PACKAGE BINDING DEVICE AND METHOD AND APPARATUS FOR FORMING SAME

Filed March 19, 1963

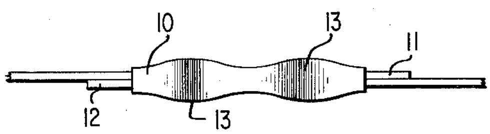


FIG. 1
(PRIOR ART)

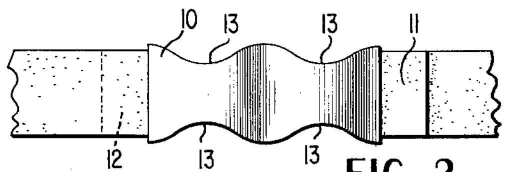


FIG. 2
(PRIOR ART)

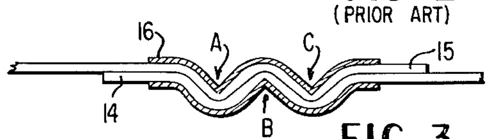


FIG. 3
(PRIOR ART)

FIG. 4

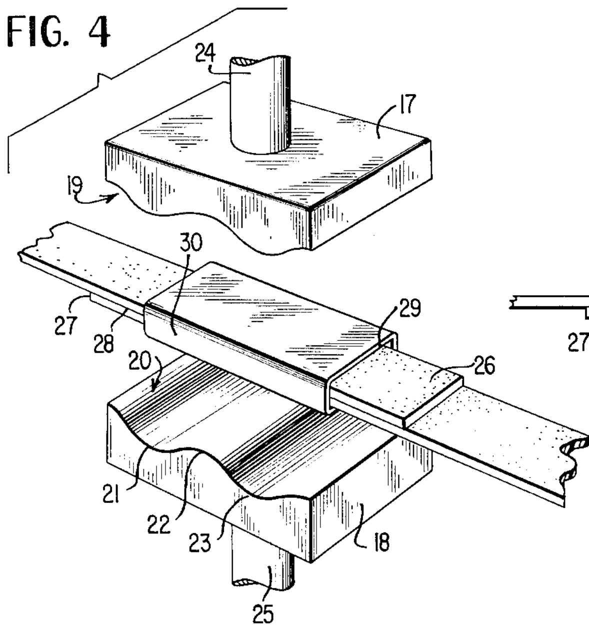


FIG. 5

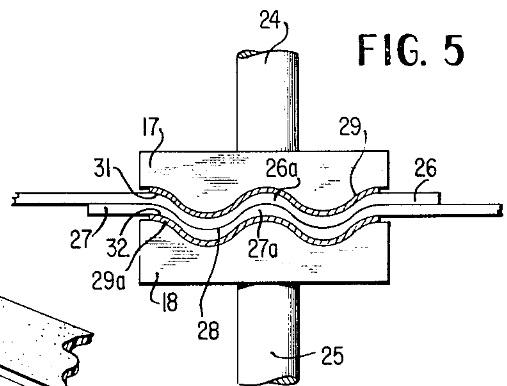


FIG. 6

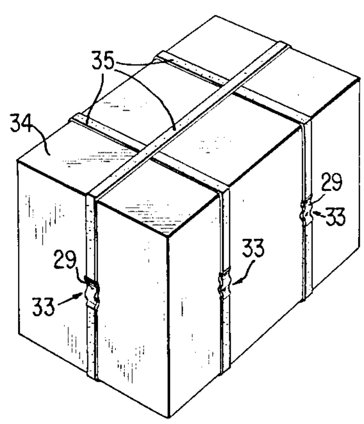


FIG. 7

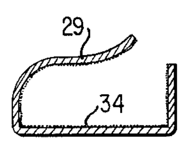


FIG. 8

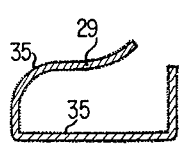
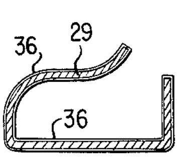


FIG. 9



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PACKAGE BINDING DEVICE AND METHOD AND APPARATUS FOR FORMING SAME

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5 Claims. (Cl. 24—16)

This invention relates to a package binding device and to a method of joining the end portions of plastic straps. It has a particular application to a binding device in which the strapping material is a plastic tape in a highly oriented condition.

