practice of this invention.

As stated in part (a) of this description, another important characteristic of the elasticized opening construction of the present invention is that the elastic
15 element is joined to layers of the garment on both of its opposed surfaces. In the case of a composite garment such as the panty 10 described above, the first or exterior (relative to the manner in which the garment is worn) surface
20 26 of the elastic element 25 is joined to the outer cover 21 of the panty and the second or inner surface 27 thereof is joined to the bodyside liner 20 of the garment. In the case of a garment having a single exterior layer along the elasticized opening, such as illustrated in Fig. 6, the exterior
25 and interior surfaces of the elastic element are joined to the same material which is folded over so as to have a

portion on both sides of the elastic element. It is necessary to have a layer of material joined to the interior surface of the elastic element in order to equalize the stress on the elastic element from side to side of the

5 element. If there is not a layer joined to the interior surface of the elastic element, the elastic element can curl transversely and thereby become longitudinally folded and/or can contract circumferentially and tend to ball up. This would have an adverse effect upon both the functionality of

10 the elastic element and its appearance. It is considered preferable that the two layers of garment material joined to opposite surfaces of the elastic element have similar flexural rigidity. Also, it is preferred that the layer of material joined to the interior surface of the elastic

15 element have a plurality of spaced bond points, but it is not necessary that the bond points of such layer have the same parameters as the bond points described above with respect to the layer of material joined to the exterior surface of the elastic element. Thus, there is a wider

20 choice of the physical structure and mechanical properties of the layer joined to the interior surface of the elastic element as compared to the parameters described above with respect to the layer joined to the exterior surface thereof.

The interior layer can be of the same types of materials
25 suitable for the exterior layer as described previously in part (d) including composite webs, nonwoven webs and plastic films.

(f) Alternate Embodiments, Figs. 23 and 24.

As mentioned previously, the elastic element can be joined to a garment layer or layers by means of adhesive instead of being directly joined thereto as illustrated in Figs. 1-10. This alternative is illustrated in Fig. 23. Elastic element 60 is joined between the outer cover 61 and bodyside liner 62 of a disposable garment having absorbent batt 63 between the two layers. The exterior surface 64 of the elastic element is joined to the outer cover along a thin layer of adhesive 65. The inner surface 66 of the elastic element is joined to the liner along a thin layer of adhesive 67. The adhesive layers 65 and 67 can be any adhesive, such as a liquid adhesive, hot melt adhesive, pressure sensitive adhesive, and the like, appropriate for bonding the material of the elastic element to material of the garment. Other structural features of the elasticized opening formed thereby remain as described previously, and the adhesive selected for this type of installation is to be joined only to the bond points of the two layers when the elastic element is retracted for the purposes of the present invention.

Also, however, joinder of the elastic element to a marginal portion of the outer cover with an adhesive layer, such as the adhesive layer 65 described above, enables an alternative construction for the bond points. The bond points 50 in Figs. 1-21 are disclosed as being formed in the

material of the outer cover 21 of the garment. However, when an elastic element is joined to a garment by means of an adhesive layer, it will be possible to form the bond points as part of the elastic element instead of as part of the outer cover material. Adhesive, such as the adhesive layer 65, can be screen printed onto the surface of an elastic element to be joined to the outer cover in a pattern comprising spaced discrete zones of adhesive that will form the bond points 50. When this alternative is employed, the zones of adhesive should have bond point area and spacing parameters within the ranges stated above in part (e). The surface of the elastic element to be joined to an inner liner can also be screen printed with discrete zones of adhesive which can have the same or different area and spacing.

The previous embodiments have shown the use of a single elastic element along the body-encircling portion to be elasticized. Also, the elastic elements in the embodiments previously described have been flat elastic tapes of rectangular cross-section including a pair of opposed planar surfaces. However, the present invention may be practiced with disposable garments having two or more elastic elements along a body-encircling portion and also with disposable garments including elastic elements having various cross-sectional configurations. Fig. 24 illustrates both of these alternatives. The section of a disposable garment shown

therein includes a plurality of spaced elastic elements 70, each consisting of a filament or string of circular cross section, which construction is described and claimed in the application of Ales et al. entitled Disposable Garments with
5 Multiple Strand Elasticized Openings, U.S. Serial No. 690349, filed on the same date herewith and assigned to the assignee of this application, which is incorporated herein by reference. Each elastic element 70 is joined to the innermost surface of outer layer 71 of the garment and
10 to the innermost surface of bodyside liner 72 of the disposable garment. One-half of the longitudinal circumferential surface of each element 70 is joined to the outer layer and the other half of the longitudinal circumferential surface of each elastic element is joined to the inner layer in this
15 fashion. The outer edges of the layer 71, liner 72 and outermost elastic element 70 are substantially coincident. Again, the structural configuration of the innermost surface of the outer layer 71 and the manner in which each elastic element 70 is joined thereto are as described previously.

