ABSTRACT: A method and apparatus for providing a plurality of longitudinally spaced integral interlocking means in overlapping upper and lower strap portions to provide a tensioned ligature about an article that does not require extraneous securing means. The method includes the steps of forming a length of strapping material into a loop about the article, gripping the leading end of the strapping material, tensioning the loop about the article, progressively forming interlockable slits in the upper and lower strap portions, severing the upper strap portion from the supply of strapping material, allowing tension in the loop to act upon the upper and lower strap portions so that the slits engage one another, and forming an upwardly struck tab in the lower strap portion adjacent the severed end of the upper strap to prevent disengagement of the interlocking slits. The apparatus includes a ratchet and pawl tensioning mechanism for pulling the strapping material into snug binding engagement with the article, and a rack and pinion actuated linkage structure for progressively shifting a plurality of longitudinally spaced notching elements downwardly into slit-forming engagement with complementarily shaped notching elements of a stationary lower die. The upper strap is severed from the supply of strapping material in response to completion of the strap-sitting operation, and the slitted strap portions are positively stripped from the lower die so that tension in the strap loop will shift the slitted strap portions into interlocking engagement with one another. The separation-preventing tab is formed in the lower strap portion in response to actuation of the mechanism for stripping the slitted strap portions from the lower die.
TOOL FOR COTTON BALE TIES

BACKGROUND OF THE INVENTION

It has been well known for many years to bind cotton bales, and other similar articles, with an encircling ligature having interlocking means formed integrally therewith that obviates the necessity of using an extraneous fastener. One of the earliest patents relating to such "seamless joint" structures is Olmsted U.S. Pat. No. 180,910, which discloses a cotton bale tie having slits in overlapping strap portions, with the slits including transversely spaced, longitudinally extending portions bridged by a transversely extending portion. When the overlapping strap portions are moved relative to one another, the bridging portions of the slits move into one of the longitudinally extending slit portions to interlock the overlapping strap portions relative to one another. Such cotton bale ties have commonly included one or more pairs of laterally spaced slits that define generally T-shaped tongues therebetween and other arrangements, wherein only single slits are provided, are also commonly used.

The earliest seamless joint ligatures were usually formed of metal strap that was cut to length, with the interlocking slits being provided at opposite ends of the strap. The strap was conventionally manually looped around the article, manually tensioned to align the interlocking slits with one another, and released to allow the interlocking slits to engage one another. Because of the troublesome and somewhat time-consuming nature of the manual manipulation, and because the cut-to-length straps were usable only with an article of a given size, those working in this field ultimately developed combination tools having various types of mechanisms for tensioning a loop of strap from a relatively continuous supply of strap and for forming the interlocking slits only after the loop had been tensioned about an article. The combination tool disclosed in Timmerbeil U.S. Pat. No. 2,040,576 is exemplary of an early type of tensioning and slit-forming mechanism.

As the seamless joint art progressed, improved mechanisms were developed to facilitate the formation of the interlocking slits in strapping materials of relatively heavy gauge. It is common to use a plurality of pairs of longitudinally spaced interleaving slits to increase the effectiveness of the article-binding ligature, and with heavy-gauge material, it has been found desirable to serially or progressively form the slits in the overlapping strap portions, so as to obviate the amount of force required to effect the slitting operation. Mosey U.S. Pat. No. 2,590,626 is exemplary of the apparatus that has been developed in the past for successively shifting movable slit-forming dies into slit-forming relationship with a stationary die.

SUMMARY OF THE INVENTION

The apparatus of the present invention includes means for tensioning a strap about an article and means for forming slits in overlapping portions of the strap, with the slits in the upper strap portions interlocking with the slits in the lower strap portion to produce a seamless joint closure. The apparatus employs a ratchet and pawl mechanism for tensioning the strap about the article. A stationary die is provided on the base of the apparatus, and a plurality of movable dies are positioned above the stationary die, with the movable dies being positioned for successive vertical sliding movement into slit-forming relationship with respect to the lower die. The movable dies are actuated by a linkage structure which is controlled by a lever-actuated ract and pinion mechanism. The upper strap is severed from the supply of strapping material in response to completion of the interlocking slits, and after the interlocking slits have been completed, a further mechanism is actuated to positively strip the slotted strap portions from the lower die. After the slotted portions have been stripped from the lower die, tension in the loop shifts the upper and lower strap portions relative to one another to place the slotted strap portions in firm interlocking engagement with one another. The apparatus further includes cutter means, operable in response to actuation of said further mechanism, for providing a bent tab in the lower strap portion adjacent the end of the upper strap to prevent separation of the overlapping strap portions, as might occur if the article about which the strap is looped subsequently becomes compressed.

