SCORING OF THIN SHEET METAL


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ABSTRACT OF THE DISCLOSURE

Disclosed herein is a method for scoring thin sheet metal workpieces including bending of the workpieces convexly toward the workpiece penetrating tool in the area to be scored to place the portion of that workpiece area nearest the tool in tension and to place that portion of the area to be scored opposite the workpiece in compression and penetrating the workpiece with the tool.

Further disclosed herein is apparatus for scoring such thin sheet metal workpieces including a workpiece penetrating tool and workpiece support. The workpiece penetrating tool and support have formed thereon workpiece bending portions for bending the workpiece toward the penetrating portion of the tool. The tool is actuated via energy storing and releasing apparatus including a compressible spring and latching provision capable of releasing the tool for movement toward the workpiece support under the influence of the compressible spring. Tool movement limiting provisions are provided for assuring the proper penetration of the workpiece by the penetrating portion of the tool.

This invention relates to the scoring of thin-sheet metal, particularly to the scoring of a container component to facilitate the easy opening of the container.

It is sometimes the practice to score can ends in a manner which facilitates opening of the containers to which the ends are applied and heretofore it has been usual to effect scoring of the can ends by the use of a crank press. In such a press the scoring tool is fixed rigidly to a reciprocable ram and, at the end of the forward stroke of the ram, is caused to penetrate into the can end. The penetration of the scoring tool into the metal is effected at a relatively low contact speed and the depth of penetration is controlled by a limiting ring which may permit scoring to a depth of about 40% to 60% of the metal thickness and so that the residual metal will be rupturable as required for easy opening. With this method of scoring the metal which is displaced by the scoring tool must flow from the opposite sides of the scoring tool and thus great part of the energy necessary for scoring is used for internal cold working of the metal and in creating friction between the scoring tool and the metal. At the same time the metal immediately beneath the scoring tool is subjected to compression in the direction of the scoring tool and to layers of stress varying from tensile to compression at right angles to the direction of scoring. All these stresses induce a great deal of work hardening in the metal immediately below the score and sometimes cause it to crack. The operational forces when performing scoring in this manner are virtually of static character and therefore their numerical values are of a high order. Further the press must be of great rigidity in order to achieve reasonable consistency in the thickness of the residual metal following scoring.

It is a main object of the present invention to provide a method of and apparatus for scoring thin sheet metal which reduces the stresses involved in scoring by providing positive tension to pull the metal away from the scoring tool as it penetrates, thus decreasing the friction between the scoring tool and the scored metal and assisting plastic deformation.

According to the invention there is provided a method of scoring thin sheet metal by locating the metal on an anvil, locally bending the metal in the region thereof to be scored towards a scoring tool thereby to cause the side of the metal facing the scoring tool to be subjected to a tensile stress and the side engaged by the anvil and immediately opposite the scoring tool to be subjected to a progressive compressive stress while causing the scoring tool to penetrate the metal. In one embodiment of the invention the scoring tool is impelled towards the anvil and against the tensioned side of the metal to effect scoring of the metal.

Further according to the invention there is provided apparatus for scoring thin metal, comprising an anvil on which metal is locatable for scoring, a reciprocable scoring tool movable towards and away from the anvil, bending elements co-operating with the anvil and scoring tool locally to bend a piece of sheet metal located on the anvil towards the scoring tool thereby to cause the side of the metal facing the scoring tool to be subjected to a tensile stress and the side engaged by the anvil and immediately opposite the scoring tool to be subjected to a progressive compressive stress simultaneously with the scoring of the metal, and actuating means operable to effect reciprocation of the scoring tool. In one embodiment of the invention the actuating means includes energy accumulating and releasing means arranged to impel the scoring tool at a high velocity towards the anvil and against the tensioned side of the metal.

Stop means may be operable to determine the extent of movement of the scoring tool towards the anvil, and a bending element on the anvil and about which the metal is bent presents a radiaed face to the scoring tool, and bending members may be located on opposite sides of the scoring tool for movement therewith to co-operate with the bending element on the anvil to effect said local bending of the metal.