20 (g) Example

A disposable panty such as the panty 10 illustrated in Fig. 1 was constructed in a size suitable for use as an infant's training panty with an elasticized waistband as shown in Fig. 4 and elasticized legbands as shown in Fig.
25 24. The material of the outer cover, or exterior panel, of the disposable underpant was a two-layer composite web

having an outer layer of nonwoven polypropylene fibers and an inner layer of ethylene methyl acrylate extrusion coated onto the nonwoven fibrous outer layer. The material of the outer cover, which is illustrated in the photomicrographs of Figs. 11-14a, had the following physical parameters:

- (1) Bond points measured as from about 0.15 to 0.30 mm² in area. (The bond points were formed along the entire area of the sheet material used for the outer cover as described previously in part (d)).
- (2) Bond points along the waist and leg openings were spaced apart from about 1.1 to 1.3 mm in the direction of elongation of the elastic elements to be joined thereto. The bond points also were spaced transversely and covered about 8 to 15% of the surface area of the marginal portions of the outer cover joined to the exterior surface of the elastic elements.
- (3) A flexural rigidity measured according to Federal Text Method STD. No. 191 of from about 0.030 to 0.055 cm-g; and
- (4) A thickness averaging from about 0.011 to 0.015 inches.

The panty had an interior panel comprising a bodyside liner of spun bonded polypropylene fibers having bond points in the same size pattern as the material of the outer cover. An absorbent batt of a composite of polypropylene microfibers

and cellulosic fibers was sandwiched between the exterior panel and the interior panel. The elastic element along the waistband was a flat member about 3/4 inch (1.9cm) wide and 0.016 inches (0.041cm) thick consisting of an A-B-A elastomeric copolymer (FULLASTIC) as described above in part (d) having a spring constant of 47 gms/cm. Three strands of the same elastomeric copolymer were arranged about each leg opening; the strands were each 1/16 inch (0.16 cm) in diameter and were spaced 1/4 inch (0.635 cm) apart. The elastic element at the waist opening was stretched to about 84% and the elastic elements at the leg openings were stretched to about 117% and attached to the bond points of the exterior panel around these openings. The elastic elements were also joined to the interior panel along the leg and waist openings. Upon retraction of the elastic elements, the material of the exterior panel buckled between the bond points along the elastic elements at the waist and leg openings to form a continuous array of very fine striations or micro-ribbing between the bond points. This provided a disposable underpant garment with an attractive tailored appearance at the waist and leg openings. Tests of the garment with infants demonstrated that the underpant remained securely held in place about an infant's waist when the waist elastic was expanded as the garment was fit onto an infant and that the elasticized leg openings provided good sealing or gasketing against the leakage of fluids therethrough. Thus, a disposable underpant in ac-

cordance with this invention proved to be an attractive garment that was capable of providing the functionality required of a utilitarian disposable training pant.

There has thus been described a new construction for an
5 elasticized marginal portion, generally a body-encircling opening, of a disposable garment. An elastic element is joined to two layers of a disposable garment along the marginal portion which is to be elasticized, and the elastic element can extend entirely or partially around the marginal
10 portion. Further, the structure of the interface between the layers and the elastic element is to comprise a plurality of closely-spaced small bond points. The elastic element is joined to the bond points when in an extended or stretched condition, and when the elastic element is in a retracted
15 condition the force generated thereby produces a micro-ribbing or micro-buckling of the exterior layer of the garment between the bond points. Other important features necessary for obtaining the elasticized construction of this invention have been fully described hereinabove. The result-
20 ing elasticized structure achieved, through the practice of this invention provides an exterior layer in a disposable garment which has a finely-ribbed or striated structure in the direction transverse to the direction of elongation of the elastic element. This produces a disposable garment
25 having a tailored, pleasing appearance which closely resembles an elasticized portion heretofore previously

achieved only with garments sewn of textile materials. In addition to the attractive appearance, however, an-elasticized opening, at least in preferred forms, is extendable when a disposable garment is worn by a person so as to provide a snug, comfortable fit around the body portion which the elasticized margin encircles. This retains the garment in place in the desired position and also provides sealing against fluid leakage if such functionality is required with a specific type of disposable garment.

