(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
29 November 2018 (29.11.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/216028 A1

(51) International Patent Classification:
E04C 2/36 (2006.01) *B31F 1/07* (2006.01)
E04C 2/32 (2006.01) *B31F 1/30* (2006.01)

(21) International Application Number:
PCT/IN2018/050205

(22) International Filing Date:
10 April 2018 (10.04.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201741018271 24 May 2017 (24.05.2017) IN

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

(54) Title: A CORRUGATED CONSTRUCTION ELEMENT

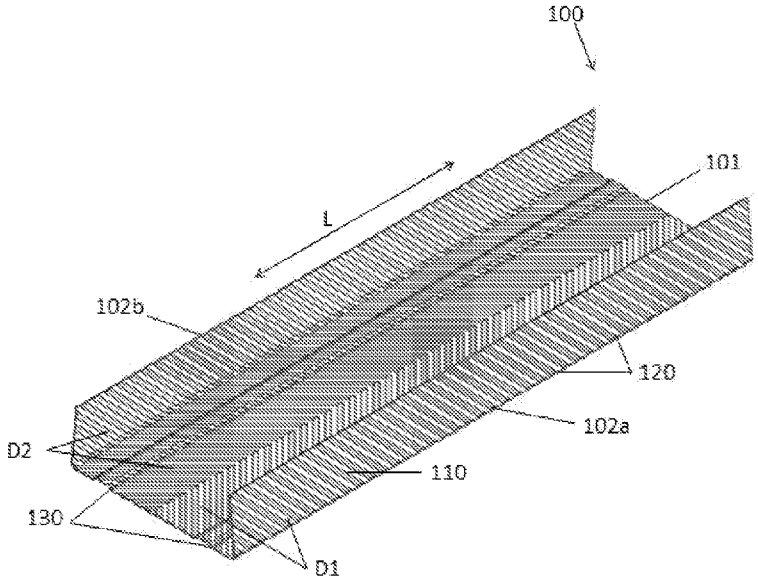

FIG. 3

(57) Abstract: A corrugated construction element (100) for drywall and ceiling construction is disclosed. The corrugated construction element (100) comprises a base profile (101) connected to at least one leg profile (102a) or (102b). The base profile (101) and/ or at least one leg profile (102a) or (102b) comprise an array of angular corrugations (110) extending across their surface in a non-parallel direction to the principal axis L of the corrugated construction element (100). The disclosure also relates to an apparatus and a method for forming a corrugated profile (770).

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WO 2018/216028 A1

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

A CORRUGATED CONSTRUCTION ELEMENT

Technical Field

The present disclosure relates, in general to a construction element, and more specifically to a corrugated construction element for drywall and ceiling construction/ gypsum ceiling.

Background

Drywall and gypsum ceilings generally make use of cold rolled metal sections that are made of plain metal sheet or knurled metal sheet (having dimples on it). These metal sections are formed by bending sheet material into desired shapes and typically comprise of an elongate base and a pair of side legs that extend on either side of the base in a perpendicular fashion. These metal sections are used as both vertical studs and horizontal channels or track. These channels and studs may be assembled into a frame and also secured to a corresponding floor, ceiling and the like. The frame may be covered with construction boards on one or both sides to form the wall or a ceiling. The plain or knurled metal sheet may be coated with a protective layer to reduce corrosion and other undesirable effects.

There are several advantages to using knurled metal sheets, compared to plain metal sheets. In order to increase the screw retention, a section may be formed from a metal sheet which is fully knurled or partially knurled. If the metal sheet is partially knurled, the positioning of the knurling can be selected so that the finished section contains knurling at the point where screws will be fixed.

In order to make sections with thin metal and therefore keep weight low, it is desirable to use thin metal. The thickness of sheet metal used to form drywall and gypsum ceiling sections is typically 0.4 mm to 1 mm, although other thicknesses may also be used. However, thin metal can result in metal sections with waviness in their shape. The waviness is overcome by providing certain reinforcing features/forms along the length of the section.

Knurled sheets are created by feeding the metal sheets between two mating rollers to create a dimpled surface. This process stretches the material in both directions (along the length and along the width). This causes cracks in any protective coating on the metal sheet and this can lead to corrosion over a period of time.

While the sections made from plain metal sheet suffer from quality issues such as waviness, twists, bending, less screw retention and stiffness, the knurled sections are prone to cracks and break due to the knurling process itself and have less perceived strength as compared to other sections and also suffer from quality issues due to excessive stretching of the metal. Therefore sections which overcome these disadvantages are required.

Metal profiles having longitudinal beads are known. The longitudinal beads are introduced on the base and/ or the side legs connected to the base to reduce carrier-to-noise transmission (as shown in EP1124023) or for improving screw retention (as shown in PCT application 2010/008296). In U.S. publication number 2009/0038255 and 2009/0126315 beads extend in the longitudinal direction of the C-shaped profile and form support surfaces for planking.

These longitudinal beads discussed in the prior art references are provided locally on the base or side legs to improve the quality of the profiles like straightness, twist etc. However these locally provided beads do not increase the moment of inertia that contributes to the strength and stability of the profiles.

Thus it may be desirable to develop a construction element that overcomes the above mentioned quality issues and provides a crack/ break resistant profile with improved screw retention, strength and one that withstands quality issues such as waviness, twisting and bending.

The present disclosure relates to a corrugated construction element provided with an array of angular corrugations extending across its surface in a non-parallel direction to the principal axis L of the corrugated construction element. The array of angular corrugations reduces deflection of the corrugated

construction element under load conditions and improves screw retention and twist resistance.

Summary of the Disclosure

In one aspect of the present disclosure, a corrugated construction element for drywall and gypsum ceiling is disclosed. The corrugated construction element has a base profile connected to at least one leg profile and comprises an array of angular corrugations that extend across its surface in a non-parallel direction to the principal axis L of the corrugated construction element. The array of angular corrugations covers a surface area of at least 25 % and less than or equal to 100 % of the total surface area of the corrugated construction element.

In another aspect of the present disclosure, an apparatus for forming a sheet material into a profile having an array of angular corrugations extending across at least 25% of the surface of the profile is disclosed. The array of angular corrugations is comprised of at least a first set of angular corrugations and a second set of angular corrugations. The apparatus comprises a first roller having a first corrugation region for forming one part of a first set of angular corrugations (D1) and a second corrugation region for forming one part of a second set of angular corrugations (D2). The apparatus further comprises a second roller having a third corrugation region for forming the other part of the first set of angular corrugations (D1) and a fourth corrugation region for forming the other part of the second set of angular corrugations (D2). The angle between the first set of angular corrugations D1 and second set of angular corrugations D2 ranges between 30 – 150 degrees.

Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

Embodiments are illustrated by way of example and are not limited to those shown in the accompanying figures.

FIG. 1 illustrates a corrugated profile, according to one embodiment of the present disclosure;

FIG. 1A illustrates corrugated profiles, according to other embodiments of the present disclosure;

FIG. 2 illustrates a perspective view of a corrugated construction element, according to an embodiment of the present disclosure;

FIG. 3 illustrates a perspective view of a corrugated construction element, according to another embodiment of the present disclosure;

FIG. 4A illustrates a cross-sectional view of a corrugated construction element, according to an embodiment of the present disclosure;

FIG. 4B illustrates a enlarged view of portion 'A' of FIG. 4A, showing a corrugated construction element, according to an embodiment of the present disclosure;

FIG. 5 illustrates a corrugated construction element, according to another embodiment of the present disclosure;

FIG. 6 illustrates a corrugated construction element, according to another embodiment of the present disclosure;

FIG. 7 illustrates a corrugated construction element, according to another embodiment of the present disclosure;

FIG. 8 illustrates a corrugated construction element, according to another embodiment of the present disclosure;

FIG. 9 illustrates a corrugated construction element, according to another embodiment of the present disclosure;

FIG. 10 illustrates a cross section of two identical corrugated construction elements joined to form a rectangular corrugated construction element, according to one embodiment of the present disclosure;

FIG. 11 illustrates a schematic view of a wall construction incorporated with corrugated construction elements, according to one embodiment of the present disclosure;

FIG. 12 illustrates a corrugated construction element being supported in a floor channel, according to one embodiment of the present disclosure;

FIG. 13 illustrates an apparatus for forming a sheet material into a profile comprising an array of angular corrugations, according to one embodiment of the present disclosure;

FIG. 14 illustrates a portion of a section provided with small square indentations covering the entire surface of the section; and

FIG. 15A demonstrates simulation of deflection under lateral load condition;

FIG. 15B demonstrates simulation of deflection under longitudinal load condition;

FIG. 15C demonstrates simulation of deflection due to self-weight; and

FIG. 16 illustrates a simulated ceiling system.

Skilled artisans appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the invention.

Detailed Description

Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or similar parts. Embodiments disclosed herein are related to a corrugated construction element.

FIG. 1 illustrates a sheet material comprising a corrugated profile 770, in accordance with an embodiment of the present disclosure. The corrugated profile 770 is formed from a flat sheet material 700. In one embodiment of the present disclosure, the sheet material is Galvanized Iron (G.I). The corrugated profile 770 is formed by passing the flat sheet material 700 between a pair of mating rollers comprising a first roller 610 and a second roller 620 (shown in **FIG. 13**) that rotate about their respective axes. The flat sheet material 700 when pressed between the rollers 610, 620 are deformed to carry a first set of angular corrugation D1 and a second set of angular corrugations D2 as shown in **FIG. 1**. The above process increases the effective thickness of the flat sheet material 700

such that the so obtained corrugated profile 770 has a thickness approximately twice that of the flat sheet material 700. The isometric view and the cross sectional view of the corrugated profile 770 clearly depict the increase in thickness of the sheet material 700 after passing through successive pair of mating roller 610, 620.

The first set of angular corrugation D1 and second set of angular corrugations D2 run angularly (at an angle Y from the principal axis of the corrugated profile L) from the edges of the corrugated profile 770 towards its center. Each angular corrugation from the first set of angular corrugations D1 meets with a corresponding angular corrugation from the second set of angular corrugations D2 to form an angle X between them. The angle X is measured in the plane of the corrugated profile 770. In one embodiment of the disclosure, the angle X between the first set of angular corrugations D1 and the second set of angular corrugations D2 ranges from 30 ° to 150 °.

In one specific embodiment of the disclosure, the angle X between the first set of angular corrugations D1 and the second set of angular corrugations D2 is 90 °. In one other embodiment, the angle X between the first set of angular corrugations D1 and the second set of angular corrugations D2 is 45 °. The angle X between the first set of angular corrugations D1 and the second set of angular corrugations D2 may be varied between 30 ° and 150 ° depending on the desired strength and stiffness required for the wall or ceiling construction.

FIG. 1A illustrates five sheet materials comprising a corrugated profile 770, where the angle X between the first set of angular corrugations D1 and the second set of angular corrugations D2 is 30 °, 60 °, 90 °, 120 ° and 150 °. The selection of the sheet material comprising corrugated profile 770 having a particular angle X depends on the desired strength and stiffness of the wall or ceiling construction.

In one embodiment of the present disclosure, the first set of angular corrugations D1 and second set of angular corrugations D2 cover a surface area greater than 25% and less than or equal to 100% of the total surface area of the corrugated profile 770. In one other embodiment, the first set of

angular corrugations D1 and second set of angular corrugations D2 cover a surface area greater than 50% and less than or equal to 75% of the total surface area of the corrugated profile 770.

