Abstract: A fastener strip (30; 600; 600'; 600") configured to be plastically deformed to a desired shape and to retain the desired shape without a significant amount of recovery.
For two-letter codes and other abbreviations, refer to the “Guidance Notes on Codes and Abbreviations” appearing at the beginning of each regular issue of the PCT Gazette.
BENDABLE FASTENER STRIPS

TECHNICAL FIELD

This invention relates to bendable fastener strips.

BACKGROUND

Fastener strips are frequently used as a closure or other type of fastening mechanism. Fastener strips can be found on a variety of items ranging from power tools to diapers, for example.

A fastener strip can be created by molding a group of fastener elements to extend from a fastener base. The fastener elements and the fastener base can be formed using various materials. Thermoplastic resin is an example of a material that can be used to form the base. The fastener elements can be configured to detachably engage with another material, e.g. a loop material or other fastener elements, in order to produce a fastening effect.

SUMMARY

In one aspect the invention features, a method of forming a fastener strip, including introducing molten thermoplastic resin into a gap formed between a pressure device and a peripheral surface of a rotating mold roll. The peripheral surface of the mold roll defines an array of cavities therein, and the molten resin is introduced under pressure and temperature conditions selected to at least partially fill the cavities to form projections molded integrally with and extending from a resin base. The method further includes introducing a deformable member into the gap with the resin such that the deformable member becomes integrally joined to the resin base as the resin cools. The resulting fastener strip is configured to be plastically deformed to a desired shape and to retain the desired shape without a significant amount of recovery.

In another aspect, the invention features a fastener strip, including a thermoplastic base having an array of integral projections extending therefrom, and a deformable member at least partially encapsulated within the thermoplastic base. The fastener strip is configured to be plastically deformed to a desired shape and to retain the desired shape without a significant amount of recovery.
Embodiments may include one or more of the following features.

In some embodiments, the method further includes introducing the deformable member into a guideplate defining a guide sleeve to position the deformable member relative to the gap.

In some embodiments, the method further includes introducing a loop material into the gap.

In some embodiments, the method includes introducing multiple deformable members into the gap.

In some embodiments, the multiple deformable members are introduced in a parallel configuration.

In some embodiments, the deformable member comprises at least one metal.

In some embodiments, the deformable member comprises a wire.

In some embodiments, the pressure device comprises a pressure roll that rotates counter to the mold roll.

In some embodiments, the mold roll and the pressure roll are internally cooled.

In some embodiments, the cavities are J-hook shaped to form J-hook shaped projections.

In some embodiments, the cavities are stem-shaped to form stem-shaped projections.

In some embodiments, the method further includes deforming the stem-shaped projections to produce mushroom-shaped projections.

In some embodiments, the fastener strip is configured to experience deflection when a force of about 300 grams or less is applied to the fastener strip, and to recover about 20 percent or less of the deflection when the force is removed.

In some embodiments, the deformable member is substantially fully encapsulated within the base.

In some embodiments, the fastener strip comprises multiple deformable members.

In some embodiments, the multiple deformable members are aligned in a substantially parallel configuration.

In some embodiments, the multiple deformable members are aligned longitudinally along the fastener strip.

In some embodiments, a loop material is attached to the base.
In some embodiments, the projections include engageable heads that overhang the base. In some embodiments, the heads overhang the base in multiple directions. Other features and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIG. 1 is a broken perspective view of a fastener strip including deformable members.

FIG. 2 is a cross-sectional view of the fastener strip shown in FIG. 1.

FIG. 3 is a cross-sectional view of a fastener strip including fastener elements extending from opposite sides of a base.

FIG. 4 is a cross-sectional view of a fastener strip including fastener elements extending from one side of a base and loops extending from an opposite side of the base.

FIG. 5 is a cross-sectional view of a fastener strip having partially encapsulated deformable members.

FIG. 6 is a cross-sectional view of fastener strip having a loop material bonded to its surface.

FIG. 7 is a plan view of a fastener strip having crisscrossing deformable members.

FIG. 8 is a plan view of a fastener strip having transverse deformable members.

FIG. 9 illustrates a method and apparatus for forming fastener strips including deformable members.

FIG. 9A is a view of a nip between a mold roll and a pressure roll.

FIG. 10 illustrates another method and apparatus for forming fastener strips including deformable members.

FIG. 11 illustrates another method and apparatus for forming fastener strips including deformable members.

FIG. 12 illustrates another method and apparatus for forming fastener strips including deformable members.

