Aug. 30, 1966 D. P. RUTTER 3,269,164

METHOD AND APPARATUS FOR THE FORMATION OF FOLDS IN METAL SHEETS

Filed Aug. 29, 1963

2 Sheets-Sheet 1

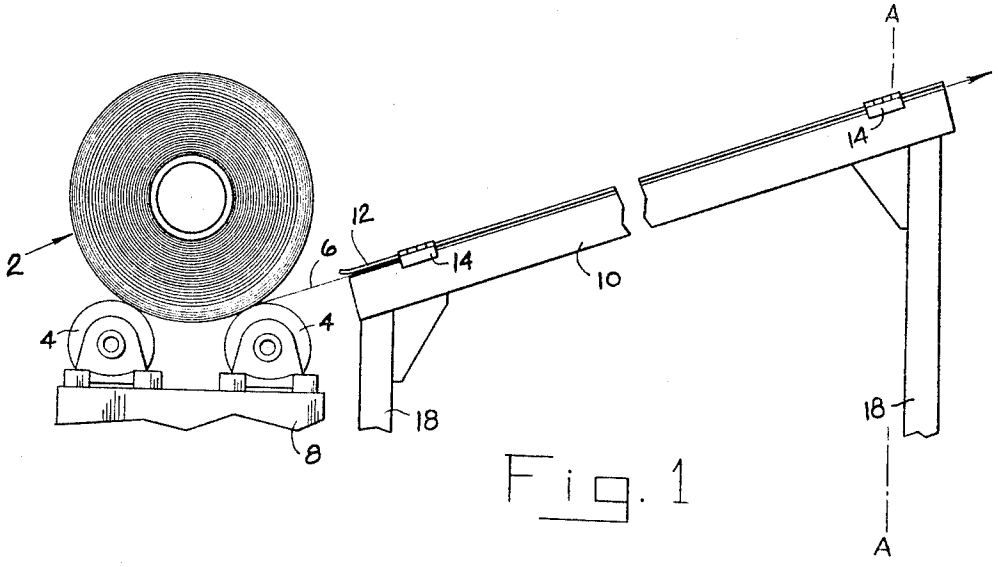

Fig. 1

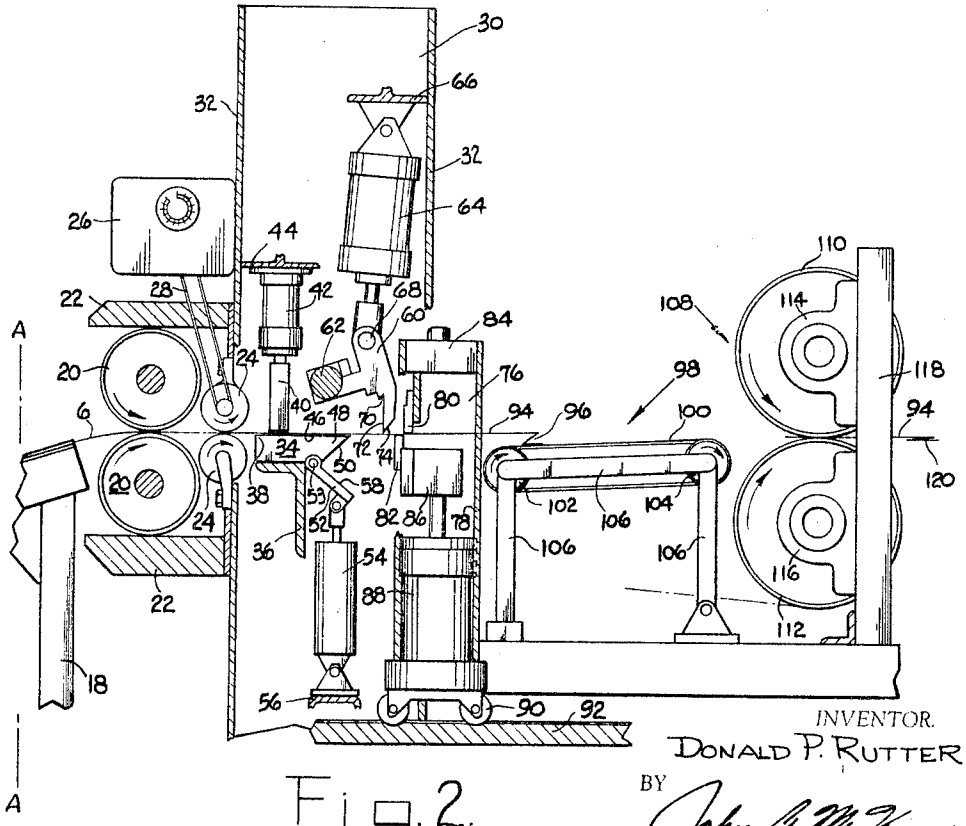

Fig. 2

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Fig. 3.