In one embodiment of the invention the scoring tool is carried by a reciprocable head in a manner permitting axial relative movement between the scoring tool and the head, the energy accumulating and releasing means is a spring located between the scoring tool and the head, and the actuating means includes a trigger device operable to restrain axial movement of the scoring tool during initial movement of the head towards the anvil and to release the scoring tool as the head nears the anvil thereby to permit the spring to impel the scoring tool towards the anvil.

In order that the invention may be clearly understood one embodiment thereof will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIGURE 1 illustrates the method of effecting scoring of thin sheet metal by the means employed prior to the present invention.

FIGURE 2 illustrates the method of effecting scoring of thin sheet metal according to the present invention, and

FIGURE 3 illustrates apparatus for carrying into effect the method according to the invention.

Referring to FIGURE 1, in a press of the kind usually employed prior to the present invention the scoring tool 1 enters the sheet metal 2, for example a can end, which is located on a flat anvil 3. The scoring force 4 is resisted by compressive stresses 5 while at the same time inducing tensile stresses 6 in the residual part of the metal. The tensile stresses are resisted by the strength of the metal and by the friction forces 7, between the metal 2 and anvil 3, directly beneath the line of scoring force 4. As
mentioned above, this method of scoring induces a great deal of work hardening and may sometimes result in failure of the metal, in the residual part, in the form of cracks 8.

FIGURE 2 illustrates the method of scoring thin sheet metal in accordance with the present invention. The metal 9, for example a can end, is located on an anvil 10 and is locally bent, in the region thereof to be scored, towards a scoring tool 11 thereby to cause the side of the metal facing the scoring tool to increase its length and so to be subjected to an induced tensile stress 12, the stress 13 being in a direction substantially at right angles to the scoring force 14. At the same time, the side of the metal which is engaged by the anvil and which is immediately opposite the scoring tool is subjected to progressive compressive stress 15. With this method friction forces 16, which are induced between the anvil and the metal being scored, work in the same direction as the compressive stress 15. Thus, as can be seen from FIGURE 2, the metal is urged away from the scoring tool simultaneously with the penetration of the too 4 into the metal, this being effected by impelling the scoring tool at a high velocity towards the anvil and against the tensioned side of the metal. The resistance to the scoring force 14 is thereby greatly reduced and the residual un scored metal does not suffer from excessive work hardening.

FIGURE 3 illustrates apparatus for carrying the method of FIGURE 2 into effect and, referring to FIGURE 3, it will be seen that the metal 9 to be scored, being a can end as shown in FIGURE 3, is located on the anvil 10 and that the scoring tool 11 is a reciprocable tool movable towards and away from the anvil. The anvil 10 is one of a plurality of anvils movable with a rocking movement about pivots 41 carried by the bracket 33 and at their upper ends are pivoted at 42 to the toggle 28. At the same time, the lipped end 58 of which soon engages the scoring tool sleeve 27 and carries the tool 11 with it.

rocking movement about pivots 41 carried by the bracket 33 and at their upper ends are pivoted at 42 to the toggle links 36. The lower ends of the trigger arms 40 carry sleeve-engaging means shown as rollers 43 and the upper ends are provided with stepped latch portions 44. Pawls 45 are pivoted at 46 to the press frame 47 and are urged to the active positions thereof by springs 48. Pawl restoring rods 49 engage the hook 29 for movement therewith, extend through the pawls 45, and have nuts 50 screwed on to the free ends thereof.

The link means 26 consists of an upper and a lower part connected for relative axial movement by an over- ride spring 51 surrounding the upper part and contained in a housing 52 secured to the upper end of the lower part. A rocker arm 53 pivoted at 54 to the press frame 47 is pivotally connected at 55 to the upper end of the upper part of link 26.

