Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).
Description

[0001] This invention pertains to a strapping tool of the type used to apply a steel strap in a tensioned loop around a package which joins the strap through a series of interlocking joints that are comprised of interlocking shoulders punched into the overlapping ends of the strap by internal tooling punches so as to seal-lessly join the strap ends. This invention provides an improved punch design which increases the wear life of the punch and facilitates de-coupling between the punch and strap after the shoulders are formed.

[0002] Strapping tools of a type in wide-spread use are designed to tension the overlapped ends of a steel strap which are drawn from a supply and are wrapped around a package or load before interlockable shoulders are punched into the overlapped ends of a steel strap, wherein they are then cut from the supply. When the tool releases the joined straps from the tool, a tightly tensioned loop having such punched, interlocking shoulders is formed. A strapping tool of the type noted above and having a punch in accordance with the preamble of appended claim 1 is exemplified in US-A Patent No. 4,825,512.

[0003] DE 1,225,543B discloses a strapping tool in which the punch is transversely domed. The overlapping steel strap portions are pressed into the domed configuration during the punching operation. Subsequent to release from the punch assembly, the curvature of the strap flattens, so that the interlocking shoulders expand, thereby preventing disengagement of the two straps.

[0004] Most of the strapping tools of the type noted above are electrically or pneumatically powered and have separate motors for respectively tensioning the overlapped ends of the straps together and for punching and cutting the straps, while manually operated versions use lever-action to perform these same functions. Also typical of such tools is the availability of differing sizes of said tools to match varying widths and thicknesses of the steel strap. For example, it is common for straps of the type mentioned to have either 1/2 inch, 5/8 inch or 3/4 inch (12,15,18mm) widths and respective strap thicknesses of 0.015 inch to 0.025 inches (0.38 to 0.64mm) . Recent trends have found much broader applications for such strapping and binding operations, and as a result, a necessity to use straps which are thicker, namely 0.025-0.031 inches (0.64 to 0.79mm), are needed to withstand the forces of larger loads.

[0005] With thicker strap requirements, it is critical to provide strapping tools which completely form the punched interlocking shoulders in order to ensure a full sealing of the straps; otherwise, a partially punched joint will compromise the integrity of the sealed package. However, it has been discovered that with the thicker gauge straps, more force per square inch is required to completely stamp the joints through both of the straps and such operation has been detrimentally affecting the strapping tool internal punches. Figure 2 illustrates a perspective view of two straps having been punched and sealed together by the above-mentioned strapping tool. One familiar with punch and die operations can appreciate that when forming the short shoulders 18, 20 of the interlocking joint 16, a highly concentrated stamping load is experienced on the corresponding punch surfaces that form the shoulders. Moreover, those stamping forces are highly concentrated over a very small punch surface area. As a result of the concentrated punch stresses, the punch surfaces become spalled, thereby compromising the formation of the interlocking shoulders.

[0006] Another problem with the thicker straps is related to the higher tensioning loads that interlock the straps together after the joints are punched and released. As will become clearer later, the punched strap shoulders vertically scrape against corresponding edges on the punch as a result of the higher tensioning loads, eventually leading to spalling of the corners of the punch shoulders.

[0007] According to this present invention a punch for use with a die in a strapping tool that joins superposed upper and lower strap ends through the formation of a series of longitudinally displaced interlocking shoulders stamped into each of said strap ends, said punch defined by a planar bottom wall, a top wall, a first and a second end wall interconnecting said top and bottom walls, and a first and a second side wall interconnecting said top, bottom and end walls, said connection between said top and side walls defining a respective first and second top edge, and each of said side walls having a plurality of opposed and like protuberances projecting therefrom and extending between said top and bottom walls, in use, said protuberances forming said interlocking shoulders in said strap segments, each of said protuberances formed by at least one short wall and at least one long wall, said short wall disposed at a generally acute angle with respect to a longitudinal direction, said long wall disposed generally parallel to said side wall, wherein said long wall and short wall form a generally Z-shaped slit in said strap segments when said punch interacts with said die, characterised in that said top wall along said short wall of each of said protuberances has a chamfer formed on it and extending in a downwards direction to the top edge to provide an extended top edge surface which is not prone to spalling when said punch forms said interlocking shoulders.

[0008] The relieved shoulders eliminate highly concentrated compressive loads on the punches by distributing those same loads over a broader surface area. Furthermore, the relieved shoulders reduce the severity of the scraping action occurring along the punch edges and the corners when the interlocking joints are removed from the punch.

