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(12) **United States Patent**
Toronjo

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(54) **ARTICLES OF APPAREL INCLUDING AUXETIC MATERIALS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

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(51) **Int. Cl.**
B32B 3/24 (2006.01)
A41D 31/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **A41D 31/0016** (2013.01); **A41B 1/08** (2013.01); **A42B 1/041** (2013.01); **A42B 1/08** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A43B 23/027; A41D 2400/82; Y10T 428/24273
See application file for complete search history.

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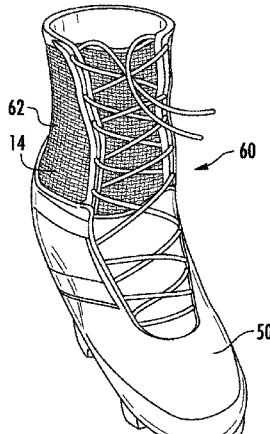
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(57) **ABSTRACT**

An article of apparel includes at least one panel including a first edge and an opposing second edge. The at least one panel includes an auxetic structure defining a primary elongation direction and a secondary elongation direction. A plurality of lace coupling pairs are positioned along the first edge and the second edge of the at least one panel. Each lace coupling pair defines a lace pull direction that is perpendicular to a line extending through two adjacent lace couplings of the lace coupling pair. Each lace pull direction is defined by the plurality of lace couplings substantially in alignment with either the primary elongation direction or the secondary elongation direction of the auxetic structure between the two adjacent lace couplings of the lace coupling pair.

19 Claims, 21 Drawing Sheets



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- (60) Provisional application No. 61/695,993, filed on Aug. 31, 2012.
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A41B 1/08 (2006.01)
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A42B 1/08 (2006.01)
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A43B 23/02 (2006.01)
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 CPC *A42B 1/22* (2013.01); *A43B 23/026* (2013.01); *A43B 23/027* (2013.01); *A43B 23/028* (2013.01); *A43B 23/042* (2013.01); *A41D 2400/38* (2013.01); *A41D 2400/82* (2013.01); *Y10T 428/24273* (2015.01)

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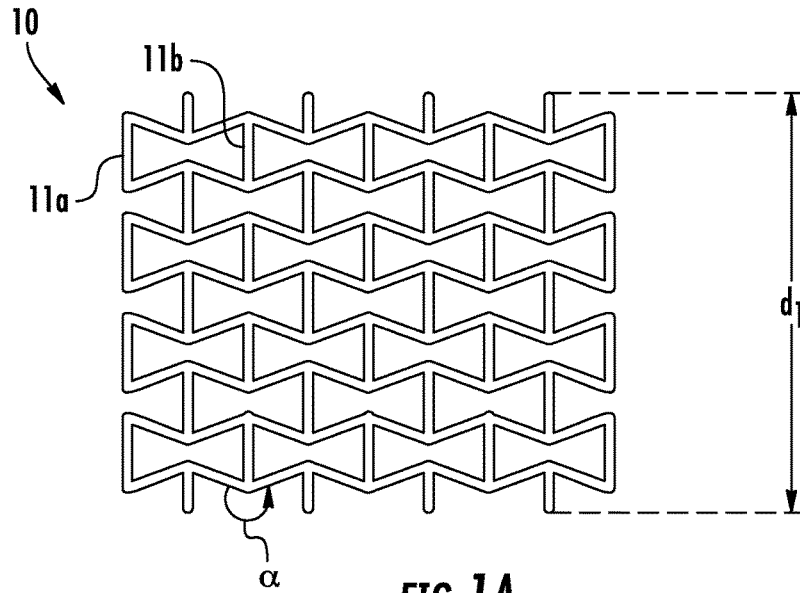