FIG. 1 depicts the corrugated profile 770 in a planar configuration. For applications in drywall and ceiling constructions, the corrugated profile 770 needs to be bent to desired shapes to form construction elements. The bending activity can be carried out using conventional bending tools and is done along the principal axis L of the corrugated profile 770. In multiple embodiments, the corrugated profile 770 is bent along the first set of angular corrugation D1 and/ or along the second set of angular corrugation D2. In yet another embodiment, the corrugated profile 770 is bent along the line bisecting the corrugated profile 770 where the first set of angular corrugation D1 meets the second set of angular corrugation D2. Such bending(s) results in corrugated construction elements 100 that will be described in detail in the following embodiments.

FIG. 2 illustrates an exemplary corrugated construction element 100, in accordance with an embodiment of the present disclosure. The corrugated construction element 100 is formed by bending the planar corrugated profile 770 along a line parallel to the principal axis L of the corrugated profile 770. In the specific embodiment shown in **FIG. 2** the corrugated profile 770 is bent along a line that is not located along the center of the corrugated profile 770. In other embodiments the corrugated profile 770 may be bent along a line that is parallel to the principal axis L and positioned anywhere on the surface of the corrugated profile 770, including along the center of the corrugated profile 770. As shown, the corrugated construction element 100 includes a base profile 101 connected to a first leg profile 102a, according to an embodiment of the present disclosure. The first leg profile 102a is non-coplanar to the base profile 101. The base profile 101 forms an opening angle Z with the first leg profile 102a. In one embodiment of the disclosure, the angle Z is less than or equal to 90 °. In another embodiment, the angle Z is greater than or equal to 90 °. The exemplary corrugated construction element 100 shown in **FIG. 2** has an opening angle Z equal to 90 °.

The base profile 101 and the first leg profile 102a comprise an array of angular corrugations 110. The array of angular corrugations 110 comprises V-shaped grooves 120. The array of angular corrugations 110 extends across the surface of the corrugated construction element 100 in a non-parallel direction to the principal axis L of the corrugated construction element 100. In one embodiment of the disclosure, the array of angular corrugations 110 covers a surface area greater than 25% and less than or equal to 100% of the total surface area of the corrugated construction element 100. In one other embodiment of the disclosure, the array of angular corrugations 110 covers a surface area greater than 50% and less than or equal to 75% of the total surface area of the corrugated wall construction element 100. In yet another embodiment of the present disclosure, the array of angular corrugations 110 is continuous throughout the surface area of the corrugated construction element 100.

The array of angular corrugations 110 is V-shaped with the bottom of the V-shaped being pointed as shown in **FIG. 2**, according to one embodiment of the disclosure. In another embodiment of the disclosure, the array of angular corrugations 110 is V-shaped with the bottom of the V-shaped being curved. The array of angular corrugations 110 as shown in **FIG. 2** is comprised of two parts viz., a first set of angular corrugations D1 and second set of angular corrugations D2. The first set of angular corrugations D1 and the second set of angular corrugations D2 run in opposite directions from the edges of the corrugated construction element 100 so that each angular corrugation from the first set of angular corrugations D1 meets with a corresponding angular corrugation from the second set of angular corrugations D2 to form an angle X between them. In one specific embodiment of the disclosure, the angle X between the first set of angular corrugations D1 and the second set of angular corrugations D2 is 90 °. In one other embodiment, the angle X between the first set of angular corrugations D1 and the second set of angular corrugations D2 is 45 °.

FIG. 2 also shows an enlarged portion of the corrugated construction element 100, where one angular corrugation from the first set D1

meets with a corresponding angular corrugation from the second set D2 at an angle X.

In the embodiment shown in **FIG. 2**, the set of angular corrugations D1 and the set of angular corrugations D2 meet on the base profile 101. The set of angular corrugations D1 and the set of angular corrugations D2 may meet at any position on the base profile 101. In other embodiments the set of angular corrugations D1 and the set of angular corrugations D2 meet on a leg profile or along the joint between the base profile and the leg profile.

The array of angular corrugations 110 extending on the first leg profile 102a has an angle Y from the principle axis L of the corrugated construction element 100. In one embodiment of the disclosure, the angle Y between the principle axis L of the corrugated construction element 100 and the angular corrugations 110 on the first leg profile 102a ranges from 15 ° to 75 °. In one specific embodiment, the angle Y between the principle axis L of the corrugated construction element 100 and the angular corrugations 110 on the first leg profile 102a is 45°. This exemplary corrugated construction element 100 shown in **FIG. 2** is used as a ceiling angle for ceiling constructions.

In one embodiment of the present disclosure, the angle X lies in the base profile 101 and the angle Y lies in the first leg profile 102a. In such a case the base profile 101 is provided with a first set of angular corrugations D1 and a second set of angular corrugations D2, while the first leg profile 102a is provided with only the second set of angular corrugations D2 (as shown in **FIG. 2**). However in an alternative embodiment, the angle of X may lie in the first leg profile 102a. In such a case the first leg profile 102a is provided with the first set of angular corrugations D1 and the second set of angular corrugations D2, while the base profile 101 is provided with only the second set of angular corrugation D2. In an alternative embodiment, the angle X may lie along the joint between the base profile 101 and the first leg profile 102a. In such an embodiment, the base profile 101 is provided with the first set of angular corrugations D1 and the first leg profile 102a is provided with the second set of angular corrugations D2. In one other alternative embodiment, there may be two pairs of angular

corrugations (D1 and D2, D1' and D2'), such that D1 and D2 meet at an angle of X along the base profile 101 and D1' and D2' meet at the angle of X' along the first leg profile 102a. Angles X and X' could be the same or different from each other. In further embodiments in which there are two pairs of angular corrugations, the pairs of angular corrugations may meet at any position on the base profile, the leg profiles or the joint between the base profile and the leg profile.

Angles X and Y may be adjusted in order to obtain desired stiffness and strength. Although the present disclosure in specific embodiments teaches one or more examples of angles X and Y, alternations to angles X and Y within the claimed ranges should be understood to be encompassed within the scope of the present disclosure.

Referring to **FIG. 3** is a corrugated construction element 100 according to one other embodiment of the present disclosure. The corrugated construction element 100 is formed by bending the planar corrugated profile 770 along a first line that is parallel to the principal axis L and which bisects the first set of angular corrugations D1 and also a second line that is parallel to the principal axis L and which bisects the second set of angular corrugations D2. In the illustrated embodiment of **FIG. 3**, the corrugated construction element 100 comprises a base profile 101 connected to a first leg profile 102a and a second leg profile 102b. The first leg profile 102a and the second leg profile 102b are non-coplanar to the base profile 101 and have an opening angle Z equal to 90 °. The corrugated construction element 100 may optionally comprise longitudinal beads 130 running along the length of the corrugated construction element 100 on the base profile 101. The longitudinal beads 130 are provided to increase strength, stiffness and avoid waviness and twisting of the corrugated construction element 100. This exemplary corrugated construction element 100 shown in **FIG. 3** is used as a floor channel for drywall constructions.

In the corrugation construction element 100 depicted in this figure, the angle X lies in the base profile 101 and angle Y lies in the first leg profile 102a and second leg profile 102b.The base profile 101 comprises both the first

set of angular corrugations D1 and second set of angular corrugations D2. The first leg profile 102a is provided with only the first set of angular corrugations D1 and the second leg profile 102b is provided with only the second set of angular corrugations D2. In one other alternative embodiment, sets of angular corrugations may meet along the base profile 101 and also along the leg profiles 102a, 102b. In such an embodiment, the corrugated construction element 100 comprises three pairs of sets of angular corrugations (D1 and D2; D1' and D2'; D1", and D2"). In such an embodiment, D1 and D2 meet at angle X, D1' and D2' meet at angle X' and D1'' and D2'' meet at angle X''.

Illustrated in **FIG. 4A** is a cross sectional view of the corrugated construction element 100 shown in **FIG. 3**. The array of angular corrugations 110 comprising V-shaped grooves 120 is clearly depicted on the base profile 101, first leg profile 102a and the second leg profile 102b. The longitudinal grooves 130 are also seen on the base profile 101. **FIG. 4B** depicts an enlarged view of portion 'A' of **FIG. 4A**, wherein the V-grooves 120 of the angular corrugations 110 each comprising a peak 140 and trough 150 can be seen. In multiple embodiments of the present disclosure, the peaks 140 and troughs 150 of the V-shaped grooves 120 is sharp or blunt or curved.

The array of angular corrugations 110 provided on the corrugated construction element 100 has a pitch P – this is the distance between two consecutive peaks 140 or troughs 150 of the V-shaped grooves 120. In multiple embodiments of the present disclosure, the pitch P ranges between 2 mm and 6 mm. The array of angular corrugations 110 provided on the corrugated construction element 100 has a height H. In multiple embodiments of the present disclosure, the height 'H' ranges between 0.1 mm and 1 mm.

In various embodiments of the present disclosure, the array of angular corrugations 110 may be provided only on the base profile 101 or only on the first leg profile 102a or only on the second leg profile 102b or combinations thereof. The exemplary corrugated construction element 100 depicted in **FIG. 5** comprises an array of angular corrugations 110 only on the base profile 101. The first set of angular corrugations D1 and the second set of angular corrugations D2

form an angle X at the center of the base profile 101. The first set of angular corrugations D1 and the second set of angular corrugations D2 do not extend beyond the base profile 101 and hence the first leg profile 102a and second leg profile 102b are devoid of any corrugations. The first leg profile 102a and second leg profile 102b as shown in **FIG. 5** terminate with inward flange profiles 160a and 160b, respectively. The flange profiles 160a and 160b overlie the base profile 101 and are parallel to each other. The flange profiles 160a and 160b may optionally be included or excluded from any of the embodiments of the present disclosure.

The exemplary corrugated construction element 100 depicted in **FIG. 6** comprises an array of angular corrugations 110 on the first leg profile 102a and second leg profile 102b. The base profile 101 is free of any corrugations. The first set of angular corrugations D1 on the first leg profile 102a and second set of angular corrugations D2 on the second leg profile 102b do not meet with each other to form angle X. The inward flange profiles 160a and 160b of the first leg profile 102a and second leg profile 102b respectively, are also seen provided with the array of angular corrugations 110.

Illustrated in **FIG. 7** is another exemplary corrugated construction element 100 used for ceiling construction, according to one embodiment of the present disclosure. The corrugated construction element 100 is formed by bending the planar corrugated profile 770 along a first line that is parallel to the principle axis L and which bisects the first set of angular corrugation D1 and along a second line that is parallel to the principle axis L and which bisects the second set of angular corrugation D2. The depicted corrugated construction element 100 comprises a base 101 connected to a first leg profile 102a and a second leg profile 102b at an opening angle Z greater than 90 °. The first leg profile 102a and second leg profile 102b terminate with outward flange profiles 170a and 170b, respectively. The outward flange profiles 170a and 170b lie outside the base profile 101 and are parallel to each other. The base profile 101, first and second leg profile 102a, 102b and out-turned flange profiles 170a, 170b are all provided with the array of angular corrugations 110. The flange profiles

170a and 170b may optionally be included or excluded from any of the embodiments of this invention.

Illustrated in **FIG. 8** is another exemplary corrugated construction element 100 used as an intermediate channel for drywall construction, according to one embodiment of the present disclosure. The corrugated construction element 100 is formed by bending the planar corrugated profile 770 along a first line that is parallel to the principle axis L and which bisects the first set of angular corrugation D1 and along a first second line that is parallel to the principle axis L and which bisects the second set of angular corrugation D2. The first leg profile 102a and second leg profile 102b of the corrugated construction element 100 has a height 'G' which according to multiple embodiments of the present disclosure is equal to or variable from each other. In specific embodiments of the present disclosure, the height 'G' of the first leg profile 102a is greater than that of the second leg profile 102b or vice versa.