Bales, packages and the like are commonly bound together by encircling them with one or more tensioned bands, the ends of which are locked together within an outer joining sleeve by deformably crimping the sleeve and enclosed straps into a lightly locking mechanical joint. Steel bands are widely used in such package binding devices, although fibrous material and other material which can be compressed and deformed without serious loss of strength are also utilized.

The material for the joining sleeve, which locks the bands together, is a malleable material, such as a steel. In forming the joint which holds the ends of the straps from slipping, the sleeve and enclosed strap ends are crimped in a manner which deforms both the sleeve and the enclosed straps into a complex shape and forms a mechanical interlock to prevent the ends of the tensioned strap from separating. U.S. Patent Nos. 1,232,674 and 2,356,059 and the illustrations shown hereafter in FIGS. 1–3 are typical of the manner in which the joining sleeve and overlapping superimposed straps within the sleeve are deformed to form a strong mechanical interlock and hold the straps in the packaging device under tension. Since the material of the baling straps is malleable and compressible, they deform when crimped within the sleeve to form a strong mechanical interlock which approaches the strength of the strap.

FIGS. 1 and 2 demonstrate a typical means heretofore used to join the end portions **11** and **12** of a metal strap utilized in a package binding device. The strap ends are enclosed within a metal sleeve **10** and the assembly is squeezed together laterally at several locations spaced longitudinally along the sleeve by applying inwardly directed pressure on opposite edges of the sleeve at these locations, thereby laterally deforming the sleeve assembly to form a number of localized indentations **13** spaced along its length. The material of the sleeve and the straps permanently deforms under pressure (a cold flow) into a complex shape as will mechanically interlock the deformed straps and sleeve and prevent them from separating. Other types of interlocking joints in package binding devices are illustrated in the referenced patents. However, in all cases the enclosed straps and joining sleeve are permanently deformed into a complex shape which locks them together and prevents the ends of the strap, which is tensioned around the package, from separating.

FIG. 3 demonstrates a typical manner in which fibrous straps may be joined which is somewhat different from that used for steel straps. This variation is necessary since the fibrous material cannot be extensively deformed by a cold forging action. The strap ends **14** and **15** are overlapped, inserted within a sleeve **16** and then the two opposing flat faces of the enclosing sleeve **16**, are crimped in ridges running transversely across the flat surfaces of the sleeve, the ridges being formed alternately on opposite sides along the length of the sleeve in the manner illustrated in FIG. 3. The anvil or crimping tool used in

this type of crimping operation has sharp wedges on opposite sides spaced alternately along its length with the sharp edge of each wedge extending laterally across the width of the sleeve. When the serrated wedges are pressed together on opposite sides of the sleeve, the sharp wedge edges indent the sleeve and enclosed straps across their width in sharply indented troughs spaced along the sleeve alternately on opposite sides, as at locations A, B and C of FIG. 3. The sharp wedges pinch the straps and reduce their thickness at points A, B and C. Since the fibrous tape and metal sleeve of a material are compressible and resilient, a strong mechanical interlocking joint is formed at this sharply crimped section.

In copending patent application Serial No. 207,718—Thin Oriented Plastic Strips and Tape—Keith L. Orser, which is assigned to the same assignee as this application, a flat plastic tape of oriented material having a high tensile strength in its longitudinal direction is disclosed. This particular tape, as well as the other types of highly oriented plastic tapes, would be most useful for straps in package binding devices if the ends of the highly oriented tape could be joined or locked together in a manner which would not damage the tape and reduce its strength. Damage normally sustained by the tape when localized pressure is applied has not made it possible to join satisfactorily plastic tapes of material in a highly oriented condition by the usual crimping operations discussed above.