10 There is thus provided an elastic construction suitable for forming one or more elasticized openings in a disposable garment according to which (1) an elastic element is joined to marginal portions of both inner and outer layers of a disposable garment around an opening, or to a layer folded over opposed surfaces of the elastic element in the case of a disposable garment having a single layer along an opening, (2) the outer edge of the elastic element is coincident or substantially coincident with the outer edges of each garment layer to which it is joined, and (3) the portion of the outer layer along the elastic element and the surface of the elastic element contacting such portion are joined together along a plurality of spaced bond points area such that the elastic element causes micro-buckling of the outer layer between the bond points when in a retracted

condition. This combination of features results in disposable garments having elasticized openings that closely resemble the appearance of a sewn cloth garment, as well as other advantages.

Modifications to the specific embodiments and to any broad aspects thereof referred to or suggested herein may be apparent to those skilled in the art and the disclosure hereof is intended to encompass any such modifications. The claims presently appended hereto define those aspect(s) for which protection is being sought for the time being.

Reference is hereby made to the applicants divisional application no. 881802 of even date.

CLAIMS

1. A disposable garment of the type including an outer marginal portion of material and an interior marginal portion of material along a part of the garment intended to fit along a wearer's body and an elastic element joined thereto
5 to provide an elasticized opening for the garment,
wherein
 - (1) the elastic element includes an exterior surface joined to the outer marginal portion of material along the opening and an inner surface joined to the interior marginal portion
10 of material along the opening;
 - (2) the outer edges of the elastic element, the outer marginal portion of material and the interior marginal portion of material are substantially coincident;
 - (3) the outer marginal portion of material is selected from
15 the class consisting of (a) composite webs having an outer layer of nonwoven fibrous material and an inner layer of plastic material, the inner layer being in contact with the exterior surface of the elastic element, (b) nonwoven webs of synthetic or natural fibers, or (c) plastic films,
20 (i) the outer marginal portion having a thickness in the range of 0.19 mm to 1.1 mm when a composite web, in the range of 0.13 mm to 0.76 mm when a nonwoven web, and in the range of 0.0076 mm to 0.05 mm when a plastic film,



- 25 (ii) the outer marginal portion having a flexural
 rigidity in the range of 0.01 to 0.1 cm-g when a
 composite web or nonwoven web and in the range of
 0.002 to 0.008 cm-g when a plastic film;
- 30 (4) the exterior surface of the elastic element and the
 outer marginal portion are in contact along an interface and
 joined together along a plurality of bond points disposed
 along the entire interface, the bond points being spaced in
 the direction of elongation of the elastic element and
 transversely thereof, and
- 35 (a) when the material of the outer marginal portion is
 a composite web, the area of each bond point is 0.05 to
 3 mm², the distance between neighboring bond points in
 the direction of elongation of the elastic element
 prior to joinder of the elastic element to the outer
40 marginal portion is 0.5 to 4 mm, and the total area of
 the bond points is 5 to 40% of the area of said inter-
 face,
- 45 (b) when the material of the outer marginal portion is
 a nonwoven web, the area of each bond point is 0.05 to
 3 mm², the distance between neighboring bond points in
 the direction of elongation of the elastic element
 prior to joinder of the elastic element to the outer
 marginal portion is 0.25 to 4 mm, and the total area of
 the bond points is 5 to 50% of the area of said inter-
50 face,



- (c) when the material of the outer marginal portion is a plastic film, the area of each bond point is 0.05 to 1.5 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.05 to 2 mm, and the total area of the bond points is 20 to 80% of the area of said interface;
- 10 (5) wherein the elastic element is joined along the bond points when in an elongated condition and remains joined only to the bond points when in a retracted condition to provide an elasticized opening characterized by micro-ribbing of the outer
- 15 marginal portion of material between the bond points.



2. A disposable garment according to claim 1
wherein: the elastic element includes a flat exterior
surface and a flat inner surface.

5 3. A disposable garment according to claim 1
wherein: the elastic element has a circular cross-
section and the exterior surface thereof comprises
one-half of the longitudinal circumferential surface
of the element and the inner surface thereof comprises
10 the remaining one-half of the longitudinal circumferen-
tial surface of the element.