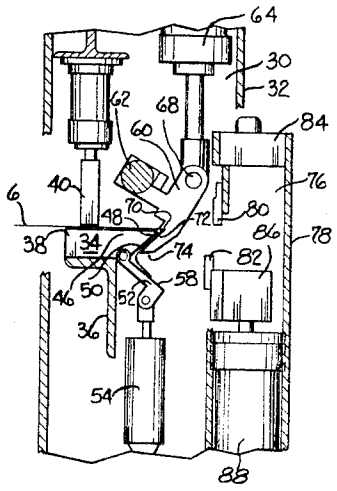
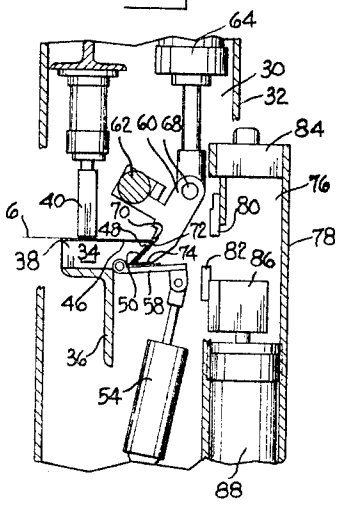


Fig. 4.



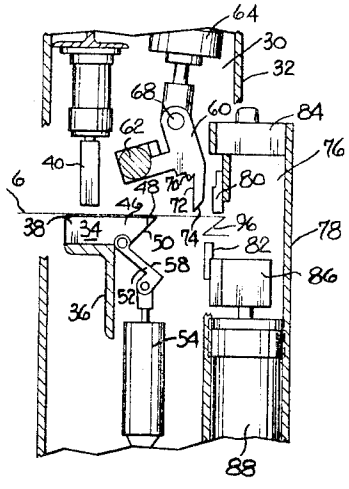


Fig. 5.

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METHOD AND APPARATUS FOR THE FORMATION OF FOLDS IN METAL SHEETS

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6 Claims. (Cl. 72—294)

This invention relates to metal working and is particularly directed to the formation of folds in metal sheets. More specifically, the invention is directed to method and apparatus for the formation of a Z-fold adjacent one edge of a sheet of metal. The Z-fold is of a nature to receive and retain an edge of a sheet of metal such as the opposite edge of the metal sheet in which the Z-fold has been formed after it has been rolled upon itself.

In U.S. Patent No. 3,058,860, a sheet of metal having a Z-fold adjacent one edge thereof is used as a protective cover for insulating material. As illustrated in this patent, the sheet of material is rolled upon itself and the free edge thereof is inserted into the Z-fold adjacent the other edge and retained therein. For this type of use, it is necessary that the circumference of the metal sheet when in the rolled position, be maintained within acceptable limits. If the circumference of the metal sheet is too small, the free edge thereof will not be retained in the Z-fold and the insulating material will be subjected to the deleterious elements. If the circumference of the metal sheet is too large, the edges of the insulating material will not be able to move into the necessary close substantially abutting relationship.

It is an object of the instant invention to provide method and apparatus for forming a plurality of metal sheets with a Z-fold adjacent one edge thereof from a relatively long and continuous strip of metal.

It is a further object of the instant invention to provide method and apparatus for the formation of a metal sheet with a Z-fold adjacent one edge thereof within predetermined dimensions.

The foregiong objects are accomplished in accordance with the instant invention by method and apparatus wherein a roll of metal is mounted so as to provide to a forming and shearing apparatus a continuous strip of metal. The continueous metal strip is held in a fixed position within the forming section of the apparatus while an open Z-fold is formed adjacent the leading section of the metal strip by a cooperating pair of dies. The strip of metal, lead by the portion containing the open Z-fold, is then passed through the severing section. A measuring system regulates the movement of the metal strip through the severing section and at the proper time, a shear functions to cut the metal strip so as to form a metal sheet with an open Z-fold adjacent one edge. The metal sheet is then passed through a press section where the open Z-fold is pressed closed.