FIG. 1 is a side elevational view, partially in section, of a preferred embodiment of the apparatus of the present invention;

FIG. 2 is an end elevational view of the structure illustrated in FIG. 1;

FIG. 3 is a sectional view taken generally along line 3–3 of FIG. 1;

FIG. 4 is a sectional view taken generally along line 4–4 of FIG. 3;

FIG. 5 is a sectional view taken generally along line 5–5 of FIG. 1;

FIG. 6 is a sectional view taken generally along line 6–6 of FIG. 2;

FIG. 7 is a fragmentary view, similar to FIG. 1, but illustrating the condition of the elements part way through the slit-forming sequence;

FIG. 8 is an enlarged top plan view of the seamless joint closure formed by the apparatus illustrated in FIGS. 1–7;

FIG. 9 is an enlarged sectional view taken generally along line 9–9 of FIG. 8; and

FIG. 10 is an enlarged sectional view taken generally along line 10–10 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail one specific embodiment, with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiment illustrated. The scope of the invention will be pointed out in the appended claims.

SEAMLESS JOINT CLOSURE

The preferred embodiment of the tool of the present invention is indicated in its entirety at 10 in FIG. 1, and the tool 10 is operable to form a seamless joint closure (FIGS. 8 and 9) in overlapping portions of a length of strap from a supply of strapping material. The tool 10 is initially placed upon an article, not shown, and the strap is then looped about the article to provide an upper strap portion 12 and a lower strap portion 14. The leading end of the length of strap is then inserted into a gripper (to be hereafter described) associated with the tool 10. The upper strap portion 12 is then inserted into the tool to overlap the gripped leading end of the lower strap portion 14. A lengthwise force is then applied to the strap portion 12 to tension the loop about the article, and when the loop is closed into snug binding engagement with the article, the slit-forming means, to be hereafter described, of the tool 10 is actuated to form a plurality of longitudinally spaced interlocking means 16 in the overlapping strap portions.

Each interlocking means 16 is defined by a pair of laterally spaced zigzag slits 17, with each slit 17 including a longitudinally extending inner portion 18, a longitudinally extending outer portion 19 and a slightly inclined generally transversely extending connecting portion 20. Each pair of laterally spaced slits 17 defines a generally T-shaped tongue 21 therebetween, and tongues 21 are inclined outwardly out of the plane of the strap portions, as can be best seen in FIG. 9. As will hereinafter be more fully apparent, after the slits 17 have been formed in the overlapping strap portions 12 and 14, tension in the strap loop is allowed to act upon the overlapping strap portions, so that the shoulders provided at the transversely slit portions 20 slide lengthwise into the longitudinally slit por-
3,621,888

TENSIONING MECHANISM

The apparatus 10 includes frame means in the form of a base 24, and a strap-tensioning means 26 provided at the right-hand end of base 24, as viewed in FIGS. 1 and 7, with the tensioning means 26 being carried by a support member 28. A transversely extending shaft 30 extends through aligned openings in support member 28 to pivotally mount the overlapping strap portion 32 against movement relative to the base 24. A spring 32 surrounds shaft 30 and has one end 32a positioned in engagement with a shoulder on support member 28 and an opposite end 32b engaged in a pin 34 that extends laterally outwardly from base 24 to bias the support member 28 in a counterclockwise direction about shaft 30. A feed wheel 36 is carried on a transversely extending shaft 38 that is rotatably mounted adjacent the lower end of support member 28, and spring 32 biases the feed wheel 36 into strap-feeding relationship with respect to a stationary anvil 40 on the base 24. An arcuate clearance slot 42 is provided in base 24, and shaft 38 is free to move in slot 42 as support member 28 is moved relative to base 24, as will be explained hereinafter.