FIG. 9 illustrates another exemplary corrugated construction element 100, according to one embodiment of the present disclosure. Herein the corrugated construction element 100 comprises a flat portion 900. In one embodiment, the flat portion 900 is used to emboss a trademark, a name of a product or other information related to the corrugated construction element 100.

In one embodiment, as depicted in **FIG. 10** two corrugated construction elements 100 with variable height 'G' can be joined to form a rectangular corrugated construction element 200. The rectangular corrugated construction element 200 form a boxed configuration that increases the strength and stability of the wall system constructed from such configuration.

The disclosure also relates to a wall construction comprising a frame assembly configured from a plurality of corrugated construction elements 100. The wall may be a drywall. Illustrated in **FIG. 11** is a wall construction 500 comprising a frame 510. The frame 510 includes two channels, namely a floor channel 520 on the bottom and a ceiling channel 530 on the top. The floor channel 520 and ceiling channel 530 have the configuration of a corrugated construction element 100, according to one embodiment of the present disclosure.

The frame 510 also includes a plurality of corrugated construction elements 100 supported by the floor channel 520 and ceiling channel 530.

The floor channel 520 and ceiling channel 530 are spaced apart from each other. A plurality of corrugated construction elements 100 are configured to be disposed in each of the floor channel 520 and ceiling channel 530. One end of each of the corrugated construction element 100 is disposed in the floor channel 520 and a second end opposite to the first end of each of the corrugated construction element 100 is disposed in the ceiling channel 530. The corrugated construction elements 100 are spaced apart from each other in the frame 510. In one embodiment of the present disclosure, the corrugated construction elements 100 are equidistantly spaced from each other.

Various parameters related to the corrugated construction elements 100, such as, the number of the corrugated construction element 100 in the frame 510, the width of the corrugated construction element 100, height 'G' of the first and second leg profiles 102a, 102b of the corrugated construction element 100, vertical length of the corrugated construction element 100, cross-section of the corrugated construction element 100, spacing of the corrugated construction element 100 may suitably vary based on the type of application. For example, the parameters related to the corrugated construction elements 100 may depend on the size of the wall 500 required for the application, strength of the wall 500 etc.

The wall 500 may include construction boards 550 coupled to the frame 510. In one example, the construction board 550 may be a gypsum board. In an embodiment, the construction board 550 may be attached to the frame 510 on one or more sides thereof. In a preferred embodiment, the construction board 500 may be attached to the corrugated construction elements 100 of the frame 510. Any suitable fastening mechanisms, for example, screws, adhesives etc. may be used to accomplish the coupling between the frame 510 and the construction boards 550, as applicable. Further, a suitable jointing method may be used to attach the construction boards 550 to each other.

In an example, the construction board 550 may be reinforced and may include a polymeric binder and a plurality of fibres. The plurality of fibres may include glass fibres, synthetic polymer fibres or natural fibres, either separately or in combination. Further, the polymeric binder may include any of starch, synthetic material etc. In various other embodiments, the construction board 550 may include any other material such as, but not limited to, MDF, plywood, glass, metal sheet, cement, fiber cement, plastic sheet or a combination thereof.

The construction wall 500 may also include one or more insulation elements (not shown). In one embodiment, the insulation element is disposed between the frame 510 and the construction board 550. In other embodiments, the insulation element is disposed at other locations in the wall 500 based on the specific type of application. In various examples, the insulation element may include a foam material or other materials to provide any of acoustic properties, strength or other properties to the wall 500. Alternatively, the wall 500 may be configured without an insulation element.

The array of angular corrugations 110 increases the screw retention properties of the corrugated construction elements 100 for screwing the construction boards 550 to the frame 510. In some embodiments the angle Y of the angular corrugations 110 on the first and second leg profiles 102a, 102b of the floor channel 520 and ceiling channel 530 correspond to that on the vertically disposed corrugated construction elements 100 and hence help in interlocking the corrugated construction elements 100 between the floor channel 520 and the ceiling channel 530. This interlocking may help to secure the vertical element within the channel without the need for crimping, screwing or other techniques used to prevent the vertical element from moving within the channel. In the illustrated embodiment of **FIG. 12**, the floor channel 520 supporting the corrugated construction element 100 is illustrated. The corrugated construction element 100 is interlocked in the floor channel 520 as shown in the figure.

In one embodiment of the present disclosure, the corrugated construction elements 100 are fastened to the base profile 101 of the floor

channel 520. In an example, mechanical fasteners such as, bolts, screws and the like may be used to fasten the corrugated construction elements 100 to the floor channel 520.

The present disclosure also relates to an apparatus for forming a sheet material into a corrugated profile comprising an array of angular corrugations 110. The corrugated construction element 100 of the present disclosure is formed from a flat sheet material 700. The flat sheet material 700 is typically passed through a series of consecutive pair of rollers to form a corrugated profile on the sheet material. In one embodiment of the present disclosure, the array of angular corrugations 110 extends over at least 25 % of the surface area of the profile.

Illustrated in **FIG. 13** is an apparatus 600 for forming a sheet material 700 into a corrugated profile 770. The apparatus 600 comprises a first roller 610 and a second roller 620 that mate with each other contra rotating about their respective axes. The first roller 610 comprises a first corrugation region 630a and a second corrugation region 640a. The first corrugation region 630a forms one part of the first set of angular corrugations D1 and the second corrugation region 640a forms one part of the second set of angular corrugations D2.

The second roller 620 comprises a third corrugation region 630b and a fourth corrugation region 640b. The third corrugation region 630b forms the other part of the first set of angular corrugations D1 and the fourth corrugation region 640b forms one part of the second set of angular corrugations D2. The first corrugation region 630a and third corrugation region 630b are co-operable and comprise V-shaped grooves 120 that correspond with each other. Similarly, the second corrugation region 640a and fourth corrugation region 640b are co-operable and comprise V-shaped grooves 120 that correspond with each other.

In an alternate embodiment, the first roller 610 and second roller 620 may have multiple sets of first, second, third and fourth corrugation regions (630a, 630b, 640a and 640b). For example a first roller and a second roller

comprising three sets of first, second, third and fourth corrugation regions viz., $630a_1$, $630b_1$, $640a_1$ and $640b_1$; $630a_2$, $630b_2$, $640a_2$ and $640b_2$; and $630a_3$, $630b_3$, $640a_3$ and $640b_3$ would produce a corrugated profile 770 with three pairs of sets of angular corrugations (D1 and D2, D1' and D2', D1'' and D2''). When bent into shape, such a corrugated profile would have three pairs of sets of angular corrugations such that one pair (D1 and D2) is on the base profile with angle X between them, one pair (D1' and D2') is on the first leg profile with angle X' between them and one pair (D1'' and D2'') is on the second leg profile with angle X'' between them. Angles X, X' and X'' could be the same or different from each other.

Passage of the flat sheet material 700 through the successive pairs of rollers causes the angular corrugations on the base profile 101, first leg profile 102a, second leg profile 102b and flange profiles 160 (160a, 160b), 170 (170a, 170b). The pair of rollers 610 and 620 stretch the sheet material angularly and effectively increases (doubles) the thickness of the sheet material. The height 'H' and pitch P of the array of angular corrugations created on the sheet material depends on the initial thickness of the sheet material.

For example, a flat sheet material 700 having a thickness of 0.5 mm when passed through the mating rollers 610, 620 will form a corrugated profile 770 having a thickness of 1mm. Such a corrugated profile 770 will have a pitch P of 3.5 mm. Similarly, a flat sheet material 700 having a thickness of 0.9 mm when passed through the mating roller 610, 620 will form a corrugated profile 770 having a thickness of 1.8 mm. Such a corrugated profile 770 will have a pitch P of 4.5 mm.

Examples

To demonstrate reduced deflection of the corrugated construction element 100 of the present disclosure, comparative studies were carried out as described below.

All comparative examples described below present the results of simulations of three different construction elements:

(1) a construction element comprising linear corrugations;

(2) a construction element comprising square indentations; and

(3) a corrugated construction element 100 comprising angular corrugations in accordance with the present disclosure.

The simulated construction element with linear corrugations comprises corrugations extending over the entire surface of the construction element. The linear corrugations are parallel to the principle axis of the construction element (e.g. parallel to the longest dimension of the construction element) and have a pitch of 3.5 mm and a depth of 0.5 mm.

The simulated construction element with square indentations comprises small square indentations covering the entire surface of the construction element. The small square indentations were created having a pitch of 3.3 mm, a diameter of 1.5 mm and a depth of 0.5 mm. An illustration of a portion of the surface of such a construction element with square indentations is shown in **FIG. 14**.

The simulated corrugated construction element 100 in accordance with the present disclosure comprises angular corrugations over the entire surface of the construction element. The angle between the corrugations and the principle axis of the construction element was 45 °. The corrugations have a pitch of 3.5 mm and a depth of 0.5 mm.

Each simulated construction element is 300 mm long. Unless specified, all other parameters (e.g. dimensions and geometry) were the same for each simulated construction element.

Comparative Example 1

Simulations of deflection under lateral load condition were compared for the three construction elements described above. In the simulation, a load of 0.5 kg was applied on both the leg profiles (as shown in **FIG. 15A**) of the three construction elements described above. The results are shown in Table 1. The results showed that the corrugated construction element 100 of the present disclosure had least deflection value and hence was stronger.

Table 1: Deflection under Lateral Load Condition

Sample/ Test Condition	Construction Element with Linear Corrugations	Construction element with Square Indentations	Corrugated Construction Element 100
Lateral Deflection at	4.2 mm	3.81 mm	3.6 mm

Comparative Example 2

Simulations of deflection under longitudinal load condition (as shown in **FIG. 15B**), were compared for the three construction elements described above having a sample size of 1200mm. **FIG. 16** depicts a simulated ceiling system. In the simulation, a suspended ceiling system 1000 comprised of intermediate channels 1010 suspended from celling angles 1020, where the spacing between consecutive ceiling angles 1020 was 1220 mm, measured from the center of one ceiling angle 1020 to the center of the next consecutive ceiling angle 1020 (as indicated in **FIG. 16** by AA). In the simulation, ceilings sections 1030 were also fixed at 457 mm, measured from the center of one ceiling section 1030 to the center of the next consecutive ceiling section 1030 (as indicated in **FIG. 16** by BB). The simulated suspended celling system 1000 was then loaded with 30 kg/m^2 and the load distribution on each of the ceiling system elements was measured to be 0.136 N/mm.

The results are shown in Table 2. The results showed that the corrugated construction element 100 of the present disclosure was stronger than the sections having square indentations but not as strong as construction elements having linear corrugations for ceiling constructions.

Table 2: Deflection under Longitudinal Load Condition

Sample/ Test Condition	Construction Element with Linear Corrugations	Construction element with Square Indentations	Corrugated Construction Element 100

Longitudinal Deflection at	2.95 mm	3.67 mm	3.25 mm

Comparative Example 3

Deflection of the 1200 mm corrugated construction element 100 of the present disclosure due to self-weight, as shown in **FIG. 15C** was simulated and compared with simulation values of 1200 mm construction elements having linear corrugations and sections having small square indentations covering the entire surface of the section. The results are shown in Table 3.