FIG. 1A

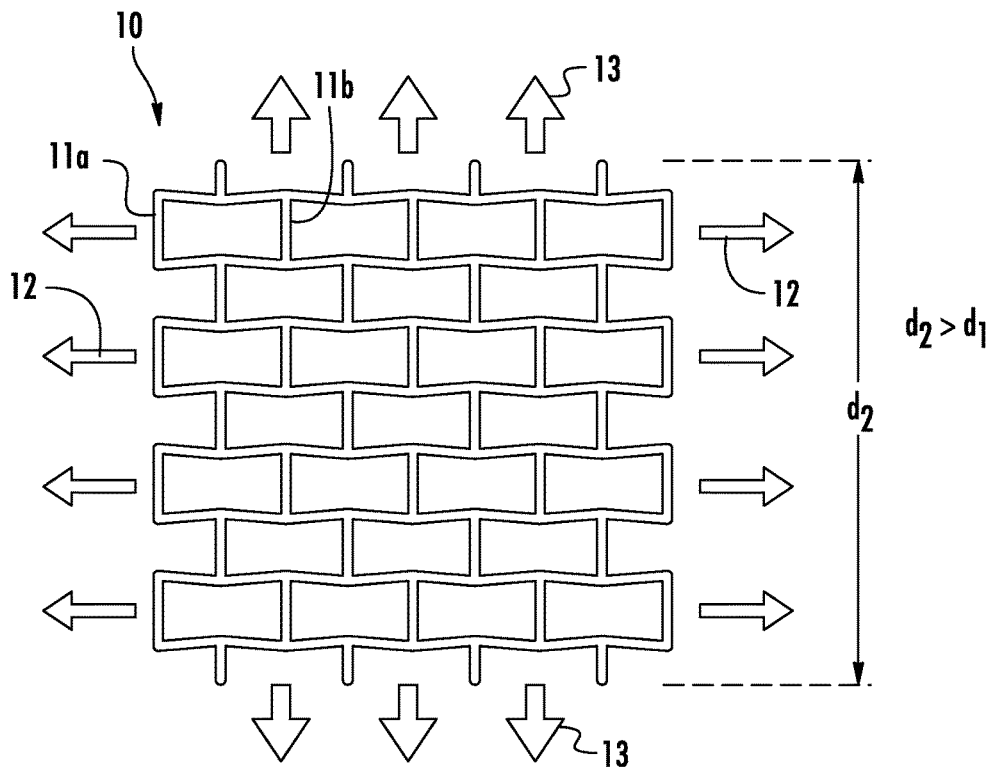
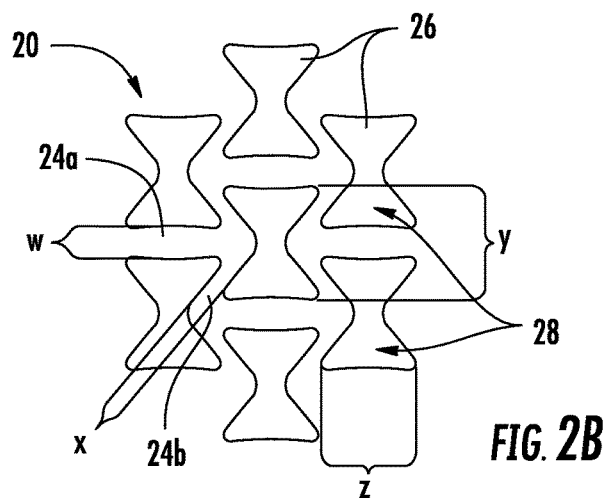
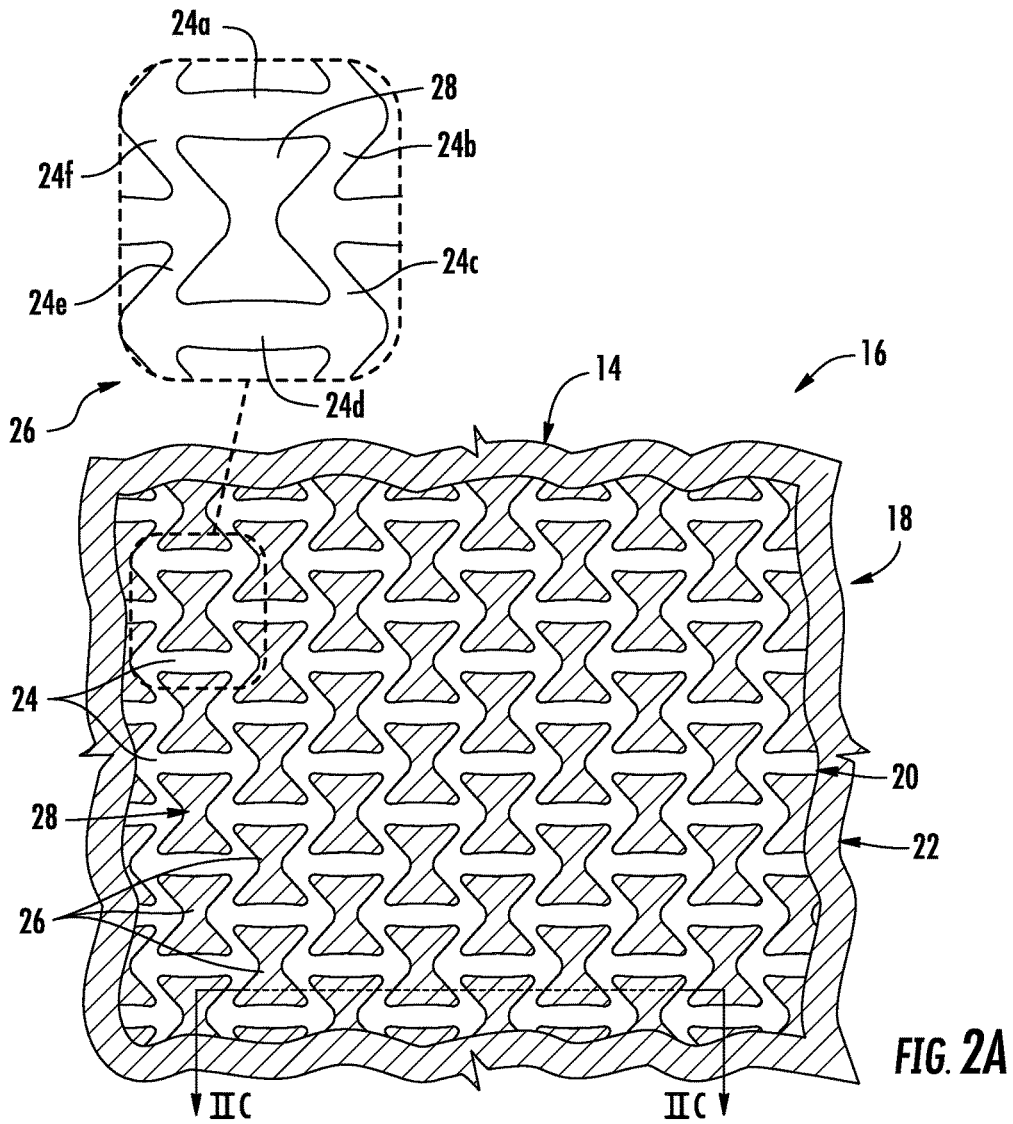