The cycle of operations of the apparatus, starting from the position thereof shown in FIGURE 3, in which the head 29 is at its top dead centre and the mainspring 31 is fully loaded, the trigger spring 38 has pressed member 35 into the uppermost position so that the toggle links 36 are holding the upper ends of the trigger arms 40 apart so that the rollers 43 are located beneath the washer 30 to restrain the head 29. As the head 29 approaches bottom dead centre, it begins to move the column 28 downwards leaving the scoring tool 11 and the mainspring 31 restrained by the rollers 43 and trigger arms 40. The outward component of force on the rollers 43 is at this time compensated for by the compression in the toggle links 36.

Continued downward movement of the head 29 causes the nuts 50 to move away from the pawls 45 which are now pressed against the tops of the trigger arms 40 by the springs 48 ready to engage the latch portions 44 when the trigger arms 40 are released.

When the head 29 approaches bottom dead centre it contacts the rocker arm 53 and puts the link means 26 into tension thus moving the lever 24 counter-clockwise to raise the anvil 10 against its return spring 23 until the stop means 20 is pressed firmly against the underside of the impact ring 18. The amount of force is determined by the setting of the over-ride spring 51 which permits the rocker arm 53 to continue to be rocked by the head 29 after contact between the stop means 20 and impact ring 18.

The apparatus is now in the cocked condition and ready for release of the scoring tool 11. During the final part of the downward movement of the head 29 towards its bottom dead centre the head engages the trigger support member 35 and pushes it beyond the dead centre of the toggle. The side force on the rollers 43 is now able to move the trigger arms 40 and collapse the toggle lock thus permitting mainspring 31 to impel the scoring tool 11 towards the anvil 10. As the scoring tool engages the end the latter is subjected to simultaneous bending and penetration, the bending being effected by the bending element 11a, FIGURE 2, of the scoring tool and the bending element 10a on the anvil, and the penetration by the cutting portion 11b of the scoring tool acting directly against the top of the bending element 10a. The compressive stress exerted by the cutting portion 11b is progressive as the cutting portion 11b penetrates the metal of the end of the tool. The scoring tool sleeve 27 slides freely on the column 28 and carries from the mainspring 31 as the drive in the spring becomes expended. The cutting edge of the scoring tool 11 enters the end to a depth determined by the dimensions of the anvil 10 and impact ring 18 since the movement of the tool 11 is abruptly halted when the tool rim 56 contacts the lip 57 within the impact ring 18.

Scoring having been effected, the head 29 passes its bottom dead centre and begins to rise together with the column 28 the lipped end 58 of which soon engages the scoring tool sleeve 27 and carries the tool 11 with it.
The washer 30 soon engages the relaxed mainspring 31 and commences to compress it. In the meantime the trigger arms 40 of the 45 pawl 45 so as to admit the mainspring 31 and washer 30 between rollers 43. As the column 28 rises the trigger spring 38 is compressed but is as yet unable to move the trigger support member 35 due to the pawls 45 locking the trigger arms 40.

As the head 29 moves upwards away from the rocker arm 53 the link 26 falls thus allowing the anvil 10 to drop under the action of its return spring 23. The anvil carrying the scored end is now in contact with either the impact ring 18 or the lever 24 and the wheel 17 is indexed round to bring another anvil 10 and can end into the scoring position.

As the head 29 again approaches top dead centre the nuts 50 again contact the pawls 45 and disengage the pawls from the latch portions 44. By this time the washer 30 is sufficiently far above the centres of the rollers 43 to permit the rollers 43 to glide beneath the washer 30 under the influence of the trigger arms 40 which are moved by the toggle links 36 and trigger spring 38. The toggle passes its dead centre when the links 36 are in positions such that the centres of the pivots 42 are in line with the trunion pivots 37 but is prevented from proceeding merely by this position which is sufficient for locking, by the heels 59 on the links 36 closing against each other. The toggle being thus locked, the trigger arms 40 are now ready to accept once more the opening force of the mainspring, now fully compressed, when it is imparted to the rollers 43. Top dead centre is again reached and the cycle of operation is repeated.