The drive to feed wheel 36 will be best understood from a consideration of FIG. 6. As illustrated therein, a first relatively small diameter gear 44 is fixed to shaft 30, while a second relatively larger diameter gear 46 is fixed to shaft 38 in meshing engagement with gear 44. A tensioner handle 48 is pivotally mounted upon shaft 30, and a pawl 50 is pivotally mounted at 52 on handle 48 adjacent gear 44, so that upon counter-clockwise rotation of handle 48, gear 46 is rotated in a counterclockwise direction to thereby rotate gear 46 and drive wheel 36 in a clockwise or strap-tensioning direction. When handle 48 is rotated in a clockwise direction, pawl 50 pivots relative to handle 48, so that the gear 44 is not rotated. A holding pawl 54 is pivotally mounted at 56 on the enlarged end portions of handle 48 for positively preventing counterclockwise rotation of handle 48. A spring 58 biases pawl 54 in a counterclockwise direction about pivot 56 to position the toothed end portion 60 of pawl 54 in engagement with the gear 46. A lug 62 is provided on handle 48 in a position to engage the upstanding abutment portion 64 of pawl 54, and the spring 58 positively holds the gear 46 against counterclockwise rotation, so that when the handle 48 is pivotally mounted in a clockwise direction, pawl 54 will move in a counterclockwise direction against the bias of spring 58 to allow the gear 46 to freely rotate. When handle 48 reaches the full extent of its counterclockwise pivotal movement, lug 62 is spaced from abutment portion 64 of the pawl 54, and the spring 58 positively holds the gear 46 against counterclockwise rotation, so that when the handle 48 is pivotally mounted in a clockwise direction, the pawl 54 will hold the tension that has been drawn on the strap loop.

Ejector structure, to be hereafter described, is operated in response to movement of the support member 28 from the full-line position of FIG. 1 to the broken line position for positively stripping the overlapping strap portions from the slit-forming dies, and it will be understood that when the support member 28 is in the broken line position, a completed strap loop can be removed from the tool, and further overlapping strap portions can be inserted between the feed wheel 36 and the anvil 40 for a subsequent article. A latch 68 (FIGS. 1 and 7) is provided for releasably retaining the support member 28 in the broken line position of FIG. 1. Wherein the feed wheel 36 is spaced a substantial distance above the anvil 40, and latch 68 is pivotally mounted at 70 between rearwardly extending ears 72 on base 24. A spring 74 (FIG. 1) bears between the base 24 and latch 68 to bias the latch 68 in a clockwise direction.

A rearwardly and downwardly facing abutment 76 is provided at the lower end of tensioning handle 48, and is positioned to engage an upwardly facing shoulder 78 on the support member 28, so that when the tensioning handle 48 is pivotally mounted in a clockwise direction, the support member 28 is pivotally mounted in a clockwise direction about shaft 30 to the broken line position of FIG. 1. A latch pin 80 (FIG. 7) extends laterally outwardly from the support member 28, and as the support member 28 moves to the broken line position of FIG. 1, latch pin 80 moves to the position designated at 82 in FIG. 1. In this position, the latch pin 80 is engaged with latch surface 82 on latch 68 to positively hold the support member 28 in the broken line position. A release pin 84 extends laterally outwardly from handle 48, so that when the handle 48 is pivotally mounted in a counterclockwise direction, pin 84 pivots latch 68 against the bias of spring 74 to release the latch surface 82 from the pin 80, whereupon the spring 32 will return the support member 28 into the strap-feeding position after abutment 76 moves out of engagement with shoulder 78.

SLIT-FORMING STRUCTURE

Apparatus 10 includes die means 90 for forming the zigzag slits 17 of locking means 16, and die means 90 includes a lower stationary die member 92 having a plurality of longitudinally spaced male notching elements 94, four such elements being shown in the exemplary embodiment of the invention. Notching elements 94 each have a substantially Z-shaped configuration at each side thereof for forming the slits 17 in cooperation with the movable die means to be hereafter described. As is evident from FIG. 1, the notching elements 94 are upwardly inclined in side elevation, so as to force the tongues 21 out of the plane of the strapping material.

The movable upper die means is indicated generally at 96, and die means 96 is mounted within a compartment means 98 (FIG. 5) that is provided between an upwardly extending portion 100 of base 24 and a generally vertically disposed sideplate 102. Sideplate 102 is secured to base 24 by screws 103 and includes generally vertically disposed walls 104 and 106 at opposite ends thereof. The inwardly facing surfaces of walls 104 and 106 cooperate with the inwardly facing surfaces of base portion 100 and plate 102 to collectively define compartment means 98. An inclined portion 108 is provided at the upper end of wall 106 for purpose to hereafter appear. Guide surfaces 110 are provided on the upper end of wall 106 outwardly of inclined surface 108, and further guide surfaces 112 are provided on the upper end of wall 104, also for a purpose to hereafter appear.