The invention will be more fully understood and further objects and advantages thereof will become apparent when reference is made to the following detailed description of a preferred embodiment of the invention and the accompanying drawing in which:

FIG. 1 is a diagrammatic illustration of the leading section of apparatus made in accordance with the invention;

FIG. 2 is a continuation of the apparatus illustrated in FIG. 1 of the remaining portion fo the apparatus from line A—A thereof;

FIG. 3 is a view of a portion of FIG. 2 with the parts in a different operating position;

FIG. 4 is a view similar to FIG. 3 with the parts in still another operating position; and

FIG. 5 is a view similar to FIGS. 3 and 4 with the parts in still another operating position.

Referring to FIG. 1, there is illustrated a roll 2 of metal which is mounted on a pair of supporting rollers 4 and from which a continuous strip 6 of metal is drawn. The rollers 4 are secured to a base 8 which is mounted on wheels (not shown) for movement in a direction generally perpendicular to the direction of movement of the strip 6. This type of mounting is necessary so that the strip 6 may be pulled over the guide and straightening table 10 without undue binding. A pair of guides 12, only one being illustrated in FIG. 1, are pivotally secured to opposite sides of the table 10 by hinges 14 so as to form with the top of the table 10 a passageway through which the metal strip 6 passes. A plurality of legs 18 support the table 10 in a desired position. As illustrated in FIG. 2, the metal strip 6 is pulled from the spool 2 over the table 10 by a pair of cooperating pull rolls 20 connected to a suitable source of power (not shown) and suitably mounted in trunnions (not shown) carried by the fixed supports 22. The metal strip 6 is straightened from its arcuate condition as associated with the roll 2 to a generally planar condition by the cooperation between the pull rolls 20 and the passage of the strip through the passageway formed by the guides 12 and the table top 10. Adjacent to the pull rolls 20 are a pair of measuring rolls 24 with the uppermost roll 24 being connected to an automatic control box 26 by a chain 28 for a purpose to be later described.

The forming section 30 is illustrated in FIGS. 2–5, inclusive, and comprises a housing 32 within which is a table 34 mounted on a fixed support 36. The table 34 comprises one element of the cooperating die members for forming the Z-fold in the metal strip 6. Located above one end 38 of the table 34 is a holding block 40 operatively connected to the hydraulic mechanism 42 mounted on a fixed support 44. The holding block 40 cooperates with the surface 46 of the table 34 to retain the metal strip 6 in a fixed position during the formation of the Z-fold.

At the other end 48, the table 34 is provided with a surface 50 which intersects the surface 46 so that the included angle, in the cross-sectional view, is less than 90° and in the embodiment illustrated in FIG. 2, the included angle is 60°. An arm 52 is pivotally mounted on the table 34 adjacent the other end of the surface 50. The arm 52 is operatively connected to the hydraulic mechanism 54 mounted on a fixed support 56 and has a surface 58 for a purpose to be later described. The surfaces 46, 50 and 58 extend in a direction perpendicular to the movement of the metal strip 6 for a distance greater than the width of the metal strip 6 and cooperate to form one portion of the die for forming the Z-fold in the metal strip 6.

As illustrated in FIGS. 2–5, inclusive, the other portion of the die for forming the Z-fold in the metal strip 6 comprises a member 60 mounted for rotation about the fixed rod 62. The rotation of the member 60 about the rod 62 is controlled by the hydraulic mechanism 64 which is pivotally connected to fixed support 66 and also, pivotally connected at 68 to the member 60. The member 60 is provided with surfaces 70, 72 and 74 which cooperate with the surfaces 46, 50 and 58, in a manner described below, in forming the Z-fold in the metal strip 6. Each of the surfaces 70, 72 and 74 extend in a direction generally perpendicular to the direction of movement of the metal strip 6 for a distance mutually coextensive with that of the surfaces 46, 50 and 58.

Adjacent to the forming section 30, there is located the severing section 76 comprising a housing 78 and enclosing a pair of cooperating shears 80 and 82. The shear 80 is

mounted in a fixed position on a support 84 and the shear 82 is connected for reciprocal movement to the piston 86 of the fixed hydraulic mechanism 88. The severing section 76 is mounted for movement in a direction generally parallel with the direction of movement of the metal strip 6 by wheels 90 riding on the rails 92. Suitable means, such as a locking pin, is provided to hold the severing section 76 in a desired position. The shears 80 and 82 cooperate to sever a sheet 94 having an open Z-fold 96 adjacent one edge thereof from the leading section of the metal strip 6. The mounting of the severing section 76 on the wheels 90 provides a suitable device for spacing the open portion of the Z-fold 96 at varying distances from the edge of the sheet 94. Also, since Z-folds of differing depths are formed by changing die members 34 and 60, this mounting of the shearing section 76 allows for insuring that sufficient metal is available for the proper formation of the Z-fold. A conveyor 98 comprising an endless belt 100 trained over rollers 102 and 104, suitably supported by members 106, carries each sheet 94 from the severing section 76 to a pressing section 108. In the pressing section 108, each sheet 94 having an open Z-fold 96 passes through press rolls 110 and 112 driven by a conventional power means (not shown) and suitably mounted on trunnions 114 and 116 supported by members 118. The open Z-fold is pressed closed by the action of the rolls 110 and 112 to form the sheet 94 with a closed Z-fold 120.