FIG. 13 is a front cross-sectional view of a fastener strip produced by the method and apparatus of FIG. 12.
FIG. 13A is a side cross-sectional view of a fastener strip produced by the method and apparatus of FIG. 12.

FIG. 14 is a cross-sectional view of a fastener strip having a substrate as produced by an alternative method and apparatus of FIG. 12.

FIG. 15 is a cross-sectional view of a fastener strip having stems as produced by another alternative method and apparatus of FIG. 12.

FIG. 15A is a cross-sectional view of a fastener strip having flat-top fastener elements as produced by another alternative method and apparatus of FIG. 12.

FIG. 16 illustrates another method and apparatus for forming fastener strips including deformable members.

FIG. 17 is a cross-sectional view of an initial base having deformable members as produced by the method and apparatus of FIG. 16.

FIG. 18 is a cross-sectional view of a fastener strip having deformable members as produced by the method and apparatus of FIG. 16.

FIG. 19 illustrates another method and apparatus for forming fastener strips having deformable members.

FIG. 20 is a front cross-sectional view of the apparatus of FIG. 19.

FIG. 21 illustrates another method and apparatus for forming fastener strips having deformable members.

FIG. 22 is a cross-sectional view of a fastener strip produced by the method and apparatus of FIG. 21.

FIG. 23 illustrates another method and apparatus for forming a fastener strip having deformable members.

FIG. 24 is a cross-sectional view of a fastener strip produced by the method and apparatus of FIG. 21.

FIG. 25 illustrates a backing tape used in the method and apparatus of FIG. 24.

FIG. 26 is a cross-sectional view of a molding device in the process of forming a fastener strip.

FIG. 27A and 27B illustrate a method and apparatus for testing plastic deformability and recovery of a fastener strip.

Like reference symbols in the various drawings indicate like elements.
DETAILED DESCRIPTION

Referring to Figs. 1 and 2, a fastener strip 30 includes a base 40, an array of projections or fastener elements 34, and multiple deformable members 110. As will be described below, the deformable members 110 and the base 40 allow the fastener strip 30 to be bent (e.g., manually deformed) to a desired shape and to substantially retain that shape bent shape.

The base 40 can be formed from a thermoplastic resin, such as high density polyethylene. A suitable high density polyethylene is Exxon Mobil #6908, for example. Alternatively or additionally, other materials exhibiting suitable plasticity (e.g., materials that can be substantially bent without rupture) can be used. For example, the base 40 can be formed from low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), polypropylene, polyurethane, nylon, vinyl, thermoplastic elastomers (e.g., Santopene®) and various combinations of the aforementioned materials.

The fastener elements 34 can be any of various fastener elements, such as hook-shaped elements, mushroom-shaped fastener elements, and flat top stems. As shown in Fig. 1, the fastener elements 34 include a stem portion 35 that extends from the base 40 and an engageable head portion 37. More specifically, the fastener elements 34 are J-shaped hooks adapted to engage with loops of a loop material (e.g., a non-woven material, a woven material, a knit material, etc.). The head portion 37 can be shaped to engage with any of various suitable materials in order to provide a desired degree of fastening strength. In some embodiments, for example, the head portion 37 is designed to engage with other like fastener elements (e.g., mushroom-shaped hooks) to form a self-engaging fastener strip.

The fastener elements 34 are integrally molded with the base 40. The base 40 and the fastener elements 34 are preferably formed of a single thermoplastic resin. However, the base 40 and the fastener elements 34 can be formed of different materials.

The deformable members 110 are permanently attached to the base 40. More specifically, as shown in Fig. 2, the deformable members 110 are completely encapsulated by resin forming the base 40. Encapsulation of the deformable members 110 stabilizes the deformable members 110 inhibiting their movement relative to the base 40. This ensures that the deformable members 110 will be maintained in a
predetermined alignment relative to each other, which can ensure that the fastener strip 30 will maintain a desired range of flexibility across its length and width.

Each of the deformable members 110 has mechanical properties selected to enable the deformable members 110 to be formed into different bent shapes and to substantially retain the respective bent shapes while remaining attached to the base 40. This allows the fastener strip 30 to be bent into a desired shape when a user applies a bending force (e.g., bends the ends of the fastener strip toward one another) and to retain that desired shape after the bending force is released. The fastener strip 30 can be bent, for example, in a position that allows it to be easily grasped by the user. Similarly, the fastener strip 30 can be bent in a desired position so that it does not impede the user's ability to grasp surrounding objects.

