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APPARATUS FOR STRETCH-WRAP FORMING METAL WORKPIECES

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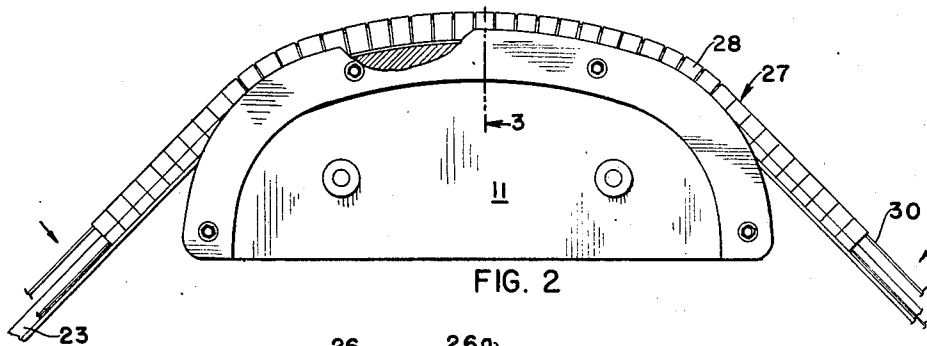


FIG. 2

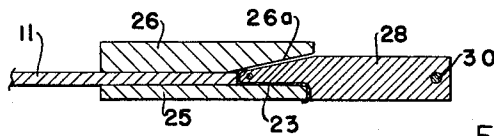


FIG. 3

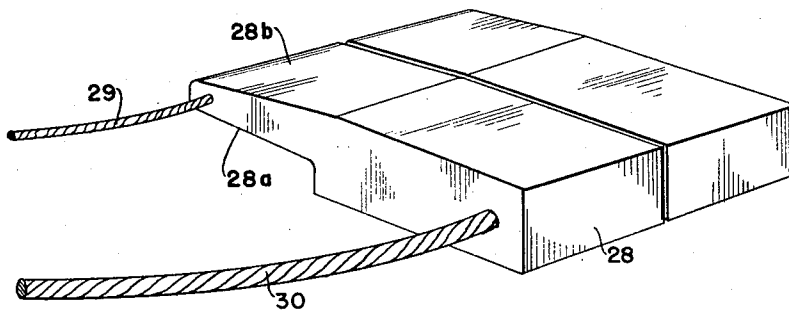


FIG. 4

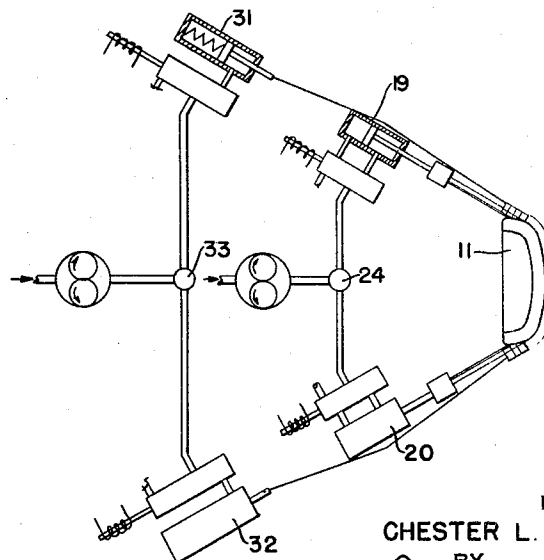


FIG. 5

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APPARATUS FOR STRETCH-WRAP FORMING METAL WORKPIECES

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13 Claims. (Cl. 153—32)

The present invention relates to the bending of metal shapes, and is more particularly concerned with an improved apparatus for use in so-called stretch-wrap forming of metal parts.

A convenient method of stretch forming elongated sections of rolled or extruded metal shapes, for example, comprises gripping the section at its ends, placing it under tension, bending the thus tensioned section around a contoured forming die or anvil, and then increasing the tension upon the section until the yield point of the metal is reached, so that a permanent deformation results. Where the shape to be bent has a substantial leg or web lying in the plane of bending, the piece may tend to buckle as it is bent, and in such cases it is common to employ a snake, which is a flexible member contoured to fit the shape of the workpiece and prevent its buckling. In accordance with prior practice the snake fits loosely against the workpiece, and is secured thereto by means of a plurality of C-clamps or the like. The present invention is directed primarily to an improved snake for use in a stretch-wrap forming machine, and to improvements in parts of the machine itself to enable the snake to be advantageously employed.

