Method and apparatus for forming continuously moving strip material

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METHOD AND APPARATUS FOR FORMING CONTINUOUSLY MOVING STRIP MATERIAL

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This invention relates to a method and apparatus for forming continuously moving strip material along a plane or planes extending transverse to the direction of movement of the material, and more particularly to a method and apparatus of the type described which will also sever the strip as it is formed.

Although not necessarily limited thereto, the present invention is particularly adapted for use with a continuous forming line wherein flat strip material is passed through a series of forming rolls which progressively shape the flat stock into the desired cross section. After leaving the forming rolls, the continuous moving shape is cut or severed into pieces of uniform length, the cutting operation being accomplished by means of flying cutoff apparatus which moves with the stock during the cutting operation. Such flying cutoff apparatus is necessary since the stock itself is continuously moving, and any attempt to sever the stock with a stationary tool would cause it to buckle and bend.

Although a forming line of the type described above can form the flat stock along planes extending parallel to the direction of movement of the stock, it cannot form the stock in planes transverse to the direction of movement. For this purpose, a punch and die arrangement must be employed. For example, in the manufacture of corrugated steel floor sections for the building industry, the corrugations may be formed in a continuous forming line of the type described above and cut into lengths by a flying cutoff shear. If, however, it is desired or necessary to form an expanded or contracted section at the ends of the lengths whereby the end of one length may fit into the other while maintaining a flat floor surface, a punch and die arrangement is required.

Previous to this invention, it has generally been considered necessary to perform the forming operation on the ends of the lengths to produce an expanded or contracted section while the material is stationary. This is due to the fact that in the forming step, the material is deformed in a plane or planes transverse to the direction of movement of the strip, meaning that under ordinary circumstances, the continuously moving material could not pass over the forming die and would buckle, even if the die were mounted on a slide which moved with the material during the forming step.

As a primary object, the present invention seeks to provide a method and apparatus for forming continuously moving stock along planes extending transverse to the direction of movement of the material.

Another object of the invention is to provide a method and apparatus of the type described above which will also sever the continuously moving stock during the forming step.

Still another object of the invention is to provide a method and apparatus for forming continuously moving strip material along planes extending both parallel and transverse to the direction of movement of the stock.

A further object of the invention is to provide a method and apparatus for severing formed sections in which one or more surfaces of the section to be severed extend substantially parallel to the direction of movement of the severing tool.

The above and other objects and features of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings which form a part of this specification, and in which:

FIGURE 1 is a perspective view of corrugated steel floor or roof sections having expanded and contracted end portions which may be fitted one over the other to form a continuous floor or roof surface;

FIG. 2 is a top view of the corrugated floor or roof sections shown in FIG. 1 and placed in end-to-end overlapping relationship.

FIG. 3 is a cross-sectional view taken along line III—III of FIG. 2;

FIG. 4 is a side elevational view of a continuous forming line in combination with the punch and die arrangement of the present invention;

FIG. 5 is an end view of the punch and die shown schematically in FIG. 4;

FIG. 6 is a cross-sectional view taken along line VI—VI of FIG. 5 showing the positioning of the punch and die of the present invention preparatory to a forming and severing operation; and

FIG. 7 is a cross-sectional view similar to FIG. 6 showing the punch and die arrangement of the present invention during a forming and severing operation.

Referring now to the drawings, and particularly to FIGS. 1, 2 and 3, there is shown a pair of corrugated steel floor sections A and B which have been shaped in a continuous forming line to form corrugations across the widths thereof. As shown in FIG. 1, only one of such corrugations 10 is shown for each section, with each corrugation having a flat top portion 12 and tapered sides portions 14. Formed along the edges of the sections A and B are female grooves 16 adapted to receive male grooves on the next succeeding row of floor sections in tongue and groove relationship.

In order to permit the end of section A to fit over the end of section B, the trailing end or portion of section A is expanded as at 18; whereas the forward end of section B is contracted as at 20. In this manner, the end of section A may simply fit over the end of section B to provide a continuous flat or even floor surface while effectively locking the two sections together. Note that the corrugations 18 are formed along planes extending parallel to the length of the sections A and B (i.e., surfaces 12 and 14); whereas the expanded and contracted portions are formed along planes extending transverse to the length of the sections (i.e., along offset portions 21).