Plastic material in a highly oriented condition is only slightly compressible and malleable when subjected to localized pressure. Hence, if the type of crimping action which is illustrated in FIGS. 1–2 for steel straps were attempted with oriented plastic tape, the tape would not be compressed and plastically deform to form a strong interlocked structure as do the steel straps, instead it would be split or cut and suffer a serious loss in strength. Likewise, the transverse crimping action, as practiced with fibrous straps as illustrated in FIG. 3, is also not suitable since the pointed, serrated crimping anvil tends to pinch and damage reduce the cross section of the straps at the point of crimping. The oriented tape is insufficiently compressible or malleable to be deformed without damage by the localized compressive forces of the crimping action and the strength of the oriented plastic straps at the point of crimping will be severely lowered. Thus, the prior methods of joining the ends of baling straps, which depend upon locally deforming the material within the joint and establishing localized areas of high stress concentrations, must be avoided.

Accordingly, an object of this invention is to provide a package binding device utilizing lengths of plastic tape in a highly oriented condition.

Another object is to provide a packaging device having straps of thin, flat, highly oriented polymeric material.

Yet another object is to provide a satisfactory method of strapping a package by wrapping the package with highly oriented plastic straps and joining the opposite ends of the straps so as to avoid damaging the straps.

A further object is to provide a satisfactory method of mechanically joining together the end portions of straps of highly oriented plastic material to avoid localized pressure areas.

Yet a further object is to provide a method of joining the end portions of highly oriented plastic tapes by means of pressure exerted by an enclosing joining sleeve of malleable material.

The applicants have discovered that a high strength package binding device can be formed by utilizing straps which are highly oriented plastic tapes if the overlapping ends of the tapes are joined by pressing together the end portions of each plastic tape within a malleable sleeve which is tightly compressed against the opposing flat sides, or faces of the tapes, so as to apply pressure which is evenly distributed over the surfaces contacted and so no localized points of pressure are produced. The superposed and overlapping ends of the straps made from oriented plastic material in tape form are enclosed within a deformable metal sleeve of the type generally similar in shape to that used for steel or fibrous straps. The sleeve is compressed around the strap in a manner to apply pressure normal to the faces of the enclosed strap end portions such that the pressure is evenly distributed over these faces, thereby eliminating any localized stresses on the strap faces or lateral pressure against the strap edges. The compressed sleeve and the enclosed straps, which are held in tight, even contact with the enveloping sleeve, form a lamination which has an evenly curved shape such that the top and bottom surfaces and all intermediate layers are formed to a surface of single curvature. In other words, shapes of complex form having surfaces of double curvature or more complex shapes are avoided. A surface of single curvature is considered to be an evenly curved surface which can be formed by bending a flat sheet, e.g., any evenly curved shape which can be formed with a flat sheet of paper without tearing or wrinkling the paper.

The method which has been discovered to be effective in joining highly oriented tapes within a sleeve, is that of applying a high, evenly distributed pressure against the flat surfaces of the superposed end portions of the tape. This evenly distributed pressure increases the total friction between the contacting surfaces of the superposed tapes and enclosing sleeve, as distinguished from the previous practice of pinching together the sleeve and strap (tape) at localized areas of high stress or of distorting the sleeve and strap (tape) into complex or discontinuous shapes which form an interlocking mechanical structure. Any pressure laterally applied against the edges of the tape is to be avoided. The crimping tool used for joining oriented plastic straps must avoid sharp wedge-like edges and the pressing surfaces of the crimping anvil should have an evenly curved surface of single curvature.

Additional techniques which will improve the effectiveness of this particular type of joint for joining a plastic tape of highly oriented material involve increasing the coefficient of friction on the inside surfaces of the joining sleeve, and also that of the faces of the plastic tape.