[0009] Particular embodiments of the invention will now be described with reference to the accompanying drawings; in which:-
[0010] As shown in Figure 1, a strapping tool or machine 5 of the type noted above is shown with two ends of steel strap inserted therein for joining together. The strapping tool 5 is used for applying the steel strap 12 in a tensioned loop around a package 10 by joining the two strap ends by means of several interlocking joints 16, as best seen in Figure 2. A die (not shown) and punch 50 arrangement within the bottom of strapping tool 5 are part of a mechanism for admitting the overlapped end 32 into the tool, before the superposed strap ends are mechanically self-tensioned by one of two internal motors (not shown). The second motor controls operation of the punch and die arrangement so as to retain the overlapped ends and to simultaneously stamp a series of interlockable shoulders into each strap. Once the stamping operation is completed, the overlapped straps are now seal-lessly joined together and are released from tool 5.

[0011] Turning attention now to Figure 2, it is seen that strap 12 now has a wave-like appearance immediate in the strap area that was exposed to the stamping operation; this appearance is the result of the punch and die interaction and has functional significance in the operation of the interlocking of the straps, as will become clearer shortly.

[0012] In accordance with known practice, the seal-less strap connection comprises six corresponding joints 16 which are arranged in side-by-side pairs so as to form two longitudinal rows. When viewing Figure 3, it is seen that each joint 16 is defined by a similar Z-shaped slit 22 formed into upper strap end 12 and lower strap end 14, of which a part of said Z-shape is downwardly configured during the stamping operation so as to create the wave-like appearance seen in Figure 2. Each joint 16 is comprised of a short shoulder 18 and a long shoulder 20. It should be understood that reference characters 18 and 20 will refer to shoulders of the joint formed in the upper strap end 12, while the reference characters 24 and 26 will refer to the short and long shoulders of the joint formed on the lower strap end 14. The above described shoulders on each strap segment are adapted to interlock with each other when the segments are released under tension by tool 5, thereby longitudinally shifting ends 12 and 14 with respect to each other so that, the Z-shaped joints 16 interlock together and form the seal-less joint. Figure 4 illustrates a longitudinally shifted set of strap ends 12, 14, where joints 16 are shown "locked". The wave-like profile in the joined straps (Figure 2) helps to promote and maintain the interlocking of the shoulders.

[0013] Figure 6 is intentionally shown positioned below Figure 4 so that a general correlation can be made between the punch surfaces and the Z-shaped slits, as well as the wave-like profile remaining in the straps after stamping. Figure 7 is a side view of the punch of Figure 5, and it is seen that punch 50 has a generally planar bottom surface 60 for attaching to machine 5 through guidepins and screws (not shown) which respectively interact with throughbores 65 and threaded holes 67; these holes pass from bottom wall 60 to top surface 52. The top wall 52 is defined by a series of arcuate, interconnecting segments 53 that also interconnect with side walls 62 and end walls 64. The side walls each have opposed protuberances formed thereon which are defined by a long wall 58 and a short wall 56. The long and short walls also define respective long and short top edge surfaces 57, 55 where top wall 52 joins side walls 62. When punch 50 and the die (not shown) interact, it can be appreciated that the superposed strap ends 12, 14 are physically stamped so as to be advanced downwardly against top surface 52, and correspondingly against punch short and long edges 55, 57 of short and long walls 56, 58, respectively. When fully compressed against punch top surface 52, each punch short edge and long edge 55, 57, cuts the Z-shaped slit simultaneously into each of upper and lower strap ends 12, 14.
As was previously disclosed, however, when strap thicknesses are increased, the compressive forces necessary to shear each strap into a Z-shaped slit becomes substantial. As Figure 5 illustrates, a highly concentrated compressive load occurs at the outer corners. In particular, edges 55 and 57 experience extreme line-loaded compressive forces, especially along the relatively shorter edges 55, causing them to become spalled after a relatively short period of use. The spalled edges entirely compromise the integrity of the seal-less joints.

Relatively, it was also discovered that even if the punches are not spalled from stamping, the straps will nevertheless experience difficulties in de-coupling or releasing from the punch after stamping is performed; this condition is mainly experienced when the strap thickness is between 0.025 and 0.031 inches (0.64 and 0.79mm). Over time, it was also found that the de-coupling problems also lead to spalling of edges 55 and 57, especially at the corners, designated by the letter C, where the two edges meet. By viewing Figure 8, it is seen that as the stamped strap is pushed upwardly and off punch 50 by a lifting device in strapping machine 5, the edge of the newly-cut strap severely scratches against the punch at the outer corners, caused by the high tensile force (up to 2000 lbs or 1000kg) held on each strap, causing chipping and spalling at the 90° corners C.

