July 12, 1966 G. HUSON 3,260,506

GRIPPER MECHANISM FOR STRAPPING TOOLS

Filed Feb. 5, 1965 2 Sheets-Sheet 1

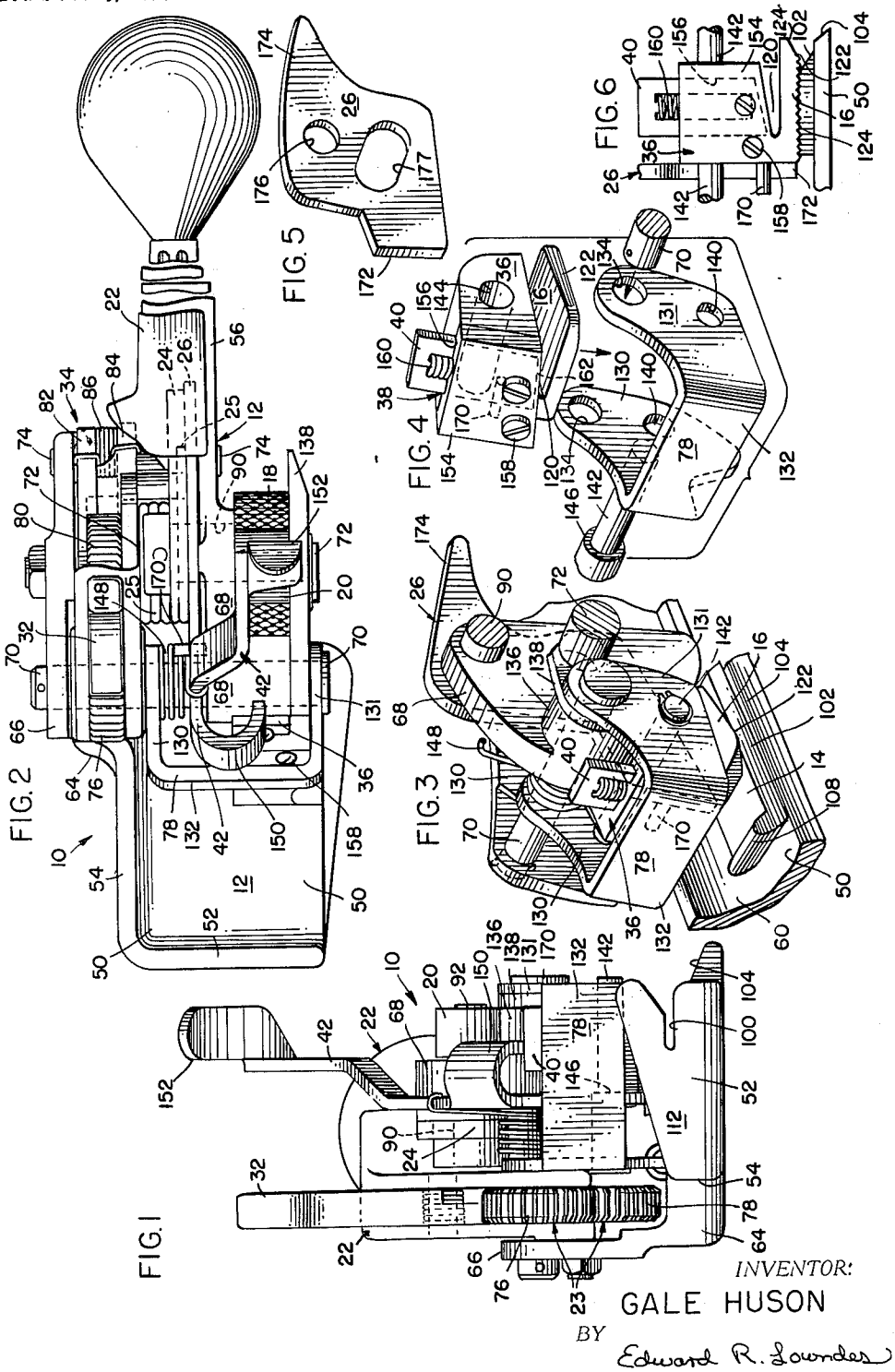


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

INVENTOR:
GALE HUSON
BY
Edward R. Lounder

July 12, 1966 G. HUSON 3,260,506

GRIPPER MECHANISM FOR STRAPPING TOOLS

Filed Feb. 5, 1965 2 Sheets-Sheet 2

FIG. 7

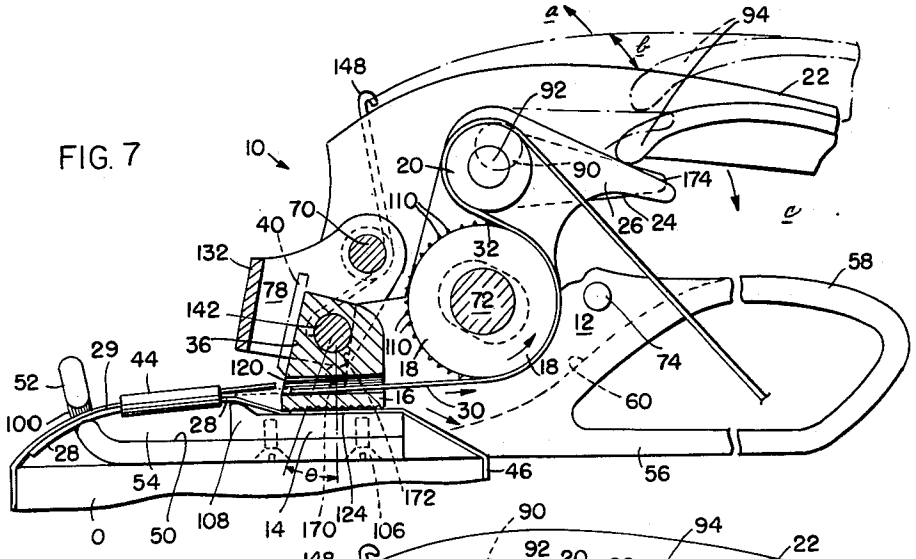


FIG. 8

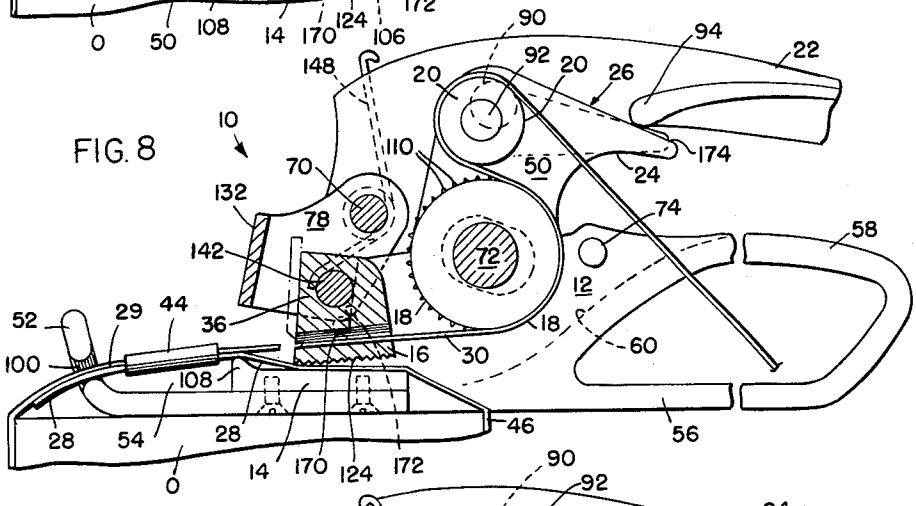
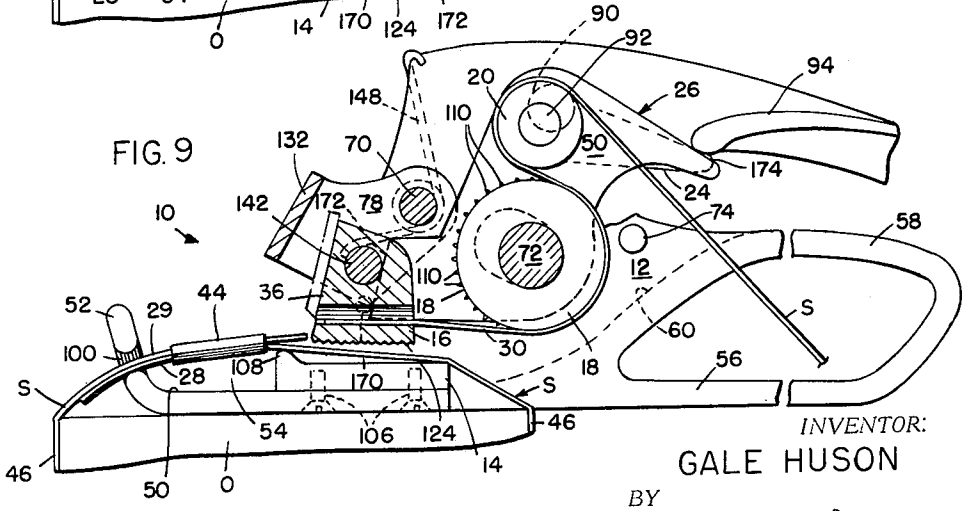


FIG. 9



INVENTOR:
GALE HUSON
BY
Edward R. Lounder

United States Patent Office

3,260,506

Patented July 12, 1966

3,260,506

GRIPPER MECHANISM FOR STRAPPING TOOLS

Gale Huson, Palatine, Ill., assignor to Signode Corporation, a corporation of Delaware

Filed Feb. 5, 1965, Ser. No. 430,646
9 Claims. (Cl. 254—51)

The improved gripper mechanism comprising the present invention has been designed for use primarily in connection with strapping tools which operate upon plastic strapping for tensioning or stretching such strapping about an object and thereafter sealing and severing the overlapping portions of the strapping. The invention is, however, not necessarily limited to use in connection with plastic strapping and gripper mechanisms constructed according to the principles thereof may, if desired, with or without modification as required, be employed in connection with strapping tools which are designed to operate upon steel or other metallic strapping. Irrespective however of the particular use to which the invention is to be put, the essential features thereof are at all times preserved.

Heretofore, in order to provide a reaction support or anchor for the free end of a length of plastic strapping at the time the strapping is tensioned or stretched about an object, it has commonly been the practice to provide a pivoted spring-pressed gripper foot which cooperates with an underlying gripper anvil for clamping such free end thereagainst by a self-energizing, wedging or binding action resulting from the tension in the strapping and which pulls the effective gripping area of the gripper foot toward the gripper anvil at a relatively small approach angle. Gripper mechanisms of this general type are possessed of numerous limitations and, principal among these, is the inability to secure an effectively wide gripping area between the gripper foot and the anvil, i.e. a gripping area which encompasses an appreciable longitudinal extent of the strapping. In an effort to provide such a wide gripping area, considerable experimentation has been conducted involving such variables as the effective length of the pivoted gripper finger or arm which carries the gripper foot, the approach angle which may be defined as the angle subtended by the longitudinal axis of the gripper arm and a plane normal to the general plane of the anvil, and the angle of incidence and emergence which may be defined as the angle subtended by the planar gripping surface of the gripper foot and the general plane of the anvil when the gripper foot is seated upon the strapping. Despite such experimentation, the width of the gripping area has, of necessity, remained relatively small.