In the drawings:

FIG. 1 is a side elevation of a crimped joint according to the prior art for joining the ends of steel straps;

FIG. 2 is a plan view of the joint of FIG. 1 as viewed from the top or bottom;

FIG. 3 is a side elevation in section of a typical crimped joint according to the prior art for joining the ends of fiber straps;

FIG. 4 is a schematic, perspective view of apparatus performing an initial step according to the applicant's invention of joining plastic straps;

FIG. 5 is a sectional side elevation of the apparatus of FIG. 4 illustrating a subsequent step in the process of the invention;

FIG. 6 is a perspective view of the package binding device of this invention; and

FIGS. 7, 8 and 9 are views of various embodiments of a joining sleeve forming one element of the package binding device.

As noted above, the object in joining the ends of oriented plastic tape is to press them together inside an encompassing sleeve so that the facing surfaces between the superposed tapes and the adjacent surfaces of the tapes and sleeve are tightly pressed together into uniform and intimate contact over their entire contacting surfaces to avoid any localized pressure areas. Referring to FIG. 4, the joining sleeve or clip **29** is of a malleable

material which will be deformed and take a permanent set under tension to establish a uniform pressure against the material within the sleeve. The forming tool, by which the sleeve **29** is compressed into a tensioned band around the enclosed strap ends, comprises opposing anvils **17** and **18** having forming surfaces **19** and **20** which are complementary in shape to nest one within the other. One effective shape for a forming surface comprises uniformly curved undulations **21, 22** and **23** extending lengthwise of the forming surface such that depressions **21** and **23** alternate with the elevation **22** along the length of the anvil with the troughs and crests lying transversely across the forming surface **20**, as shown in the lower anvil **18** of FIG. 4. The upper anvil **17** has a forming surface **19** of the same undulating shape as the forming surface **20** in the lower anvil but is complementary to that of the lower anvil **18**. The evenly undulating forming surfaces of the anvils, illustrated in FIG. 4, are not the only shapes which would be satisfactory, the basic criterion being that the forming surfaces must be evenly curved and have a surface of single curvature so that the overlapping strap ends and the enclosing sleeve are pressed together to form a laminated structure which has a single curvature shape. Since a curved shape having a surface of single curvature may be formed from a flat sheet without stretching or forging any areas, forming (crimping) the sleeve to this shape will avoid any localized areas of stress in the lamination compressing the joint.

FIG. 4 is a schematic illustration of a pressing or crimping tool which is suitable to this invention. A source of pressure (not illustrated) forces the opposing anvils together by applying oppositely directed forces inwardly on each of the rods **24** and **25** which protrude from the top and bottom of the anvils **17** and **18**, respectively. The important feature of this invention pertains to the shape of the pressing surfaces of the crimping tool and not the remaining details of the tool itself. Therefore, no attempt is made to illustrate and describe in detail the full structure of the actual tool. Such tools are common in the art and often incorporate provisions for tensioning the straps prior to crimping the sleeve. Standard crimping tools can be used if the pressing surfaces are modified in accordance with this invention, a Texstrap crimp tool having been modified and used successfully to form the joints of highly oriented linear polyethylene tape tabulated below.

In forming a joint, the opposite ends of the plastic strap are overlapped so that the end portions **26** and **27** of the strap are superposed to overlie one another at their mutually contacting surface **28**. The joining sleeve **29** made from some malleable material, such as steel or other metal, is placed around a portion of the superposed end portions **26** and **27** to substantially enclose them. The joining sleeve or clip **29** illustrated in FIG. 4 is a continuous band. In actual practice an open type of clip, as illustrated in FIGS. 7–9, would be preferable as it is not always convenient and practical to slide a closed sleeve over both ends of the strap.

