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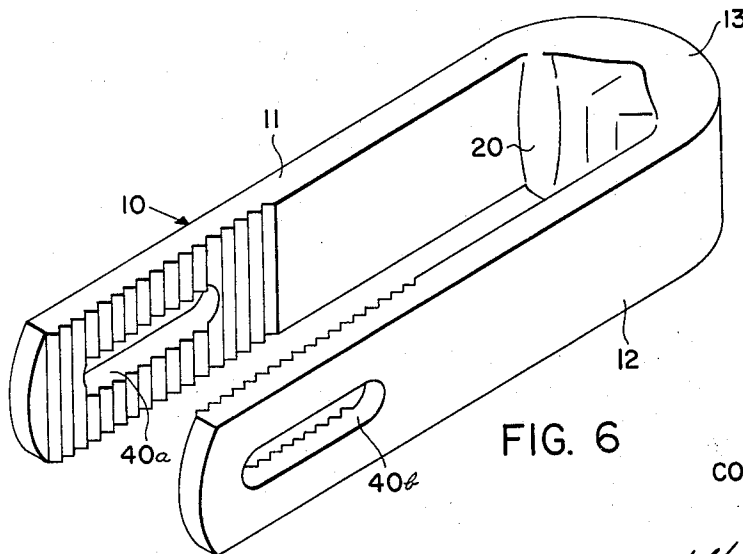
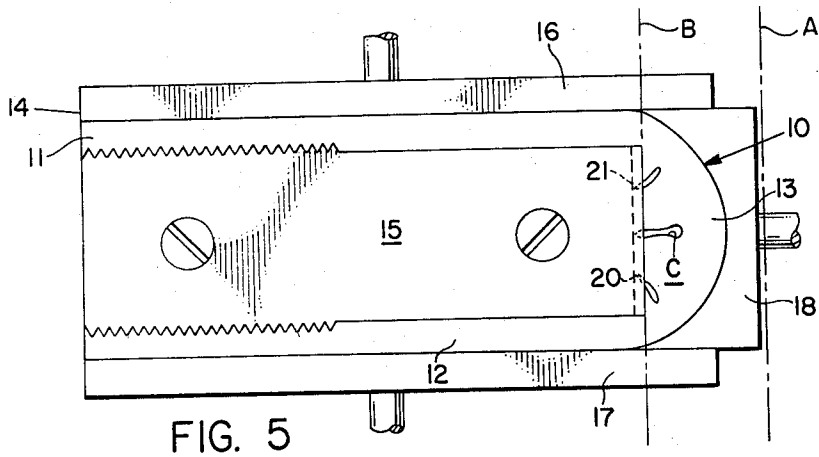
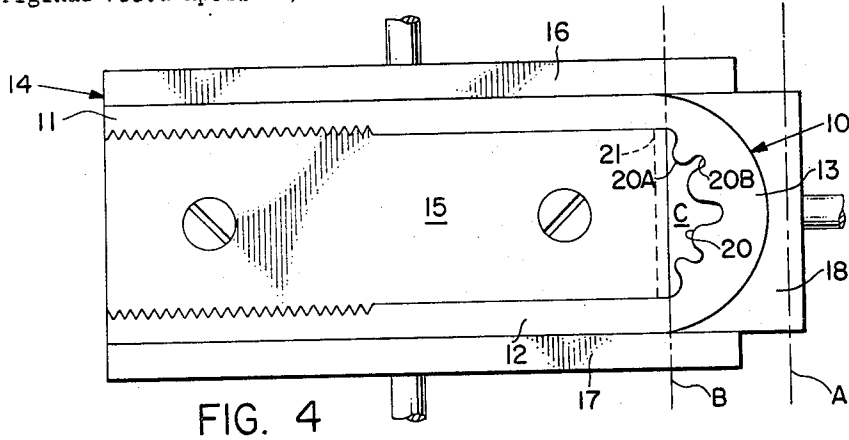
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## METHOD OF MAKING LUG STRAPS