More particularly, the invention provides an improved stretch-wrap forming apparatus wherein means are provided for placing the snake, as well as the workpiece, under tension. Thus, the invention contemplates the use of a stretch-wrap forming machine of the type having a pair of pivoted bending arms, on which are mounted cylinder-actuated clamps for placing the workpiece under tension during bending. On the arms are mounted secondary tension cylinders which engage the snake, placing the same under tension and drawing it forcibly toward the workpiece. This results in the application of an auxiliary force to the workpiece, pressing it firmly against the forming anvil and causing it to conform more intimately with the anvil contours. The improved arrangement results in substantial saving in the time required in handling the snake, and also in an improved product.

In conventional stretch-wrap forming machines, the forming anvil generally has a backing plate or flange at its lower edge and a cap at its upper edge to confine the workpiece during a bending operation. In the apparatus of the present invention, one of the flanges is adapted to cooperate with the snake so that the latter serves actively to guide the workpiece toward the die, and also to hold it firmly against buckling as the bending progresses. The snake thus serves to guide the workpiece and clamp it in position, as well as to prevent buckling.

As one of its more specific features, the invention provides a snake for use in stretch-wrap forming of metal which is comprised of a series of articulately joined wedge-like blocks adapted to coast with an angular flange surface, the series of blocks being engaged at each end and drawn toward the face of the die during the forming operation so that the blocks slide along the angular flange surface to guide and support the workpiece.

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For a better understanding of the invention, reference may be made to the accompanying drawings, in which:

Fig. 1 is a perspective view of a stretch-wrap forming machine incorporating the improvements of the invention;

Fig. 2 is an enlarged fragmentary top plan view of the improved apparatus of Fig. 1;

Fig. 3 is a fragmentary section taken along line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragmentary perspective view of an improved snake forming part of the improved apparatus of Fig. 1; and

Fig. 5 is a simplified schematic representation of certain actuating means employed in the machine of Fig. 1.

The stretch-wrap forming machine, which is generally of conventional design, comprises a base 10 upon which is mounted a die plate or forming anvil 11 having an arcuate front face. A pair of bending arms 12, 13 are pivotally mounted on the base 10, at each side of the anvil 11, and are connected through tie rods 14, 15 to an actuating cylinder 16, by means of which the arms 12, 13 may be pivoted in unison with respect to the base 10. The arms 12, 13 support housings 17, 18, which in turn support fluid cylinders 19, 20 for pivotal movement about vertical axes. The operating rods of the cylinders 19, 20 extend forwardly and mount grippers 21, 22 at their forward ends. The grippers 21, 22 are adapted to receive the opposite end portions of an elongated workpiece 23 so that tension may be applied to the latter by means of the fluid cylinders 19, 20.

A bending operation in accordance with known practice is carried out by first moving the bending arms 12, 13 to a position approximately at right angles with the base 10. In this position the arms 12, 13 are aligned along a common axis passing in front of the forming anvil. The workpiece 23 is then engaged at its ends in the grippers 21, 22, so that an intermediate portion of the workpiece is tangent to a forward surface portion of the forming anvil 11. When the workpiece 23 is thus positioned, fluid under a predetermined pressure is supplied to the rod ends of cylinders 19, 20, through a pressure-regulating valve 24, so that a predetermined tension force is applied to the piece 23. Fluid is then supplied to the actuator 16 to extend its operating rod 16a and cause the bending arms 12, 13 to pivot rearwardly toward the base 10. As the arms 12, 13 swing toward the base the workpiece 23 is caused to bend or wrap around the front face of the anvil 11, and the maintenance of a predetermined tension force at the ends of the piece causes it to conform with the anvil about its entire surface. When the workpiece 23 has been bent to its approximate final form the fluid pressure in tension cylinders 19, 20 is substantially increased, stressing the piece 23 beyond its yield point, so that it thereby acquires a permanent set and retains its bent form.

The apparatus and procedure described thus far are purely conventional and are not to be considered as part of the present invention.

When the workpiece 23 has a flange or web portion of a considerable dimension lying in the plane of bending, the workpiece will have substantial resistance to bending in such plane and will tend to buckle during the bending operation. It is therefore conventional practice in such cases to employ a snake comprised of a plurality of articulately joined elements which follow the contours of the workpiece during the bending and prevent it from buckling.

The improved apparatus, which, in its illustrated form, is designed for bending a workpiece 23 having a generally Z-shaped cross-section, includes a lower flange or backing plate 25 secured to the lower surface of the anvil 11 and extending outwardly of the front face thereof to support the web portion of the workpiece 23, which lies in the

plane of bending. Secured to the upper surface of the anvil 11 is a second flange 26, which may be considered a guiding flange, and has an inclined surface 26a extending outwardly from the front face of the die.