The preferred mechanical properties of the deformable members 110 are dependent upon many variables. For example, the mechanical properties can depend on the thickness of the base 40, the material from which the base 40 is formed, and the number and geometry of deformable members 110 attached to the base 40. The preferred mechanical properties allow the deformable members 110 to be bent by the user such that the deformable members 110 are plastically deformed and the strain produced by the user is less than the relevant failure strain. Suitable materials for forming the deformable members 110 include those that exhibit plasticity (i.e., the material can be deformed plastically into a desired shape or shapes without rupture). The deformable members 110, once bent, are capable of substantially retaining that bent shape while remaining attached to the base 40. Due to the mechanical properties of the deformable members 110 and the base 40, the fastener strip 30 can be bent into a desired shape and retain that shape.

As shown in Figs. 1-6, multiple deformable members 110 are preferably arranged parallel to one another along the longitudinal direction of the base 40. However, other suitable arrangements may be used. Referring to Fig. 7, for example, the deformable members 110 may be arranged in a crisscrossing pattern along the base 40. Similarly, as shown in Fig. 8, the deformable members 110 may be arranged transversely across the base 40. In addition, many other arrangements are contemplated. For example, the deformable members may be arranged diagonally. Furthermore, the deformable members may be restricted to discrete regions along the
fastener strip, such that the fastener strip is retainably bendable only in those discrete regions.

The flexibility of the fastener strip 30 depends, in part, on the arrangement of the deformable members 110 with respect to the base 40. For example, a longitudinally parallel arrangement of deformable members 110 will produce a fastener strip that can be retainably bent about the transverse direction of the fastener strip, but not about the longitudinal direction. Similarly, when the deformable members 110 are arranged in a transversely parallel direction along the fastener strip 30, they can provide for retainable bending about the longitudinal direction, but not about the transverse direction. Arranging the deformable members 110 in a crisscrossing pattern provides for retainable bending in both the longitudinal and transverse directions.

The deformable members 110 are preferably deformable metal wires. However, any other suitably shaped device having mechanical properties that allow the deformable members 110 to be manually formed (e.g., bent) into a desired shape and to substantially retain that shape while remaining attached to the base 40 may be used. For example, the deformable members 110 may be in the shape of bars, plates, sheets, and/or strips. The deformable members 110 may be constructed of any suitable material or materials, such as metals (e.g., annealed steel, copper, aluminum).

The fastener strip 30 is configured to be plastically deformed to a desired shape and to substantially retain that shape without a significant amount of spring back or recovery. The plastic deformability and recovery can be tested using a testing apparatus like the one shown in Figs. 27A and 27B, for example. To test the deformability and recovery, fastener strip 30 is laid flat on a support 50 (e.g., a bench or a table) having a substantially flat top surface 51 and a relatively sharp edge 52. The fastener strip 30 is arranged with an end 31 of the fastener strip overhanging the edge 52 of the support 50 by a distance d of about 15 millimeters. A force F of about 300 grams is then applied to the end 31 of the fastener strip 30, causing the fastener strip 30 to plastically deform, as shown in Fig. 27B. The deformed fastener strip 30 experiences deflection $\rho$ of between about one degree and about 90 degrees. Upon releasing the force F from the end 31 of the fastener strip 30, the deformed end of the fastener strip 30 springs back or recovers about 20 percent or less (e.g., 15 percent or less, ten percent or less, five percent or less, three percent or less, one percent or less) of the deflection $\rho$. 

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In certain embodiments, the fastener strip 30 is configured such that a force of less than 300 grams (e.g., 250 grams or less, 200 grams or less, 150 grams or less, 100 grams or less, 50 grams or less) can have a similar effect on the fastener strip. In such embodiments, the fastener strip 30 can become plastically deformed in response to the force F applied to its end 31 such that the fastener strip 30 experiences a deflection \( p \) of between about one degree and about 90 degrees and recovers about 20 percent or less (e.g., 15 percent or less, ten percent or less, five percent or less, three percent or less, one percent or less) of the deflection \( p \).

Referring to Figs. 3-5, other fastener strip embodiments are shown. As shown in Fig. 3, the fastener strip 30 may include fastener elements 34 extending from opposite sides of the base 40. In another variation, as shown in Fig. 4, the fastener strip 30 may include fastener elements 34 extending from one side of the base 40 and a loop material 44 (e.g., hook-engageable loop material) extending from an opposite side of the base 40. As shown in Fig. 6, the fastener strip 30 may include only loop material extending from one side of the base 40. The loop material can, for example, be bonded to the base 40, as discussed in more detail below. The loop material 144 is preferably a non-woven knit material. However, any suitable material capable of engaging a fastener element may be used.

