Nov. 6, 1956 K. R. NEER 2,769,477

BENDING APPARATUS

Filed April 17, 1952 3 Sheets-Sheet 1

Fig. 1

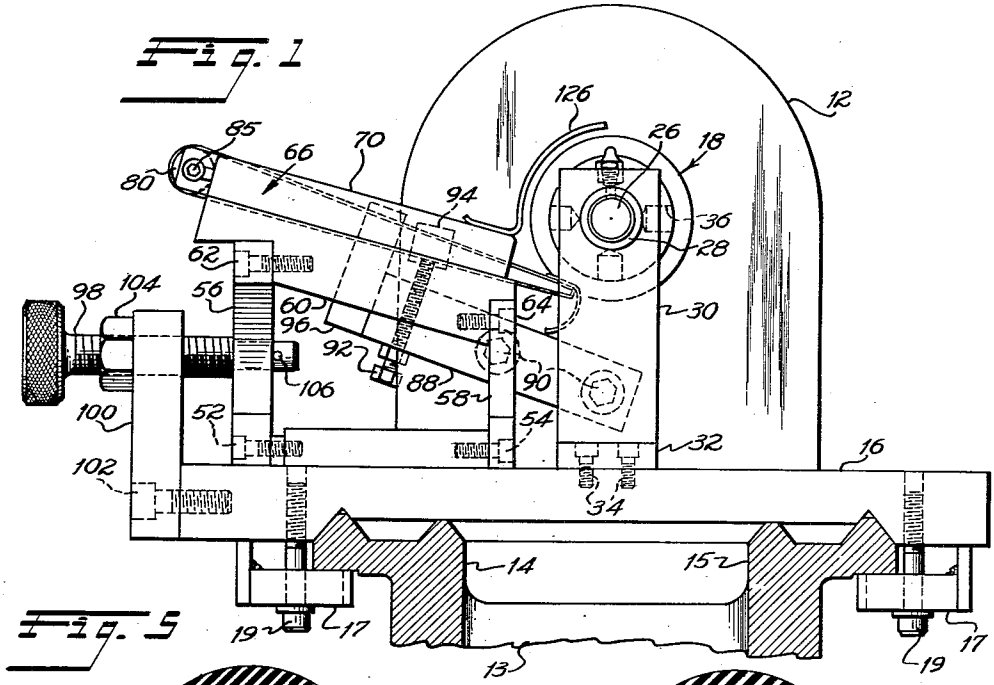
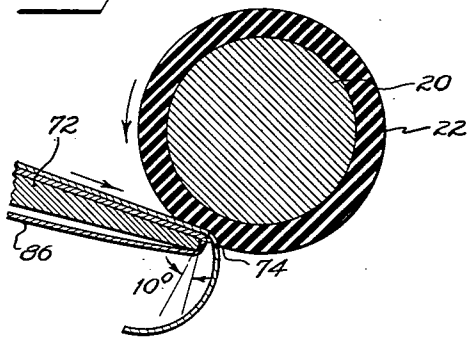


Fig. 5



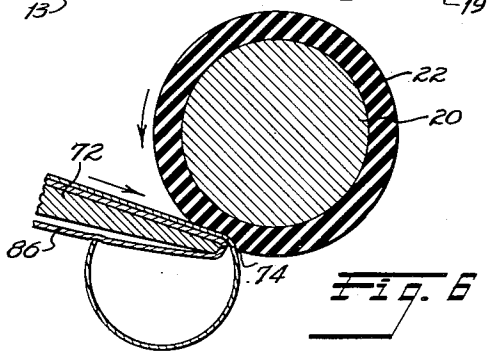
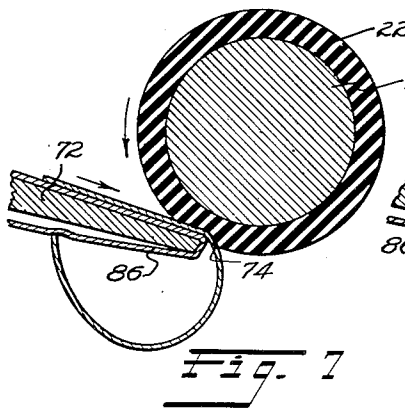