Movable die means 96 includes a plurality of longitudinally spaced female notching elements 114 that are mounted for vertical sliding movement within compartment means 98. Four female notching elements 114 are shown in the exemplary embodiment of the invention, and it will be understood that the lower portion of each notching element 114 has an internal zigzag configuration that is shaped complementarily with the configuration of the corresponding male notching element 94 to form the slits 17 when the female notching elements 114 are moved downwardly into slit-forming relationship with respect to the male notching elements 94. Linkage means 116 mounts the notching elements 114 for vertical sliding movement within compartment means 98 between a clearance position illustrated in FIG. 1 spaced above stationary die member 92, and a lower position, wherein the notching elements 114 are positioned in slit-forming relationship with respect to the notching elements 94. Movable notching elements 114 are positioned with flat side faces that are positioned in sliding, face-abutting engagement with the inwardly facing surfaces of base portion 100 and sideplate 102, and the endmost elements are also positioned in sliding, face-abutting engagement with the inwardly facing surfaces of walls 104 and 106, while the inter-
mediate elements 114 are positioned in sliding, face-abutting engagement with the adjacent elements 114. The upper end of each movable notching element 114 is bifurcated to provide laterally spaced, vertically extending portions 118, with the laterally spaced portions 118 on adjacent notching elements 114 cooperating to collectively define a longitudinally extending groove 120 (FIG. 5).

Linkage means 116 includes a single link 122 for each movable notching element 114, and as can be best seen in FIG. 5, links 122 are generally rectilinear members having their side surfaces positioned in sliding face-abutting engagement with the inwardly facing surfaces of the upwardly extending portions 118 of notching elements 114. Each link 122 is pivotally connected at 124 adjacent its lower end to its respective notching element 114, and each link 122 is pivotally connected at 126 adjacent its upper end between the downwardly extending flanges 127 of an actuating member 128. Links 122 assume a relatively steeply inclined position in the normal, or unactuated, position illustrated in FIG. 1, and it will be noted that the inclined surface 108 at the upper end of wall 106 provides a clearance for the link 122 connected to the notching element 114 adjacent wall 106. The links 122 for the notching elements 114 outwardly of the notching element adjacent wall 106 are progressively inclined at larger angles, and it will noted that the grooves 120 in the notching elements provide a clearance for the links 122 on adjacent notching elements. As the actuating member 128 moves to the left from the position of FIG. 1 toward the position of FIG. 7 (which shows only the first notching element 114 in slitting-forming relationship with its corresponding stationary notching element 94), the links 122 progressively assume a vertical disposition to serially move the adjacent notching elements 114 into slitting-forming relationship with their corresponding stationary notching elements 94.

As can be best seen in FIGS. 1 and 7, actuating member 128 includes a plurality of downwardly facing, longitudinally spaced rack teeth 132 at the left hand end thereof, and the flattened lower surfaces of rack teeth 132 are slidably along the guide surfaces 112 at the upper end of wall 104. The flattened lower surfaces of the flanges 127 at the opposite end of actuating member 128 are slidably along surfaces 110 on wall 106, so that the actuating member 128 is positively guided during its actuating stroke. A pair of laterally spaced, longitudinally extending arcuate grooves or raceways 134 are provided in the upper surface of actuating member 128, and a plurality of ball bearings 136 are provided in each raceway 134. The ball bearings 136 are rotatable within a ball retainer plate 138 having a pair of ladder spaced, longitudinally extending slots 142 therein that are positioned in alignment with grooves 134. A bearing support member 144 is positioned above actuating member 128 and bearing retainer 138, and bearing support member 144 includes a pair of laterally spaced downwardly facing arcuate grooves 146 that are positioned in vertical alignment with grooves 134 and slots 142, and which receive balls 136 therein. The left-hand end of bearing support member 144 (as viewed in FIGS. 1 and 7) is enlarged at 148, and enlarged portion 148 includes a planar lower surface 148a that guides actuating member 128 during its reciprocating movement. Bearing support member 144 is held against movement relative to a cover plate 150 by a pin 152 that passes through aligned openings in cover plate 150 and bearing support member 144, adjacent the left-hand ends thereof, as viewed in FIG. 7. Cover plate 150 is positively secured to base 24 and sideplate 102 by screws 154 (FIG. 2), and cover plate 150 includes a handle 156 to facilitate manipulation of the tool.