In accordance with the invention, a snake 27 is provided which comprises a plurality of guide blocks 28 connected together along their inner edges by a flexible cable 29 and slidably receiving another cable 30, which extends through the outer edge portions of the guide blocks 28 in series. Each of the blocks 28 is provided with a recess 28a at its lower inner portion for receiving the outer wall and web portions of the Z-shaped workpiece 23. Also, each of the guide blocks 28 has an inclined upper surface 28b at its inner end which is complementary to the inclined surface portion 26a of the guiding flange 26. The arrangement is such that the guide blocks 28 fit closely between the flanges 25 and 26 when the workpiece 23 is against the anvil 11.

The cable 30, which is slidably received in the outer portions of the guide blocks 28, is substantially longer than the connected series of blocks and has free portions at each end of the series. In accordance with the invention, the free end portions of the cable 30 extend through the housings 17, 18, beyond the primary tension cylinders 19, 20, and are connected to the operating rods of secondary tension cylinders 31, 32, mounted at the ends of arms 12, 13, respectively. The secondary tension cylinders 31, 32 are supplied with fluid under pressure through regulating valve 33 whereby a predetermined tension force may be applied to the cable 30.

In a bending operation carried out with the improved apparatus, bending arms 12, 13 are initially in aligned position, engaging the ends of the workpiece 23. The ends of the cable 30 are attached to cylinders 31, 32, and the plurality of blocks 28 are received over the web and outer wall portions of the workpiece 23. At this point, the workpiece is straight, and is tangent with the forming anvil 11 only at the center portion of the latter. Tension is now applied to both the primary cylinders 19, 20 and the secondary cylinders 31, 32, and cylinder 16 is energized to cause the arms 12, 13 to pivot toward the base. As the bending operation progresses, the workpiece 23 is drawn against the face of the anvil 11, and in a similar manner, the guide blocks 28 of the snake follow the contours of the workpiece 23 and exert an auxiliary force thereon urging the piece 23 into intimate contact with the anvil 11. If the piece 23 tends to buckle out of the plane of bending, the complementary inclined surfaces of the guiding flange 26 and guide blocks 28 progressively urge the workpiece downwardly against the supporting flange 25. At all points between the respective points of tangency of the workpiece 23 with the forming anvil 11 the guiding blocks 28 will wedge the piece 23 tightly against the supporting flange 25 defining the bending plane.

At the end of the bending operation the workpiece 23 will be wedged into position against the flange 25 about the entire extent of the bend by the tension applied through the cable 30, which forcibly urges the series of articulately joined blocks 28 toward the face of the anvil 11. In this condition, the workpiece 23 is properly formed, and upon the subsequent application of stressing tension by the primary tension cylinders 19, 20 the piece takes a permanent set and assumes its final form.

One of the most important advantages resides in the improved arrangement for placing the snake under tension by means of actuators mounted on the bending arms of the forming machine. This results in the application of an auxiliary force upon the workpiece, urging it into tight conformity with the anvil 11, about the entire bending surface. The workpiece is also thereby firmly wedged against the supporting flange 25, so that when the final stressing tension is applied the workpiece 23 assumes a set in a substantially perfect condition. This materially simplifies design problems with respect to the

forming anvil 11, since spring-back is substantially avoided.

Another advantage of the invention is that as the bending operation proceeds, the plurality of guide blocks 28 progressively move into guiding relation with the flange 26, so that adequate guiding and support is at all times provided at the point of bending, which progressively moves along the periphery of the forming anvil 11. This is of substantial importance where the workpiece has a flange or web in the plane of bending which would otherwise tend to buckle during the bending operation.

The advantages of the invention are most obviously manifested in the savings in time resulting from the avoidance of the need for any manual clamping operations. Thus, in practice, it has been found that hand-work time is reduced by as much as seventy percent.

I claim:

1. In a bending machine, the combination of a forming anvil, a pair of bending arms pivoted at the sides of the anvil, power means to pivot the arms, clamps movably mounted on the arms for engaging the ends of a workpiece to be bent around the anvil, means to urge the clamps outwardly on the arms to maintain tension on the workpiece during pivoting movement of the arms, a snake comprised of a series of articulately joined blocks adapted to engage the exposed surface of the workpiece, and means on the bending arms for engaging the snake and maintaining the same under tension to urge the workpiece into tight conformity with the forming anvil during a bending operation.

2. Apparatus according to claim 1 further characterized by the snake comprising a series of blocks positioned in side-by-side relation, and a cable slidably received in the blocks and extending beyond the series thereof at each end, the cable being engaged at each end and maintained under tension during bending operations.