In operation, the roll 2 of metal is placed on the rollers 4 and a strip 6 of the metal is pulled over the table 10 and positioned between the pull rolls 20. The guides 12 are then moved to a position over the table 10 so that the metal strip 6 passes over the table 10 between the guides 12 and surface of the table 10. The leading edge of the strip 6 is then guided through the forming section 30 until it passes through the plane defined by the shears 80 and 82. The various operating mechanisms are then generally in the position illustrated in FIG. 5 with the exception that the leading section of the strip 6 does not have the open Z-fold 96. The apparatus is now ready for automatic operation by appropriate mechanism (not shown) in the following sequence as illustrated generally in FIGS. 2–5, inclusive. The pull rolls 20 are held in a non-rotating position. The block 40 is moved by the hydraulic mechanism 40 into contact with the metal sheet 6 to hold the metal sheet 6 in proper position on the table 34. The shear 82 is moved by the hydraulic mechanism 88 so as to sever the leading portion of the metal strip 6. Immediately after the completion of the severing action by the shears 80 and 82, the member 60 is rotated by the hydraulic mechanism 64 so as to move the member 60 toward the end 48 of the table 34. The portion of the metal sheet 6 between the end 48 of the table 34 and the shears 80 and 82 is forced by the movement of the member 60 into a position between the surfaces 46 and 50 of the table 34 and the surfaces 70 and 72 of the member 60. The movement of the member 60 is continued until it reaches the position illustrated generally in FIG. 3. During the movement of the member 60, the shear 82 is moved to the position illustrated in FIG. 3 by the piston 86 of hydraulic mechanism 88. The arm 52 is then rotated about its pivot 53 by the hydraulic mechanism 54 and forces the end of the metal strip 6 between its surface 58 and the surface 74 of the member 60, as illustrated generally in FIG. 4. The arm 52 is then rotated back to its original position by the hydraulic mechanism 54 and the member 60 is rotated back to its original position by the hydraulic mechanism 64 to positions illustrated generally in FIG. 5. The block 40 is then moved out of contact with the metal strip 6 by the hydraulic mechanism 42 and the pull rolls 20 are operated so as to move the metal strip 6 with the open Z-fold and its leading section through the severing section 76 to a position adjacent the conveyor 100. The movement of the metal strip 6 is measured by the rolls 24 and when the desired length of the metal strip 6 has passed through the rolls 24, the mechanism in the control box 26 stops the movement of the pull rolls 20. The block 40 is then moved by the hydraulic mechanism 42 into contact with the metal strip 6 to hold the metal strip 6 in a fixed position on the table 34. The shear 82 is then moved by the piston 86 of hydraulic mechanism 88 so as to sever a metal sheet 94 having an open Z-fold 96 adjacent one edge from the leading section of the metal strip 6. The metal sheet 94 is then moved by the conveyor belt 100 from the severing section 76 to the press section 108 where it passes between the press rolls 110 and 112 to close the open Z-fold 96. The metal sheet 94 passes from the press section 108 with a closed Z-fold 120 adjacent one edge thereof.

During one operation of the apparatus of the instant invention, the metal roll 2 comprised a hard aluminum, such as 3003H18 aluminum alloy, having a thickness of approximately .016 inch and the axial length of the roll was approximately 3 feet. Each sheet 94 severed from the leading section of the strip 6 with the Z-fold in closed position had a width of approximately 22 inches and the depth of the Z was approximately 1¼ inches. Each sheet of this configuration was used as a protective cover for insulation surrounding a pipe wherein the outside diameter of the insulation was approximately 6 inches. In the preferred embodiment of the instant invention the metal in the roll 2 comprises a hard aluminum or stainless steel alloy having a thickness of between about .010 and .018 inch. Although the axial length of the roll 2 may be varied as desired, the most commonly used length is approximately 3 feet. The sheets 94 with the Z-fold in closed position have a width between about 11 and 120 inches and wherein the Z-folds have a depth between about 1¼ and 1¾ inches. It is understood that the foregoing dimensions are given for illustration purposes only and the invention is not to be limited thereto. Furthermore, the die members 34 and 60 and in particular the portions defining the surfaces 58 and 74 may be changed to make Z-folds of differing depths. Additionally, the die members 34 may be provided with a fixed surface 58 instead of the pivoted arm 50. The severing section 76 may be moved over the rails 92 so as to provide for varying the spacing of the open portion of the Z-fold 96 from the edge of the sheet 94.