For an effective binding action which is a prerequisite to gripper mechanisms of the type under consideration, it is essential that the approach angle (sometimes referred to as the energizing angle) be relatively small, for example not more than 15°. For maximum gripping contact with the strapping, utilizing a planar gripping area on the gripper foot, it is essential that the angle of incidence and emergence be approximately zero so that such planar gripping area will seat substantially squarely upon the strapping, if not initially, at least at such time as tension is first applied to the strapping. Assuming then a small angle of approach and a zero angle of incidence and emergence so that the gripper foot will seat squarely upon the strapping, if an effectively long gripper arm is employed, difficulty is encountered during the kick-out operation whereby the gripper arm is forcibly swung in a direction to withdraw the gripper foot from the strapping. Due to the small approach angle, the component of horizontal movement of the gripper foot is large while the component of upward movement thereof is small, the latter being a function of the sine of the angle involved.

Therefore, with a long gripper arm, a fairly long horizontal sweep will take place before the gripper foot finally leaves the strapping. If an effectively short gripper arm is employed, difficulty is encountered in getting the gripper foot to seat squarely upon the strapping when tension is first applied to the latter. Difficulty also is encountered in effecting the kick-out action. With a small angle of approach, the trailing edge of the gripper foot will intersect the plane of the strapping both during initial seating of the gripper foot and during unseating thereof at the time of kick-out, the tendency being to shear the strapping along the transverse line where the trailing edge of the gripper foot intersects the plane of the strapping.

From the above considerations, it will be appreciated that for each combination of gripper arm length and approach angle, there will be a gripper area which cannot be exceeded, either in the trailing direction or the leading direction of the gripper foot, and the net result of this has been to limit the width of the gripping area of the gripper foot to less than adequate proportions for proper frictional contact and minimum strapping distortion. To extend the gripping area in the trailing direction of the gripper foot would be to initiate the aforementioned strapping shearing. To extend the gripping area in the leading direction of the gripper foot would be to give the effect of an increased approach angle, ineffective for proper binding or wedging action.