Table 3: Deflection due to Self-Weight

Sample/ Test Condition	Construction Element with Linear Corrugations	Construction element with Square Indentations	Corrugated Construction Element 100
Deflection due to self-weight	0.034 mm	0.038 mm	0.035 mm

The above results show that though construction elements with linear corrugations are stronger to longitudinal deflection and deflection due to self-weight, the corrugated construction element 100 of the present disclosure is strongest when subjected to lateral deflection that may cause the leg profiles 102a, 102b to collapse while the construction board is being screwed to the frame and may lead to instability of the construction.

Comparative Example 4

A construction element comprising square indentations and a corrugated construction element 100 of the present disclosure were placed vertically on an UTM machine and were applied with different loads. The maximum load at which the construction elements axially buckled was recorded. The results are shown in Table 4. The corrugated construction element 100 of the present disclosure axially buckled at a load of 9.20 kN which was much higher compared to the construction element with square Indentations.

Table 4: Axial Buckling

Sample/ Test Condition	Construction element with Square Indentations	Corrugated Construction Element 100
Maximum load at which axial buckling occurred (kN)	6.87	9.20

Comparative Example 5

Three-point bending test was performed for the construction element comprising square indentations and a corrugated construction element 100 of the present disclosure by screwing together the base profiles of a pair of each of the construction elements using metal screws. A load of 1 kN was applied on the construction element comprising square indentations and a deflection of 16 mm was observed. Then the corrugated construction element 100 of the present disclosure was applied with load until a 16 mm deflection was detected. It was found that a 16 mm deflection appeared on the corrugated construction element 100 at a load of 1.2 kN. This showed the corrugated construction element 100 of the present disclosure to have 20% increased load bearing capacity.

Comparative Example 6

The shear strength of the corrugated construction element 100 of the present disclosure was measured and compared with the shear strength of the construction element comprising square indentations. The corrugated construction element 100 was found to withstand a load of 2.11 kN while the construction element comprising square indentations was found to take up a load of only 2.05 kN. Hence the improved shear strength of the corrugated construction element 100 of the present disclosure was illustrated.

Industrial Applicability

With the implementation of the corrugated construction elements 100 of the present disclosure, quality issues associated with construction elements such as flange deflection, deflection due to self-weight, twisting and bending may be avoided. Further, using of these corrugated construction elements also increase the screw retention property and load bearing capacity of the construction elements. The array of the angular corrugations 110 provide for interlocking of vertically disposed corrugated construction elements 100 between the floor channel 520 and ceiling channel 530.

The invention also relates to a method of forming a corrugated profile 770 comprising an array of angular corrugations 110 extending across at least 25% of the surface of the sheet material 700. The method involves passing the flat sheet material 700 between the first roller 610 and second roller 620. The sheet material 700 is pressed against the V-grooves 120 present on the corrugation regions (630a, 630b, 640a, 640b) of the first roller 610 and second roller 620.

Note that not all of the activities described above in the general description or the examples are required, that a portion of a specific activity may not be required, and that one or more further activities may be performed in addition to those described. Still further, the order in which activities are listed is not necessarily the order in which they are performed.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any feature(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature of any or all the claims.

The specification and illustrations of the embodiments described herein are intended to provide a general understanding of the structure of the various embodiments. The specification and illustrations are not intended to serve as an exhaustive and comprehensive description of all of the elements and features of apparatus and systems that use the structures or methods described

herein. Certain features, that are for clarity, described herein in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features that are, for brevity, described in the context of a single embodiment, may also be provided separately or in a sub combination. Further, reference to values stated in ranges includes each and every value within that range. Many other embodiments may be apparent to skilled artisans only after reading this specification. Other embodiments may be used and derived from the disclosure, such that a structural substitution, logical substitution, or another change may be made without departing from the scope of the disclosure. Accordingly, the disclosure is to be regarded as illustrative rather than restrictive.

The description in combination with the figures is provided to assist in understanding the teachings disclosed herein, is provided to assist in describing the teachings, and should not be interpreted as a limitation on the scope or applicability of the teachings. However, other teachings can certainly be used in this application.

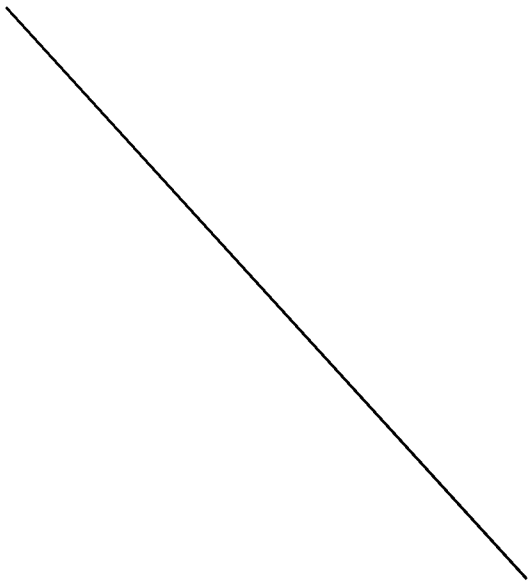
As used herein, the terms "comprises," "comprising," "includes," "including," "has," "having" or any other variation thereof, are intended to cover a non-exclusive inclusion. For example, a method, article, or apparatus that comprises a list of features is not necessarily limited only to those features but may include other features not expressly listed or inherent to such method, article, or apparatus. Further, unless expressly stated to the contrary, "or" refers to an inclusive-or and not to an exclusive-or. For example, a condition A or B is satisfied by any one of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

Also, the use of "a" or "an" is employed to describe elements and components described herein. This is done merely for convenience and to give a general sense of the scope of the invention. This description should be read to include one or at least one and the singular also includes the plural, or vice versa, unless it is clear that it is meant otherwise. For example, when a single item is

described herein, more than one item may be used in place of a single item. Similarly, where more than one item is described herein, a single item may be substituted for that more than one item.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The materials, methods, and examples are illustrative only and not intended to be limiting. To the extent that certain details regarding specific materials and processing acts are not described, such details may include conventional approaches, which may be found in reference books and other sources within the manufacturing arts.

While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed machines, systems and methods without departing from the spirit and scope of what is disclosed. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof.



List of Elements

TITLE: A CORRUGATED CONSTRUCTION ELEMENT

100	Corrugated Construction Element
101	Base Profile
102a	First Leg Profile
102b	Second Leg Profile
110	Array of Angular Corrugations
120	V-groove
130	Longitudinal Bead
140	Peak of the V-groove
150	Trough of the V-groove
160a	Inward Flange Profile of First Leg Profile 102a
160b	Inward Flange Profile of Second Leg Profile 102b
170a	Outward Flange Profile of First Leg Profile 102a
170b	Outward Flange Profile of Second Leg Profile 102b
200	Rectangular Construction Element
500	Wall
510	Frame
520	Floor Channel
530	Ceiling Channel
550	Construction Boards
600	Apparatus
610	First Roller

620	Second Roller
630a	First Corrugation Region
630b	Third Corrugation Region
640a	Second Corrugation Region
640b	Fourth Corrugation Region
700	Flat Sheet Material
770	Corrugated Profile
800	Method
900	Flat Portion
1000	Simulated Suspended Ceiling System
1010	Intermediate Channel
1020	Ceiling Angle
1030	Ceiling Section
D1	First set of Angular Corrugations
D2	Second set of Angular Corrugations
L	Principal Axis of 100
P	Pitch of the Angular Corrugation Array
H	Height of the Angular Corrugation Array
G	Height of Leg Profiles 102a and 102b
X	Angle between D1 and D2
Y	Angle between Array of Angular Corrugation and Principal Axis L
Z	Opening Angle
AA	Distance between Two Consecutive Ceiling Angles
BB	Distance between Two Consecutive Ceiling Sections

Claims

We Claim:

1. A corrugated construction element 100 having a base profile 101 connected to at least one leg profile 102a or 102b, wherein at least one of the base profile 101 and at least one leg profile 102a or 102b comprise an array of angular corrugations 110 extending across their surface in a non-parallel direction to the principal axis L of the corrugated construction element 100 covering a surface area greater than 25% and less than or equal to 100% of the total surface area of the corrugated construction element 100.

2. The corrugated construction element 100 as claimed in claim 1, wherein the array of angular corrugations 110 cover a surface area greater than 50% and less than 75% of the total surface area of the corrugated construction element 100.

3. The corrugated construction element 100 as claimed in claim 1, wherein the array of angular corrugations 110 is V-shaped, wherein the bottom of the V-shaped corrugations is curved or pointed.

4. The corrugated construction element as 100 claimed in claim 3, wherein the angle X of the angular corrugations 110 ranges between 30 ° and 150°.

5. The corrugated construction element 100 as claimed in claim 1, wherein the array of angular corrugations 110 on the at least one leg profile 102a or 102b is at an angle Y ranging between 15 ° and 75 ° from the principle axis L of the corrugated construction element 100.

6. The corrugated construction element 100 as claimed in claim 1, wherein the at least one leg profile 102a or 102b, is non-coplanar to the base profile 101.

7. The corrugated construction element 100 as claimed in claim 1, wherein the base profile 101 forms an opening angle Z with the first leg portion 102a and/ or second leg profile 102b which is less than or equal to 90 °.

8. The corrugated construction element 100 as claimed in claim 1, wherein the base profile 101 forms an opening angle Z with the first leg portion 102a and/ or second leg profile 102 which is greater than or equal to 90 °.

9. The corrugated construction element 100 as claimed in claim 1, wherein the first leg profile 102a and the second leg profile 102b may optionally terminate with inward flange profiles 160a, 160b, respectively wherein the flange profiles 160a, 160b overlie the base profile 101 and are parallel to each other.

10. The corrugated construction element 100 as claimed in claim 1, wherein the first leg profile 102a and the second leg profile 102b may optionally terminate with outward flange profiles 170a, 170b, respectively wherein the flange profiles 170a, 170b lie outside the base profile 101 and are parallel to each other.

11. The corrugated construction element 100 as claimed in claim 1, wherein each corrugation in the array of angular corrugations 110 comprises a V-shaped groove 120.

12. The corrugated construction element 100 as claimed in claim 11, wherein the V-shaped groove 120 comprises of peaks 140 and/ or troughs 150 that are sharp, blunt or curved.

13. The corrugated construction element 100 as claimed in claim 1, wherein the array of angular corrugations 110 has a pitch P ranging between 2 mm and 6 mm.

14. The corrugated construction element 100 as claimed in claim 1, wherein one or more V-shaped cross sections of the array of angular corrugations 110 has a height H ranging between 0.1 mm and 1 mm.

15. The corrugated construction element 100 as claimed in claim 1, wherein the first leg profile 102a and the second leg profile 102b have different heights from each other such that two identical corrugated construction elements 100 can be joined to form a rectangular corrugated construction element 200.

16. A frame assembly 510 for a wall or ceiling construction 500 comprising vertically and horizontally arranged corrugated construction elements 100 as claimed in claim 1.

17. A wall construction 500 comprising:

a frame 510 comprising:

a plurality of corrugated construction elements 100 as claimed in claim 1;

a floor channel 520 configured to receive a first end of each of the plurality of corrugated construction elements 100; and

a ceiling channel 530 spaced apart from the floor channel 520, wherein the ceiling channel 530 is configured to receive a second end opposite to the first end of each of the corrugated construction elements 100 in a horizontal plane, wherein the floor channel 520 and the ceiling channel 530 are made from corrugated construction element 100 as claimed in claim 1 and wherein the plurality of corrugated construction

elements 100 are vertically and/ or horizontally disposed at a predetermined distance between the floor channel 520 and the ceiling channel 530.