While the invention has been described in rather full detail, it will be understood that these details need not be strictly adhered to and that various changes and modifications may suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

What I claim is:

1. A method for forming a metal sheet having a configuration adjacent one edge thereof from a relatively long and continuous strip of metal comprising:
   (a) moving at least a portion of a relatively long and continuous strip of metal into a forming apparatus,
   (b) holding said portion of said strip of metal in a fixed position within said forming apparatus,
   (c) forming an open Z-fold in the leading section of said portion of said strip of metal by confining a portion of said leading section adjacent the leading edge thereof between cooperating die members,
   (d) moving said leading section and at least part of said portion of said strip of metal through a severing station,
   (e) severing said leading section and said part of said portion of said strip of metal from said strip of metal to form a metal sheet having said open Z-fold adjacent the edge thereof, and
   (f) passing said metal sheet through a press section to close said open Z-fold.

2. A method for forming a plurality of metal sheets, each having a configuration adjacent one edge thereof, from a relatively long and continuous strip of metal comprising:
   (a) moving at least a portion of a relatively long and continuous strip of metal into a forming apparatus,

(b) holding said portion of said strip of metal in a fixed position within said forming apparatus,

(c) forming an open Z-fold in the leading section of said portion of said strip of metal by confining a portion of said leading section adjacent the leading edge thereof between cooperating die members,

(d) moving said leading section and at least part of said portion of said strip of metal through a severing station,

(e) severing said leading section and said part of said portion of said strip of metal from said strip of metal to form a metal sheet having said open Z-fold adjacent the edge thereof,

(f) passing said metal sheet through a press section to close said open Z-fold, and

(g) repeating said foregoing steps to form a plurality of sheets, each having a closed Z-fold adjacent one edge thereof.

3. Apparatus for forming a metal sheet having a configuration adjacent one edge thereof from a relatively long and continuous strip of metal comprising:

(a) means for supporting a relatively long and continuous strip of metal adjacent a forming apparatus,

(b) means for moving at least a portion of said strip of metal into said forming apparatus,

(c) means for holding said portion of said strip of metal in a desired position within said forming apparatus,

(d) means for forming an open Z-fold in the leading section of said strip of metal,

(e) severing said leading section and said part of said portion of said strip of metal from said strip of metal to form a metal sheet having said open Z-fold adjacent the edge thereof,

(f) means for severing said leading section and said portion of said strip of metal from said strip of metal to form a metal sheet having said open Z-fold adjacent one edge thereof, and

(g) means for pressing together portions of said open Z-fold after said leading section and said portion have been severed from said strip of metal to form a closed Z-fold.

4. Apparatus for forming a metal sheet having a configuration adjacent one edge thereof from a relatively long and continuous strip of metal comprising:

(a) means for supporting a relatively long and continuous strip of metal adjacent a forming apparatus,

(b) means for moving at least a portion of said strip of metal into said forming apparatus,

(c) means for holding said portion of said strip of metal in a desired position within said forming apparatus,

(d) a plurality of cooperating die members,

(e) means for moving said die members to confine the leading portion of said metal strip therebetween and to form in said metal strip an open Z-fold,

(f) means for moving said leading section and at least said portion of said strip of metal through a severing station,

(g) means for severing said leading section and said portion of said strip of metal from said strip of metal to form a metal sheet having said open Z-fold adjacent one edge thereof, and

(h) means for pressing together portions of said open Z-fold after said leading section and said portion have been severed from said strip of metal to form a closed Z-fold.

5. Apparatus as defined in claim **4** wherein

(a) one of said die members comprises a fixed die member having a pair of intersecting surfaces,

(b) an arm pivotally connected to said fixed die member,

(c) said arm having a surface thereon,

(d) a movable die member,

(e) said movable die member having a plurality of connected surfaces having a cross-sectional configuration in the form of a Z, and

(f) said surfaces on said movable die member cooperating with said surfaces on said fixed die member and said surface on said arm to form said open Z-fold in said leading section of said strip of metal.

6. Apparatus as defined in claim **5** and further comprising:

(a) means for adjusting the position of said severing means relative to said die members so as to vary the distance between the open portion of said Z-fold and said one edge of said metal sheet.

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