Closing pressure is applied to the opposing anvils **17** and **18** of the crimping tool to compress the malleable joining sleeve **29** and forcing it into evenly applied, tight engagement with the underlying top and bottom surfaces of the superposed strap ends. This compresses the sleeve and strap ends into a laminated structure having the evenly curved shape of the mandrel forming surfaces **19** and **20** in a manner indicated in FIG. 5. After opening the crimping tool to retract the anvils **17** and **18**, due to the malleable nature of the sleeve material, the sleeve **29** takes a permanent set conforming to the evenly curved shape of the forming anvils and remains compressed in tight engagement with the flat outer forces of the enclosed strap to form the joint **33** (FIG. 6). In the joint **33**, the strap ends **26** and **27** are tightly pressed together by the evenly applied pressure against the outwardly facing strap surfaces by the pressure from the compressed joining sleeve **29**. As illustrated in FIG. 5, the joint **33** comprises a lamination in which the respective layers of outer sleeve segments and overlapping stop ends **29**, **26a**, **27a** and **29a** are tightly pressed together. The compression of the deformed sleeve produces an inwardly directed pressure which is evenly applied normal to the common contacting surface **28** between the overlapping strap ends **26** and **27** to the common contacting surfaces **31** and **32** between the inner surface of the sleeve **29** and the outer flat surfaces of the strap ends **26** and **27**.

The physical characteristics of the material chosen for the joining sleeve are quite important. The material must not only be sufficiently malleable to conform readily to the shape of the pressing tool dies and apply to the enclosed tape the even pressure exerted by the pressing tool, but the sleeve must retain its shape and hold the pressure uniformly after the pressing tool is removed. After considerable experimentation it was found that a steel clip with the characteristics and dimensions specified in connection with Table I (2¼" long clip of .08 carbon steel of B66 hardness and .025 thick) provides a very satisfactory joining clip for joining oriented plastic tape approximately ½' wide and .02" thick without using excessively thick metal. As discussed in more detail below, the strength of the joint can be increased by treating the inner surface of the clip. The configuration of the clip which was evolved from the experiments is simple, being one which can be utilized in an adaptation of a standard pressing tool, is comparable in size to the clips in use on steel or fibrous tapes and when utilized as described will produce a joint having a high percentage of the strength of the tape. For example, the 2¼" clip noted above will produce a joint having 70% of the breaking strength of ½" oriented, polyethylene tape (575 lb.). A joint with a 1¾" long clip develops 60% of the strength of the tape and one with a 1¼" clip develops 55% of the tape strength. The .025 gauge clip was utilized as this was as thick as the modified Texstrap tool would handle. A somewhat heavier gauge clip would produce a stronger joint.

FIG. 6 illustrates the package binding device of this invention. The package **34** is encircled with a suitable number of straps **35** or orientable plastic material which have been fully stretched longitudinally to produce a strap of highly oriented material. The straps **35** are tensioned around the package **35** in the usual manner and the end portions are superposed to oppositely overlap one another within a joining sleeve **29**. The overlapping strap ends of each tensioned strap **35** and encompassing joining sleeve **29** are pressed into an evenly curved, compressed lamination with pressure evenly applied over the area of each layer, as described above, to form the joint **33**. The strength of the joint is not produced by a mechanical interlock developed by deforming the strap ends and joining sleeve into a complex shape, but by the high frictional forces developed between the adjacent layers forming the joint **33** due to the evenly applied pressure of the undulating, compressed sleeve.

It has also been discovered that the strength of the joint **33** can be further improved by roughening the inside surface of the joining sleeve (or clip) **29** or applying a thin coating which will increase the coefficient of friction of these surfaces. FIG. 7 illustrates one embodiment in which the interior surface of a steel clip **29** is sand blasted with a fine grit to produce the roughened interior surface **34**.

FIG. 8 illustrates another embodiment in which the steel clip **29** is etched for approximately ten minutes at room temperature in a solution of one percent picric acid and four percent hydrochloric acid in ethyl alcohol. After etching, the clip is rinsed and dried. The etching action of the acid solution produces a roughened coating **35** on the exterior and interior surfaces of the clip which increases the coefficient of friction.