Original Filed April 26, 1965

3 Sheets-Sheet 2



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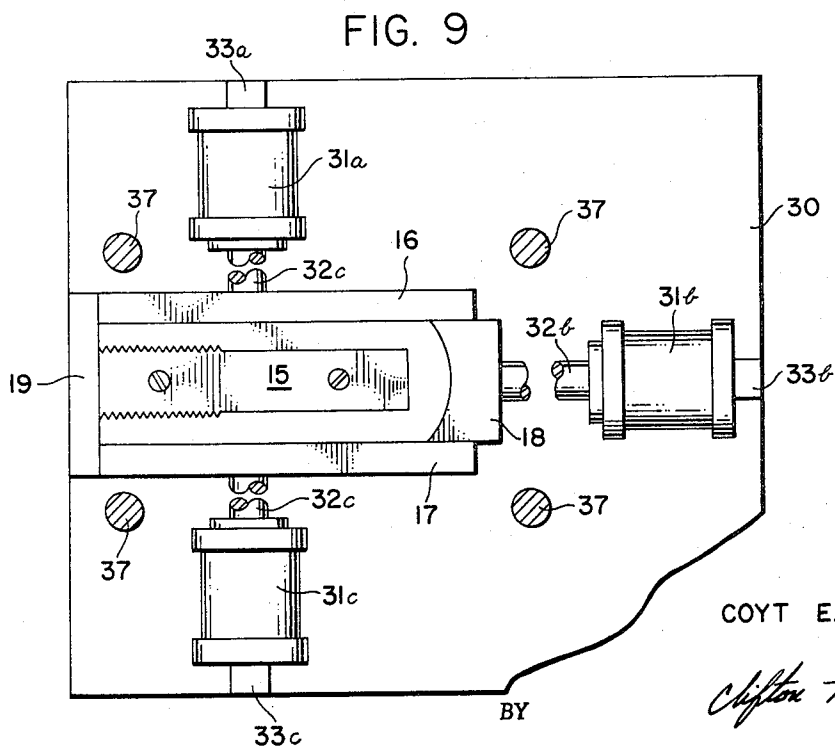
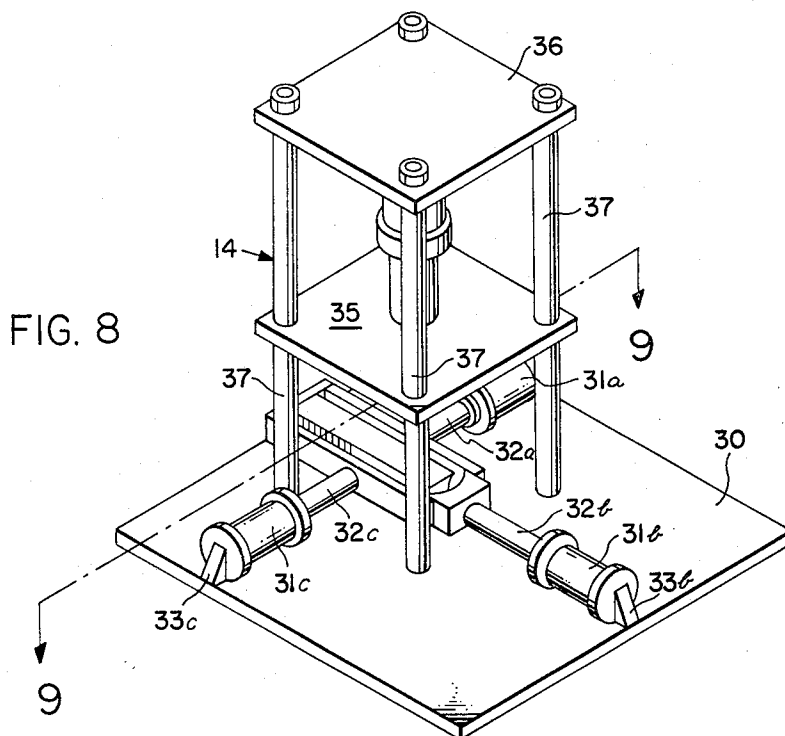
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## METHOD OF MAKING LUG STRAPS

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Original application Apr. 26, 1965, Ser. No. 450,918.

Divided and this application May 12, 1967, Ser.

No. 638,148

8 Claims. (Cl. 264—294)

### ABSTRACT OF THE DISCLOSURE

A method for forming plastic lug straps from high molecular weight polyethylene consisting of bending heated stock to form a U-shaped configuration. Then the stock is compression molded at a pressure of at least 200 p.s.i. for at least one minute to reorient and align the molecular chains in the web.

### CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a division of my copending application Ser. No. 450,918, filed Apr. 26, 1965.

### BACKGROUND OF THE INVENTION

It has long been known in the art of making lug straps that a U-shaped lug strap will wear longer in use on today's high speed looms if the bowed, impact-receiving web portion of the strap is thicker than the sides. Thickening of the web has previously been accomplished by fixing an impact-absorbing plug to the inner surface of the web.