Referring to Fig. 5, the fastener strip 30 includes deformable members 110 that are only partially encapsulated by the material forming the base 40 with fastener elements 34 extending from only one side of the base 40. Of course the fastener strip 30 can include fastener elements 34 extending from both sides of the base 40; fastener elements 34 extending from one side and loops of a loop material extending from another side, only loop material extending from one or both sides, or any other suitable arrangement of fastener elements and/or loop material.

Fig. 9 illustrates multiple methods and apparatus for producing the above described bendable fastener strip. The methods build upon the continuous extrusion/roll-forming method for molding fastener elements on an integral, sheet-form base described by Fischer in U.S. Patent No. 4,794,028, and the nip lamination process described by Kennedy et al. in U.S. Patent No. 5,260,015, each of which is incorporated by reference herein. An extrusion head 100 supplies a continuous sheet of molten resin 140 to a nip 102 between a rotating mold roll 104 and a counter-rotating pressure roll 106 (nip arrangement illustrated in FIG 9A). The mold roll 104 contains
an array of miniature, fastener element-shaped mold cavities 134 extending inward from its periphery for molding the fastener protrusions or elements 34 (shown in Figs. 1-5). Pressure in the nip 102 forces resin into the fastener element cavities and forms the substrate or base 40 (shown in Figs 1-6). The formed product is cooled on the mold roll until the solidified fastener elements (e.g., hooks) are stripped from their fixed cavities by a stripping roll 108. Along with the molten resin, the deformable members 110 are fed into the nip 102, where they are bonded with the resin 140 and become permanently encapsulated within the substrate or base 40. Thus, the product 162 that is stripped from the mold roll 104 includes both fastener elements 34 and deformable members 110 as illustrated, for example, in FIG 1 described above.

Fig. 9 indicates several variations of the above-described method. For instance, rather than introducing the deformable members 110 through the nip 102 and thereby joining them to the substrate as the substrate is molded, the deformable members may be joined to the substrate after the substrate has been formed, such as is indicated by the run 110' of deformable members shown in dashed outline. In this case, a front face idler 122 is heated and has a contoured surface to bond the deformable members and the substrate in desired areas while not damaging the molded hooks.

Fig. 9 also illustrates a method and apparatus for producing a bendable fastener strip having engageable loops on one surface. In this method, the deformable members 110 are fed into the nip 102 along with the extruded resin 140. The nip 102 is formed between the mold roll 104 and the pressure roll 106, but in this embodiment, the mold roll 102 lacks element-forming mold cavities. A continuous strip of loop material 144, as described above in reference to Figs. 6, is simultaneously fed into the nip 102. The deformable members 110 and the loop material 144 are bonded to the resin of the substrate by pressure in the nip 102.

Fig. 10 illustrates an alternative method and apparatus for forming the above-described bendable fastener strips. The contoured surface of an extrusion head 200 (sometimes called an injection head) is placed adjacent a mold roll 104 (mold roll 104 once again lacking fastener protrusion shaped cavities to produce the loop bearing strip of Fig. 6), and a continuous flow of molten resin is injected under pressure into the gap 202 defined between the head 200 and the mold roll 104, filling the gap 202 and forming the front and back faces of the substrate or base. The configuration and construction of the mold roll 104 is similar to that of Fig. 8. In this embodiment, the
extrusion head 200, rather than the pressure roll 106, creates the pressure necessary to fill the molding cavities with resin and/or bond the loop material to the base. To create the loop bearing strip, such as that illustrated in Fig. 6 above, using this method and apparatus the strip 144 of loop material is fed through a predetermined region of the gap 202, and held up against the surface of the mold roll 104 by resin pressure in the gap 202. The deformable members 110 are laminated to the back face of the substrate, while the molded product is retained on the mold roll 104, by pressure supplied by the pressure roll 206.

Figure 10 also illustrates an alternative method and apparatus for producing the bendable fastener protrusion bearing strip illustrated in Fig. 5, for example. In this embodiment loop material 144 is not present and mold roll 104 has fixed fastener element molding cavities as described above with respect to Fig. 9. Resin alone is fed through the extrusion head 200 into the gap 202 between the extrusion head 200 and the mold roll 104 where gap pressure forces the resin to fill the mold cavities as previously described. The deformable members 110 are laminated to the back face of the substrate, while the molded product is retained on the mold roll 104, by pressure supplied by the pressure roll 206 to produce a bendable fastener strip having protruding fastener elements.