It will be understood that with the apparatus described with reference to FIGURE 3 the scoring operation is effected independently of the head 29 and that scoring is effected by the kinetic energy of the scoring tool 11 without the press frame taking part in the process, thus if the kinetic energy is sufficiently high the scoring operation will be carried out consistently without reliance on the rigidity of the press frame. It will, however, also be understood that the strength of the mainspring 31 and the working stroke of column 28 must be evaluated according to the kind of metal being scored and to the scoring specification.

By scoring the metal by the method described with reference to FIGURES 2 and 3 the material is automatically pulled away from the scoring tool particularly if the bending moment induces yield stresses in upper portion of the scored metal.

The foregoing description of apparatus for carrying the invention into effect the scoring tool has been described as impelled towards the anvil by the mainspring 31. It is to be understood, however, that the scoring tool may be impelled towards the anvil by any other suitable kind of means for accumulating and releasing energy. For example such means may consist of appropriately controlled air cylinders, or electro-magnetic devices.

1. A method of scoring thin sheet metal comprising the steps of locating the metal on an anvil, subjecting the side of the metal facing a scoring tool to a tensile stress and subjecting the side engaged by the anvil and immediately opposite the scoring tool to a progressive compressive stress and simultaneously causing the scoring tool to penetrate the metal said steps of subjecting comprising locally bending the metal in the region thereof to be scored towards the scoring tool.

2. The method according to claim 1 including impelling the scoring tool towards the anvil and against the tensioned side of the metal at a high velocity to effect scoring of the metal.

3. Apparatus for scoring thin sheet metal, comprising an anvil on which metal is locatable for scoring, a reciprocable scoring tool movable towards and away from the anvil, bending means co-operating with the anvil and scoring tool for bending locally a piece of sheet metal located on the anvil towards the scoring tool, for subjecting the side of the metal facing the scoring tool to be subjected to a tensile stress and for subjecting the side engaged by the anvil and immediately opposite to the scoring tool to a progressive compressive stress simultaneously with the scoring of the metal, and actuating means operable to effect reciprocation of the scoring tool.

4. Apparatus according to claim 3 wherein the actuating means includes energy accumulating and releasing means arranged to impel the scoring tool at a high velocity towards the anvil and against the tensioned side of the metal.

5. Apparatus according to claim 3 wherein stop means are provided for determining the extent of movement of the scoring tool towards the anvil, said bending means comprising a bending element on the anvil about which the metal is bent to present a radially face to the scoring tool, and bending members located on opposite sides of the scoring tool and movable therewith for cooperation with the bending element on the anvil to effect said local bending of the metal.

6. Apparatus according to claim 4 in which the scoring tool is carried by a reciprocable head and is axially movable relative to the head, said energy accumulating means comprising a spring located between the scoring tool and the head, and said actuating means further comprising trigger means for restraining axial movement of the scoring tool during initial movement of the head towards the anvil and for releasing the scoring tool as the head near the anvil to permit the spring to impel the scoring tool towards the anvil.

7. Apparatus according to claim 6 wherein the scoring tool is movable with a scoring tool sleeve slidable on a column movable with and extending lengthwise from said head, said sleeve being constrained by the trigger means against movement with said column during initial movement of the head towards the anvil to maintain the spring in the loaded condition thereof until the sleeve is released by the trigger means, and wherein the column is provided with a lip at the leading end thereof to engage the scoring tool and restore it to the constraint of the trigger means during movement of the head away from the anvil.

8. Apparatus according to claim 7 wherein the trigger means comprises trigger arms mounted on stationary supports for pivotal movement about pivots located between the opposite ends of the arms, each of said arms at like ends thereof being provided with sleeve-engaging means for permitting axial movement of said column relative to said sleeve and said arms at the opposite ends thereof being connected with toggle link means for retaining the sleeve-engaging means in cooperation relation with said sleeve and for actuation by said head to release the sleeve-engaging means from the sleeve as the leading end of the column nears the anvil.