Traditionally, lug straps have been formed from lengths of a suitable material by bending said lengths into U-shapes and treating or mechanically fixing the formed strap so that the said U-shape is retained during use. United States Letters Patent No. 2,216,999 to Bacon discloses a method of making lug straps with a thickened web from a flat, woven webbing impregnated with an excess quantity of rubber or other thermo-setting materials by so molding the impregnated webbing as to force additional impregnant from the side portions of the lug strap into the web and to shape the excess impregnant in the web of the strap to provide the desired thickened area or cushion.

The known methods of manufacturing lug straps from polyethylene of a high molecular weight or from other suitable plastic materials either have involved the provision of a separate plug and the subsequent affixing of the plug to the inner surface of the web by suitable means, or have involved the formation of the lug strap from a blank stock having a medial portion which is thicker than the end portions which are to become the sides of the formed strap.

The use of separate plugs necessitates the extra manufacturing step of mechanically affixing the plug to the formed lug strap blank or of forming the strap about the plug under pressure and temperature conditions conducive to some polymerization between the molecules of the plug and the molecules of the blank. Unless there has been sufficient polymerization between the molecules of the plug and of the blank, the lug straps so formed are subject to failure by reason of plug pulverization under impact, by reason of separation of the plug from the lug strap, or by reason of fracture of the side portions at their junction with the web.

The use of non-uniformly thick lengths of plastic has been unsatisfactory in that complicated and costly machinery for forming same may be required or else expensive and time consuming machining of uniformly thick pieces into desired shapes is necessary. In either event there is a consequential waste of material.

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Unsuccessful attempts have been made to manufacture lug straps with an integral plug by injection molding of high molecular weight polyethylene. The resultant product has proven unsatisfactory in use because of a high incidence of faults and defects which undesirably weaken the strap.

### SUMMARY

It is, therefore, an object of this invention to provide a method of forming an improved plastic lug strap having an integral thickened web from a length of high molecular weight polyethylene stock of substantially uniform thickness throughout its length, which method has the attendant advantages of avoiding the use of separately formed plugs or cushions; and of avoiding the necessity of providing lengths of stock having portions of varying thicknesses with a consequent waste of material.

It is a still further object of this invention to provide a method of manufacturing plastic lug straps wherein substantial economies in machinery, labor, and materials can be effected.

It is another object of this invention to provide an improved lug strap which includes an integral plug and wherein the entire lug strap and plug are formed from a length of high molecular weight polyethylene which is of substantially the same uniform width and thickness throughout its length as the legs of the finished lug strap.

It is a more specific object of the invention to provide an improved method of making an improved lug strap with an integral plug from high molecular weight polyethylene of the type described wherein the improved method of defining the integral plug results in a substantial increase in tensile strength of the plug due to the orientation of the molecular chain in the direction of the impact to which the plug is subjected in use. The increased tensile strength of the plug greatly improves the wear and abrasion properties of the lug strap and significantly increases the useful life of the strap.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view of a length of plastic stock of substantially uniform width and thickness throughout its length from which the improved lug strap is formed;

FIGURE 2 is a perspective view illustrating the initial step of bending the stock into a U-shaped configuration;

FIGURE 3 is a plan view of the U-shaped strap loosely positioned within a schematically illustrated mold;

FIGURES 4 and 5 are plan views of the strap within the schematically illustrated mold at sequential stages during the molding operation;

FIGURE 6 is a perspective view of the completed lug strap removed from the mold;

FIGURE 7 is a sectional view with parts broken away taken substantially along the line 7—7 in FIGURE 3 and omitting the lug strap blank;

FIGURE 8 is a somewhat schematic perspective view of a mold used in practicing the invention; and

FIGURE 9 is a sectional plan view taken substantially along the line 9—9 in FIGURE 8.

According to the preferred form of the present invention a charge of powdered high molecular weight polyethylene having a molecular weight in excess of one million is placed in an extruder and heated above the fusion point. Bar stock is extruded under a sufficiently high temperature to polymerize the polyethylene. While the bar stock is at a temperature within its fusion range of 200°–500° F., wherein the plastic stock is sufficiently softened to be bonded or welded, it is cut into desired lengths to define blanks 10, each blank being of substantially uni-

form width and thickness throughout its length, and from which the lug straps are to be formed according to the invention. While it is preferred, in an integrated operation, to shape and define the lug straps from bar stock which still retains the heat from the extruder, it is to be understood that it is within the spirit of the invention to form the lug straps from inventories of extruded bar stock which has been allowed to cool and reheated subsequent to its extrusion, or to cut stock of the desired dimensions from slab material to define a blank 10 and reheat it. In any event, the method and product of the invention are obtained while the blank 10 is at a temperature within the said fusion range of the high molecular weight polyethylene, preferably at a temperature between 289° to 350° F.