The present invention is designed to overcome the above-noted limitations that are attendant upon conventional gripper foot design and mounting and, toward this end, the invention contemplates the provision of an articulated gripper mechanism which, instead of employing a single pivoted gripper arm, employs a gripper arm linkage consisting of an upper link which is pivoted to a fixed point on the gripping tool frame or chassis, and a lower gripper link which is pivoted to the free or distal end of the upper link and which, at its own free or distal end, carries the gripper foot proper. The two links, in effect, constitute a toggle joint which is effective between the pivot point for the upper link and the gripper anvil but in which the spreading action is attained, not by the application of force to the medial toggle pivot point, but by the tension of the strapping acting upon the gripper foot. The gripper foot has a relatively wide planar gripping area in the longitudinal direction of the strapping and the height of the lower gripper link which carries the gripper foot is small. Thus the gripper foot, being pivoted for independent swinging movement upon the upper link, when seated upon the strapping is possessed of an appreciable degree of stable equilibrium. The lateral pull exerted upon the gripping area of the gripper foot will therefore not upset this degree of stable equilibrium of the gripper foot and, since there is little tendency for the gripper foot to tilt because of the downward pressure which is applied to the gripper foot substantially midway between the leading and the trailing edges of the gripper foot, this lateral pulling force of the strapping will be translated to the pivot point between the upper and lower links and the latter will be forced inwardly of the toggle structure by the indirect application of lateral thrust thereto from the tension in the strapping operating through the gripper foot itself.

This indirect application of spreading force to the toggle joint lends a graduating clamping effect to the gripper foot which is not attainable with conventional pivoted gripper members. The lateral pull exerted upon the gripper foot by the tension in the strapping exerts a somewhat greater clamping effect in the trailing region of the gripper foot than is exerted in the leading regions of the gripper foot and thus, the gripper foot assumes a small angle with respect to the normal zero angle of

incidence and emergence, the angle being in effect a negative angle with the plane of the gripper foot being inclined slightly upwardly and rearwardly in the direction of the strap tensioning to provide the aforementioned so-called graduated clamping effect.

Because the gripper foot is pivoted for independent swinging movement on the upper link, it is readily movable into a square seating relationship on the strapping irrespective of the particular approach angle maintained by the upper gripper-supporting link. Its own approached angle, as well as its angle of incidence and emergence, may therefore be maintained at substantially a zero angle, regardless of the approach angle maintained by the upper link. In fact, the approach angle of the gripper foot need never deviate appreciably from a zero angle regardless of whether the gripper foot be seated upon or elevated from the strapping. The gripper foot is moved into initial contact with the strapping at such a zero approach angle and it is likewise lifted from the strapping at such a zero approach angle. Raising or lowering of the gripper foot from the strapping is effected solely by the swinging movement of the upper link. Furthermore, pressure of the gripper foot against the strapping is substantially uniform over the entire gripping area regardless of the degree of tension applied to the strapping and therefore there are no limitations upon the width of the gripping area in any direction other than those imposed by the design characteristics of the strapping tool.

The attainment of a zero angle of incidence and emergence of the gripper foot with respect to the plane of the strapping so that square seating of the gripper foot on the strapping will obtain has thus been divorced from any consideration of the approach angle of the lower link which is at all times maintained substantially at a zero angle except for the slight deviation thereof during tensioning of the strapping to produce the aforementioned graduated clamping effect. The degree of gripping pressure which is maintained by the gripper foot upon the strapping at any given instant is entirely a function of the approach angle of the upper link, coupled with the degree of tension in the strapping. The larger the approach angle of the upper link, the greater will be the component of upward lifting movement of the gripper foot during the initial kick-out operation and the smaller will be the horizontal component of movement thereof. Thus it is possible to use an approach angle for the upper link which is somewhat greater than is customary with single integral pivoted gripper arms so that there will be a larger component of vertical lifting of the gripper foot from the strapping at the time of initial kick-out. Because of the provision of the lower pivoted link which carries the gripper foot and which automatically maintains its own zero angle of approach, a mean effective approach angle for the gripper foot will be established, this angle being defined as the angle subtended by a plane perpendicular to the plane of the gripper anvil and a plane passing through the fixed pivot point for the upper link and the trailing edge of the gripper foot. This angle is smaller than the approach angle maintained by the upper link and it may be considered as the true energizing angle.

From the above description it will be appreciated that movement of the gripper foot both into and out of a square seating relationship with the strapping during initial tensioning thereof and during the kick-out operation is greatly facilitated due to the free floating nature of the lower gripper-supporting link. However, due to the relatively soft nature of the plastic strapping as distinguished from steel strapping, any kick-out force which is applied to the upper link alone, particularly where the approach angle of the latter link is sufficiently small as to present the necessary binding or wedging effect on the gripper foot, may not operate immediately to raise the gripper foot completely out of contact with the strapping. If strapping tension is high and the gripper foot has been pulled hard into the strapping so that it has sunk into or penetrated the strapping to any degree, however, slight, kick-out force applied to the upper link alone may serve to tilt the gripper foot and thus cause binding of the leading edge of the gripper foot against the strapping, thus giving rise to a shearing tendency as explained previously in connection with the trailing edge of conventional pivoted gripper arms. To obviate this condition, means are provided whereby, after an initial kick-out force has been applied to the upper gripper-supporting link and the latter has been moved through a small angle to impart an upward component of motion to the gripper foot sufficient to materially relieve the binding pressure, a second kick-out force is applied directly to the lower gripper-supporting link tending to straighten the same, i.e. to restore the angle of emergence to a zero angle, thus relieving all binding pressure of the gripper foot on the strapping, whereby the continuance of kick-out force to the upper link will lift the gripper foot bodily upwardly from the surface of the strapping, this latter lifting action being enhanced by an appreciable increase in the angle of approach which at this time has a large sine function so that further swinging movement of the upper link will entail a large component of upward movement of the gripper foot. By such an arrangement not only is a comparatively wider gripping area than has heretofore been possible with one-piece integral pivoted gripping elements made available, but comparative ease of gripper removal from the strapping is attained without damaging or appreciably defacing the strapping. Furthermore, the self-energizing or binding action associated with conventional pivoted gripper elements is preserved.

The provision of a gripper mechanism for strapping tools such as has briefly been outlined above being the principal object of the invention, numerous other objects and advantages, not at this time enumerated, will readily become apparent as the following description ensues.

In the accompanying two sheets of drawings forming a part of this specification, one illustrative embodiment of the invention has been shown.

In these drawings:

FIG. 1 is an end elevational view of an exemplary form of strapping tool, showing the improved gripper release mechanism of the present invention operatively applied thereto;

FIG. 2 is a top plan view of the structure shown in FIG. 1;

FIG. 3 is an enlarged fragmentary perspective view of a subassembly of parts including a combined gripper foot and cutter unit employed in connection with the present invention, together with the supporting means therefor;

FIG. 4 is an exploded perspective view of a portion of the structure shown in FIG. 3;

FIG. 5 is a perspective view of a kick-out cam employed in connection with the present invention;

FIG. 6 is a fragmentary sectional view taken substantially along the line **6—6** of FIG. 2 with certain parts removed in the interest of clarity; and

FIGS. 7, 8 and 9 are similar fragmentary sectional views, schematic in their representation, taken longitudinally through the strapping tool in the vicinity of the gripper foot and illustrating progressively the kick-out action by means of which the gripper foot is released from the tensioned strapping.