18. An apparatus 600 for forming a sheet material 700 into a profile comprising an array of angular corrugations 110 extending across at least 25% of the surface of the profile, the apparatus comprising:

a first roller 610 comprising:

a first corrugation region 630a for forming one part of a first set of angular corrugations (D1); and

a second corrugation region 640a for forming one part of a second set of angular corrugations (D2); and

a second roller 620 comprising:

a third corrugation region 630b for forming the other part of the first set of angular corrugations (D1); and

a fourth corrugation region 640b for forming the other part of the second set of angular corrugations (D2);

wherein the angle between the first set of angular corrugations D1 and the second set of angular corrugations D2 ranges between 30 – 150 degrees.

19. The apparatus 600 as claimed in claim 18, wherein the first roller 610 and second roller 620 are configured to mate with each other.

20. The apparatus 600 as claimed in claim 18, wherein the first and third corrugation regions 630a, 630b are co-operable and comprise V-shaped grooves that correspond with each other.

21. The apparatus 600 as claimed in claim 18, wherein the second and fourth corrugation 640a, 640b regions are co-operable and comprise V-shaped grooves that correspond with each other.

22. A method of manufacturing a sheet material comprising an array of angular corrugations 110 extending across at least 25% of the surface of the sheet material, the method 800 comprising

passing the sheet material 770 between the first roller 610 and second roller 620 of the apparatus 600 as claimed in claim 19, wherein the sheet 770 is pressed against the V-shaped grooves present in the corrugation regions 630a, 630b, 640a, 640b of the first roller 610 and second roller 620.