While the blank 10 is still within the said fusion range, it is manually bent into generally U-shaped configuration as shown in FIGURE 2. Upon being bent into U-shaped configuration, the blank 10 comprises legs or sides 11 and 12 interconnected by a web 13. The blank 10, while still at a temperature above its fusion point is loosely placed in an open mold 14 comprising a fixed core 15, a pair of movable side plates 16 and 17 and a movable end plate 18.

The other end of the mold is closed by a fixed end plate 19 which abuts the corresponding end of the core 15. The mold 14 additionally includes a base 30 to which the core 15 and fixed end plate 19 are fixed. The movable side plates 16 and 17 and the movable end plate 18 may be reciprocated by respective hydraulic cylinders 31a, 31b, and 31c and hydraulic pistons 32a, 32b, and 32c. The cylinders 31a, 31b, and 31c are fixed against movement relative to the base 30 as by stops or abutments 33a, 33b, and 33c.

The mold also includes a top plate 35 fixed to the lower end of a ram or piston 32d (FIGURE 8). The piston 32d is reciprocable within a hydraulic cylinder 31d, the upper end of which depends from a stationary supporting plate 36. The support plate 36 is held in fixed spaced relation to the base 30 by a plurality of tubular legs 37 (FIGURE 8), each of which loosely penetrate the movable top plate 35 of the mold 14, and are fixed at their respective ends to the base 30 and the support plate 36.

After the U-shaped blank 10 is loosely placed in the open mold 14, the top plate 35 is moved downwardly under hydraulic pressure to close the top of the mold. The hydraulic rams 32a and 32c are then actuated to move their respective side plates 16 and 17 inwardly to clamp the legs of the U-shaped blank 10 against the core 15. Next, the end plate 18 is moved inwardly under hydraulic pressure imparted to the ram 32b to shape the web of the lug strap.

The inner limit of the inward movement of the side plates 16 and 17 and the movable end plate 18 is predetermined to coincide with the desired thickness of the legs and web of the finished lug strap. In general, the thickness of the legs of the finished lug strap corresponds to the thickness of the initial bar stock and the thickness of the web in the finished lug strap is in the order of one and one-half to two and a half times the thickness of the legs.

As most clearly seen in FIGURE 3, the inner surface 20 of the web 13 is deformed into alternate transverse projections and depressions 20A and 20B as a result of the compression to which the surface 20 is subjected during bending of the blank into U-shaped configuration. The end of the core 15 adjacent the end plate 18 has a concave surface 20 (FIGURE 7) with which the inner surface 20 of the web 13 is adapted to engage under inward pressure of the mold end plate 18.

When loosely placed in the mold, the outer surface of the web 13 is located at a point spaced beyond the concave surface 20 on the core, the location of the outer surface of the web being designated by the line A in FIGURE 3. Arranged in this manner, the inner surface

20 of the web 13 is likewise spaced from the end 21 of the core 15 to define a cavity C between the core and the inner surface 20 when the blank 10 is initially positioned in the mold as shown in FIGURE 3.

Continued inward pressure of the end plate 18 moves the outer surface of the web 13 away from the line A and toward the end surface 21 of the core 15 (FIGURES 4 and 5). It is apparent from the sequential steps illustrated in FIGURES 3, 4 and 5 that the continued inward movement of the end plate 18 collapses and reorients the web causing it to move into the cavity C until the projections 20A on the inner surface of the web enlarge under inward movement of the end plate 18 and engage the concave surface 21 of the core 15 (FIGURE 5). The cavity C is gradually filled in and closed by the thickening web as the molecular structure of the plastic is reoriented in the mold. Meanwhile, the sides or legs 11 and 12 have been subjected to pressure sufficient to serrate the inner end surfaces of the legs 11 and 12, but the pressure is not sufficient to significantly change the dimensions of the legs as in flow molding. Thus, when removed from the mold the lug strap as shown in FIGURE 6 has legs of substantially the same dimensions as the thickness and width of the bar stock from which the blank 10 was formed, while the web 13 with its integral plug is much thicker.