Referring now to the drawings in detail and in particular to FIGS. 1 and 2, a strapping tool embodying the improved gripper release mechanism of the present invention has been designated in its entirety at **10**. The tool **10** is a hand operated tool and it is merely exemplary of one form of strapping tool to which the gripper release mechanism may be applied. It will be distinctly

understood however that the gripper release mechanism of the present invention may, if desired, with or without modification as required, be applied to other forms of strapping tools, whether the same be hand or power operated. Irrespective of the particular form of strapping tool to which the gripper mechanism may be applied, the essential features of the invention are at all times preserved.

Briefly, the strapping tool **10** involves in its general organization a main frame or chassis **12** upon which all of the operating instrumentalities of the tool are operatively assembled. These instrumentalities include a fixed gripper anvil **14** (FIGS. 3 and 7) and a cooperating gripper foot **16**, a strap-tensioning wheel **18**, a cooperating hold-down roller **20**, and an operating lever **22** having a first range of swinging movement *a* (FIG. 7), a second range of swinging movement *b*, and a third range of swinging movement *c*. Within the first range *a*, movement of the operating lever **22** serves to actuate the strap-tensioning wheel **18** by means of a gear train **23** (FIGS. 1 and 2). Within the second range *b*, the lever **22** serves to actuate the hold-down roller **20**. Within the third range of movement *c*, the lever **22** serves to actuate certain gripper release mechanism the nature and function of which will be made clear presently, this latter mechanism constituting the principal feature of the present invention.

In applying the tool **10** to the strapping S, the operating lever **22** is moved from the range *a*, through the range *b* and into the range *c*. In moving through the range *b*, the lever actuates a cam **24** (FIGS. 6, 7 and 8) which raises the hold-down roller **20** out of cooperating engagement with the strap-tensioning wheel **18**. Within the range *c* the lever **22** is effective by means of a kick-out cam **26** (see also FIG. 5) to elevate the gripper foot **16** from the gripper anvil **14**.

With the hold-down roller **20** removed from the strap-tensioning wheel **18** and the gripper foot **16** elevated from the anvil **14**; the free end region **28** of the strapping S is then inserted sidewise within the space thus created between the gripper foot **16** and anvil **14** as shown in FIG. 7; the strapping S is passed around the object O and brought into overlapping relationship as shown at **29** with the free end region **28**; a medial region **30** of the strapping is then passed over the gripper foot **16** as shown in dotted lines, is partially wrapped around the tensioning wheel **18** and is introduced sidewise between the wheel **18** and hold-down roller **20**. If desired the strapping may be partially wrapped around the roller **20** so that the strapping assumes the position wherein it is illustrated in FIG. 7, the strapping S extending from the hold-down roller **20** to a suitable source of the strapping (not shown) positioned below the level of the tool **10**.

The operating lever **22** is then moved back into the range *a* and, upon leaving the range *c* the gripper foot **16** is lowered into gripping contact with the free end region **28** of the strapping S, thus clamping this region hard against the anvil **14**. In moving through the range *b*, the hold-down roller **20** is moved into cooperating clamping relationship with the tensioning wheel **18** to clamp the medial region or feed portion **30** of the strapping thereagainst. Then, in the range *a*, the operating lever **22** is rocked back and forth, thus actuating certain ratchet and pawl mechanism including an operating pawl **32** (FIGS. 1 and 2) carried by the handle **22** and a dual holding pawl assembly **34**, to advance the tensioning wheel **18** in a counterclockwise direction as indicated by the arrow in FIG. 7 in step-by-step fashion and thus pull the feed portion **30** of the strapping S to the right and tension the same about the object O.

As best seen in FIGS. 3 and 4, the gripper foot **16** is formed as an integral portion of a gripper block **36** and the latter has associated therewith a cutter assembly **38** including a cutter blade proper **40**, operable under the control of a lever **42** (FIGS. 1 and 2) to effect shearing of the excess portion of the strapping after the strapping has been tensioned about the object O. Prior to manipulation of the lever **42** for shearing purposes, a conventional seal **44** (FIG. 7) is applied to the overlapping portions **29** of the strap forwardly of the gripper anvil **14**. Then, with the lever **22** remaining in the range *a*, the lever **42** is actuated to cause the cutter blade **40** to shear the upper overlapping portion of the strapping S against the forward edge of the gripper foot **16**, thereby freeing the tensioned strapping from the source of strapping material and completing a circumscribed, tensioned and sealed strap **46** about the object O as indicated in full lines in FIG. 7.

Finally, to free the strapping tool **10** from the thus strapped object O, the operating lever **22** is returned to the range *c* and depressed as previously indicated to effect release of the gripper foot from its clamping cooperation with the gripper anvil **14** and from the strapping S. During such manipulation of the lever **22**, the kick-out cam **26** becomes effective in a novel manner that will be set forth in detail presently to raise the gripper block **36**, and consequently the gripper foot **16**, from the strap S with a minimum deformation and consequent minimum weakening of the strap in the vicinity of the gripped portion thereof. The strapping tool **10** may then be slid sidewise from the tensioned strap **46**.

Considering the tool **10** in greater detail, the chassis or framework **12** is preferably in the form of a casting including a flat base portion the forward region of which provides upwardly presented shallow tray-like support **50** on which the previously mentioned gripper anvil **14** is fixedly mounted. The area immediately above this support **50** and slightly rearwardly thereof constitutes the working area of the tool. A transverse wall **52** extends along the forward edge of the support **50** and a similar wall **54** extends along one longitudinal edge of the support. An elongated narrow extension **56** (FIG. 7) extends rearwardly from the support **50** in the general plane thereof and the rear end of this extension merges with an arched reentrant portion **58** which overlies the extension and, in turn merges with an upwardly and rearwardly inclined wall portion **60** of somewhat greater height than the height of the walls **52** and **54**. The extension **56** and arched portion **58** constitute, in effect, an integral handle which may be employed for transporting the strapping tool, and the upper arched portion **58** of which constitutes a reaction member adapted to be gripped by four fingers of the hand, while the operating lever **22** is engaged by the ball portion of the thumb so that, by a squeezing action, the handle may be depressed toward the base extension **56** during final movement of the handle in the range *c* thereof to bring the same to the position wherein it is illustrated in FIG. 9 for gripper foot-releasing purposes, all in a manner that will be described subsequently.

The longitudinal wall **54** merges gradually at **64** (FIG. 2) with an upstanding vertical side member **66**, the latter being offset outwardly of the wall **54**. The side member **66** is opposed by a second side member **68** which is positioned rearwardly of the base support **50** and is disposed between this base support and the arched portion **68** of the handle. The two upstanding side members **66** and **68** serve to support therebetween three transverse shafts **70**, **72** and **74** (see also FIG. 7). The shaft **70** is a fixed shaft and it constitutes a pivotal support for the proximate end of the operating lever **22** and for the proximate end of the cutter-actuating lever **42**. It also rotatably carries a combined idler and ratchet gear **76** associated with the previously mentioned gear train **23**. The shaft **70** further serves as a pivotal support for a gripper cradle **78**, the nature and function of which will be made clear presently. The shaft **72** constitutes the driving or feed shaft for the tensioning wheel **18**, the latter being fixedly secured to the shaft **72** alongside the support **68** and on the side thereof remote from the support **66**. The shaft **72** also carries a driving gear **80** which meshes with the

idler gear 76 as best seen in FIG. 2. The shaft 74 serves to support thereon a pair of holding pawls 82 and 84 which constitute the dual pawl assembly 34 and which are spring pressed as at 86 against the driving gear 80 and cooperate therewith in the usual manner of such holding pawls to prevent reverse rotation of the driving gear.