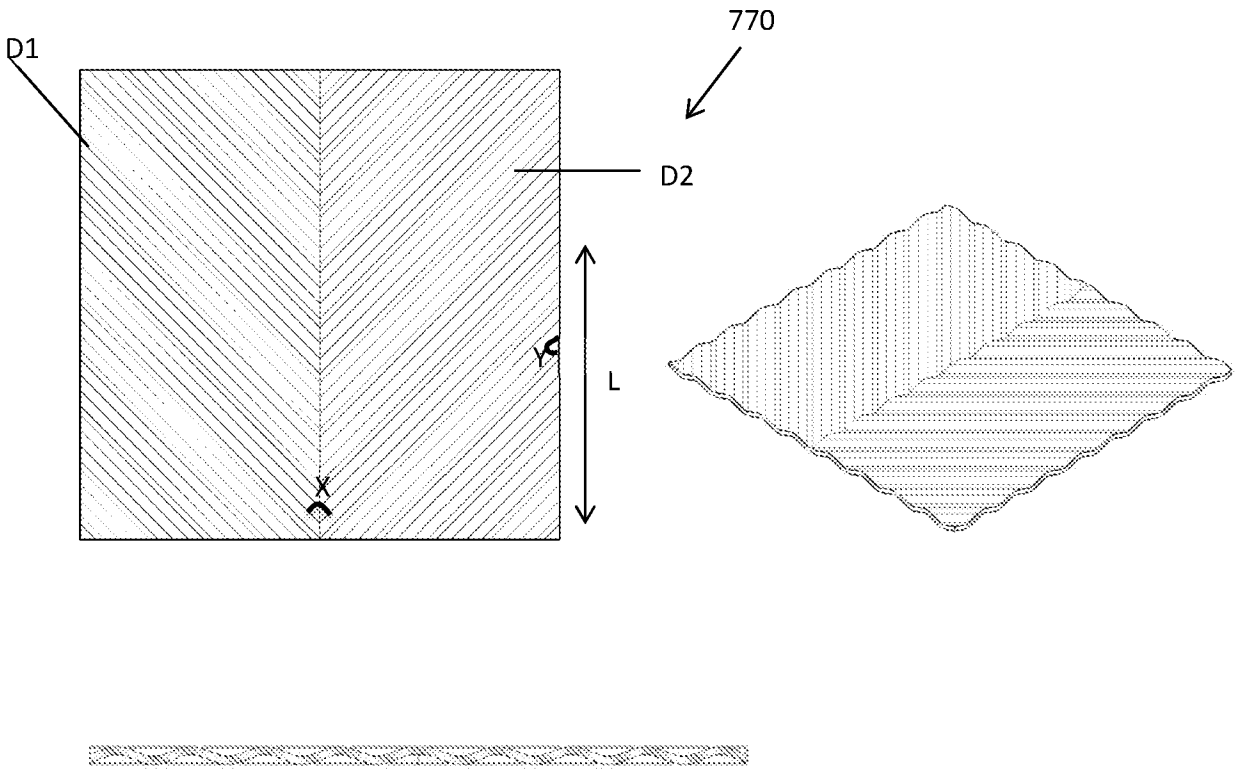


FIG. 1

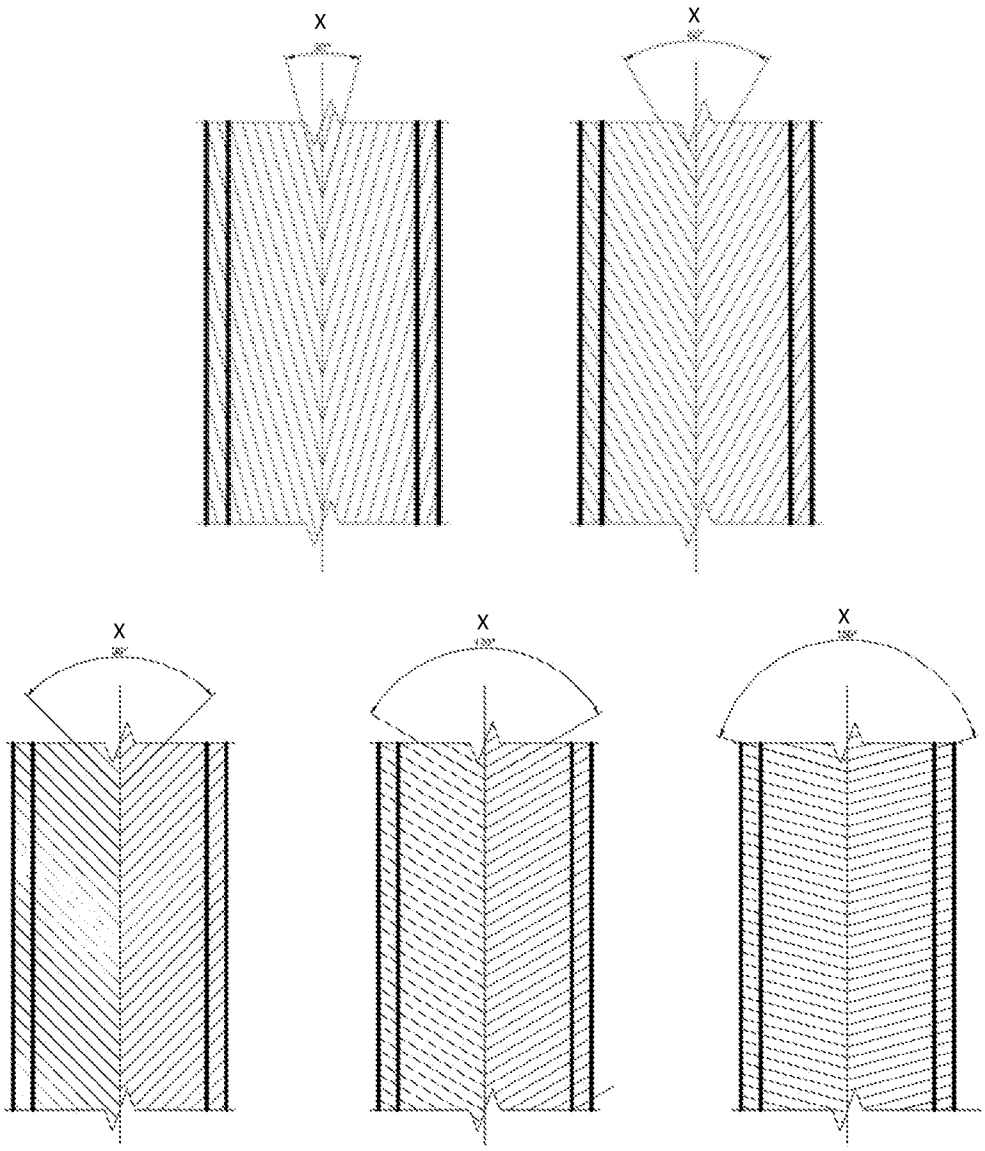


FIG. 1A

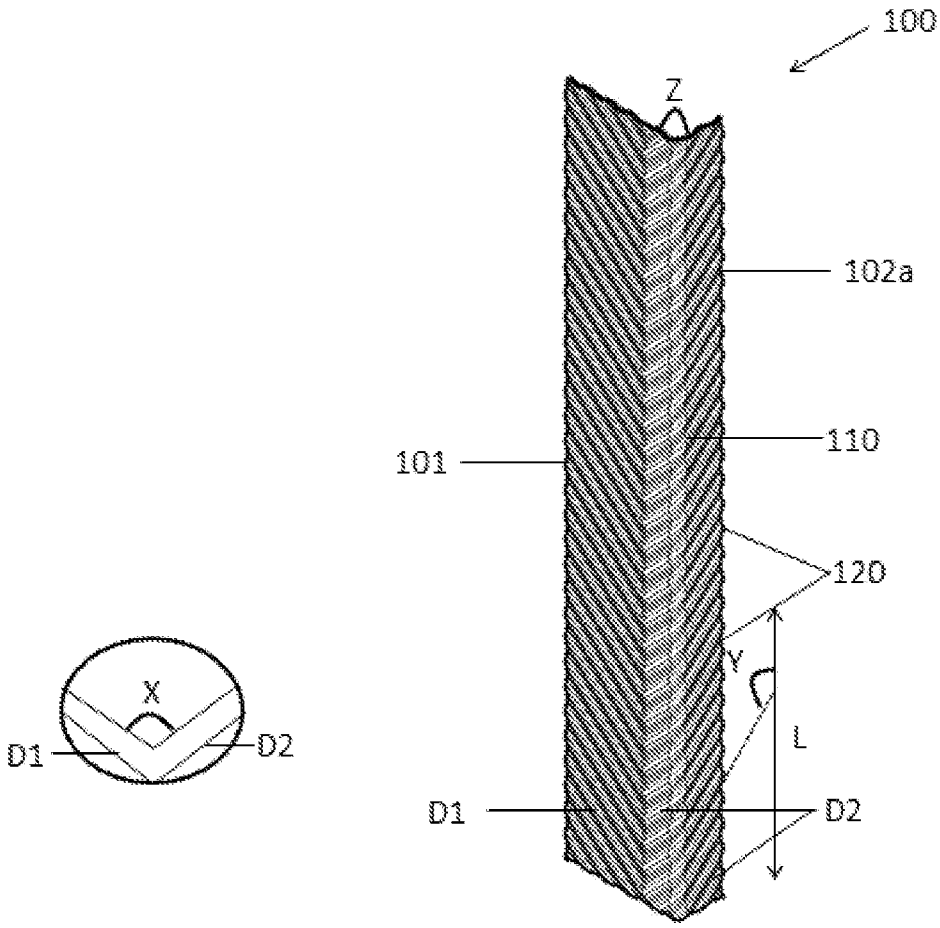


FIG.2

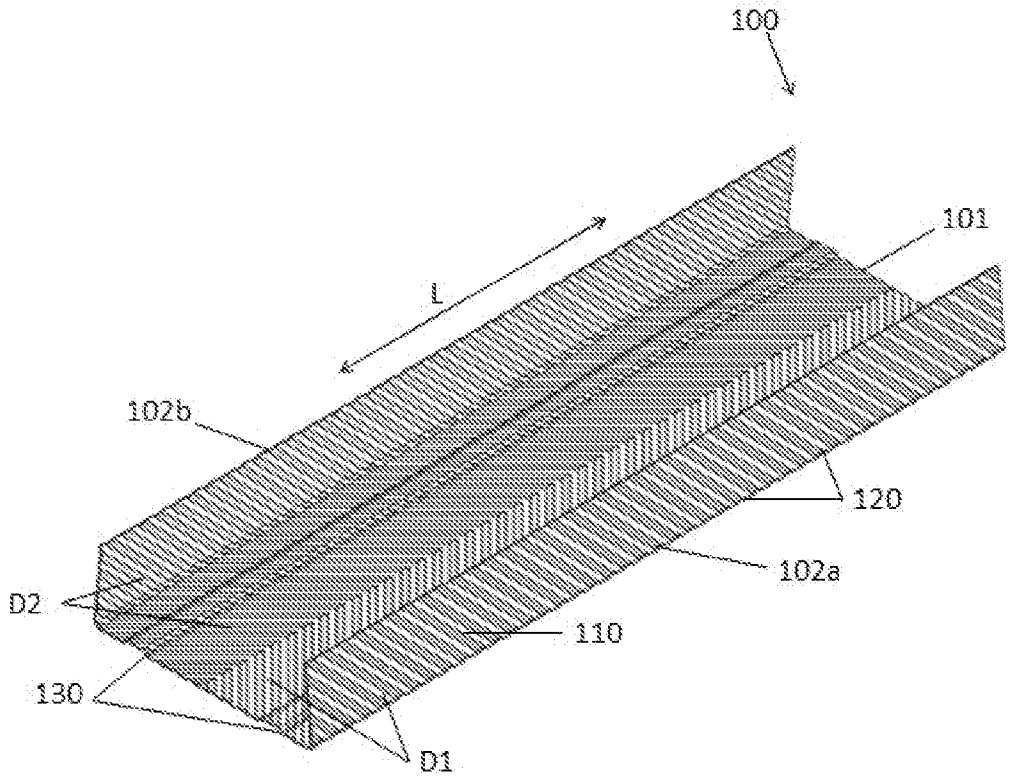


FIG. 3

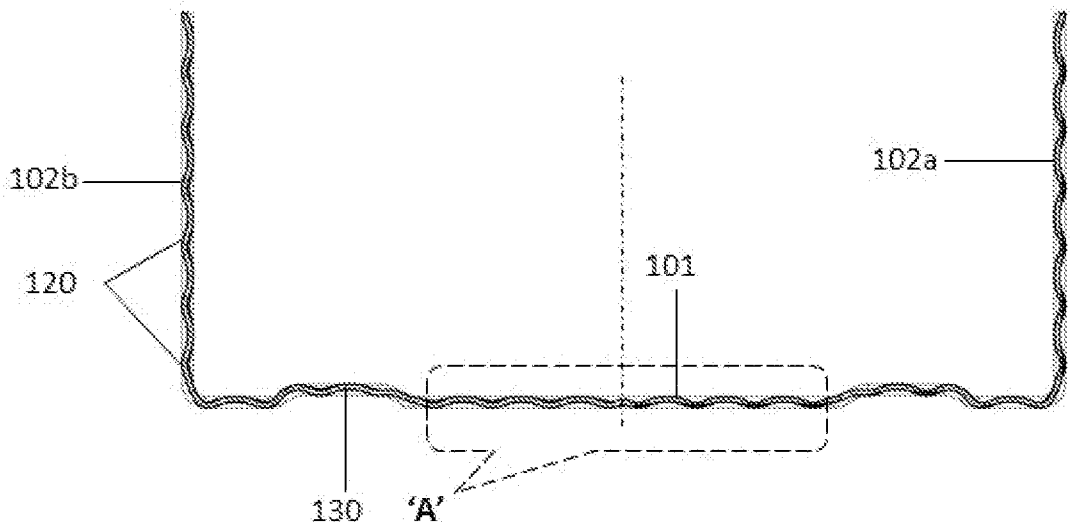


FIG. 4A

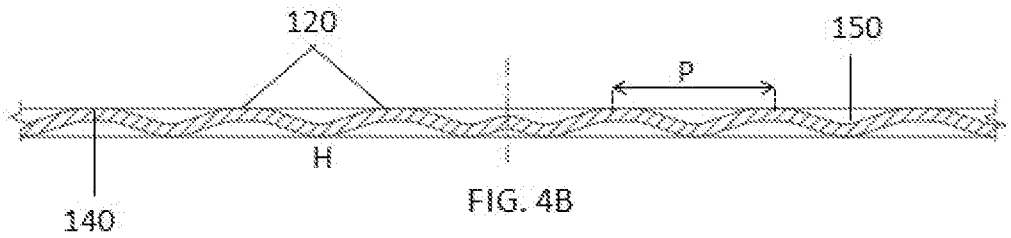


FIG. 4B

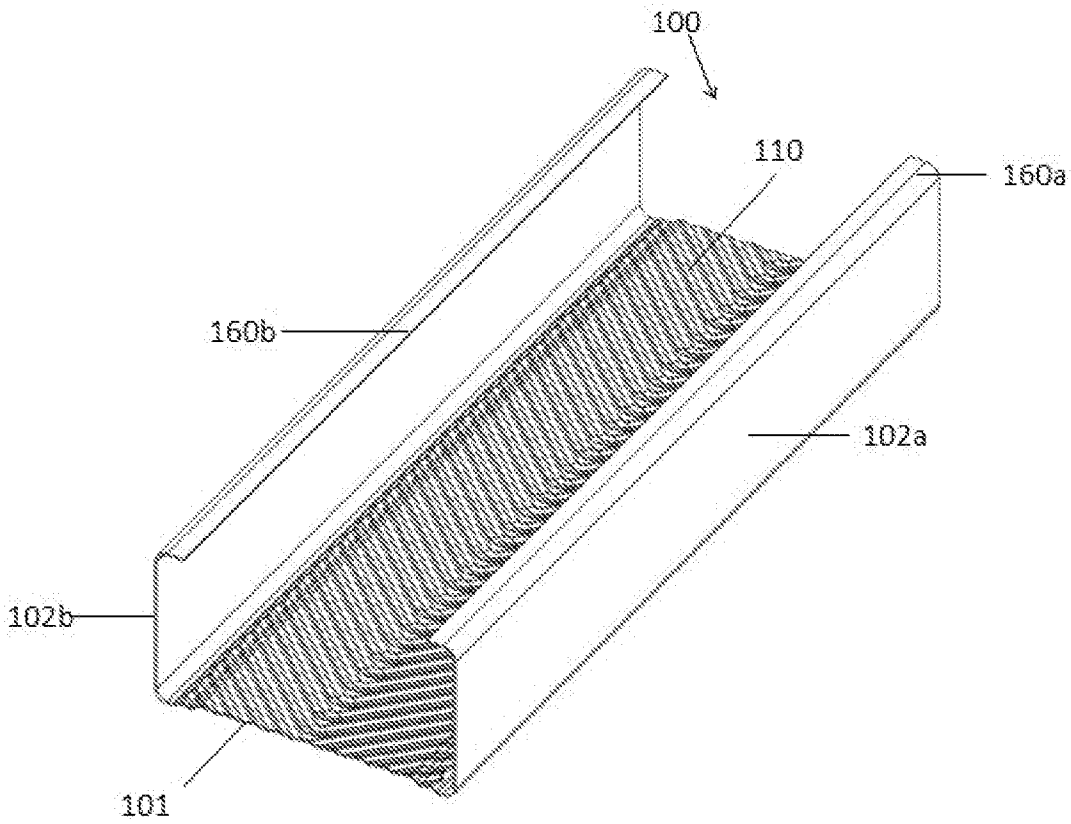


FIG. 5

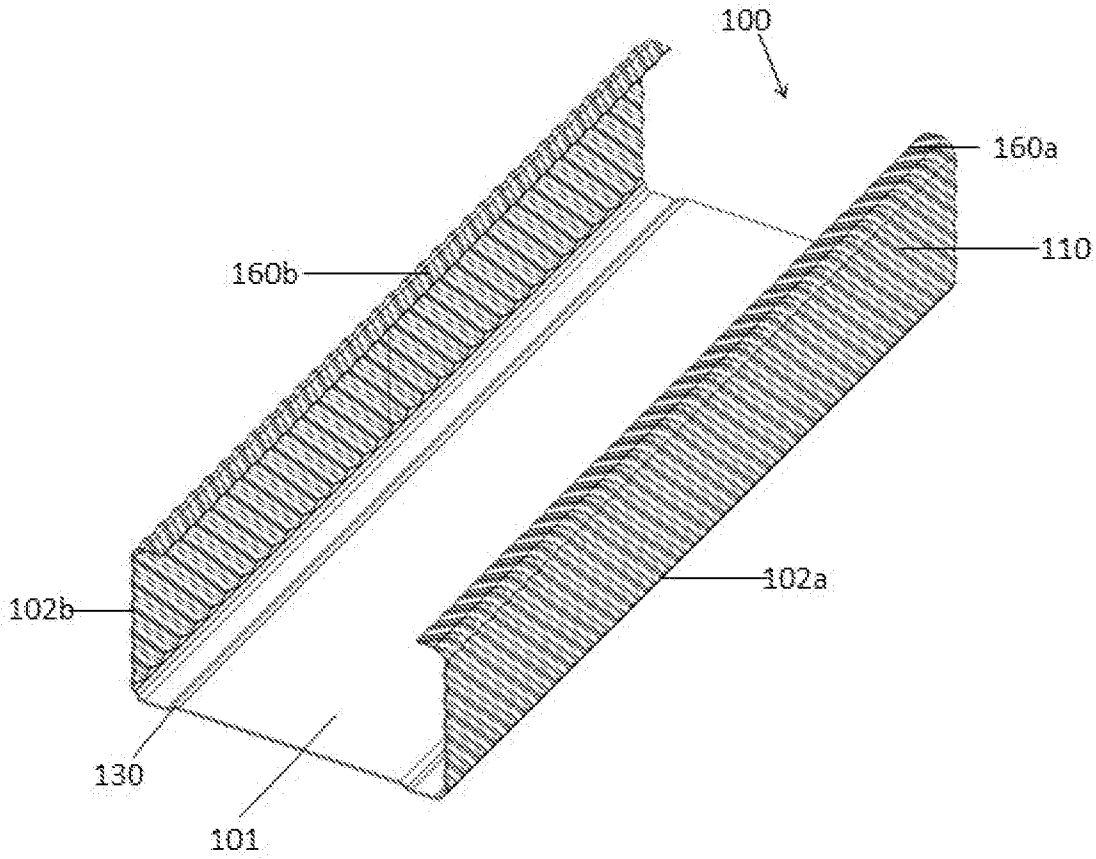


FIG. 6

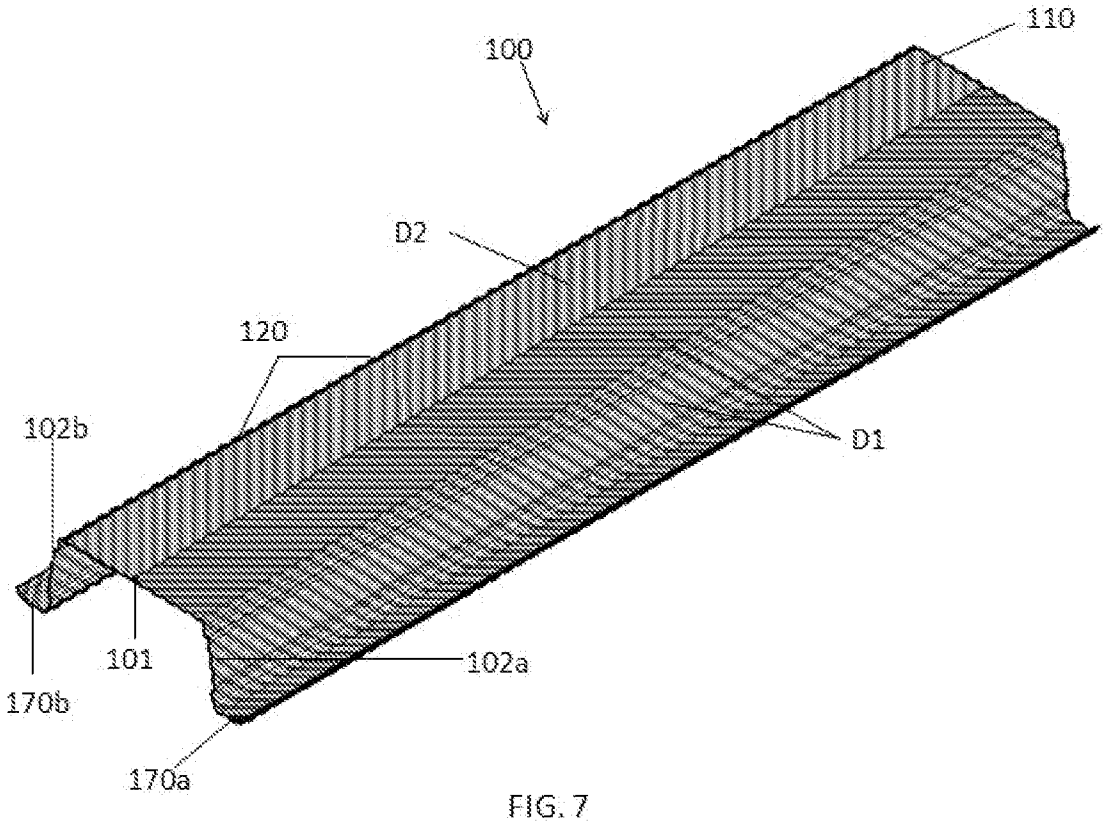


FIG. 7

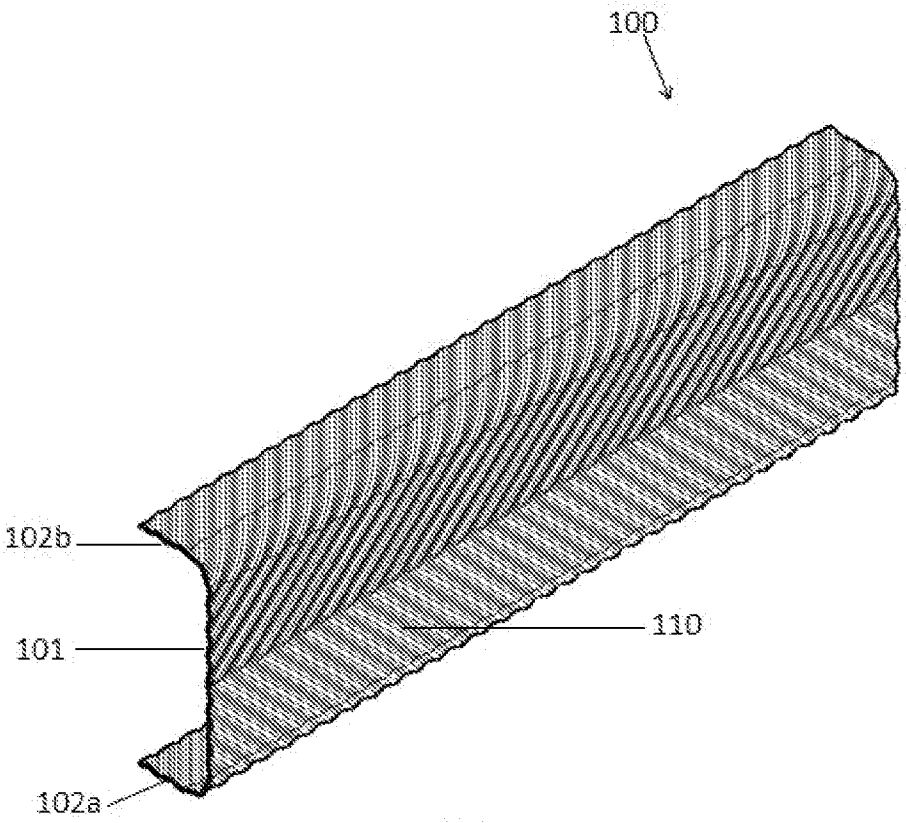


FIG. 8

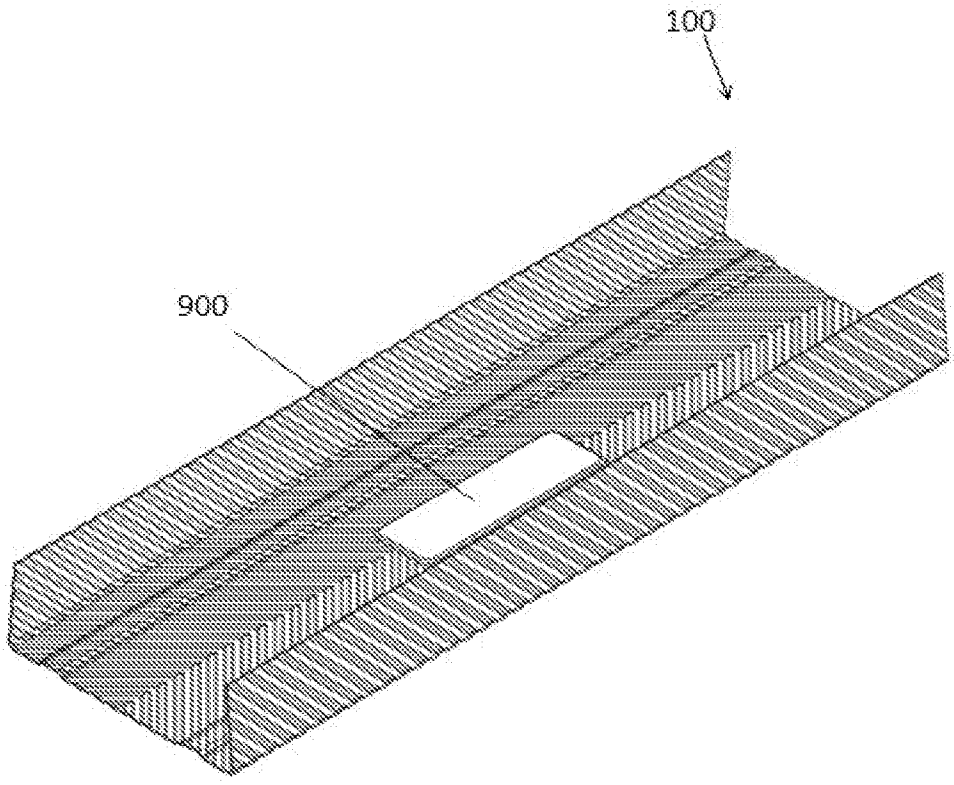


FIG. 9

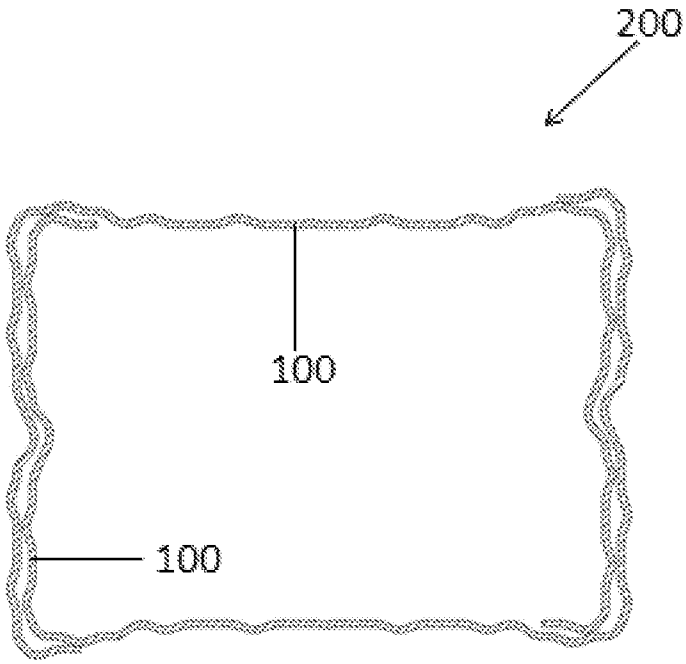


FIG. 10

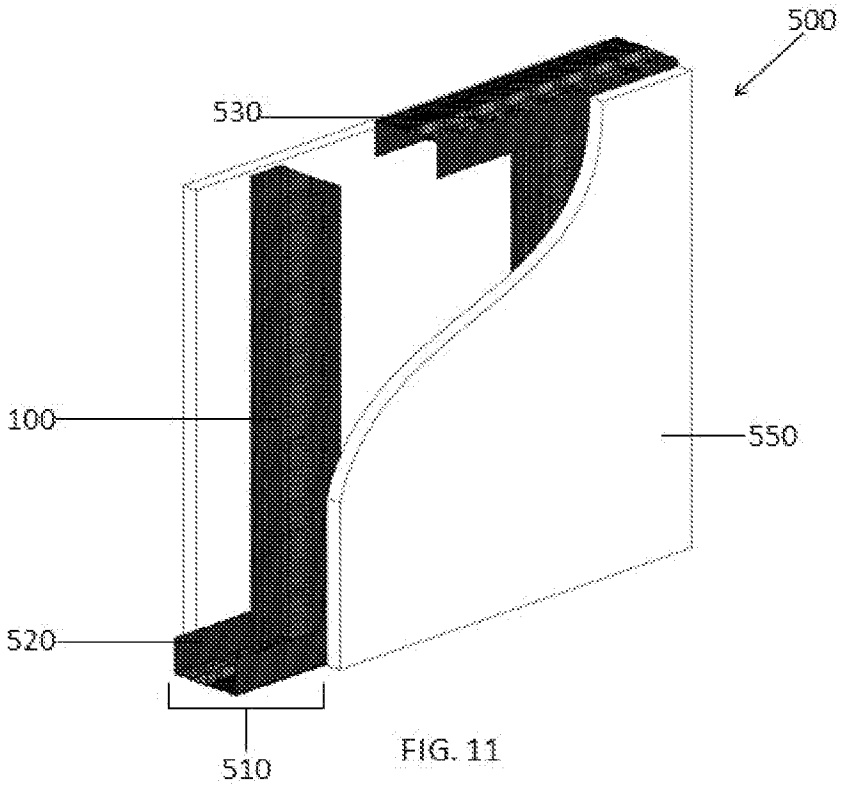


FIG. 11

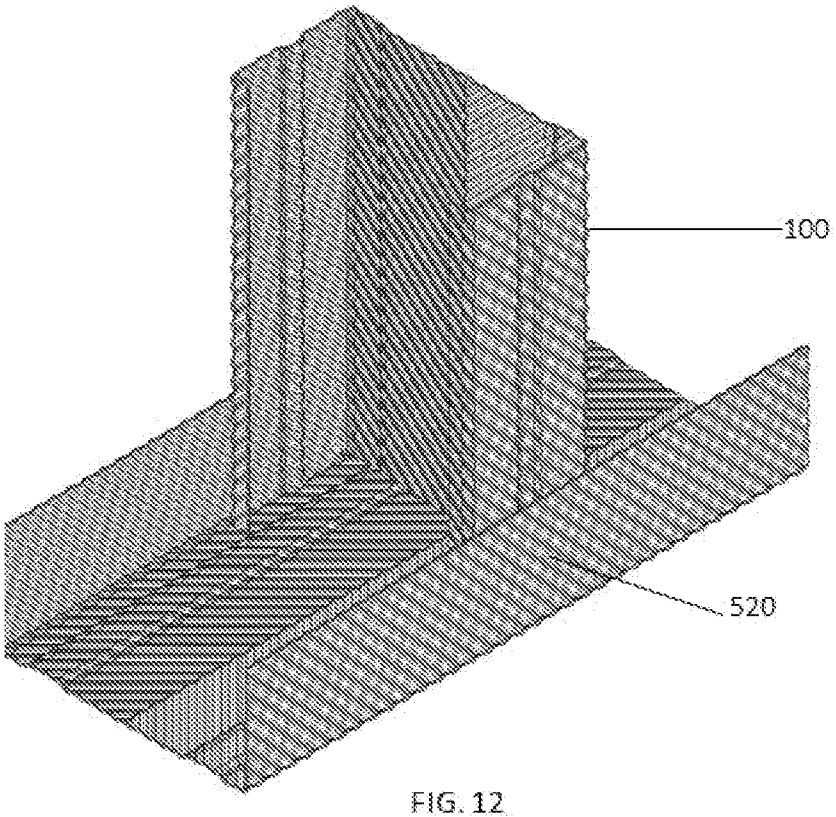


FIG. 12

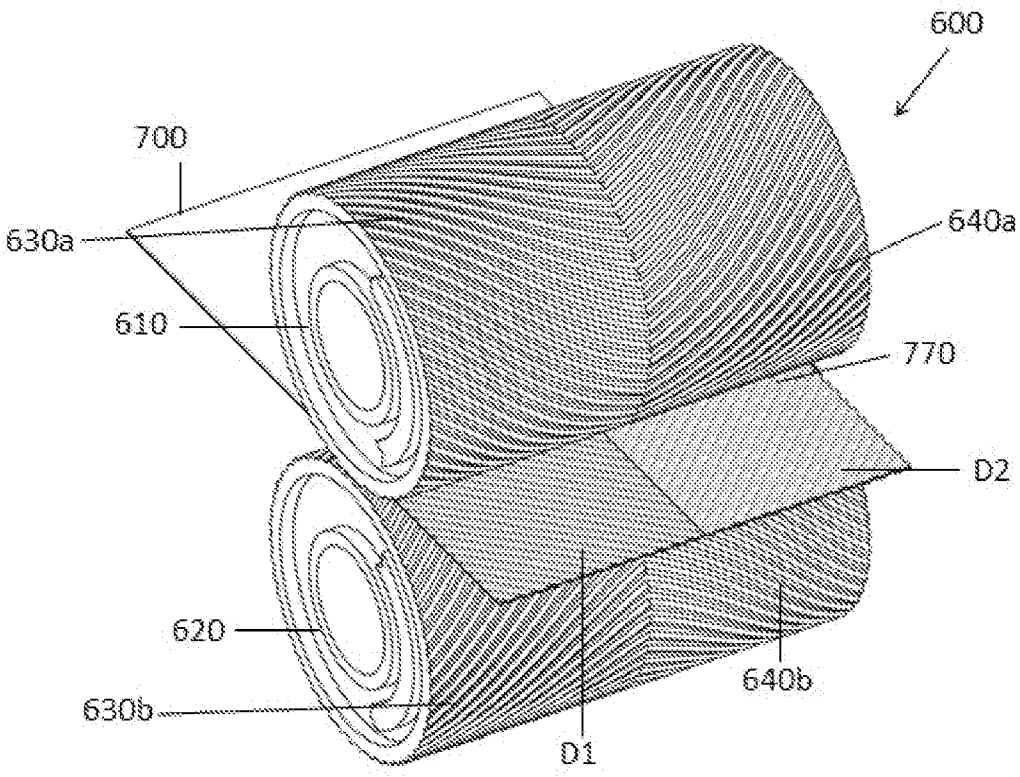


FIG. 13

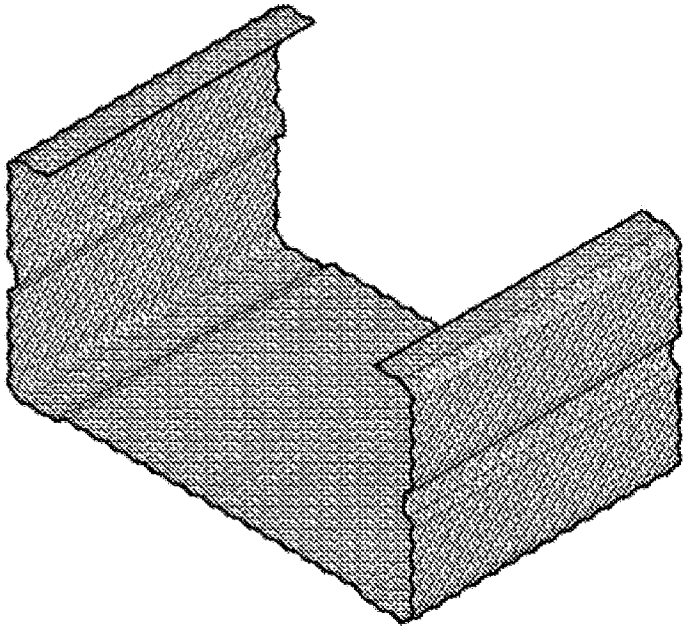


FIG. 14

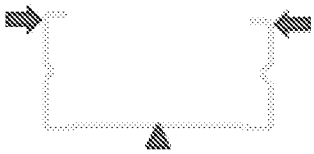


FIG. 15A

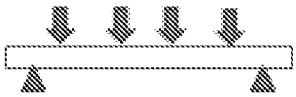


FIG. 15B

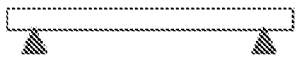


FIG. 15C

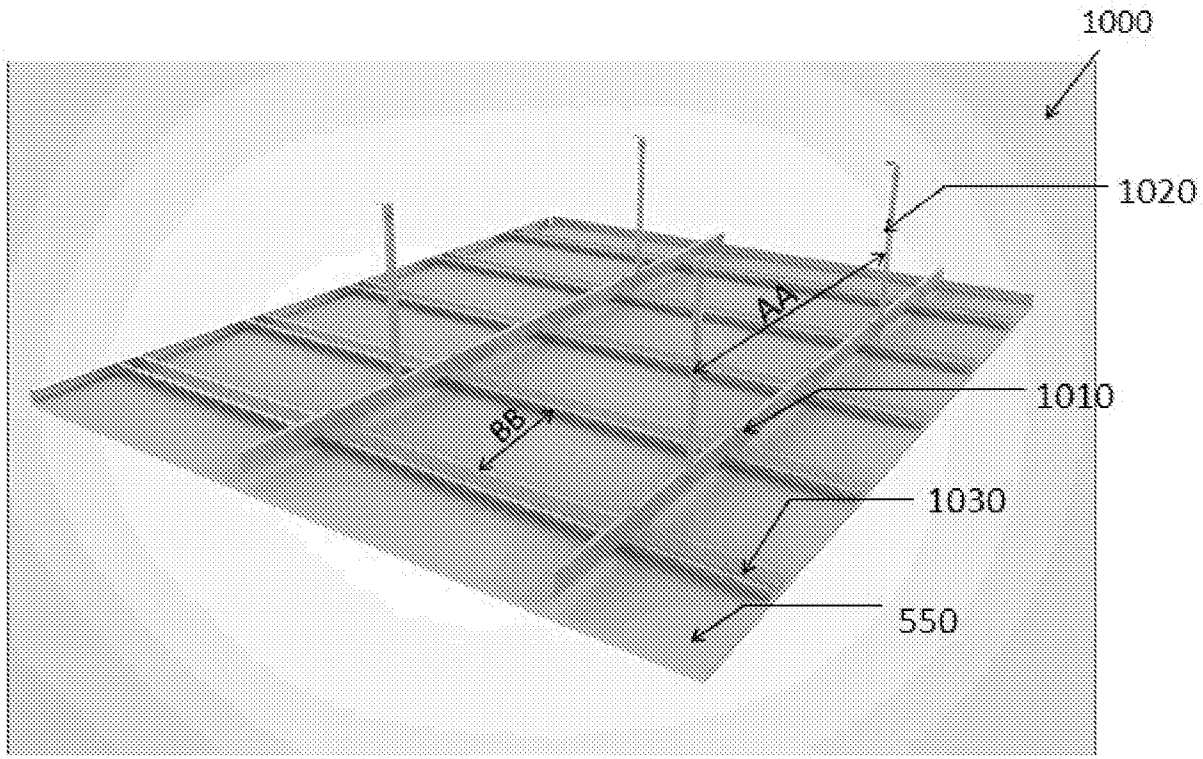


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2018/050205

A. CLASSIFICATION OF SUBJECT MATTER