Referring now to FIG. 4, a continuous forming line is shown which includes a collar box 23 for supporting collar 22 of flat strip material which is to be formed into the corrugated cross section shown in FIGS. 1 and 3. From the collar 22, the strip material 24 passes through a starting table 26 where it passes between four rollers 28 which guide the material into a cold roll forming machine 30. The cold roll forming machine which follows the starting table 26 comprises a plurality of roll stands, only the first and last of such stands 32 and 34 being shown in FIG. 4. As the strip material 24 passes through successive ones of the stands in the roll forming machine 30, it is progressively formed into the desired cross-sectional shape which is the corrugated floor sections shown in FIGS. 1, 2 and 3. The completely formed corrugated section emerges from the last roll stand 34 and passes through exit rolls 36 to the punching and severing apparatus of the invention, generally indicated at 40.

As shown, the apparatus 40 includes a base 42 which supports a reciprocating punch and die arrangement 44 through which the formed section 46 passes. The punch and die arrangement 44 includes a lower die 48 and an upper punch 50 which is adapted to be forced downwardly into the die 48 by the upper ram 52 of the press 40. The ram 52 is connected through columns 54 to a crankshaft, not shown, contained within the base 42. This crankshaft,
3,140,789

3. In turn, is connected through clutch means to a flywheel 56 which is driven by a belt 57 connected to a motor 59, the arrangement being such that when the clutch is engaged, the flywheel will rotate the cam plate 51, forcing the ram 52 to lower the upper ram 52 and force the punch 50 into the die 48.

In operation, the formed section 46 may be pre-notched at intervals along its length, one such notch being indicated at 47 in FIGS. 1 and 2. As each notch reaches the press 49, it engages the right hand or forward ridge which actuates the aforementioned clutch to cause the upper ram 52 to move downwardly. At the same time, by virtue of the engagement between the lever and the notch in section 46, the punch 50 and die 48, being mounted on guide ways such as those described heretofore, move to the left in FIG. 4 in synchronism with the moving stock 46. As the punch 50 moves downwardly, it will eventually form and sever the section 46, whereupon it will begin its upward stroke. As the punch 50 moves upwardly, springs or other similar means will retract the punch and die to their original starting positions preparatory to a succeeding punching and forming operation. Similarly, the notches 47 along the strip 46 are equally spaced, the severed lengths will also be of equal lengths. Alternatively, instead of notching the strip 46 at spaced points along its length, a target may be provided at a fixed point beyond the press 40 which will be triggered to actuate the press. In either case, the result is a series of uniform length sections cut from the strip 46.

Referring now to FIG. 5, provided on the base 42 of press 49 are rails or guide ways 58 which receive slide blocks 60 depending downwardly from the die 48. In a similar manner, rails 62 are provided in the upper ram 52 to receive slide blocks 64 which are secured to the punch 50. In this way, the punch 50 and die 48 may reciprocate as a unit into or out of the plane of the drawing in FIG. 5. At the same time, when the upper ram 52 is moved downwardly by downward movement of columns 54, the punch 50 will also move downwardly on column 66 carried on the die 48. When the upper ram 52 is moved downwardly by downward movement of columns 54, the punch 50 of FIG. 5, the punch 50 is shown in its lowest position with the corrugated strip 46 being clamped between the punch and the die. With reference to FIGS. 6 and 7, the die 48 includes a pair of blocks 65 and 70 which are shaped to form the contracted and expanded sections, respectively, shown in FIG. 6. Furthermore, it will be noted that the block 70 is lower than block 68 to provide a cutting edge 72, this cutting edge extending along the entire width of the formed section 46. In a somewhat similar manner, the punch 50 is provided with a pair of blocks 74 and 76, with the block 76 being lower than block 74 to provide a cutting edge 78 which cooperates with cutting edge 72 to sever the formed strip 46. Also provided in the die 48 are a pair of pillow blocks 80 and 82 adapted to reciprocate within gib 84 and 86 provided therefor. Interposed between the bottoms of gib 84 and 86 and the pillow blocks 80 and 82 are coil springs 88 which urge the pillow blocks upwardly into the positions shown in FIG. 6. Of course, when the die 48 moves downwardly, the pillow blocks 80 and 82 will also be forced downwardly while compressing the springs 88, the lower positions of the blocks being shown in FIG. 7.