Rotatably carried in the upper region of the support 68 is an eccentric rock shaft 90 (FIGS. 1, 3 and 7) having a reduced eccentric extension 92 projecting laterally from the side support 68 and overlying the projecting end of the shaft 72. The hold-down roller 20 is freely and rotatably mounted on the eccentric extension 92 as best shown in FIGS. 1, 2 and 7. The eccentric rock shaft 90 serves to rotatably support the previously mentioned kick-out cam 26 while the cam 24 is fixedly secured to this shaft and is normally maintained in the dotted line position in which it is shown in FIG. 7 by means of a spring 25 (FIG. 2) which encircles the driving or feed shaft 72 and bears at its free end against the cam 26.

The operating lever 22 is formed with a laterally offset cam-engaging shoulder portion 94 which is capable of overlying both the cam 24 and the cam 26 and which moves into engagement first with the cam 24 as the operating lever 22 enters the range *b* after leaving the range *a*, and secondly with the cam 26 as the lever 22 enters the range *c* after leaving the range *b*. Thus it will be seen that during clockwise swinging movement of the lever 22 as viewed in FIG. 7, initial engagement and depression of the cam 24 by the shoulder 94 and actuation of the cam will cause orbital movement of the eccentric extension 92 in a direction to withdraw the hold-down roller 20 from clamping cooperating with the tensioning wheel 18 for insection of the strapping S between the roller and wheel or for release of the strapping at the end of a given strap severing operation as the case may be. Subsequent engagement and depression of the kick-out cam 26 by the shoulder portion 94 will serve to effect gripper release operations in a novel manner as schematically illustrated in FIGS. 7, 8 and 9 and which will subsequently be more fully described with reference to certain considerations which are peculiar to the handling of plastic strapping but which, to a lesser extent, may be prevalent where steel strapping is concerned.

As best seen in FIGS. 7, 8 and 9, the exposed end edge of the transverse wall 62 on the base support 60 is provided with a tapered slot 100 (see also FIG. 1) for reception therein of the overlapping portions of the strapping S at the time of initial installation of the strapping in the tool 10. This slot 100 serves to guide the strapping and align the same with the gripper anvil 14 and tensioning wheel 18. The gripper anvil 14 is in the form of a hardened steel plate of elongated rectangular configuration and having an outside bevelled edge 102 which constitutes, in effect, an extension of a similar bevelled edge 104 (FIG. 1) formed on the front side edge of the base support 50 so that the strapping may be readily guided into the working area of the strapping tool. The gripper anvil 14 may be removably secured in position on the upper surface of the support in any suitable manner, as for example by fastening screws 106. The forward edge of the anvil 14 is formed with a raised transverse rib 108 over which the strapping S passes and on which it is supported when the same is initially projected into the working area of the tool.

The medial region of the strapping passes around approximately 180° of the circumference of the tensioning wheel 18 before it makes its reentrant bend around the hold-down roller 20. The outer surface of the tensioning wheel 18 is provided with a multiplicity of relatively small protuberances 110 presenting sharp points and these protuberances offer an appreciable degree of frictional drag to the relatively soft plastic strapping S, especially when the hold-down roller 20 is lowered into contact with the tensioning wheel.

Referring now to FIGS. 3, 4 and 6, the gripper block 36 is generally of rectangular configuration and it is formed with a relatively deep slot 120 therein (see also FIG. 7), thus defining the gripper foot 16 which projects outwardly a slight distance beyond the front side face of the block 34. The front edge of the gripper foot 16 is bevelled downwardly as at 122 and cooperates with the upwardly bevelled edge 102 to establish a tapered guide channel for entry of the strapping into the working area of the tool at the time that initial strap installation is effected. The underneath clamping area of the gripper foot 16 is provided with a multiplicity of relatively small pointed protuberances 124 (FIG. 6) which are similar to the protuberances 110 on the tensioning wheel 18, these protuberances serving to enhance the frictional characteristics of the gripper foot on the plastic strapping S when the gripper foot is in its operative clamping position thereon.

The gripper cradle 78 is in the form of a swinging bracket of U-shape design and having parallel side wings 130 and 131 and a connecting bight portion 132. The side wings project upwardly above the bight portion 132 and a pair of aligned holes 134 (FIG. 4) are formed in the upper regions of these side wings for reception therethrough of the transverse supporting shaft 70. The cradle 78 is thus suspended from the shaft 70 with the side wings straddling the upstanding side member 68 of the tool framework or chassis 12. A circular boss 136 is formed on the side member 68 and, in combination with a stationary guide plate 138 which is supported on the shafts 70 and 72 (see also FIGS. 2 and 3), serves to space the side wing 131 laterally from the side member 68 proper. The guide plate 138 extends across the front end face of the tensioning wheel 18 and extends below the level of the latter, and slightly rearwardly thereof, thus serving as an edge guide for the strapping S which is partially wrapped around the wheel.

Still referring to FIGS. 3 and 4, the side wings 130 and 131 of the gripper cradle 78 are formed with a second pair of aligned holes 140 in the lower regions thereof for reception therethrough of an elongated pivot pin 142 which passes through a transverse bore 144 formed substantially centrally in the gripper block 36. The gripper block 36 is thus pivotally supported within the confines of the cradle 78 below the level of the suspension shaft 70, the shaft 70 and pin 142 establishing a dual pivot arrangement for the gripper block and by means of which the latter is floatingly suspended within the working area of the strapping tool 10. The cradle 78 thus, in effect, constitutes a supporting link for the gripper block 36, the upper end of the link being pivoted to the main frame or chassis 12 and the lower end of the link serving to pivotally support the gripper block. The pivot pin 142 is formed with a shoulder 146 (FIGS. 1 and 4) by means of which the gripper block 36 is maintained spaced from the side wing 130 of the cradle 78, thus affording a clearance space between the side wing 130 and gripper block 36. A coil spring 148 surrounds the suspension shaft 70 and has its opposite ends bearing against the pivot pin 142 and the cutter-actuating lever 42, thus serving the dual function of yieldingly biasing the lever 42 to its retracted position and of applying light spring tension to the gripper cradle 78 tending to urge the same in a counterclockwise direction as viewed in FIGS. 3 and 7 to the end that the gripper foot 16 will be yieldingly urged toward the gripper anvil 14 for strap-engaging purposes.