Fig. 6



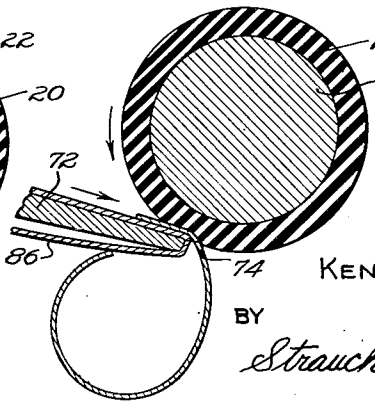


Fig. 8

Fig. 7

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BENDING APPARATUS

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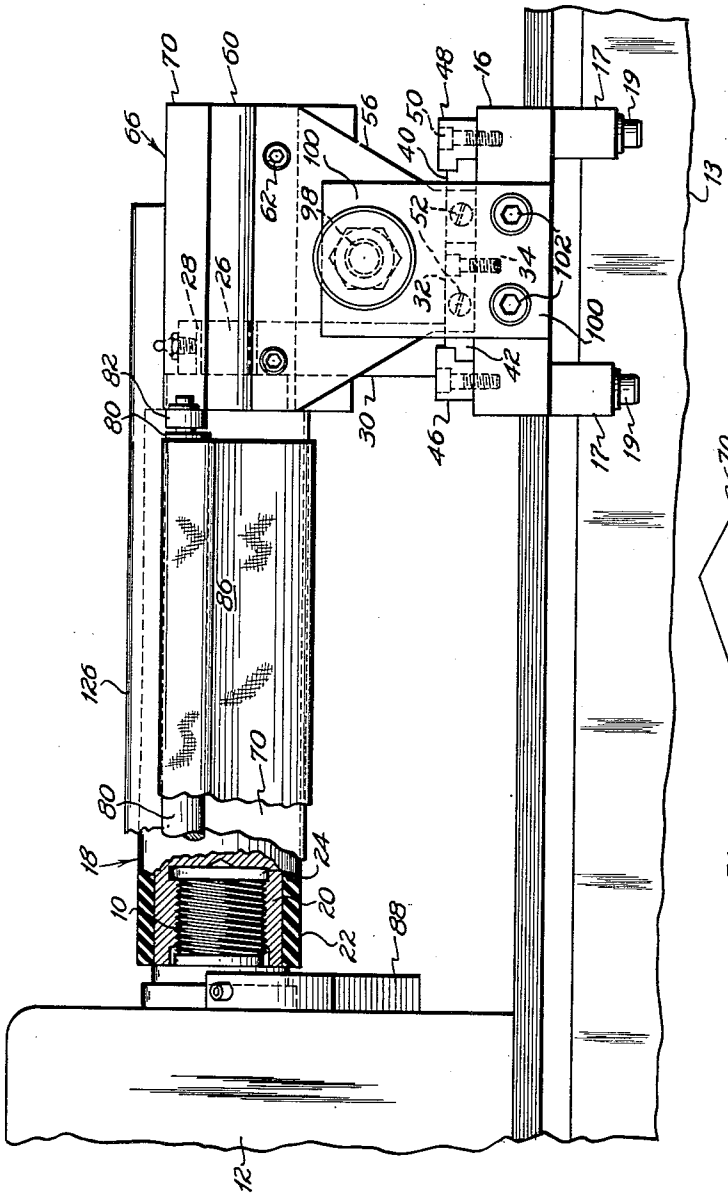


