United States Patent

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[54] METHOD AND APPARATUS FOR MAKING FLEXIBLE STRIPS OF MATERIAL HAVING A PILE OF HOOK-SHAPED ELEMENTS

15 Claims, 4 Drawing Figs.

[52] U.S. Cl. ..... 139/46, 26/9, 28/72 P, 24/204
[51] Int. Cl. D03d 39/24
[50] Field of Search ..... 24/204; 26/9; 28/72; 139/46, 47, 291; 28/72 R, 72 P

[56] References Cited

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2,717,437	9/1955	De Mestral	28/72
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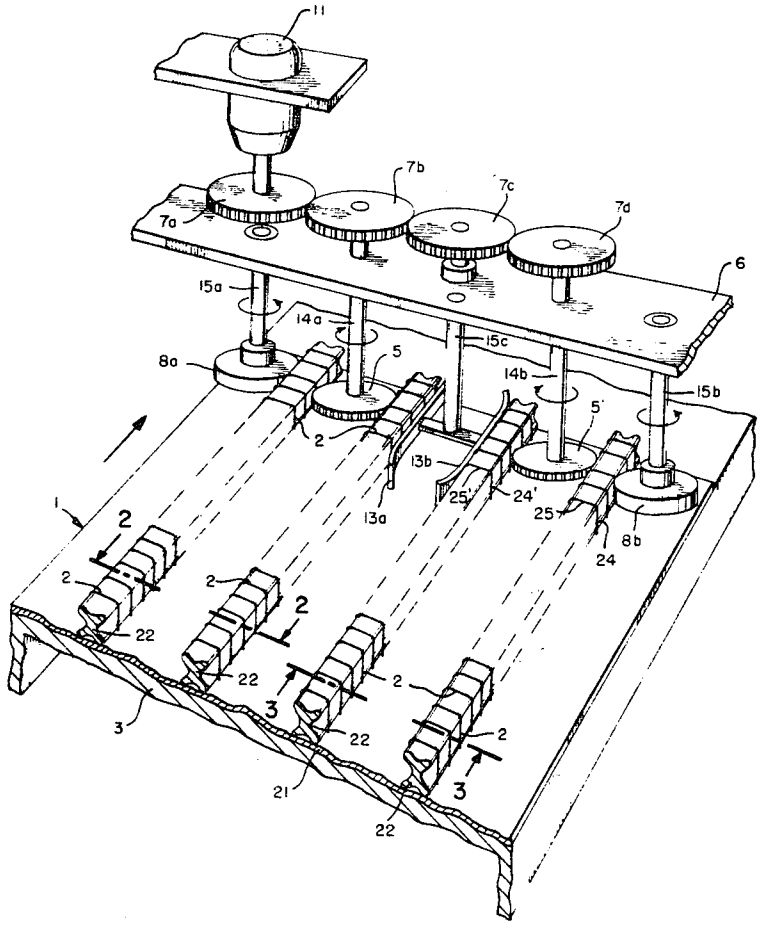
ABSTRACT: A method and apparatus is disclosed for making the hook part of a separable hook and loop-type fastener by inserting a backup bar through a row of loops and subjecting opposite vertical legs of each hook in a row simultaneously and respectively to a cutting and holding action.