As previously stated, the cutter-actuating lever 42 has its lower or proximate end pivotally connected to the transverse shaft 70. The medial region of the lever 42 is formed with a curved cutter-engaging finger 150 which overlies the upper end of the cutter blade 40. The upper or distal end of the lever 42 is formed with a lateral operating finger 152 which is conveniently accessible for lever manipulating purposes. As best seen in FIG. 4, the cutter blade 40 is slidable on the front face of the cutter block 36 and is maintained slidingly in position

thereagainst by means of a retaining plate 154 having a guide channel 156 therein for the blade and held in position on the cutter block by fastening screws 158. A spring 160 maintains the cutter blade in an elevated retracted position. The cutter blade 40 is adapted to be depressed under the influence of the lever 42 against the yielding action of the spring 160 and, when so depressed, an inclined shearing edge 162 formed on the cutter blade cooperates with the forward edge of the gripper foot 16 to sever the strapping in the working area of the tool and which extends through the slot 120 in the gripper block 36.

Referring now to FIGS. 3, 4 and 7, the cutter block 36 is provided with a laterally projecting kick-out pin 170 (see also FIG. 6) which projects outwardly from the lower regions of the inside face of the block and which underlies the pivot pin 142. Both the kick-out pin 170 and the pivot pin 142 are positioned in the path of movement of the leading edge 172 (FIG. 6) of the kick-out cam 26 and are adapted to be engaged thereby during rocking movement of the cam under the influence of the shoulder 94 provided on the operating lever 22. The kick-out cam 26 is formed with a trailing edge region 174 (FIG. 5) which is engaged by the shoulder 94 of the lever 22 when the latter is disposed within the operating range *c*. It also is formed with an opening 176 therethrough by means of which it is pivotally mounted on the eccentric rock shaft 90. A clearance slot 177 is formed in the medial region of the cam 26 and receives the tensioning wheel drive shaft 72 therethrough.

It is to be noted at this point that when the gripper foot 16 is seated squarely upon the strapping S as shown in FIG. 7, the pivot pin 142 is disposed a slight distance forwardly from the vertical plane passing centrally through the supporting shaft 70 and normal to the gripper anvil 14 so that a small angle is subtended between this plane and the inclined plane passing through the longitudinal axes of the shaft 70 and pin 142. This angle (designated at θ in FIG. 7) is critical only within fairly wide limits and it has been found that an angle on the order of 15° will give optimum gripper action during strap-tensioning operations as will be described in detail when the operation of the strapping tool 10 is set forth. It is also to be noted that the spring 148 which, as previously stated, biases the gripper cage 78 in a counterclockwise direction is a relatively light spring and its function is merely to hold the gripper foot 16 initially in seating engagement with the strapping S. This spring has little effect on the gripping action of the gripper foot 16, the effectiveness of the latter during tensioning of the strapping S being the result of a self-energizing gripping action which takes place automatically due to the relatively small approach angle θ and the magnitude of which is an inverse function of the sine of such angle.

In the operation of the strapping tool 10, the tool is loaded in the manner previously described so that the overlapping free end and feed end portions of the strapping pass through the slot 100 in the transverse rib or wall 52 with the underlying or free end portion resting upon the transverse rib 108 at the forward edge of the anvil 14 and with the overlying or feed end portion passing through the slot 120 in the gripper block 36 and then extending around the underneath side of the tensioning wheel 18 and between this wheel and the hold-down roller 20 as shown in the dotted line illustration of the strapping in FIG. 7. The gripper foot 16 and hold-down roller 20 are maintained elevated by depression of the operating lever 22 in the range *c* as set forth previously. Depression of the operating lever 22 is facilitated by a hand gripping operation wherein the lever 22 and reentrant arched portion 58 of the base extension 56 are "squeezed," so to speak, utilizing four fingers of the hand and the ball portion at the base of the thumb. Upon release of the operating lever 22, the gripper foot 16 will seat squarely upon the strapping S under the influence of the spring 148, while the hold-down roller 20 will be restored to its normal strap-clamping position as shown in dotted lines in FIG. 7 under the influence of the spring 25 which operates through the cam 24 to bias the eccentric rock shaft 90 in a counterclockwise direction. The strapping S is then tensioned about the object O undergoing strapping by rocking the lever 22 in the range *a* as also set forth previously, the seal 44 applied and the lever 152 actuated to effect the cut-off operation, after which the severed strap 46 assumes the full line position wherein it is shown in FIG. 7.

During the tensioning operation and prior to application of the seal 44, the tensioning wheel 18 serves to pull the excess portion 30 of the strapping S in the direction indicated by the horizontal arrow in FIG. 7, thus tightening the strapping about the object O and applying tension to the strap 46 tending to pull the same in the direction indicated by the inclined arrow in this view. Due to the relatively long span of the underneath gripping surface of the gripper foot 16 in the longitudinal direction of the strapping S, due to the high coefficient of friction which obtains over the entire gripping area of the gripper foot 16, and due to the fact that the pivot pin 142 exerts a relatively great vectorial component of downward thrust upon the gripper foot at its mid-region by reason of the small magnitude of the approach angle θ as previously explained, the tendency is for the gripper foot 16 to remain squarely seated upon the strapping despite the magnitude of the pull exerted upon the strapping. The greater the tension in the strapping, the greater will be the downward thrust exerted by the pivot pin 142 on the mid-region of the gripper block and, since the gripper block is pivoted on the pivot pin 142, it possesses an appreciable degree of stable equilibrium and will not tilt away from its squarely seated position on the strapping. The latter will thus remain firmly clamped against the upper face of the anvil 14 over a large area thereof.

The stability of the gripper block when seated on the strapping may be enhanced by employing an approach angle θ which is sufficiently small that a plane passing through the pivotal axes of the shaft 70 and pin 142 will intersect the clamping area of the gripper foot as shown in FIG. 7.

This seating of the gripper foot 16 squarely upon the strapping S at the time that tension is applied to the latter constitutes one of the salient features of the present invention and it may be explained in somewhat different terms by stating that the pivot pin 142, constitutes a floating pivotal axis for the gripper block, this axis being capable of a limited range of swinging movement in an arc about the fixed axis of the pivot shaft 70. When tension is applied to the strapping S by the tensioning wheel 30, torque is applied to the gripper block 36 tending to rotate the same in a counterclockwise direction. However, since the gripper block 36 is in engagement with the strapping over a large surface area thereof and is initially held in such engagement under the influence of the spring 148, the pulling force applied to the gripper block and which, in the absence of the floating pivot pin 142, would ordinarily tend to rotate the gripper block, is now applied to the floating pivot pin 142 which causes the gripper cradle 78 to swing in a counterclockwise direction so that the pin 142 will exert a powerful downward thrust upon the gripper block at a mid-region thereof. This downward thrust is effective between the vertical planes of the forward and rear transverse lower edges of the gripper foot 16 to maintain stability of the gripper block against the strapping without tilting of the gripper block. The longer the longitudinal extent of the effective gripping area of the gripper foot 16, the greater will be the stability of the gripper foot against the strapping S. In this manner equalization of the gripping pressure exerted upon the strapping over the entire gripping area will be attained and there will be no tendency for shearing of the strapping S by the trailing edge of the gripper foot 16 when the latter is lowered into contact with the strapping S and tension is initially applied to the latter, or, as will be explained subsequently, by the leading edge

of the gripper foot when the gripper foot is lifted from the strapping during kick-out or release operations.