A pin 158 extends downwardly from bearing support plate 148 of bearing support member 144 adjacent the right-hand end thereof, and pin 158 is positioned in the path of ball retainer plate 138 to provide a locating stop for the retainer plate 138. A further pin 160 extends upwardly from actuating member 128 adjacent the left-hand end thereof, and pin 160 is positioned to engage ball retainer plate 138 when the actuat-

ing member 128 moves from left to right toward the clearance position to move the ball retainer member 138 into engagement with stop pin 158. A clearance slot 162 for pin 160 is provided in the lower surface of the enlarged portion 148 of bearing support member 144 to allow the actuating member 128 to move to the left. Thus, as actuating member 128 is moved to the left from the position of FIG. 1 to initiate the slitting-forming operation, pin 160 moves away from the left-hand end of ball retainer member 138, so that the ball retainer member and balls are free to move under the influence of friction. The engagement of balls 136 within grooves 134 and 146 supports and guides the actuating member 128 during its longitudinal movement. When the actuating member 128 returns to the clearance position, pin 160 picks up the ball retainer member 138 and moves it against stop pin 158. Actuating member 128 is stopped and located in the clearance position through the engagement of the flattened upper end portion of the left-hand notching element 114 with the flattened undersurface of actuating member 128, as can be best seen in FIG. 1.

The means for reciprocating actuating member 128 includes a pinion 164 that meshes with the rack teeth 132 on actuating member 128, and pinion 164 is carried upon a transversely extending shaft 166 which is rotatably mounted in base portion 100 by bearing 168 and in sideplate 102 by bearing 170. An operating handle 172 is fixed by a transverse pin 173 to the flattened end portion of shaft 166 that extends outwardly of sideplate 102, and it will be understood that upon counterclockwise rotation of handle 172 from the position of FIG. 1 to the position of FIG. 7, actuating member 128 is moved outwardly through the interaction of pinion 164 with rack teeth 132.

Strap-severing means for cutting the upper strap portion 12 from the supply of strap is operatively responsive to actuating member 128 reaching the end of its outward stroke, and the strap-severing means will be best understood from FIGS. 2-4. The strap-severing means includes a stationary cutter block 174 (FIGS. 1 and 3) that is secured to base 24 by screws 176. Cutter block 174 includes a central recess or notch 177, and a first or lower tapered portion 178 (FIG. 3) extends outwardly from cutter block 174 so as to be positioned over the strap-supporting surface 24a of base 24. A holding gripper 180 is pivotally mounted within groove 177 by a transversely extending pin 182, and gripper 180 includes a serrated lower surface 184 that is adapted to grip the leading end of the strap during a strap-tensioning cycle. Gripper 180 is biased in a clockwise direction about pin 182 toward a strap-gripping position with respect to base surface 24a by a spring 186 (FIG. 3) having one end seated within a recess 188 in base 24, and having its opposite end surrounding a spring seat 190. Cutter block 174 includes a second or upper outwardly extending portion 179 (FIG. 4) positioned above portion 178 to form a clearance gap therebetween through which the trailing end of the strap extends to the strap supply. Cutter block portion 178 includes an upwardly facing, slightly downwardly inclined cutting edge 178a which cooperates with a cutting edge 174a (FIGS. 1 and 4) on the leftmost notching element 114 to sever the upper strap portion when the actuating member reaches the end of its outward stroke.

Cam means 192 is provided for pivoting the gripper member 180 in a counterclockwise direction at the end of the stroke of actuating member 128, and cam means 192 includes a cam 194 that is fixed by a pin 196 to the end of shaft 166 that extends outwardly of base portion 100. A cam follower roller 198 is rotatably supported between a pair of lugs 200 at the upper end of gripper 180 by a pin 202, and roller 198 is positioned by spring 186 in a location to be engaged by the lobe portion 204 of cam 194 when the actuating member 128 reaches the end of its outward stroke.