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SHEET 1 OF 2

FIG. 1

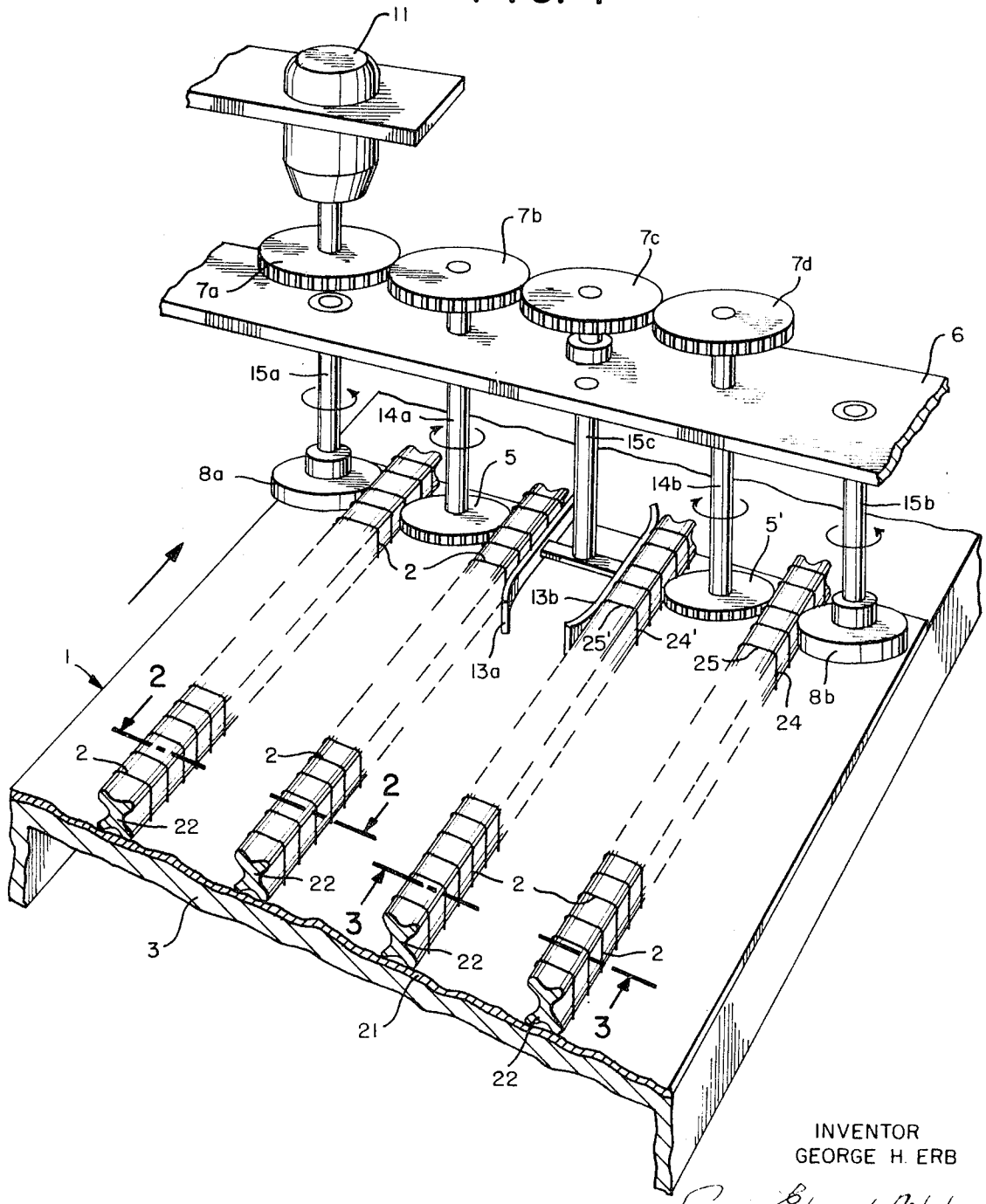

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FIG. 2

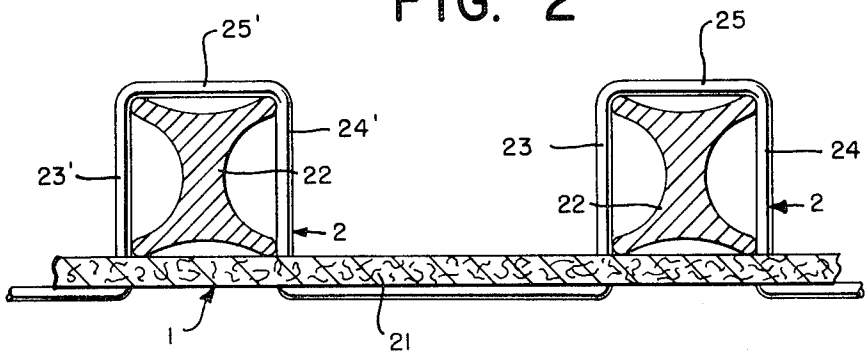


FIG. 3

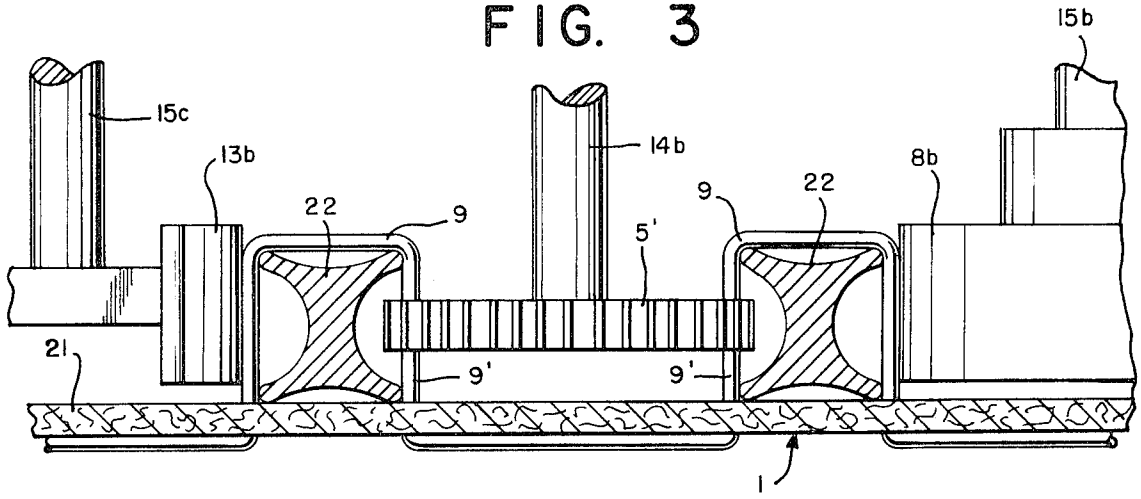
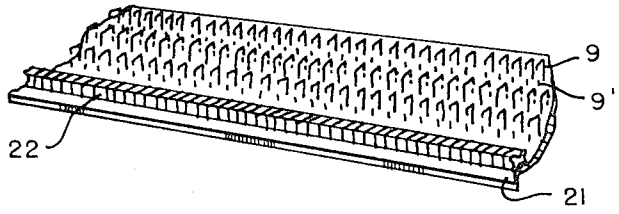


FIG. 4



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METHOD AND APPARATUS FOR MAKING FLEXIBLE STRIPS OF MATERIAL HAVING A PILE OF HOOK-SHAPED ELEMENTS

BACKGROUND OF THE INVENTION

This invention relates to separable fastening devices of the type wherein one part of the fastener has a multiplicity of small outwardly projecting loops of thin filamentary material and the other surface is provided with a multiplicity of curled or hooklike resilient projections. Such fasteners have been described in U.S. Pat. Nos. 2,717,437 and 3,009,235.

It will be understood that when two layers of this type are pressed into face-to-face contact, their respective hooks and loops interengage one within the other thereby securing said layers into locking engagement. Separation of the two layers requires a force of considerable magnitude when attempting to effect the separation of a large number of hooks and loops at once, but separation may be quite readily effected by progressively peeling the layers apart.

Fasteners constructed with interlocking hooks and loops of the type described find a wide variety of applications. For instance, they can be substituted for existing closing devices such as buttons, buckles, clasps, slidable fasteners of the type popularly termed zippers, or like attachments which are currently used in many diverse types of wearing apparel. In addition, they serve a useful function in many particular environments where it is desired to fasten one object to another in a quick and efficient manner.