E04C2/36,E04C2/32,B31F1/07,B31F1/30 Version=2018.01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E04C, B31F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

TotalPatent One, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US3243930A (NATIONAL GYPSUM CO) 05 April 1966 (05/04/1966) column 2, line 41-44, fig.2, fig. 1, fig 6 and claim 1	1-16
X	US2664179A (JACOB M GWYNNE) 29 December 1953 (29/12/1953) column 4 lines 45- 48, fig. 4	1-16
Y	RU114981 (U1) (Ivan Sergeevich Rybkin) 20 April 2012 (20.04.2012) abstract and claim 1	17
Y	US4709517A (C & M ACQUISITION INC) 01 December 1987 (01.12.1987) figures 1-27, abstract and claim 1	17
X	WO2014207159A2 (BRITISH AMERICAN TOBACCO (INVESTMENTS) LIMITED) 31 December 2014 (31.12.2014) figures 1-7, claim 1 & 25, and summary	18-22
X	US4170122A (COVRAD LTD) 09 October 1979	

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18-07-2018	18-07-2018
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Authorized officer Lokesh Sisodiya Telephone No. +91-1125300200

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	(09/10/1979) figures 3-5 and claim 1 & 8	18-22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2018/050205

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The separate inventions are not so linked as to form a single general inventive concept for the following reasons:

Set of claims 1-16 discloses a corrugated construction element having base profile corrugated to at least one leg profile, base profile and leg profile comprising an array of angular corrugation.

Claim 17 discloses a wall construction.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☒ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

International application No.
PCT/IN2018/050205

Continuation of Observations where unity of invention is lacking(Box III)

Set of claims 18-21 discloses apparatus for forming a sheet material into a profile.

Claim 22 discloses method of manufacturing a sheet material.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2018/050205

Citation	Pub.Date	Family	Pub.Date
US 3243930 A	05-04-1966	US 3243930 A	29-05-1962
US 2664179 A	29-12-1953	US 2664179 A	27-04-1949
RU 114987 U1	20-04-2012	RU 2010147972 U	25-11-2010
US 4709517 A	01-12-1987	US 06869439 A	02-06-1986
WO 2014207159 A2	31-12-2014	GB 201311638 A	28-06-2013
US 4170122 A	09-10-1979	US 0587762 B	14-02-1978