In an alternative method and apparatus illustrated in Fig. 10, deformable members 110” (as indicated by dashed lines) are fed directly into the gap 202. The deformable members 110” are preferably in the form of wire, rod, or bar, as discussed above. In this embodiment, the deformable members 110” can become more fully encapsulated within the resin.

Figure 11 illustrates an additional method and apparatus for producing the above described bendable fastener strip. In this embodiment an extruder head 300 supplies resin flows or films 140, 141 into the nip 102 formed by the mold roll 104 (the mold roll having fixed fastener element molding cavities 134 as described above with respect to Fig. 9 to produce a product such as that illustrated in Fig. 1) and the pressure roll 106, respectively. The arrangement of the nip 102 is as described above in reference to Figs. 9 and 9A. Simultaneous with the resin feed, multiple deformable members 310 are fed through an extrusion die of the extruder head 300 and into the nip 102 between the separate resin flows or films 140, 141. Pressure and temperature conditions in the nip 102 force the resin flow or film 140 to flow into the molding
cavities as described above, encapsulates the deformable members 310 within the resins 140, 141, and bonds the separate resin flows or films 140, 141 to create an integral fastener strip having deformable members insulated within a substrate and fastener protrusions extending from a surface of the substrate.

The method and apparatus illustrated in Fig. 11 are also capable of producing fastener strips such as that illustrated in Fig. 6 and described above. In such an arrangement the mold roll 102 lacks fastener protrusion shaped cavities and the loop material 144 (shown as dashed lines in Fig. 11), as described above with reference to Fig. 6, is fed directly onto the surface of the mold roll 102 prior to the entrance of the resin flow 140 into the nip 102. The methods and apparatus of Figs. 9, 10, and 11 are also capable of forming bendable fastener strips having both fastener protrusions (e.g., hooks or mushrooms) and loop fastener material capable of engaging the protrusions to form a fastening, as shown in Fig. 4. Using the above described techniques wherein the mold roll 104 has fastener protrusion forming cavities and the loop material 144 is fed into the nip or gap while resin and deformable members are introduced can yield a self-engageable fastener strip having both types of fastener elements.

Referring now to Fig. 12, a continuous fastener strip 600 is manufactured by feeding multiple deformable members 602 into a nip 604 formed by a rotating mold roll 606 and a counter-rotating pressure roll 608. The deformable members 602 are laterally spaced apart from one another as they enter nip 604. In order to control the lateral position of the deformable members as they enter the nip, guide rollers 616 are provided with individual grooves, one for each deformable member introduced, to prevent the deformable members 602 from wandering laterally as they approach the nip 604. Furthermore, the pressure roll 608 has corresponding grooves that aid in aligning the deformable members 602 during the encapsulation process now to be described.

Simultaneously with the deformable members 602, a band 610 of molten thermoplastic resin is introduced to the nip 604 from the extruder head 612. Pressure and temperature conditions in the nip cause the molten resin to envelop the deformable members 602 and also cause a portion of the resin to fill hook shaped cavities 614 provided in the mold roll 606. As the cooled mold roll continues to rotate, the resin and encapsulated deformable members remain adjacent the periphery of the mold roll until take-off rollers 618 and 620 act to strip the product 600 from the mold roll 606, thus extracting the now solidified hooks 622 from their respective cavities 614.
Referring now to Figs. 13 and 13A, the product 600 has a thermoplastic resin base 632 with an upper surface 624 and a lower surface 626. Loop-engageable hooks 622 extend from the upper surface 624, each hook being an integral extension of the thermoplastic resin of the insulating body. Hooks 622 have a stem portion 623 and a loop-engageable head portion 625 that extends outward from the stem to overhang the upper surface 624. The bottom surface 626 has peaks 628 corresponding to the deformable member guiding grooves in the pressure roll 608 with a valley 630 of reduced thickness separating adjacent peaks 628. Each deformable member 602 is encapsulated within a peak 628 and separated from an adjacent deformable member by thermoplastic resin body 632. In one example, the resin body 632 is of a deformable PVC material.