Gripper release operations according to the present invention are effected by swinging the operating lever 22 from the range *a* (FIG. 7) completely through the range *b* to release the hold-down roller 20 and into the range *c*, and thereafter depressing the lever 22 within this latter range, utilizing the arched reentrant portion 58 of the base extension 56 as a reaction member for the handle "squeezing" operation as previously set forth. Upon entering the range *c*, the shoulder 94 of the operating lever 22 engages the trailing edge region 174 of the kick-out cam 26 and depresses the same, thus moving the leading edge 172 of the cam in a forward direction, i.e. to the left as viewed in FIG. 7, so as to shift the position of the pivot pin 142 and cause the gripper cradle 78 to be swung bodily as a unit in a clockwise direction. Such movement of the gripper cradle 78 serves to increase the magnitude of the angle θ. At this time, the leading edge 172 of the cam 26 is out of engagement with the laterally projecting pin 170 (FIG. 7) on the gripper block 36 and therefore swinging movement of the gripper cradle 78 is effected solely by the camming action which takes place between the leading edge 172 of the cam 26 and the pivot pin 142.

It will be appreciated that at the time that the leading edge 172 initially effectively engages the pivot pin 142, the gripper foot 16 is seated squarely upon the strapping S and the strap is under full working tension. The small pointed protuberances 124 on the gripper foot 16 are all in intimate contact with the strapping and the clamping force of the gripper foot is distributed throughout the entire effective area of the gripper foot extending from the forward edge of the foot to the rear edge thereof. Since the magnitude of the angle θ at this time is small, shifting movement of the pivot pin 142, and consequently of the gripper block 36 as a whole, will be largely in a horizontal direction with only a small component of vertical or lifting movement being involved due to the small magnitude of the sine of the angle θ. Thus there will be an initial tendency for the gripper block 36 to tilt in a counterclockwise direction about the axis of the pivot pin 142 by reason of its tractional engagement with the strap 46 which, having been severed from the strapping S and sealed, is now in a state of equilibrium and is devoid of the unilateral tension formerly offered by the tensioning wheel 18. However, this tilting of the gripper block 36, as illustrated in FIG. 8 in a somewhat exaggerated manner, is of short duration inasmuch as further rocking movement of the kick-out cam 26 will bring the leading edge 172 of the cam into engagement with the laterally projecting pin 170 and this leading edge, then in contact with both the pivot pin 142 and laterally projecting pin 170, will terminate the tilting movement of the gripper block 36 while further swinging movement of the gripper cradle 78 will serve to elevate the gripper block 36 bodily as a unit from the strap. This elevation of the gripper block 36 is a result of the increase in the magnitude of the angle θ and the consequent increase in the sine function thereof whereby a larger increment of vertical shifting movement of the pivot pin 142 and a smaller increment of horizontal shifting movement thereof obtains. The underneath gripping surface of the gripper foot 16 thus is elevated from the strap in a uniform manner, all points on this surface moving substantially vertically in unison with negligible binding against the strap because the tendency for the free floating gripper block 36 to tilt is completely arrested by reason of the engagement between the laterally projecting pin 170 and the leading edge 172 of the kick-out cam 26.

The hold-down roller 20, at this time being free from the tensioning wheel 18, leaves the excess region 30 of the strapping free and the strapping tool 10 may thus readily be shifted bodily as a unit laterally so that the strap 46 will be withdrawn from the slot 120 in the gripper foot 36 and the strapping S withdrawn from between the hold-down roller 20 and tensioning wheel 18.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Therefore, only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention, what I claim and desire to secure by Letters Patent is:

1. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil adapted to underlie said free end portion, means for applying tension to said feed end portion, a gripper member movable toward and away from said anvil into and out of clamping engagement with the strapping thereon, and a link pivoted at its upper end to said framework and at its lower end to said gripper member whereby the gripper member is floatingly suspended from the framework by said link, the combined effective lengths of said link and gripper member being greater than the distance between the point of pivotal connection for the link on the framework and the anvil.

2. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil having a planar horizontal gripping surface adapted to underlie said free end portion, a gripper foot having a planar gripping area designed for cooperation with said gripping surface of the anvil for clamping the free end portion of the strapping against said gripping surface, means for applying tension to said feed end portion of the strapping, and means for floatingly supporting said gripper foot from the framework for movement bodily toward and away from said anvil and comprising an upper link having its upper end pivoted to the framework, and a lower link pivoted at its upper end to the free end of the upper link, said gripper foot being fixedly carried at the lower end of said lower link, the combined effective lengths of said links being slightly greater than the distance between the point of pivotal connection for the link on the framework and anvil whereby a small approach angle will be subtended by the upper link and a plane normal to said gripping surface when said gripping area of the gripper foot is seated squarely on the strapping, the effective width of said gripping area in the direction of strap tensioning and its placement on the lower link being such that the tension in the strapping will draw the gripper foot in the direction of strap tensioning and be effective through the lower link to swing the upper link in a direction to decrease said approach angle and apply downward pressure to the lower link, thus establishing progressively increasing binding pressure on the strapping by said gripper foot.

3. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil having a planar horizontal gripping surface adapted to underlie said free end portion, a gripper foot having a planar gripping area designed for cooperation with said gripping surface of the anvil for clamping the free end portion of the strapping against said gripping surface, means for applying tension to said feed end portion of the strapping, and means for floatingly supporting said gripper foot from the framework for movement bodily toward and away from said anvil and comprising an upper link having its upper end pivoted to the framework, and a lower link pivoted at its upper end to the free end of the upper link, said gripper foot being fixedly carried at the lower end of said lower link, the combined effective lengths of said links being slightly greater than the distance between the point of pivotal connection for the link on the framework and anvil whereby a small approach angle will be subtended by the upper link and a plane normal to said gripping

surface when said gripping area of the gripper foot is seated squarely on the strapping, the longitudinal axis of the upper link intersecting said planar gripping area of the gripper foot when the latter is seated squarely on the strapping whereby the leading and trailing edges of said gripping area will lie on opposite sides of the vertical transverse plane passing through the point of pivotal connection between the two links to the end that the tension in the strapping will be effective through the gripper foot and lower link to swing the upper link in a direction to decrease said approach angle and apply downward pressure to the lower link, thus establishing progressively increasing binding pressure on the strapping by the gripper foot and maintaining stability of the gripper foot on the strapping.

4. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil having a horizontal gripping surface and adapted to underlie said free end portion, means for applying tension to said feed end portion, a gripper member movable toward and away from said anvil into and out of clamping engagement with the strapping thereon and provided with a planar gripping area thereon opposing said anvil, a link pivoted for swinging movement at its upper end to said framework and at its lower end to said gripper member whereby the gripper member is floatingly suspended from the framework by said link, the combined effective lengths of said link and gripper member being slightly greater than the distance between the point of pivotal connection for the link on the framework and the anvil whereby a small approach angle will be subtended by the upper link and a plane normal to said gripping surface, the effective width of said gripping area in the direction of strap tensioning being sufficient to lend a degree of stable equilibrium to the gripper member when the gripping area is seated squarely upon the strapping and downward pressure is applied to the gripper member by said upper link due to swinging movement of the link in a direction tending to decrease said approach angle.

5. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil adapted to underlie said free end portion, means for applying tension to said feed end portion, and means effective between a fixed point on the framework and the anvil establishing a toggle joint including upper and lower toggle links having their inner ends pivotally connected together, the outer end of the upper link being pivoted to the framework at said fixed point and the outer end of the lower link being formed with a planar gripping area opposing said anvil and designed for clamping cooperation with the anvil to bind the strapping thereagainst due to the spreading action of the toggle joint, said toggle joint being self-energizing under the influence of tension in the strapping operating through the lower toggle link upon the pivotal connection between the toggle links.

6. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil adapted to underlie said free end portion, means for applying tension to said feed end portion, means effective between a fixed point on the framework and the anvil establishing a toggle joint including upper and lower toggle links having their inner ends pivotally connected together, the outer end of the upper link being pivoted to the framework at said fixed point and the outer end of the lower link being formed with a planar gripping area opposing said anvil and designed for clamping cooperation with the anvil to bind the strapping thereagainst due to the spreading action of the toggle joint, said toggle joint being self-energizing under the influence of tension in the strapping operating through the lower toggle link upon the pivotal connection between the toggle links, a kick-out member mounted on the framework and movable between a retracted position wherein it is out of effective engagement with said toggle joint and an advanced position wherein it is effective against said toggle links to collapse the toggle joint and forcibly raise said gripping area from the tensioned strapping on the anvil, and means for moving said kick-out member between its advanced and its retracted positions.

7. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil adapted to underlie said free end portion, means for applying tension to said feed end portion, means effective between a fixed point on the framework and the anvil establishing a toggle joint including upper and lower toggle links having their inner ends pivotally connected together, the outer end of the upper link being pivoted to the framework at said fixed point and the outer end of the lower link being formed with a planar gripping area composing said anvil and designed for clamping cooperation with the anvil to bind the strapping thereagainst due to the spreading action of the toggle joint, said toggle joint being self-energizing under the influence of tension in the strapping operating through the lower toggle link upon the pivotal connection between the toggle links, a kick-out member mounted on the framework and movable between a retracted position wherein it is out of effective engagement with said toggle joint, through an intermediate position wherein it effectively engages the upper toggle link and swings the same in a direction to increase said approach angle and relieve the binding pressure of the gripping area on the strapping, to a fully advanced position wherein it additionally effectively engages the lower toggle link and arrests swinging movement of the latter in the direction of strap tensioning while simultaneously further swinging the upper toggle link to still further increase said approach angle and effect raising of the gripper foot out of contact with the strapping on said anvil.

8. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil adapted to underlie said free end portion, means for applying tension to said feed end portion, means effective between a fixed point on the framework and the anvil establishing a toggle joint including upper and lower toggle links, a pivot pin pivotally connecting the inner ends of said toggle links together, the outer end of the upper link being pivoted to the framework at said fixed point and the outer end of the lower link being formed with a planar gripping area opposing said anvil and designed for clamping cooperation with the anvil to bind the strapping thereagainst due to the spreading action of the toggle joint, said toggle joint being self-energizing under the influence of tension in the strapping operating through the lower toggle link upon the pivotal connection between the toggle links, and a kick-out pin on said lower toggle link medially of its ends, a kick-out member mounted on the framework and movable between a retracted position wherein it is out of effective engagement with said toggle joint, through an intermediate position wherein it engages said pivot pin and swings the upper toggle link in a direction to decrease the approach angle and relieve the binding pressure of the gripping area on the strapping, to a fully advanced position wherein it additionally engages said kick-out pin and arrests pivotal movement of the lower toggle link in the direction of strap tensioning while simultaneously further swinging the upper toggle link to still further increase said approach angle and effect raising of the gripper foot out of contact with the strapping on said anvil.

9. In a strapping tool for tensioning a loop of strapping about an article, said loop having a free end portion and a feed end portion, a framework including an anvil having a gripping surface adapted to underlie said free end

portion, means for applying tension to said feed end portion, a gripper block having an underneath planar gripping area thereon designed for cooperation with said anvil for clamping the free end portion of the strapping against said gripping surface, means for applying tension to said feed end portion of the strapping, means for floatingly supporting said gripper block from the framework for movement bodily toward and away from said anvil and comprising a generally U-shaped cradle having parallel side wings and a connecting bight portion, a supporting shaft projecting through the upper distal end regions of said side wings and a portion of the framework and serving to pivotally support the cradle for swinging movement toward and away from said anvil, said gripper block being nested within the confines of said gripper cradle between said side wings, a pivot pin projecting through said side wings in the lower region thereof parallel to and below the level of said supporting shaft and through said gripper block and serving to pivotally support the gripper block on the cradle, the combined effective distances between the supporting shaft and pivot pin and between the pivot pin and gripping area being slightly greater than the distance between the supporting shaft and gripping surface of the anvil whereby the cradle and gripper block, in effect, constitute a toggle joint effective between the framework and anvil by a spreading action to bind the strapping against the gripping surface of the anvil, the common plane passing through said supporting shaft and pivot pin intersecting said gripping area when the latter is seated squarely upon the strapping whereby the leading and trailing edges of the gripping area will lie on opposite sides of the vertical plane passing through

the pivot pin to the end that tension in the strapping will be effective through the gripper block to swing the gripper cradle downwardly toward the anvil and exert a downward pressure upon the gripper block, thus progressively increasing binding pressure on the strapping by the gripper area while maintaining stability of the gripper block on the strapping, a kick-out pin projecting laterally from said gripper block below the level of said pivot pin, and a kick-out member mounted on the framework and movable between a retracted position wherein it is out of effective engagement with said pivot pin and kick-out pin, through an intermediate position wherein it engages the pivot pin and swings the gripper cradle in a direction counter to the direction of strap tensioning to relieve the binding pressure of the gripping area on the strapping, to a fully advanced position wherein it additionally engages said kick-out pin and arrests pivotal movement of gripper block in the direction of strap tensioning while simultaneously still further swinging the gripper cradle in a direction counter to strap tensioning to raise the gripper block out of contact with the strapping on said anvil.

References Cited by the Examiner

UNITED STATES PATENTS

2,368,969	2/1945	Cleveland.	
2,796,891	6/1957	Mathewson	140—93.4
2,941,782	6/1960	Winkler	254—51
3,083,742	4/1963	Orme	254—51 X

WILLIAM FELDMAN, *Primary Examiner.*

M. S. MEHR, *Assistant Examiner.*