A latch member 205 is pivotally mounted to base 24 at 206, and a spring 208 biases the latch 205 in a counterclockwise direction about pivot 206. Latch 205 includes a latch surface 210 at the lower end thereof that is movable into latching en-
gagement with a corresponding latch surface 212 at the upper end of gripper member 180, when gripper member 180 is pivoted in a counterclockwise direction by cam 194. Thus, when the actuating member completes its outward stroke to success fully bring all of the movable die members 114 downwardly into slit-forming relationship with respect to stationary die member 92, cutting edge 114a sever s the upper strap 12 from the strap supply source and cam 194 moves into engagement with roller 198 to pivot the gripper member 180 against the bias of spring 186. Latch 205 retains gripper 180 in a clearance position spaced above the strap supporting surface 24a on base 24 so that a further length of strap can be looped around a subsequent article to be strapped. Once the further length of strap is in position, latch 205 is manually released to allow the spring 186 to move the gripping member 180 into gripping engagement with the leading end of the new length of strap. A guide member 214 is positioned to the left of cutter block 174, as viewed in FIGS. 1 and 7, with guide 214 including spaced upper fingers 216 for guiding the upper strap portion to the strap supply, and with the guide 214 further including spaced lower fingers 218 for guiding the lower strap portion around the article being strapped. A movable strap guide 219 is pivotally mounted on pin 182 and is positioned between the outwardly extending portions 216 and 218 of stationary strap guides 221 to bias the movable strap guide 219 in a clockwise (as viewed in FIG. 2) direction about pivot 183, and strap guide 219 serves to maintain tension on the upper strap portion.

After the slit-forming and strap-severing operations have been completed, it will be appreciated that the overlapping strap portions 12 and 14 will be substantially impaled upon the lower die member 92. The present invention includes means for positively stripping the overlapping strap portions from the lower die and for allowing the overlapping strap portions to move relative to another to effect the interlocking of means 16. The strap-stripping means is operatively responsive to movement of the support member 28 from the full-line position of FIG. 1 to the broken line position of FIG. 1. To this end, a downwardly extending lug 220 (FIG. 6) is provided on support member 28, and the rearward end of a generally f'ront and aft extending ejector link 222 is pivotally connected to lug 220. An enlarged slot 226 is provided in link 222 adjacent the midportion thereof, and link 222 is connected to an ejector lever 230 by a transverse pin 228 that impales slot 226 and aligned openings in bifurcated portions of lever 230. A stripper member 232 is connected to lever 230 by a transverse pin 234, and stripper member 232 includes a cylindrical portion that is rotatably mounted within an opening 236 in base 24. Striper member 232 includes a flattened portion 238 at the outer end thereof that is normally positioned below the plane of the stationary die 92 when the support member 28 is in the full-line position of FIG. 1. When the support member 28 is pivoted from the full-line to the broken line position, stripper member 232 is rotated through the action of link 222 and lever 230 to pivot the stripper portion 238 above the lower die 92 to strip the slitted overlapping strap portions 12 and 14 from the lower die, as is illustrated in FIG. 5. When the strap portions are in this position, tension in the loop causes the upper and lower strap portions to move relative to one another to effect the interlocking of the overlapping strap portions.

When tension in the strap loop effects the interlocking of the overlapped strap portions, the severed end of the upper strap portion 12 is pulled to the right as viewed in FIGS. 1 and 7 beyond a cutter member 240 (FIG. 5). Cutter member 240 is mounted for pivot movement by a transversely extending pivot pin 242, and a spring 244 is biased between the cutter member 240 and the base 24 to bias the cutter member 240 in a clockwise direction about pivot 242. A cam follower roller 246 is provided at the outer end of cutter 240 in alignment with link 222. Link 222 has a cam profile 248 on the outer end thereof that is movable into engagement with cam follower roller 246 to pivot the cutter member 240 in a counter-clockwise direction about pivot 242 against the bias of spring 244, and during this latter movement, an upwardly facing inclined cutting edge 250 at the outer end of the cutter member 240 strikes the tab 22 upwardly from the side edge of the lower strap portion 14 in front of the severed end of the upper strap portion 12 to prevent the strap portions from becoming unlocked. A yieldably mounted hold-down member 252 is provided adjacent cutter member 240 to hold the upper and lower strap portions 12 and 14 during the cutting of tab 22. The cam profile 248 on link 222 is guided into engagement with cam follower roller 246 by a guide member 254 positioned above cam roller 246, and guide member 254 is supported upon a transverse shaft 256, best seen in FIG. 5.

OPERATION

In use, the tool 10 is placed on the article to be strapped, and a length of strap from a supply source, not shown, is looped about the article to provide upper and lower strap portions 12 and 14, respectively. During the initial strap-threading operation, the feed wheel 26, the notchings element 114 and the gripping member 180 are all elevated into a clearance position to allow the overlapping strap portions to be positioned on the base 24 of the tool. Once the strap loop has been completed, latch 205 is manually released to allow gripper 180 to move into strap-holding relationship with respect to base portion 24a.