In the past, the hooked surface of these fasteners has been formed by subjecting a multiplicity of loops to the cutting action of a device consisting of a comb of tapered needles having mounted thereon small rapidly reciprocating scissorslike cutters which clip each hook at a predetermined point thereby resulting in a hook and stub formation which, due to the resilient nature of the filamentary loops, to a great extent resembles a snap hook configuration.

A drawback in this type of hook member is due to the fact that the strength of adhesion between the hooks and loops depends largely on the number of hooks and loops which become interengaged with one another. The greater the number of such connections, the greater will be the adhesive force between the two members. A disadvantage of existing hooked members is that very often a number of uncut loops are found to be intermixed with the cut loops or hooks. It will be apparent that uncut loops effectively reduce the adhesive force between the mating surfaces in direct proportion to the number of such uncut loops. These uncut loops result from the fact that present cutting devices of the type described above often fail to take into account that, because of the extremely thin sectional mass and resilient nature of these loops, a certain percentage of these loops tend to become misaligned thereby avoiding the cutting operation entirely or, in some cases, resulting in loops which are partially cut or cut on a skew. The existence of these defective loops inhibits the effectiveness of the separable fasteners to which they are intended to be applied.

It is a principal object of this invention to provide a method and apparatus for producing a hooked surface of the type described which obviates many of the above disadvantages of the prior art.

A new and useful cutting apparatus is disclosed which efficiently transforms every loop into an open hook and stub formation in spaced apart relationship, of the type described, and wherein virtually 100 percent cutting is insured.

SUMMARY OF THE INVENTION

In accordance with the invention, a length of flexible base material, in the form of a strip or tape of any suitable composition, is provided with a multiplicity of loop-shaped elements arranged in spaced apart parallel rows and wherein each loop-shaped element is supported by a portion of a longitudinal bar extending through the archway formed by each row of loops,

thereby presenting a starting tape the surface of which assumes an undulating pattern of individually supported loops in spaced apart parallel rows.

Each loop so supported is then subjected to a cutting operation wherein a segment of one leg of each loop is removed leaving a hook and stub formation in spaced apart relationship. Finally, the bars are removed from the hook and stub formation resulting in a finished composite tape of flexible material consisting of a base material in which are anchored a multiplicity of outwardly projecting open hook and stub formations arranged in substantially even spaced-apart rows over the surface of the said base material.

In at least one application for the composite male tape of the slidable fastener hereby produced, the loop-shaped elements are made of thin monofilament material which can be made to assure a relatively permanent shape by subjecting them to a suitable heat setting treatment. Since such heat setting treatment occurs while the rows of loops are being formed by the bars extending therethrough, the shape of the bar determines the shape of the hook member. For this particular application then an intermediate step just prior to the cutting operation is included which consists of subjecting the loop-shaped elements to a thermic treatment and allowing said elements to cool thereby imparting a rather permanent shape to said loop-shaped elements.

The cutting operation is accomplished by means of a simple and efficient device comprising in one embodiment a stationary support having attached thereto a line of positively drawn rotary cutters. Every loop in each row is progressively subjected to the action of the cutters and rollers in such a manner that each cutter simultaneously mills away a segment of opposed legs of the two loops. The opposite legs of each upstanding loop while being cut are supported by backup means in the form of a roller or backup bar. The rollers or backup bar are disposed alternately between each cutter in a line and located in relation to the loops between adjacent pairs of rows so that the other leg of each loop being milled is in abutting contact with the surface of one of the rollers or backup bar.

Although in the illustrated embodiment the cutters mill away a segment of upstanding loops to form hooks, it will be understood that in certain cases knife edge cutters may be used.