Fig. 2

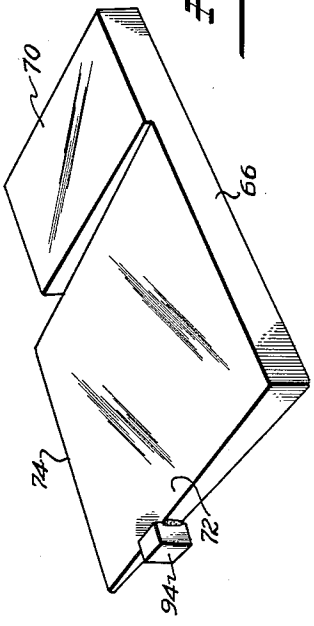


Fig. 4

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BENDING APPARATUS

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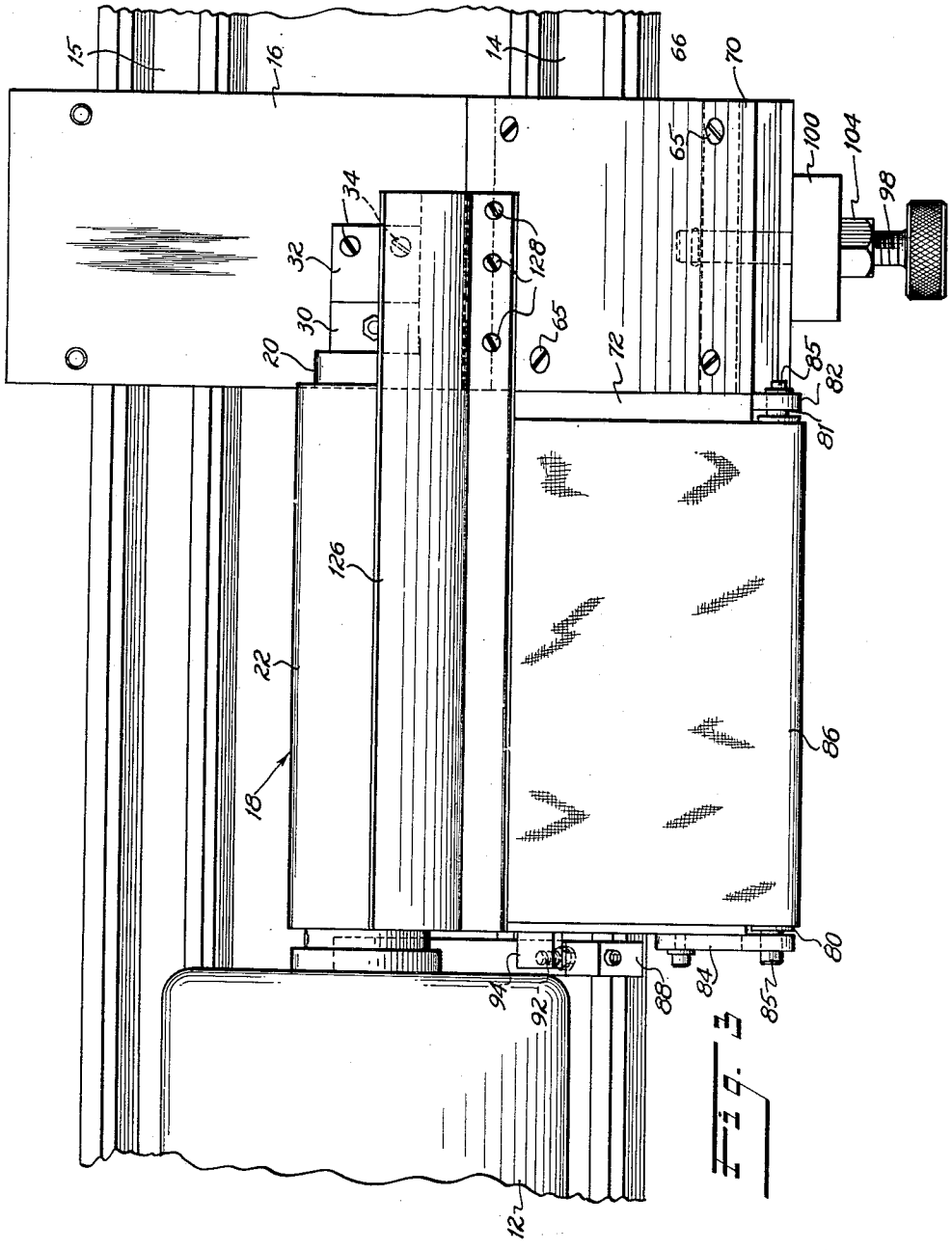


Fig. 3

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United States Patent Office

2,769,477

Patented Nov. 6, 1956

2,769,477

BENDING APPARATUS

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Application April 17, 1952, Serial No. 282,861

7 Claims. (Cl. 153—54)

This invention relates to apparatus for forming blanks of sheet material and more particularly to apparatus for forming precut flat sheet metal blanks into arcuate shapes, especially cylinders.