Tension is then drawn on the strap loop by pivoting handle 48 in a counterclockwise direction, which rotates feed wheel 26 in a clockwise direction to shift the upper strap portion 12 to the left, as viewed in FIG. 7, and to thereby apply tension to the strap loop. Once the desired degree of tension has been drawn in the strap, handle 172 is pivoted in a counterclockwise direction to rotate pinion 164 (FIG. 7) in a counterclockwise direction to shift-actuating member 128 to the left through the engagement of pinion 164 with rack teeth 132. As actuating member 128 moves to the left, links 122 cause locking elements 114 to progressively move downwardly, so that slits 16 and 17 are successively formed in the overlapping strap portion through the cooperative action of notching elements 114 and stationary die member 92.

When actuating member 128 reaches the end of its stroke, cutting edge 114a on the leftmost notching element 114 moves adjacent a cutting block 178 into strap-severing relationship with upper strap portion 12 to sever the strap loop from the strap supply 194 that is mounted on shaft 166 along with pinion 164 is also rotated by actuating member 128, and when the actuating member reaches the end of its stroke, cam lobe portion 204 engages the follower 198 on gripper 180 to pivot the same upwardly to a strap clearance position where handle 205 is reengaged.

Handle 48 is then moved clockwise to pivot link 222 and cause stripper portion 238 of member 232 to move upwardly and strip the slitted strap off of the lower dies. The tension in the strap loop then moves the upper and lower strap portions outwardly relative to one another to cause the slits 16 and 17 to interlock. Cam profile 248 on link 222 then moves into engagement with follower roller 246 on notch 240 to pivot the cutting edge 250 upwardly to form locking tab 22 in the lateral edge of lower strap portion 14 adjacent the outer end of upper strap portion 12. The base portion of the tool 10 is then removed from beneath the interlocked strap loop by shifting the tool 10 laterally.

What is claimed is:

1. A ligature comprising: a length of strapping material formed into a loop having an upper strap portion overlapping a lower strap portion, said upper strap portion having an exposed end portion; interengaging means in said upper and lower strap portions for preventing said strap portions from moving in one direction only relative to one another; and a locking tab struck upwardly from one lateral edge of said lower strap portion outwardly of the free end of said upper strap portion, said tab having an upright locking face severed.
from said lower strap portion and positioned immediately adjacent the free end of said upper strap portion for preventing said strap portions from moving relative to one another in a direction opposite to said one direction.

2. Strapping apparatus for forming a plurality of longitudinally spaced, integral interlocking means in overlapping upper and lower strap portions comprising: first die means having a plurality of notching elements; second die means positioned adjacent said first die means at a strap-working station, said second die means having a plurality of notching elements shaped complementarily to the notching elements of said first die means and adapted to act therewith to from said interlocking means; and means for effecting relative movement between said die means to being said notching elements into contact with one another including, a movable actuating member, rack and pinion means for shifting said actuating member, linkage means connected between said actuating member and the notching elements of one of said die means, said linkage means being arranged so that upon movement of said actuating member, the notching elements of said one die means are progressively moved into coating relationship with the notching elements of said other die means.

3. Strapping apparatus for forming a plurality of longitudinally spaced, integral interlocking means in overlapping upper and lower strap portions comprising: first die means having a plurality of notching elements; second die means positioned adjacent said first die means at a strap-working station, said second die means having a plurality of notching elements shaped complementarily with the notching elements of said first die means and adapted to coat therewith to form said interlocking means; means for effecting relative movement between said die means to bring said notching elements into contact with one another including, a movable actuating member, linkage means connected between said actuating member and the notching elements of one of said die means, said linkage means being arranged so that upon movement of said actuating member, the notching elements of said die means are progressively moved into coating relationship with the notching elements of said other die means; frame means supporting said first and second die means and said movement effecting means; loop-tensioning means mounted on said frame means adjacent said first and second die means, said tensioning means being carried by a support member mounted on said frame means for movement between first and second positions; and means for said frame means for gripping said overlapping upper and lower strap portions from said die means, said gripping means being operated in response to movement of said support member away from said first position.

4. Strapping apparatus for forming a plurality of longitudinally spaced, integral interlocking means in overlapping upper and lower strap portions comprising: frame means; first die means having a plurality of movable notching elements; second die means positioned adjacent said first die means at a strap-working station, said second die means having a plurality of stationary notching elements shaped complementarily with the notching elements of said first die means and adapted to coat therewith to form said interlocking means; means on said frame means mounting the movable notching elements for reciprocating movement toward and away from said stationary die means; and means for effecting relative movement between said die means to bring said notching elements into contact with one another including, a movable actuating member, means on said frame means mounting said actuating member for movement along a path perpendicular to the path of movement of said movable notching elements, linkage means connected between said actuating member and the movable notching elements, said linkage means being arranged so that upon movement of said actuating member, the movable notching elements are progressively moved into coating relationship with the stationary notching elements.