The open hooks of the finished composite produced by the method and apparatus of this invention have a high degree of probability of interengagement with corresponding female loops.

Other advantages and novel features of this invention become apparent in the following detailed description taken in conjunction with the accompanying drawings in which a suitable apparatus for producing the finished composite tape has been shown for purposes of illustration.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of the composite starting tape and cutting apparatus in operative engagement with each other at the beginning of the cutting operation;

FIG. 2 is a cross-sectional view taken along the lines 2–2 of FIG. 1;

FIG. 3 is a cross-sectional view taken along the lines 3–3 of FIG. 1;

FIG. 4 is an isometric view of the finished composite tape showing the arrangement of the open hooks and stubs produced by the method of this invention; and

DESCRIPTION OF THE PREFERRED EMBODIMENT

The first step of the method herein disclosed for producing the hooked member of a separable fastener begins by utilizing a base material 21 having a multiplicity of loop-shaped elements 2 arranged in parallel spaced apart rows. Longitudinal bars 22 are extended through the archways formed by the rows of axially aligned loop-shaped elements. This is accomplished most readily by interweaving the bars 22 with the rows

of loop-shaped elements 2 as the latter are produced by a loom.

The bars in the preferred embodiments are of I-beam configuration and should preferably be made of a relatively flexible noncompressible material so as not to impart too much rigidity to the composite starting tape 1. This I-beam configuration imparts a substantially rectangular cross-sectional shape to the loop-shaped elements 2 defined by vertical upright legs 23 and 24 and horizontal crosspieces 25.

The bars are preferably made of an easily machined ductile material having a melting point sufficiently higher than the heat setting temperature of the loop-shaped elements, which assures that these bars will retain their shape and position for the subsequent cutting operation. The bars may be made of an easily reclaimable material that can rapidly be reprocessed such as antimonial lead. However, other materials are equally well suited such as copper, brass, tin, zinc, aluminum, a suitable cermometal and possibly even a monofilament of another suitable plastic substance.

The composite starting tape 1 is subjected to the cutting action of the apparatus shown in FIG. 3 in such a manner as to result in a finished composite tape illustrated in FIGS. 4, wherein each loop-shaped element 2 of the starting tape 1 is transformed into an open hook 9 and stub 9' in spaced apart relationship and suitable for use as the hooked member of a separable fastener.

The starting tape 1 with projecting upright loop-shaped elements 2 is drawn into contact with the rotary cutters 5 and 5' along the slideway 3. The cutters are pivotally mounted within the frame 6 by shafts 14*a*, 14*b* and are drawn through a gear train comprising drive gear 7*a* connected to motor 11, cutter drive gears 7*b* and 7*d* and idler gear 7*c*. Nondriven backup rollers 8*a*, 8*b* are pivotally mounted to and dependent from frame 6 by shafts 15*a*, 15*b* and backup bars 13*a*, 13*b* are affixed by shaft 15*c* to frame 6. Opposed legs 23 and 24 of the respective loops are simultaneously brought into contact with diametrically opposed portions of one of the rotary cutters 5 or 5', the legs 23 and 24 and the corresponding legs of each adjacent pair of loop-shaped elements being thereby simultaneously subjected to the cutting or milling action of said cutters. At the same moment at which the cutting action commences, the other legs 23' and 24' of each loop being cut will enter into rolling contact with the surface of a roller 8*a* or 8*b* or into sliding contact with a backup bar 13*a* or 13*b*, aligned with said other leg, thereby preventing the lateral displacement of the loop being cut.

Although in the illustrated embodiment, rotary milling cutters have been shown, it will be appreciated that in alternative embodiments, driven or nondriven rotary knife blades or system of straight-edged knives may be used.