In order to help in maintaining the plastic at a temperature which will permit reorientation of the web under pressure of the mold, and to improve the surface appearance of the strap, the mold is desirably heated to a temperature within the range of 130° to 230° F., preferably at about 180° F., for controlled cooling of the blank while in the mold. The mold can be used at room temperature, if desired, but experience has shown that the surface appearance of the lug strap is improved by heating the mold as indicated.

In practice, the blank is molded under a molding pressure of from about 200 to 300 p.s.i. for one to four minutes. If desired, the molding pressure can be increased as high as practical, such as 5000 p.s.i., and the molding time can be lengthened indefinitely; but an increase in pressure and time does not improve the product and the invention is not limited to a top range of molding pressure and time.

The slots 40a and 40b in the serrated end portions of the legs 11 and 12 (FIGURE 6) may be cut after the lug strap is removed from the mold. Alternatively, if desired, the mold may be equipped with suitable punches or dies to form the slots 40a and 40b during the post-forming molding operation.

The completed lug strap has exhibited unusual wear-resistant properties in use and these properties are attributed in part to the reorientation of the molecular structure during the post-forming molding operation at which time the web is reoriented and thickened in the manner described and illustrated.

The term "plastic" as used throughout the specification and claims refers to high molecular weight polyethylene and/or to any material which is its equivalent, and the invention is not limited specifically to the use of high molecular weight polyethylene.

In the drawings and specification there have been set forth preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. A method of forming a lug strap having a thickened web from bar stock of a thickness less than that of the web in the finished strap, said method including the steps of:

(a) causing the bar stock to be heated to a temperature within its fusion range;

- (b) bending the said heated bar stock into a U-shaped configuration to define a blank including a web having an inner surface;
  - (c) providing a mold having a centrally located core spaced between inwardly movable side plates of the mold and spaced from an inwardly movable end plate of the mold;
  - (d) loosely positioning the said heated blank in the mold with the inner surface of the web spaced from the core to define a cavity between the web and the core;
  - (e) closing the mold; and
  - (f) reorienting the molecular chains in the web to align them with the legs of said U-shaped blank by moving the end plate inwardly toward the core and exerting a molding pressure of at least 200 p.s.i. on said web for at least one minute to fill the cavity while molding the inner surface of the web against the core.
2. A method of forming a plastic lug strap having a pair of spaced-apart legs interconnected at corresponding ends by a web of increased thickness including the steps of:
- (a) providing high molecular weight polyethylene in powdered form;
  - (b) shaping from said powder, bar stock of uniform thickness wherein the said polyethylene is polymerized;
  - (c) causing said bar stock to have temperatures within the fusion range of said polyethylene during the forming operation;
  - (d) bending the said bar stock into a blank of U-shaped configuration to define:
    - (i) spaced-apart legs, and
    - (ii) a web interconnecting corresponding ends of said legs, said web having an inner surface;
  - (e) providing a mold having a centrally located core spaced between inwardly movable side plates of the mold and spaced from an inwardly movable end plate of the mold;
  - (f) loosely positioning the said blank in the mold so that:
    - (i) the respective legs of said blank are positioned between respective side plates and the core;
    - (ii) the said web is positioned between said core and said inwardly movable end plate, and
    - (iii) the said inner surface of said web of said blank is spaced from the core to define a cavity between the said web and the said core;
  - (g) closing the mold; and
  - (h) reorienting the molecular chains in the web to align them with the legs of said U-shaped blank by moving the said end plate of said mold inwardly toward said core and exerting a molding pressure of at least 200 p.s.i. on said web for at least one minute to fill said cavity while molding the inner surface of said web against the core.
3. A method of forming a high molecular weight polyethylene lug strap having improved surface characteristics and having a thickened web from bar stock of a substantially less thickness than that of the web in the finished strap, said method comprising the steps of:
- (a) causing the bar stock to have progressively cooler temperatures within the range of 250° F. to 350° F. during the forming operation;
  - (b) bending the said bar stock into a blank of U-shaped configuration to define a web having an inner surface;
  - (c) providing a mold having a centrally located core spaced between inwardly movable side plates of the mold and spaced from an inwardly movable end plate of the mold;
  - (d) loosely positioning the blank of U-shaped configuration in the mold with the inner surface of the web spaced from the core to define a cavity between the web and the core;