4. A disposable garment of the type including
an outer marginal portion of material and an interior
marginal portion of material along a part of the
garment intended to fit along a wearer's body and
5 an elastic element joined thereto to provide an
elasticized opening for the garment, wherein

(1) the elastic element includes an exterior
surface joined to the outer marginal portion of
10 material along the opening and an inner surface
joined to the interior marginal portion of material
along the opening;

(2) the outer edges of the elastic element, the
outer marginal portion of material and the interior
15 marginal portion of material are substantially
coincident:

(3) the outer marginal portion of material is
selected from the class consisting of (a) composite
webs having an outer layer of nonwoven fibrous material
20 and an inner layer of plastic material, the inner
layer being in contact with the exterior surface
of the elastic element, (b) nonwoven webs of synthetic
or natural fibers, or (c) plastic films,

(i) the outer marginal portion having a
25 thickness in the range of 0.19 mm to 1.1 mm
when a composite web, in the range of 0.13 mm
to 0.76 mm when a non-woven web, and in the
range of 0.0076 mm to 0.05 mm when a plastic
film,



- 25 (ii) the outer marginal portion having a flexural rigidity in the range of 0.01 to 0.1 cm-g when a composite web or nonwoven web and in the range of 0.002 to 0.008 cm-g when a plastic film;
- (4) the outer marginal portion of material includes a
30 plurality of closely-spaced bond points extending along the entire exterior surface of the elastic element joined thereto, the bond points being spaced in the direction of elongation of the elastic element and transversely thereof, and
- (a) when the material of the outer marginal portion is
35 a composite web, the area of each bond point is 0.05 to 3 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.5 to 4 mm, and the total area of
40 the bond points is 5 to 40% of the area of the exterior surface of the elastic element,
- (b) when the material of the outer marginal portion is
45 a nonwoven web, the area of each bond point is 0.05 to 3 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.25 to 4 mm, and the total area of the bond points is 5 to 50% of the area of the exterior surface of the elastic element,



(c) when the material of the outer marginal portion is a plastic film, the area of each bond point is 0.05 to 1.5 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.05 to 2 mm, and the total area of the bond points is 20 to 80% of the area of the exterior surface of the elastic element;

(5) wherein the elastic element is joined to the bond points when in an elongated condition and remains joined only to the bond points when in a retracted condition to provide an elasticized opening characterized by micro-ribbing of the outer marginal portion of material between the bond points.

5. A disposable garment according to claim 4, wherein: the elastic element includes a flat exterior surface and a flat inner surface.



6. A disposable garment according to claim 4, wherein:
the elastic element has a circular cross-section and the
exterior surface thereof comprises one-half of the longitudinal
circumferential surface of the element and the inner
5 surface thereof comprises the remaining one-half of the
longitudinal circumferential surface of the element.

7. A disposable garment according to claim 4, 5 or 6
wherein:
the garment comprises an exterior panel including the outer
marginal portion and an interior panel including the inner
5 marginal portion.



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8. An integral disposable panty comprising the combination of

(1) an outer cover;

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(2) a bodyside liner;

(3) an absorbent batt between the outer cover and the bodyside liner;

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(4) a pair of opposed side seams joining together portions of the outer cover and bodyside liner to form a panty having a waist opening defined by an outer marginal portion of the bodyside liner, and a pair of leg openings each defined by an outer marginal portion of the outer cover and an interior marginal portion of the bodyside liner;

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(5) an elastic element along the waist opening and an elastic element along each leg opening,

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each elastic element including an exterior surface joined to an outer marginal portion of the outer cover and an inner surface joined to an interior marginal portion of the bodyside liner along its respective waist or leg opening;

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(6) the outer edges of the elastic element, the outer marginal portion of the outer cover and the interior marginal portion of the bodyside liner along the waist opening and each leg opening being substantially coincident;