As the starting tape progresses, it will be seen that the leg of one of the loops being cut will be subjected to positive cutting action in the direction of tape travel while the leg of the other loop being cut will be subjected to positive cutting action in the opposite direction. As the cutting continues, depending on the width of the cutting surface, a segment of the leg of each loop being milled, equal to said width, is removed to leave a hook 9 and stub 9' in spaced apart relationship. Depending upon the particular shape of the longitudinal bar, it will be recognized that a portion of the bar 22 may also be continuously milled away.

Upon further passage of the starting tape, the next succeeding pair of opposed loops will be brought into operative engagement with the cutters and rollers, the cutting action of each cutter being thereby repeated in the manner described above, and so on over and over for every succeeding pair of opposed loops. It will be appreciated that each adjacent pair of rows of loops will be subjected to similar cutting action by the other cutters and rollers in the line so that virtually all the loop-shaped elements of the tape are transformed into spaced apart hook and stub formations as described above.

The loop-shaped elements are usually made of a synthetic thermoplastic material which is capable of being heat set into a relatively permanent shape at ordinary ambient temperatures. In one particular application these loop-shaped elements are made of strands of monofilament material anchored in any suitable base material in which case it becomes necessary to eat set these elements into a somewhat permanent shape in order to impart sufficient resiliency to the open hooks 9 for efficient use of the male tape. Accordingly, prior to the cutting operation, the starting tape is subjected to heat for a time sufficient to heat set the loop-shaped elements.

The heating can be accomplished by any suitable means such as by passing the starting composite tape through a heating tunnel or oven (not shown) in which the monofilament loop-shaped elements 2 are heat set to a relatively permanent shape conforming to the corresponding sectional shape of the bar 22 supporting each loop-shaped element. In the particular embodiment described herein the hooks will resemble the numeral "seven" after their formation.

In the foregoing description of the apparatus and method of this invention, reference has been made to the fact that the starting tape is pulled through a fixed line of rotary cutters and rollers positioned above the tape. It should be noted, however, that the apparatus of this invention will function equally well by securing the starting tape in a fixed position on a stationary table and moving the line of the rotary cutters and rollers transversely through the pile of upstanding loop-shaped elements. Furthermore, it is possible to invert the starting tape so that the projecting loop-shaped elements extend downwardly with the line of rotary cutters and rollers positioned underneath the tape. Such an arrangement would cause cut pieces of monofilament generated by the cutting operation to drop below the tape.

Thus, in summary, it will be seen that the subject matter of this invention provides an apparatus and method which produces the hooked member of a hook and loop-type fastener by removing opposed segments of upstanding loops. In the embodiment, each cutter simultaneously mills a segment of two loop-shaped elements, by rotating between paired rows of solidly backed-up loops. One loop is milled in the direction of tape travel and the other is milled away from the direction of travel. But in either case, removal of the entire segment is insured because of the solid nature of the enclosed bars and backup rollers. The bars provided on the starting composite tape of this invention serve to shape each loop-shaped element and align it with the appropriate cutter so that 100percent cutting is insured. Finally, the hooked surface produced by the method and apparatus of this invention greatly enhances the utility of the separable fastener in which it is intended to be used by providing a pilelike fabric consisting of a multiplicity of open hook and stub formations, the open hooks greatly increasing the probability of engagement with a mating looped surface, and, greatly increasing the adhesive force of the separable fastener.

While a preferred specific embodiment of the invention has been heretofore described, it is to be clearly understood that various modifications can be made in the details of the invention herein without departing from the spirit of the invention and the scope of the appended claims.

I claim:

1. A method of making the male or hook member of a hook and loop type fastener by utilizing a base material with a multiplicity of projecting loop-shaped elements arranged in parallel spaced apart rows, comprising the steps of supporting each loop-shaped element by a longitudinal bar extending through the archway formed by each row of loop-shaped elements, cutting away a segment of one leg of each loop-shaped element to form each loop-shaped element into a hook-shaped element, providing separate backup means cooperating with said longitudinal bar to prevent the cutting means from laterally displacing the loop being cut, and removing said bars from the formations defined by the hook-shaped elements thereby presenting a composite tape having a multiplicity of hook-shaped elements arranged in parallel spaced apart rows over the surface of said tape.