The position of deformable members 602 relative to the upper surface 624 and the lower surface 626 is dictated by the relative positions of the deformable member and the molten thermoplastic resin as they enter the nip and the flow dynamics of the molten thermoplastic resin within the nip. As illustrated in Fig. 12, by introducing the deformable members 602 above the extruder head 612 the tendency is for the deformable members to be relatively nearer the upper surface 624 of the final product 600 (as indicated by deformable members 602' shown as dashed lines in Fig. 13). Conversely, if the deformable members are fed from below the extruder head (as indicated by deformable member feed 602A illustrated in dashed lines in Fig. 12) the tendency is for the deformable members to be relatively nearer the lower surface 626 in the final product 600 (as indicated by deformable members 602" shown as dashed lines in Fig. 13). The deformable members can be introduced into the resin so that only a lower portion or an upper portion of the deformable member is encapsulated by the resin to produce a product as shown in Fig. 5, for example.

One alternative for controlling the vertical position of the deformable members 602 within the base 632 is to provide a supporting substrate 633 beneath the deformable members as the molding process takes place. As illustrated in Fig. 12, a substrate 633 (shown as dashed lines) is fed onto the grooved pressure roll 608 so that it sits on the peaks of the grooves of the roll. The substrate 633 can be any material that suitably allows the molten thermoplastic resin to flow through and encapsulate the substrate during the molding process. In one example, the substrate 633 is a mat of nonwoven fibers. The deformable members 602A are then fed onto the substrate at positions
corresponding to the guiding grooves of the pressure roll 608. The somewhat resilient substrate 633 allows deformable members 602A to enter only partially into their respective guiding grooves in the pressure roll 608, thus allowing the lateral position of the deformable members to be controlled while preventing the deformable members from reaching the bottom of the grooves. Upon entering the nip, molten resin 610 flows upward to fill cavities 614 and downward through the substrate 633 to fill the grooves of the pressure roll, meanwhile the substrate 633 prevents the deformable members 602A from sinking into contact with the pressure roll 608.

The resulting product 600', as shown in Fig. 14, has the supporting substrate 633 embedded beneath the deformable members 602 within the base 632.

In an alternative embodiment, also illustrated in Fig. 12 and further referring to Figs. 15 and 15A, mold cavities 614 are of a shape protruding straight inwardly from the periphery of the mold roll 606 toward its center, i.e., the cavities 614 are shaped to form stems only and do not have an undercut portion for forming an engaging head of a fastener element. The rest of the fastener strip forming method proceeds as described above except the product 600" (Fig. 15) stripped from the mold roll has only integrally molded stems 622' protruding from its upper surface 624'. Subsequent to the stripping operation, the strip 600" is passed between a heated roller 634 and an anvil roller 636 (shown in dashed lines) to produce a final fastener strip 600''' (Fig. 15A). Rollers 634, 636 are arranged so that the heated roller 634 contacts and deforms a tip portion 623' of each stem 622' to form a loop-engageable head portion 625' that overhangs upper surface 624'.

Referring now to Figs. 16-18, another technique for avoiding any potential problems of centering and/or fully encapsulating the deformable members within the base is to form the base in a two step process. Initially, an intermediate product 640 (Fig. 16) is formed by feeding deformable members 602 and a band 610 of thermoplastic resin into a nip formed by two pressure rolls 644 and 646. Similar to the pressure roll 608 described above with reference to Fig. 12, the lower pressure roll 646 has peak and valley forming grooves on its surface to aid in guiding the wires laterally, however, in this two step process, upper pressure roll 644 has a flat peripheral surface which forms the flat upper surface 648 (Fig. 17) of the intermediate product 640. The intermediate product 640 is then fed into a second nip 651 formed by a grooved lower pressure roll 650 and a mold roll 652 having hook cavities as described above.
Simultaneously with the intermediate product 640, a band of thermoplastic resin 654 is introduced from an extruder head 653 to the nip directly adjacent the periphery of the mold roll 652, and hooks 656 (shown in Fig. 18) are formed in a manner similar to that described above with reference to Fig. 12. The resulting final product 658 has a multilayered structure including an upper, hook bearing layer 660 permanently bonded during the hook molding operation to a lower layer 662 that was initially formed as intermediate product 640. The deformable members 602 are either fully encapsulated by lower layer 662 or are fully encapsulated by being sandwiched between the upper and lower layers 660, 662, respectively.

Referring now to Figs. 19 and 20, in yet another method for forming a continuous strip with integrally molded fastener element stems extending from a base, a die 670 is positioned just upstream of a nip 672. The die 670 includes a deformable member guide plate 674 defining individual guide sleeves 676 each of which receives and guides a deformable member 678. The guide sleeves 676 can be cylindrically shaped for receiving wires of round cross-section or can be of rectangular cross-section for receiving flattened members to produce relatively flat strips. Arranged perpendicular to the feed direction of the deformable members is an extruder 680 which introduces molten thermoplastic resin through a nozzle 681 to an internal resin flow path 683 defined by the die 670. The flow path 683 directs the molten resin to flow above, below and between the plurality of deformable members 678 before the combination 682 of deformable members and molten resin is forced through a slot 684 and into the immediately adjacent nip 672. Once the material is in the nip 672, the molding process proceeds as described above with reference to Fig. 12 with no further need for lateral or vertical wire guiding and/or alignment.