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- 25 (7) the outer marginal portion of the outer cover along the
waist opening and each leg opening being a material selected
from the class consisting of (a) composite webs having an
outer layer of nonwoven fibrous material and an inner layer
of plastic material, the inner layer being in contact with
30 the exterior surface of the elastic element, (b) nonwoven
webs of synthetic or natural fibers, or (c) plastic films,
(i) the outer marginal portion having a thickness in
the range of 0.19 mm to 1.1 mm when a composite
web, in the range of 0.13 mm to 0.76 mm when a non-
35 woven web, and in the range of 0.0076 mm to 0.05 mm
when a plastic film,
(ii) the outer marginal portion having a flexural
rigidity in the range of 0.01 to 0.1 cm-g when a com-
posite web or nonwoven web and in the range of 0.002 to
40 0.008 cm-g when a plastic film;
- (8) the outer marginal portion of the outer cover along the
waist opening and each leg opening including a plurality of
closely-spaced bond points extending along the entire exter-
ior surface of the elastic element joined thereto, neighbor-
45 ing bond points being spaced in the direction of elongation
of the elastic element and transversely thereof, and



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50 (a) when the material of the outer marginal portion is a composite web, the area of each bond point is 0.05 to 3 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.5 to 4 mm, and the total area of the bond points is 5 to 40% of the area of the exterior surface of the elastic element,

55 (b) when the material of the outer marginal portion is a nonwoven web, the area of each bond point is 0.05 to 3 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer
60 marginal portion is 0.25 to 4 mm, and the total area of the bond points is 5 to 50% of the area of the exterior surface of the elastic element,

65 (c) when the material of the outer marginal portion is a plastic film, the area of each bond point is 0.05 to 1.5 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer
70 marginal portion is 0.05 to 2 mm, and the total area of the bond points is 20 to 80% of the area of the exterior surface of the elastic element;



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(9) wherein the elastic element is joined to the bond points when in an elongated condition and remains joined only to the bond points when in a retracted condition to provide an elasticized waist opening and elasticized leg 75 openings characterized by micro-ribbing of the material of the outer marginal portion of the outer cover between the bond points.



9. A disposable garment of the type including an outer marginal portion of material and an interior marginal portion of material along a part of the garment intended to fit along a wearer's body and
5 a plurality of spaced elastic elements joined thereto to provide an elasticized portion of the garment, wherein

(1) each elastic element includes an exterior surface joined to the outer marginal portion of
10 material and an inner surface joined to the interior marginal portion of material;

(2) the elastic elements are spaced from each other in a direction transverse to their direction of elongation with one of said elastic elements
15 arranged about the boundary of said marginal portions, and the outer edges of said one elastic element, the outer marginal portion of material and the interior marginal portion of material are substantially coincident;

(3) the outer marginal portion of material is selected from the class consisting of (a) composite webs having an outer layer of nonwoven fibrous material and an inner layer of plastic material, the inner layer being in contact with the exterior
20 surface of the elastic element, (b) nonwoven webs of synthetic or natural fibers, or (c) plastic films,

(i) the outer marginal portion having a thickness in the range of 0.19 mm to 1.1 mm when
25 a composite web, in the range of 0.23 mm to 0.76 mm when a non-



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woven web, and in the range of 0.0076 mm to 0.05 mm when a plastic film,

(ii) the outer marginal portion having a flexural rigidity in the range of 0.01 to 0.1 cm-g when a composite web or nonwoven web and in the range of 0.002 to 0.008 cm-g when a plastic film;

(4) the outer marginal portion of material includes a plurality of closely-spaced bond points extending along the entire exterior surface of each elastic element joined thereto, neighboring bond points being spaced in the direction of elongation of the elastic elements and transversely thereof, and

(a) when the material of the outer marginal portion is a composite web, the area of each bond point is 0.05 to 3 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.5 to 4 mm, and the total area of the bond points is 5 to 40% of the area of the exterior surface of the elastic element,

(b) when the material of the outer marginal portion is a nonwoven web, the area of each bond point is 0.05 to 3 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.25 to 4 mm, and the total area of



the bond points is 5 to 50% of the area of the exterior surface of the elastic element,

5 (c) when the material of the outer marginal portion is a plastic film, the area of each bond point is 0.05 to 1.5 mm², the distance between neighboring bond points in the direction of elongation of the elastic element prior to joinder of the elastic element to the outer marginal portion is 0.05 to 2 mm, and
10 the total area of the bond points is 20 to 80% of the area of the exterior surface of the elastic element;

(5) wherein the elastic elements are joined to the bond points when in an elongated condition
15 and remain joined only to the bond points when in a retracted condition to provide an elasticized body-encircling opening characterized by micro-ribbing of the outer marginal portion of material between the bond points.



10. . A disposable garment substantially as hereinbefore described with reference to the accompanying drawings.



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