2. The method according to claim 1 wherein said cutting means removes a segment of one leg of each loop-shaped element to leave a multiplicity of open hook and stub formations arranged in parallel spaced apart rows over the surface of said tape.

3. The method according to claim 1 wherein said loop-shaped elements are woven into the base material by a loom and said bars are interwoven with the rows of loop-shaped elements as the loop-shaped elements are produced by said loom, the interweaving of the bars assuring that the loop-shaped elements are maintained in parallel spaced-apart rows to facilitate uniformly cutting each loop-shaped element by the cutting means.

4. The method according to claim 1 wherein said loop-shaped elements are heat-settable and which include an intermediate step just prior to cutting away a segment of one leg of each loop-shaped element, said step comprising heating said loop-shaped elements and allowing said elements to cool into a relatively permanent shape.

5. The method according to claim 1 wherein said base material is fixed and the cutting means is moved transversely across said base material, the cutting means being adapted to progressively subject every loop-shaped element in each row of elements to the cutting action to form hook-shaped elements.

6. The method according to claim 1 wherein the cutting means is fixed and the base material is continuously moved to cause the cutting means to progressively subject every loop-shaped element in each row of elements to the cutting action to form hook-shaped elements.

7. The method according to claim 1 wherein said base material is inverted so that said loop-shaped elements project downward during cutting thereby permitting chips generated by the cutting operation to drop below said base material under the action of gravity.

8. A method of making flexible strips of material in which are anchored a multiplicity of projecting thin hook-shaped elements by utilizing a base material with a multiplicity of projecting heat settable loop-shaped elements arranged in parallel spaced apart rows, comprising the steps of supporting each loop by a longitudinal bar extending through the archway formed by each row of loop-shaped elements, heating said loop-shaped elements for a time sufficient to heat set said loop-shaped elements into a relatively permanent shape, subjecting each pair of loop-shaped elements to the action of a rigid line of positively driven rotary cutters and backup means thereby cutting away a segment of one leg of each loop-shaped element to leave an open hook and stub in spaced apart relationship, one cutter disposed between each cutter in said line and located in relation to said loops between adjacent pairs of said loops so that the other leg of each loop cut is in supporting contact with the surface of said backup means, and removing said bars from the formations defined by said open hooks and stubs thereby presenting a composite tape having a multiplicity of open hook and stub formations arranged in parallel spaced apart rows over the surface of said tape.

9. A method according to claim 8 in which the loops are permanently formed into the shape of the bar which extends through each row of loop-shaped elements.

10. A method according to claim 9 in which the hooks are formed in a configuration resembling the numeral "seven."

11. An apparatus for producing a flexible strip of material having a pile of upstanding hook-shaped elements from a starting material one surface of which has anchored therein a multiplicity of projecting loop-shaped elements arranged in parallel spaced apart rows, said device comprising a stationary support having attached thereto a series of alternately positioned rotary cutters and backup means, said cutters when in operative engagement with said loop-shaped elements simultaneously and cutting one leg of two loop-shaped elements thereby transforming said elements into hooks, the other leg of each of said loop-shaped elements being at the same time in contact with the surface of said backup means.

12. An apparatus according to claim 11 wherein said cutters simultaneously cut away a segment of one leg of two loop-shaped elements thereby transforming said elements into spaced-apart hooks and stubs.

13. An apparatus according to claim 11 which further includes a bar extending through the arches formed by the loops of each said row, said bar cooperating with said rollers to secure tightly said elements for cutting.

14. An apparatus according to claim 11 wherein said bar is generally of I-beam cross section having horizontally extending upper and lower legs of greater width than the vertical connection therebetween to provide clearance for said cutters.

15. An apparatus according to claim 13 in which said backup means comprises rollers and backup bars.