In the operation of the device, a pneumatic cylinder 90 (FIG. 5) is pressurized to force a detent 92 into engagement with the side of the strip, and when the notch 47 in the strip reaches the detent 92, the detent will be forced into the notch whereby the punch 50 and die 48 will be accelerated from left to right as shown in FIGS. 6 and 7 to move in synchronism with the moving stock 46. At the same time, the foregoing clutch in press 40 will be actuated to lower the upper ram 52. At the point where the detent 92 enters notch 47, the punch 50 will be in the position shown in FIG. 6. At this time, it will be noted that the stock 46 travels between the punch and die along a straight line path and as the upper ram 52 moves downwardly, it will carry the punch 50 while the punch and die move from the position shown in FIG. 6 to the position shown in FIG. 7. During this time, the punch 50 continues to move downwardly until it first engages the stock 46 to deflect it downwardly as shown in FIG. 7 (as shown in FIG. 6), the dotted outline of FIG. 4) and force it into engagement with the blocks 68 and 70 where the expanded and contracted sections shown in FIG. 1 are formed. Finally, at the lowest position of the punch 50 shown in FIG. 7, the stock 46 will be severed at the cutting surfaces 78 and 72 with the stock 46 being deflected downwardly out of its straight line path of travel and with the coil springs 88 compressed. When the upper ram 52 begins its upward stroke, it will carry the die 50 with it, thereby permitting the coil springs 88 to push the pillow blocks 80 and 82 as well as the severed stock 46 upwardly into its original position shown in FIG. 6. The blocks 68 and 70, however, do not move upwardly such that when the strip again returns to its straight line path of travel after having been deflected, the expanded and contracted portions will easily pass over the blocks 68 and 70 while the punch 50 and die 48 are returned on tracks 58 and 62 to their original starting positions. The punch 50 and die 48 will then be brought back to the position shown in FIG. 5. Thus, during the forming and severing step, the strip is deflected downwardly and is thereafter forced upwardly by spring-loaded blocks 80 and 82 whereby it can pass over the die to permit it to be formed along a plane or planes extending transverse to its direction of movement.

It will be noted from the features of the present invention that the sides 14 of the corrugations have an extremely steep slope extending almost parallel to the direction of movement of punch 50. Under ordinary circumstances, the punch and die could not sever the material along this slope; however by expanding or contracting the ends of the sections in accordance with the present invention as shown in FIG. 3, a sufficient slope is provided along the sides to permit the severing operation to be performed. Thus, the invention not only provides a means for deforming the cross section of continuously moving strip material, but also provides a means for severing sections having extremely steep slopes such as those shown in FIG. 1.

In the particular embodiment of the invention shown herein, the die 50 includes a cam arrangement enabling the stroke of the press to be increased over that which could otherwise be possible. Thus, as shown in FIGS. 5, 6 and 7, the die 50 includes a lower member 94 which may reciprocate in a vertical direction relative to an upper member 96 carried by the slide block 64. Between the members 94 and 96 is a cam arrangement including two cams 98 and 104 on either side of a slide block 100 carried on the upper member 96. Also carried on the lower member 94 are cams 102 positioned beneath the slideble block 100. The assembly is completed by cams 104 carried on the slideble block 100.