In one particular embodiment, illustrated in Figs. 21 and 22, the deformable members and thermoplastic resin are fed through a nip 700 formed by two mold rolls 702, 704, rotating in opposite directions. Each mold roll 702, 704 defines an array of hook (or stem) forming cavities 706, similar to those described above. In the embodiment shown, two streams 708, 710 of molten thermoplastic resin are fed into the nip 700 while a plurality of laterally spaced apart deformable members 709, in the form of flat strips, are introduced to the nip 700 between the streams 708, 710 of resin.

Alternatively, the streams 708, 710 of resin can be initially two solidified thermoplastic resin films. The temperature and pressure conditions in the nip force the thermoplastic
resin (whether initially molten or solid) to at least partially fill the cavities so that a solidified product 712 stripped from the exit side of the nip has loop-engageable fastener elements 714 (or stems that can be later post-formed as described above) protruding from opposite broad surfaces 716, 718 of the body 720 of thermoplastic resin.

Yet another method for producing fastener strips is illustrated in Figs. 23-26. The method is a lamination process in which a pre-formed hook tape 730, spaced apart deformable members 732 and a backing tape 734 are simultaneously fed between two bonding rollers 736, 738. The pre-formed hook tape 730 is of a thermoplastic resin, having a base 740 defining first and second surfaces 742, 744, respectively. Hooks 746 extend from the base 740. The hooks 746 are protrusions of the thermoplastic resin of first surface 742 and are suitable for engaging a loop material. The hook tape 730 is fed between the pressure rolls 736 and 738 with its hook-bearing first surface 742 immediately adjacent the peripheral surface of the first pressure roll 736. The backing tape 734 defines a first surface 748 and a second surface 750 and is fed between the rolls 736 and 738 with its first surface 748 immediately adjacent the peripheral surface of pressure roll 738.

Simultaneously with the hook tape 730 and the backing tape 734, a plurality of deformable members 732 is introduced between the pressure rolls 736, 738 in laterally spaced apart fashion. The deformable members 732 are positioned between the second surface 744 of the hook tape 730 and the second surface 750 of the backing tape 734. The pressure roll 736 has a series of protruding rings 752 arranged to contact the first surface 742 of the hook tape 732 only along regions 753 of a forming laminate 754 that lie between the spaced-apart deformable members 732. The rolls 736 and 738 are heated and positioned to create pressure in the regions 753 corresponding to each ring 752 such that thermal bonding occurs along the contacted regions of the laminate 754. The thermal bonding lines act to permanently weld the hook tape 730 to the backing tape 734 in a manner that isolates the deformable members 732 from one another and at least partially encapsulates the deformable members between the hook tape and the backing tape. The pre-formed hook tape 734 can be provided with regions 753 distinguished by flat areas (as illustrated in Fig. 24) on first surface 742, i.e., areas lacking rows of hooks 746. Alternatively, the first surface 742 of pre-formed hook tape can have a uniform array of hooks 746 across its surface, the hooks in regions 753
subsequently coming into contact with the rings 753 whereby the hooks are melted and
or crushed by the applied pressure and heat. Either way, the hooks remaining on the
surface 742, i.e., those positioned between rings 752 during the lamination process, are
sufficient to provide the necessary fastening capability with mating loop materials.

In another alternative, the pressure roll 736 acts as an anvil (rotary or stationary)
while the pressure roll 734 is ultrasonically vibrated at a frequency which causes the
hook tape 730 to be welded to the backing tape 734 along the regions 753 where the
rings 752 contact the hook tape 730.