In order to overcome the above-described difficulties, punch 50 was provided with relieved corners C’, which are defined by relieved or extended short and long edges 55’ or 57’ on each of the walls 56 and 58 that were shown in Figure 6, as best seen from viewing Figures 9 and 10. When comparing the punch of the present invention (Figure 9) to the prior art punch that experiences spalling (Figure 6), it is seen that the short edges 55’ and a part of the long edges 57’ now include a much wider edge surface. In this way, the extreme compressive stamping forces are no longer concentrated only along the discrete outside edge of the punch. Rather, they are now distributed along a much larger edge surface area, and as Figure 11 illustrates, the cutting of the slits actually starts towards the inside corners D’ of the punch, where stronger, and larger edge surfaces lie. Relief of these surfaces thereby eliminates the spalling problems caused solely by stamping. Furthermore, as Figure 12 shows, whenever the edges are relieved, a less acute angle (less than 90°) is formed on the punch, also favorably eliminating the chipping and spalling problems related solely to the strap tensioning forces during strap release. As Figure 10 shows, it is preferable to provide said relief at an angle θ of up to 10°, and to a depth X of about 0.015 inches (0.38mm). In this way, stamping forces are now distributed across the wider surface edge area W, without compromising the ability of punch 50 to properly form the Z-shaped slits that eventually create each joint 16. It should be clear that the angle is greater than 10°, the relief surface edge area W will become smaller.

**Claims**

1. A punch (50) for use with a die (50) in a strapping tool that joins superposed upper and lower strap ends (12,14) through the formation of a series of longitudinally displaced interlocking shoulders (16) stamped into each of said strap ends (12,14), said punch (50) defined by a planar bottom wall (60), a top wall (53), a first and a second end wall (62) interconnecting said top and bottom walls (60), and a first and a second side wall (62) interconnecting with said top (53), bottom (60) and end (64) walls. Said connection between said top (53) and side (62) walls defining a respective first and second top edge (55,57), and each of said side walls (62) having a plurality of opposed and like protuberances projecting therefrom and extending between said top (53) and bottom (60) walls, in use, said protuberances (12,14) forming said interlocking shoulders (16) in said strap segments (12,14), each of said protuberances formed by at least one short wall (56) and at least one long wall (58), said short wall (56) disposed at a generally acute angle with respect to a longitudinal direction, said long wall (58) disposed generally parallel to said side wall (62), wherein said long wall and short wall form a generally Z-shaped slit (16) in said strap segments (12,14) when said punch (50) interacts with said die (5), characterised in that said top wall (53) along said short wall (56) of each of said protuberances has a chamfer (55,57) formed on it and extending in a downwards direction to the top edge (55,57) to provide an extended top edge surface which is not prone to spalling when said punch (50) forms said interlocking shoulders (16).

2. A punch according to Claim 1, wherein said chamfer (55,57) is cut into each said protuberance short wall (56) in a like fashion, said chamfer (55,57) formed at an acute angle θ from said top wall (53) of said punch.

3. A punch according to claim 2, wherein said chamfer (55,57) extending downwardly from said top wall such that said acute angle θ is no greater than 10°.

4. A punch according to any one of the preceding claims, wherein said chamfer (55,57) is provided solely on said short and long walls (56,58) of said punch.

5. A strapping machine including a punch in accordance with any one of the preceding claims.

**Patentansprüche**

1. Stempel (50) zur Verwendung mit einer Matrize (50)
in einem Umreifungswerkzeug, das übereinanderliegende obere und untere Bandenden (12, 14) durch Bildung einer Reihe in Längsrichtung ver- setzt, ineinandergreifender Schultern (16) verbin- det, die in jedes der Bandenden (12, 14) gestanzt sind, wobei der Stempel (50) durch eine ebene un- tere Wand (60), eine obere Wand (53), eine erste und eine zweite Stirnwand (64), welche die obere und untere Wand (60) verbinden, und eine erste und eine zweite Seitenwand (62), welche die obere Wand (53), die untere Wand (60) und die Stirnwän- de (64) verbinden, definiert ist, wobei die Verbin- dung zwischen der oberen Wand (53) und den Sei- tenwänden (62) eine erste bzw. zweite obere Kante (55, 57) begrenzt, und wobei an jeder der Seiten- wände (62) mehrere entgegengesetzte und gleiche Erhebungen abstehen und sich zwischen der obe- ren (53) und der unteren Wand (60) erstrecken, wo- bei in Verwendung diese Erhebungen die ineinандergreifenden Schultern (16) in den Bandsegmenten (12, 14) bilden, wobei jede der Erhebungen durch mindestens eine kurze Wand (56) und min- destens eine lange Wand (58) gebildet ist, wobei die kurze Wand (56) in einem im wesentlichen spit- zen Winkel in bezug auf eine Längsrichtung ange- ordnet ist, wobei die lange Wand (58) im wesentli- chen parallel zu der Seitenwand (62) angeordnet ist, wobei die lange Wand und die kurze Wand einen im wesentlichen Z-förmigen Schlitz (16) in den Bandsegmenten (12, 14) bilden, wenn der Stempel (50) mit der Matrise (50) zusammenwirkt, dadurch gekennzeichnet, daß die obere Wand (53) entlang der kurzen Wand (56) jeder der Erhebungen mit ei- ner Abschrägung (55', 57') ausgebildet ist, die sich in eine Abwärtsrichtung zu der oberen Kante (55', 57') erstreckt, um eine erweiterte obere Kantenflä- che bereitzustellen, die nicht zum Splittern neigt, wenn der Stempel (50) die ineinandergreifenden Schultern (16) bildet.