5. Strapping apparatus as set forth in claim 1 wherein said linkage means includes a driving link for each movable notching ele-
ment, each driving link being pivotally connected adjacent one end to said actuating member and adjacent the other end to its respective movable notching element, said driving links being arranged to move from an inclined position to an in-line position to shift their respective notching elements into coating relationship with said other die means.

6. Apparatus as set forth in claim 1 wherein said frame means includes spaced sidewalls and end walls defining a chamber therebetween, said movable notching elements being confined for movement between said sidewalls, with the first and last of said elements engaging an end wall and with intermediate elements engaging adjacent elements.

7. Apparatus as set forth in claim 4 wherein said movable notching elements each have a bifurcated upper end defining a recess having the other end of the driving link therein, the recesses of said movable notching elements being aligned to accommodate said driving links when they are in the inclined position.

8. Apparatus as set forth in claim 5 wherein the upper end of the end wall adjacent the first movable notching element is inclined to accommodate the driving link associated therewith when it is in the inclined position.

9. Apparatus as set forth in claim 2 wherein said rack is formed integrally with said actuating member, and said pinion is associated with a manually operable handle.

10. Apparatus as set forth in claim 9 including frame means supporting and guiding said actuating member for longitudinal movement.

11. Apparatus as set forth in claim 10 including bearing means interposed between said frame and said actuating member to facilitate movement of the latter.

12. Apparatus as set forth in claim 11 in which said actuating member includes at least one arcuate trackway in the upper surface thereof; and wherein said bearing means includes a ball retainer member having a ball retaining slot therein positioned in alignment with said trackway a bearing support member held against movement relative to said frame and having an arcuate trackway in the lower surface thereof positioned in alignment with said first-mentioned trackway and said slot, and a plurality of balls in said slot and being between said trackways.

13. Apparatus as set forth in claim 12 in which said actuating member and said bearing support members each include a pair of spaced parallel trackways, said ball retainer member including a pair of slots each positioned in alignment with a trackway of said actuating member and said bearing support member, and wherein a plurality of balls are provided in each slot to bear between said actuating member and said bearing support member.

14. Apparatus as set forth in claim 12 including stop means on said bearing support member member engageable with one end of said ball-retaining member, and abutment means on said actuating member engageable with the other end of said ball-retaining member to move said ball-retaining member against said stop means and thereby limit movement of said ball-retaining member in one direction.

15. Apparatus as set forth in claim 1 wherein loop-tensioning means is mounted on said frame means adjacent said first and second die means.

16. Apparatus as set forth in claim 3 including means responsive to movement of said support member to said second position for forming a locking tab in the lower strap portion.

17. Apparatus as set forth in claim 1 including means responsive to movement of said actuating member for severing said upper strap portion from a supply of strap material.

18. A method of securing a ligature about an article without the use of extraneous securing means comprising: forming a length of strapping material from a supply of strapping material into a loop about the article to provide overlapping upper and lower strap portions; gripping the leading end of said strapping material; applying a lengthwise force to said strapping material to tension the loop about the article;
progressively forming a plurality of longitudinally spaced interlocking slits in said upper and lower strap portions; severing said upper strap portion from the supply of strapping material; releasing said lengthwise force to allow the interlocking slits in the upper strap portion to engage the interlocking slits on the lower strap portion; and forming an upwardly struck tab in the lower strap portion adjacent the severed end of the upper strap portion to prevent disengagement of the interlocking slits.

19. The method set forth in claim 18 wherein said interlocking slits are formed by serially moving a plurality of longitudinally spaced upper notching elements downwardly into engagement with a die having a plurality of complementarily shaped lower notching elements.

20. The method of claim 19 including the step of stripping said upper and lower strap portions from said lower notching elements prior to the release of said lengthwise force.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,621,888 Dated November 23, 1971

Inventor(s) ARVID I. ERICSSON

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 9, line 12, "from" should read -- form --.
Column 9, line 14, "being" should read -- bring --.
Column 10, line 13, "4" should read -- 6 --.
Column 10, line 19, "5" should read -- 7 --.
Column 10, line 41, "being" should read -- bearing --.

Signed and sealed this 17th day of October 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCHALK
Attesting Officer Commissioner of Patents