3. In a bending machine, the combination of a forming anvil, a pair of bending arms pivoted at the sides of the anvil, power means to pivot the arms, clamps movably mounted on the arms for engaging the ends of a workpiece to be bent around the anvil, means to urge the clamps outwardly on the arms to maintain tension on the workpiece during pivoting movement of the arms, a flexible snake adapted to engage the exposed surface of the workpiece, and means engaging the ends of the snake and drawing outwardly thereon along the bending arms for maintaining the snake under tension during a bending operation to urge the workpiece into tight conformity with the forming anvil.

4. Apparatus according to claim 3 further characterized by the means engaging the ends of the snake comprising fluid cylinders mounted on the bending arms, and a source of fluid under pressure for actuating the cylinders.

5. Apparatus according to claim 4 further characterized by the source of fluid under pressure including a regulating valve for maintaining a predetermined pressure in the cylinders.

6. Apparatus according to claim 3 further characterized by the snake comprising a series of articulately joined blocks, and a cable slidably received in the series of blocks, the cable being engaged at its ends and maintained under tension during a bending operation.

7. Apparatus according to claim 3 further characterized by the means engaging the ends of the snake being mounted on the bending arms.

8. In a bending machine of the type having a forming anvil, a pair of bending arms pivoted at the sides of the anvil, power means to pivot the arms, clamps movably mounted on the arms for engaging the ends of a workpiece to be bent around the anvil and means operable to urge the clamps outwardly on the arms to maintain tension on the workpiece during pivoting movement of the arms; the improvement which comprises a lower flange at the lower edge of the anvil, extending outwardly thereof and

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forming a support for the workpiece, a guide flange at the upper edge of the anvil and extending outwardly thereof, the guide flange having a lower surface which diverges from the lower flange outwardly of the anvil, a plurality of articulately joined guide blocks, the blocks having portions for engaging the workpiece and having inclined upper surface portions complementary to the diverging surface of the guide flange, a flexible member extending through the plurality of blocks, and means on the arms engaging the ends of the flexible member and actuatable to place the same under tension during the bending of a workpiece.

9. In a bending machine of the type having a forming anvil, a pair of arms pivoted at the sides of the anvil, power means to pivot the arms, clamps movably mounted on the arms for engaging the ends of a workpiece to be bent around the anvil and means operable to urge the clamps outwardly on the arms to maintain tension on the workpiece during pivoting movement of the arms; the improvement which comprises a pair of flanges at respective opposite edges of the anvil and extending outwardly of the face of the anvil, the opposing faces of the flanges diverging outwardly from the face of the anvil, a plurality of articulately joined guide blocks having portions for engaging the workpiece, at least one of the surfaces of the blocks being complementary to the opposing face of the adjacent flange, and means acting at the ends of the plurality of blocks for urging the blocks toward the anvil, throughout the bending movement of the workpiece around said anvil, whereby buckling of the workpiece during bending is prevented.

10. Apparatus according to claim 9 further characterized by the means to urge the blocks toward the anvil comprising a flexible cable extending through the blocks in series, and means carried by the arms for placing the cable under tension.

11. In a bending machine of the type having a forming anvil and means to engage a workpiece to be bent at its ends for bending around the face of the anvil; the improvement which comprises a pair of flanges at the respective opposite edges of the anvil and extending outwardly of the face of the anvil, a series of articulately joined guide blocks having portions for engaging the workpiece, the blocks being guided for movement toward the anvil

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face by the flanges, means to urge the blocks toward the face of the anvil comprising a flexible member engaging the blocks in series, and means for drawing the flexible member toward the face of the anvil, so that said blocks will engage the workpiece throughout its bending movement, said means to draw the flexible member toward the anvil face comprising a pair of fluid cylinders positioned at each side of the anvil and engaging the ends of the flexible member, said fluid cylinders being on said means for bending the workpiece.

12. Apparatus according to claim 13 further including a second flange spaced from the guiding flange, and further characterized by the guiding flange having an inclined guiding surface, and the blocks having complementary inclined cooperating surfaces whereby upon movement of the blocks toward the face of the anvil the blocks are urged toward the second flange.

13. In a bending machine of the type having a forming anvil and means to urge a workpiece to be bent toward the face of the anvil; the improvement which comprises a guiding flange adjacent one edge of the anvil, a plurality of articulately joined guide blocks having portions for engaging the workpiece and anvil, the blocks having means cooperating with the guiding flange to guide the blocks toward the face of the anvil, and means to urge the blocks toward the face of the anvil and into contact with said guiding flange during bending of a workpiece to guide the workpiece at the point of bending to prevent buckling thereof, said means to urge the blocks toward the face of the anvil including a flexible member connected to the guide blocks in series, and means engaging the ends of the flexible member to apply tension thereto.

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