2. Stempel nach Anspruch 1, wobei die Abschrägung (55', 57') in jede abstehende kurze Wand (56) in ähnlicher Weise geschnitten ist, wobei die Abschrä- gung (55', 57') in einem spitzen Winkel θ von der oberen Wand (53) des Stempels gebildet ist.

3. Stempel nach Anspruch 2, wobei die Abschrägung (55', 57') von der oberen Wand nach unten verläuft, so daß der spitze Winkel θ nicht größer als 10° ist.

4. Stempel nach einem der vorangehenden Ansprü- che, wobei die Abschrägung (55', 57') nur an den kurzen und langen Wänden (56, 58) des Stempels vorgesehen ist.

5. Umreifungswerkzeug, enthaltend einen Stempel nach einem der vorangehenden Ansprüche.

**Revendications**

1. Poinçon (50) pour utilisation avec une matrice (50) dans un outil de cerclage qui relie des extrémités supérieure et inférieure superposées (12, 14) de ruban par la formation d'une série d'épaulements décalés longitudinalment (16) de verrouillage mutuel découpés à la presse dans chacune desdites extrémités (12, 14) de ruban, ledit poinçon (50) étant défini par une paroi inférieure plane (60), une paroi supérieure (53), des première et seconde parois d'extrémité (64) reliant mutuellement lesdites parois supérieure et inférieure (60), et des première et seconde parois latérales (62) étant reliées mutuellement avec lesdites parois supérieure (53), inférieure (60) et d'extrémité (64), la ditte liaison entre lesdites parois supérieure (53) et latérales (62) définissant des premier et second bords supérieurs respectifs (55, 57), et chacune desdites parois laté- rales (62) comportant une pluralité de protubérances opposées et identiques en saillie de celles-ci et s'étendant entre lesdites parois supérieure (53) et inférieure (60), en utilisation, lesdites protubérances (12, 14) formant lesdits épaulements (16) de verrouillage mutuel dans lesdits segments (12, 14) de ruban, chacune desdites protubérances étant formée par au moins une paroi courte (56) et au moins une paroi longue (58), ladite paroi courte (56) étant disposée à un angle globalement aigu par rapport à la direction longitudinale, ladite paroi longue (58) étant disposée globalement parallèlement à ladite paroi latérale (62), dans lequel ladite paroi lon- gue et ladite paroi courte définissent une fente (16) globalement en forme de Z dans lesdits segments (12, 14) de ruban lorsque ledit poinçon (50) interagit avec ladite matrice (5), caractérisé en ce que ladite paroi supérieure (53) de même que ladite paroi courte (56) de chacune desdites protubérances comportent un chanfrein (55', 57') formé sur celles-ci et s'étendant dans des directions vers le bas vers ledit bord supérieur (55', 57') pour fournir une surface de bord supérieur étendue qui n'a pas tendan- ce à éclater lorsque ledit poinçon (50) forme lesdits épaulements (16) de verrouillage mutuel.

2. Poinçon selon la revendication 1, dans lequel ledit chanfrein (55', 57') est découpé, de façon similaire, dans chaque dite paroi courte (56) de protubéran- ce, ledit chanfrein (55', 57') étant formé à un angle aigu θ par rapport à ladite paroi supérieure (53) du- dit poinçon.

3. Poinçon selon la revendication 2, dans lequel ledit chanfrein (55', 57') s'étend vers le bas depuis ladite paroi supérieure de façon que ledit angle aigu θ ne soit pas supérieur à 10°.

4. Poinçon selon l'une quelconque des revendications
précédentes, dans lequel ledit chanfrein (55', 57')
est réalisé seulement sur lesdites parois courte et
gle (56, 58) dudit poinçon.

5. Machine de cerclage comprenant un poinçon selon
l'une quelconque des revendications précédentes.