- (e) closing the mold;
  - (f) reorienting the molecular chains in the web to align them with the legs of said U-shaped blank by moving the end plate inwardly toward the core and exerting a molding pressure of at least 200 p.s.i. on said web for at least one minute to fill the cavity while molding the inner surface of the web against the core; and
  - (g) maintaining said core, side plates and end plate within the temperature range of 130° F. to 230° F. during the reorientation operation.
4. A method of forming a plastic lug strap having a thickened web from a U-shaped blank of plastic, the said blank having legs and a web of substantially equal thicknesses, the said method including the steps of:
- (a) causing the web of said U-shaped blank to have temperatures within the fusion range of the said plastic during the forming operation;
  - (b) providing a mold having a centrally located core spaced between inwardly movable side plates of the mold and spaced from an inwardly movable end plate of the mold;
  - (c) loosely positioning the said blank in the mold so that:
    - (i) the respective legs of said blank are positioned between said core and a respective side plate, and
    - (ii) the web of said blank is positioned between said core and said inwardly movable end plate and spaced from said core to define a cavity between the web and the core;
  - (d) moving the said side plates inwardly to clamp the said legs of said blank to the said core; and
  - (e) reorienting the molecular chains in the web to align them with the legs of said U-shaped blank by moving the end plate inwardly to fill said cavity and abut said core while exerting a molding pressure of at least 200 p.s.i. on said web for at least one minute.
5. A method of forming a plastic lug strap having a thickened web from bar stock of a high molecular weight polyethylene, said bar stock having a uniform thickness less than that of the web in the finished strap, said method including the steps of:
- (a) causing the bar stock to have temperatures within the fusion range of the said high molecular weight polyethylene during the forming operation;
  - (b) bending said bar stock into a blank of U-shaped configuration to define:
    - (i) spaced-apart legs, and
    - (ii) a web interconnecting corresponding ends of said legs, said web having an inner surface;
  - (c) providing a mold having a centrally located core spaced between inwardly movable side plates of the mold and spaced from an inwardly movable end plate of the mold;
  - (d) loosely positioning the said U-shaped blank in the mold:
    - (i) the web being positioned between said end plate and said core to define a cavity between the inner surface of said web and the core, and
    - (ii) the legs of said U-shaped blank being positioned between respective side plates and said core;
  - (e) moving the said side plates inwardly to clamp the said legs of said blank to said core;
  - (f) moving the said end plate inwardly toward said core to engage the said web of said blank and to exert thereon a compressive pressure having an intensity in the range of two-hundred to three-hundred pounds per square inch so as to reorient the molecular chains in said web to fill said cavity and cause the inner surface of the web to conform to the abutting surface of the core; and
  - (g) maintaining said pressure on said web for from one to four minutes.

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6. A method of forming a plastic lug strap from bar stock of a given thickness including the steps of:

- (a) causing said bar stock to have temperatures within the fusion range of said plastic during the forming operation;
- (b) bending said bar stock into a U-shaped blank to define:
  - (i) spaced-apart legs of said thickness, each leg having a corresponding free end, and
  - (ii) a web interconnecting said legs at corresponding ends opposite said free ends;
- (c) physically moving the web a predetermined distance relative to a reference line and toward said free ends of said legs while maintaining said legs in fixed relation to said reference line to collapse the web upon itself and increase the thickness of the web; and
- (d) reorienting the molecular chains in said web to align them with the legs of said blank by maintaining a molding pressure of at least 200 p.s.i. for at least one minute.

7. A method according to claim 6 which method includes the step of shaping the web to a desired configuration while forming the lug strap.

8. A method of forming a lug strap from plastic bar stock of a given thickness, said method including the steps of:

- (a) causing said bar stock to have temperatures within the fusion range of said plastic during the forming operation;
- (b) bending said bar stock into a U-shaped blank to define:

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- (i) a pair of spaced-apart legs of said given thickness,
- (ii) a web interconnecting corresponding ends of said legs,
- (iii) said legs each being of a predetermined length and extending from their respective junctures with the web,
- (iv) said web including an inner perimeter and outer perimeter extending between the junctures of the web with the legs;
- (c) decreasing the length of said outer perimeter of said web of said blank while maintaining the respective lengths of said legs to form a new web of increased thickness; and
- (d) reorienting the molecular chains in said web to align them with the legs of said blank by maintaining a molding pressure of at least 200 p.s.i. for at least one minute.

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