A number of embodiments of the invention have been described. Nevertheless,
it will be understood that various modifications may be made without departing from
the spirit and scope of the invention.
WHAT IS CLAIMED IS:

1. A method of forming a fastener strip (30; 600; 600'; 600"; 600'"), the method comprising:
   - introducing molten thermoplastic resin (140; 141; 610; 654; 708, 710) into a gap (102; 202; 604; 672; 700) formed between a pressure device (106; 206; 608; 650; 702) and a peripheral surface of a rotating mold roll (104; 606; 652; 704), the peripheral surface of the mold roll defining an array of cavities (134; 614; 706) therein, the molten resin being introduced under pressure and temperature conditions selected to at least partially fill the cavities to form projections (34; 622; 622'; 656; 714) molded integrally with and extending from a resin base (40; 632; 720); and
   - introducing a deformable member (110; 110"; 602; 602'; 602"; 602A; 678; 709) into the gap with the resin such that the deformable member becomes integrally joined to the resin base as the resin cools,

   wherein the fastener strip is configured to be plastically deformed to a desired shape and to retain the desired shape without a significant amount of recovery.

2. The method of claim 1, further comprising introducing the deformable member into a guideplate (674) defining a guide sleeve (676) to position the deformable member relative to the gap.

3. The method of claim 1 or claim 2, further comprising introducing a loop material (144) into the gap.

4. The method of any of the above claims, wherein the method comprises introducing multiple deformable members into the gap.

5. The method of claim 4, wherein the multiple deformable members are introduced in a parallel configuration.

6. The method of any of the above claims, wherein the deformable member comprises at least one metal.
7. The method of any of the above claims, wherein the deformable member comprises a wire.

8. The method of any of the above claims, wherein the pressure device comprises a pressure roll that rotates counter to the mold roll.

9. The method of claim 8, wherein the mold roll and the pressure roll are internally cooled.

10. The method of any of claims 1-9, wherein the cavities are J-hook shaped to form J-hook shaped projections.

11. The method of any of claims 1-9, wherein the cavities are stem-shaped to form stem-shaped projections.

12. The method of claim 11, further comprising deforming the stem-shaped projections to produce mushroom-shaped projections.

13. The method of any of the above claims, wherein the fastener strip is configured to experience deflection when a force of about 300 grams or less is applied to the fastener strip, and to recover about 20 percent or less of the deflection when the force is removed.

14. A fastener strip, comprising:
   a thermoplastic base (40; 632; 720) having an array of integral projections (34; 622; 622'; 656; 714) extending therefrom; and
   a deformable member (110; 110"; 602; 602'; 602"; 602A; 678; 709) at least partially encapsulated within the thermoplastic base,
   wherein the fastener strip is configured to be plastically deformed to a desired shape and to retain the desired shape without a significant amount of recovery.

15. The fastener strip of claim 14, wherein the deformable member comprises at least one metal.
16. The fastener strip of claim 14 or claim 15, wherein the deformable member comprises a wire.

17. The fastener strip of any of claims 14-16, wherein the deformable member is substantially fully encapsulated within the base.

18. The fastener strip of any of claims 14-17, wherein the fastener strip comprises multiple deformable members.

19. The fastener strip of claim 18, wherein the multiple deformable members are aligned in a substantially parallel configuration.

20. The fastener strip of claim 18, wherein the multiple deformable members are aligned longitudinally along the fastener strip.

21. The fastener strip of any of claims 14-20, wherein a loop material (144) is attached to the base.

22. The fastener strip of any of claims 14-21, wherein the projections include engageable heads that overhang the base.

23. The fastener strip of claim 22, wherein the heads overhang the base in multiple directions.

24. The fastener strip of any of claims 14-23, wherein the fastener strip is configured to experience deflection when a force of about 300 grams or less is applied to the fastener strip, and to recover about 20 percent or less of the deflection when the force is removed.
INTERNATIONAL SEARCH REPORT

PCT/US2006/041552

A. CLASSIFICATION OF SUBJECT MATTER

INV. B29C43 V/22r8

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B29C A44B

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 practical search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>1,3-7, 13-21,24</td>
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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 document but published on or after the international filing date

'D' 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

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'Z' 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

'A' document member of the same patent family

Date of the actual completion of the international search

3 April 2007

Date of mailing of the international search report

13/04/2007

Name and mailing address of the ISA

European Patent Office, P B 5818 Patentlaan 2 NL-2280 HV Rijswijk

Tel (+31-70) 340-2040, Tx 31 651 epo nl, Fax (+31-70) 340-3016

Authorized officer

Schneider, Dominik
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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)

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

see additional sheet

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 an additional fee, this Authority did not invite payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by 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.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (January 2004)
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1,2,14
   Guiding device to guide a deformable member into an apparatus for manufacturing fastener strips

2. claims: 3-7,13,15-21,24
   Configuration of deformable member(s)

3. claims: 8,9
   Configuration of the pressure device

4. claims: 10-12,22,23
   Definition of the shape of the projections/cavities
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