It will be noted that the slideble block 100 is connected through rod 106 to a pneumatic cylinder 108, the arrangement being such that the pneumatic cylinder may be pressurized in either direction to move the slideble block 100 to the right or left as viewed in FIG. 5 or into or out of the plane of the drawing as viewed in FIGS. 6 and 7. Thus, the block 100 and the cams 104 may move to the right or left. As they move to the left as viewed in FIG. 5, cam surface 110 on cam 104 will engage cam surface 112 on cam 98 on either side of the block 100. This will cause the member 94 as well as blocks 74 and 76 to move to the member 96. The position of the cam 104 is shown by dotted outlines when it has moved to the left as viewed in FIG. 5, and it will be noted that in this position the separation between members 96 and 94 is increased. When it is desired to move the members 94 and 96 closer together, the pneumatic cylinder 108 is pressurized in the opposite direction whereby cam surfaces 114 on cams 104 will engage the cam surfaces 116 on cams 102 to force the two members 94 and 96 apart.
It can thus be seen that the effective stroke of the press 40 can be increased by actuating the cylinder 108 to move members 94 and 96 apart. This is particularly useful in a punch and die arrangement of the type shown herein where a particularly long stroke is required. Although the invention has been shown in connection with a specific embodiment, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention.

I claim as my invention:

1. In the method for forming continuously moving longitudinally corrugated strip material along a plane extending transverse to the direction of movement of the strip, with the strip material moving along a straight line path extending parallel to its longitudinal axis, the steps of passing the strip material between a punch and die with the punch being located below the straight line path of travel of the strip, accelerating said punch and die to move in the direction of strip movement until they move in synchronism with the strip, thereafter forcing the punch into the die while deforming the corrugated material in a sideways direction with respect to its direction of travel and while deflecting the strip downwardly from its normal path of travel, and finally separating the punch and die while forcing the strip back into its normal path of travel such that it will pass over the die with its cross section formed into the shape of the die.

2. The method of claim 1 wherein the strip is severed during the forming step when the punch is forced into the die.

3. In the method for forming continuously moving longitudinally corrugated strip material along a plane extending transverse to the direction of movement of the strip, with the strip normally moving along a straight line horizontal path and having upper and lower horizontal portions interconnected by generally vertical portions, the steps of passing the material between a punch and die with the horizontal path of travel of the strip being above the die and below the punch, accelerating said punch and die to move in the direction of strip movement until they move in synchronism with the strip, thereafter forcing the punch into the die while deforming said generally vertical portions in a sideways direction and while deflecting the strip downwardly into the die, and finally elevating the punch while forcing the strip upwardly such that it will pass over the die with its cross section formed into the shape of the die.

4. In the method for forming continuously moving strip material along a plane extending parallel to its direction of movement and also along a plane extending transverse to its direction of movement, the steps of passing the strip through a succession of forming rolls to form it along a substantially vertical plane extending along the length of the strip, passing the strip from the forming rolls between a punch and die, accelerating said punch and die to move in the direction of strip movement until they move in synchronism with the strip, thereafter forcing the punch into the die while deflecting the strip from its normal path of travel, and finally separating the punch and die while forcing the strip back into its normal path of travel such that it will pass over the die with its cross section formed into the shape of the die.

5. Apparatus for forming continuously moving strip material along a plane extending parallel and transverse to the direction of movement of the strip comprising a plurality of forming rolls adapted to progressively form the strip along a plane extending parallel to its direction of movement, a punch and die positioned on opposite sides of said strip at a point removed from the end of said forming rolls along the path of travel of the strip, said punch and die being adapted to form the strip along a plane extending transverse to its direction of movement, means for mounting the punch and die for reciprocating movement along a path parallel to the direction of movement of the strip with the die being positioned below the normal path of travel of the strip, means for accelerating the punch and die in the direction of strip movement while forcing the punch into the die to deflect it out of its normal path of travel, and spring-loaded pillow blocks carried on the die below the strip and which are forced downwardly with the strip by the punch, the arrangement being such that the punch and die are spaced from the end of the forming rolls in an amount such that when the punch is moved downwardly into the die, the strip may be deflected downwardly also whereas when the punch is moved upwardly out of the die after the forming operation the pillow blocks will force the strip back into its normal path of travel where it will pass over the die while the punch and die are moved backwardly to their original starting positions.

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