FIG. 1B



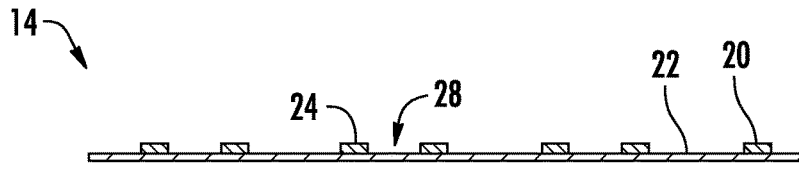


FIG. 2C

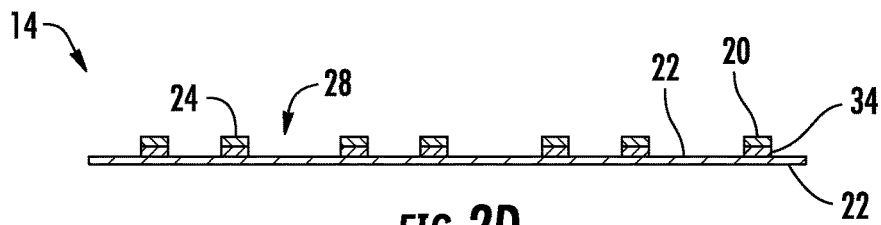


FIG. 2D

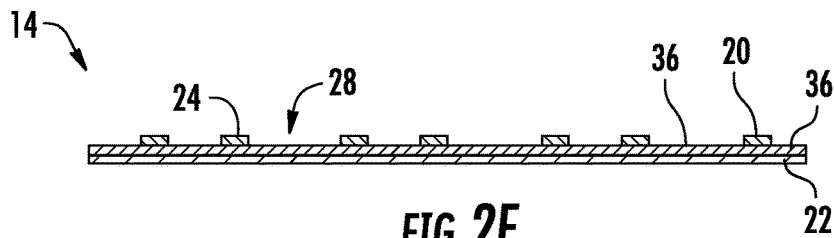


FIG. 2E

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