9. Apparatus according to claim 8 wherein the trigger means includes for each of said trigger arms pivoted spring-biased pawl means for latching engagement with a latch portion on the arm to retain the sleeve-engaging means provided on the arm in the position thereof in which it is disengaged from said sleeve, and pawl-restoring means movable with said head for effecting disengagement of the pawl means from said latch portion when the scoring tool sleeve has been restored by said column to the position at which the spring is compressed by the sleeve and the sleeve is in position for co-operation with the sleeve-engaging means.

10. Apparatus according to claim 8 wherein said sleeve-engaging means comprises a freely rotatable roller mounted on each of said trigger arms.

11. Apparatus according to claim 8 wherein said trigger link means are mounted on a trunion carried by a trigger support member slidable lengthwise of said column, and said trigger means further comprises a
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trigge spring extending between the trigger support member and a collar secured to said column for restoring the sleeve-engaging means into operation with said sleeve.

12. Apparatus according to claim 6, wherein the anvil is supported for movement with and relative to a rotatable wheel arranged to align the anvil with the triggering tool, and stop means are provided for determining the extent of movement of the triggering tool, an impact ring being located between the triggering tool and anvil and movable with said wheel and having a lip provided thereon for engagement by said stop means.

13. Apparatus according to claim 12, wherein the anvil is supported by mounting means for axial movement relative to said wheel and impact ring, said anvil being spring-urged away from the impact ring, and being movable into firm engagement with the impact ring by operating means for actuation of the anvil in timed relation with the movements of said head whereby the anvil is engaged with the impact ring before the triggering tool is released by the trigger device and is disengaged from the impact ring as the head approaches the position thereof from which it commences its movement towards the anvil.

14. Apparatus according to claim 13, wherein said operating means comprises a lever pivoted for movement into and out of engagement with said means, a rocker arm pivoted for rocking movement by said head, and link means connecting the rocking arm with said lever to effect movement of the lever about the pivot thereof.

15. Apparatus according to claim 14, wherein the link means comprises two link elements connected for relative lengthwise movement and over-ride spring means for allowing continued movement of the rocker arm after the link means has rocked said lever to effect engagement of the anvil with the impact ring.

16. The method of scoring thin sheet metal workpieces comprising the steps of providing a workpiece of thin sheet metal, placing the area of the workpiece to be scored in tension on one side thereof, placing the area of the workpiece to be scored in progressively increasing compression on the remaining side thereof, providing a metal penetrating tool, penetrating the workpiece with the tool on the one side thereof and terminating penetration prior to movement of the tool through the workpiece.

17. The method of scoring thin sheet metal comprising the steps of providing a portion of sheet metal to be scored, providing a sheet metal scoring tool, convexly bending the thin sheet metal toward the tool in the area to be scored, penetrating the sheet metal with the tool and terminating penetration prior to movement of the tool through the sheet metal.

18. Apparatus for scoring thin sheet metal workpieces comprising a tool, means for convexly bending the thin sheet metal toward the tool in the area to be scored, means for penetrating the sheet metal with the tool and means for terminating penetration prior to movement of the tool through the sheet metal.

19. Apparatus for scoring thin sheet metal comprising sheet metal support means, a scoring tool mounted for movement toward and away from said support means and including a sheet metal penetrating portion, means located on said support means and tool for cooperatively bending the sheet metal convexly towards its penetrating portion in the area to be scored, and means for moving said tool toward said support means and into contact with the sheet metal for the scoring thereof.

20. Apparatus according to claim 19 wherein said support means comprises stop means for limiting the penetration of said sheet metal by said penetrating portion.

21. Apparatus according to claim 19 wherein said means for moving comprises energy storing and releasing means, means for maintaining said energy storing and releasing means in an energy storing condition and trigger means for causing said energy storing and releasing means to release energy in driving relation to said tool for driving said tool into engagement with the sheet metal.

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