Another embodiment of the joining clip is shown in FIG. 9 in which the coating is applied to the clip by dipping it in a slightly acid solution of copper sulphate for approximately ten minutes, after which the clip is washed and dried by heating. This operation produces a copper oxide coating **36** on the interior and exterior surfaces of the clip **29**. The coating **36** of copper oxide on the surfaces of the clip is believed to promote a direct adhesion between the plastic tape and the metal of the clip when they are pressed together but, whether due to this or a roughening of the surface, the effective strength of the joint is increased. In all of these embodiments the object is to increase the coefficient of friction of the interior surfaces of the joining sleeve but the surface must not be roughned to the degree that this will cause localized stresses in the oriented plastic and induce abrasion of their surfaces.

The following table indicates comparative test results of the tensile strength of a joint formed with 2¼ inch, .08 carbon steel clip of a B66 hardness, .025 inch thick of the closed type illustrated in FIG. 4 and treated as indicated in the table below. The tape joined was nominal ½ inch oriented polyethylene tape (.460" x .019") which was produced by the method disclosed in the above referenced copending patent application. This tape has a breaking strength of 575 lbs. The sleeve was compressed in the evenly undulating pattern lengthwise of the joint as described above with reference to FIGS. 4 and 5 in a 5/4 crimp pattern.

Table I

Untreated Clip, lbs.	Sand Blasted Clip, lbs.	Acid Etched Clip, lbs.	Copper Oxide Coated Clip, lbs.
346	437	414	415
349	446	434	407
310	402	414	362
339	404	424	413
379	400	420	377
356	459		416
			420
			405
Aver. 346	Aver. 424	Aver. 421	Aver. 402

In addition to treating the interior of the clip to increase its coefficient to friction, the surface of the oriented tape can be treated to increase its coefficient of friction. The surface of an oriented plastic tape has a very smooth, wax-like surface. Treating the surface of the tape by means of a corona discharge tends to slightly roughen the surface, to alter it chemically, and so to increase its coefficient of friction. Other techniques for slightly roughening the surface of the oriented plastic tape will be readily apparent to those skilled in the art, but care must be taken not to abrade the surface so as to lift up the ends of the oriented bundles of elemental fibers in the tape and reduce the strength of the tape.

While the above matter describes and illustrates preferred embodiments and methods of the invention, it should be understood that the invention is not restricted solely to the described embodiments, devices, and methods, but that it covers all modifications which would be apparent to one skilled in the art which would fall within the spirit and scope of the invention.

What is claimed is:

1. A package binding device comprising a length of generally flat tape of homogeneous, orientable plastic material in a longitudinally oriented condition encircling the package, and a uniformly wide sleeve of compressed material enclosing both end portions of said tape, the faces of said tape having an even surface, the interior surfaces of said sleeve pressingly engaging the faces of said enclosed tape portions with a pressure evenly distributed thereover, said sleeve and enclosed end portions forming a lamination having a single curvature shape in the form of a series of smoothly curving undulations

extending longitudinally of the tape, that portion of each said tape end portion enclosed within said sleeve being a continuous section of substantially uniform thickness and width.

2. The device of claim 1 wherein the interior surface of said sleeve has a finely roughened textured.

3. The device of claim 2 wherein said finely roughened texture on the interior surface of said sleeve is an oxidized layer.

4. The device of claim 3 wherein said oxidized layer on the interior surface of said sleeve is copper oxide.

5. A package binding device comprising a generally flat strap having even and smooth faces and formed of polymeric material in a uniaxially, longitudinally oriented condition, said strap encircling the package with the strap end portions overlapping, and a uniformly wide sleeve of malleable material encompassing at least a part of said end portions and deformingly compressed into uniform engagement with the faces of said overlapping strap portions to have the top and bottom internal faces of said sleeve evenly pressingly engaging the exterior faces of said encompassed strap portions to apply an inwardly directed pressure which is evenly distributed over each of said encompassed strap faces, said compressed sleeve and enclosed strap portions forming a lamination shaped into a series of evenly curving, single curvature shaped undulations extending lengthwise of said strap, the cross sectional shape and dimensions of said sleeve encompassed strap portions being substantially the same as the remaining portions of said strap.

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