It has been found that the apparatus of the present invention have particular utility in connection with the manufacture of relatively thin walled bellows and similar expansible convoluted units. Such units are now commonly made from cylindrical blanks of thin gauge which are convoluted or corrugated by a number of well known methods.

Considerable difficulty has been experienced in the past in the manufacture of cylindrical blanks at reasonable expense which are suitable for use in bellows forming operations. It has been common practice to employ Buffalo rolls and similar apparatus for this purpose. However, the product of apparatus of this type has an unrolled portion at its opposite edges which must be trimmed before the bent workpiece can be welded to form a complete cylinder. As a consequence, the formation of cylinders by this practice inevitably entails considerable wastage of materials.

More important is the increased labor cost of the additional trimming step which must be carefully manually performed to insure the production of cylinders which meet exact size requirements and have the necessary parallelism between their opposite edges which are to be welded.

In partial solution to these problems it has been proposed to bend a sheet metal blank over a roll of predetermined size as shown, for example, in Patent 2,454,282. While this method eliminates the wastage produced by the Buffalo rolls, it introduces other costs which off-set this advantage. For example, in apparatus of this kind the forming rolls, which are relatively expensive, must be replaced to permit the slightest change of diameter of the formed cylinder. Further, apparatus of this kind is inherently incapable of performing a continuous process. That is, this apparatus must be stopped after each forming operation to permit the removal of the formed cylinder before the next work blank can be formed.

In accordance with the present invention, flat workpieces are formed as required by being subjected to the action of a resilient deformable rotating roller and a relatively stationary forming implement, the latter being maintained in deforming pressure contact with the resilient surface of the roller.

Despite the simplicity of the apparatus, it provides for the automatic feeding of work blanks to the work forming station and for the automatic delivery of one or a series of completely formed arcuate shapes ready for welding.

Accordingly, it is the primary purpose and object of the present invention to provide novel apparatus for deforming one or a series of sheet metal blanks into arcuate shapes at lower cost and higher speed than heretofore possible.

It is a further object to provide novel apparatus of this kind which may, by means of simple adjustment and without replacement of parts, be utilized for the production of sheet metal cylinders of widely varying precisely controlled diameters.

It is an additional object to provide novel apparatus for forming sheet metal cylinders in which sheet metal blanks, precut to exact size, are formed as desired over their entire surface and are automatically delivered ready for welding.

It is also an object of the present invention to provide novel apparatus for deforming sheet metal blanks into arcuate shapes which comprises a minimum number of structurally rugged parts compactly arranged for utilization as an attachment for a standard metal working lathe.

It is a further object of this invention to provide apparatus for bending a thin sheet metal blank into a cylinder or like shape having a continuously curved surface wherein the blank is fed into a forming pass defined by a resiliently surfaced roller and a relatively stationary edge extending along the roll.

Further objects and advantages will become apparent as the description proceeds in connection with the accompanying drawings in which:

Figure 1 is an end elevation of a metal forming apparatus constructed in accordance with the present invention shown mounted on a lathe bed;

Figure 2 is a side elevation of the apparatus of Figure 1 with parts broken away and in section to illustrate details;

Figure 3 is a top plan view of the apparatus of Figures 1 and 2;

Figure 4 is a perspective view of one of the forming elements of the apparatus of Figure 1; and

Figures 5, 6, 7 and 8 illustrate diagrammatically the several stages in the formation of a metal cylinder in accordance with the present invention.

The metal forming apparatus will be shown and described as an attachment for a standard metal working lathe since experience has shown that, where the size of the workpiece permits, minimum production costs may be achieved by the utilization of the apparatus in this manner. However, it is within the scope of the invention to provide a complete unit including a drive mechanism to be utilized independently of existing apparatus such as lathes or other powered shop equipment.

With continuing reference to the drawings, a power operated lathe head, having the usual threaded spindle 10, is shown diagrammatically at 12. The details of the lathe form no part of the present invention and the head may take any conventional form.

In accordance with conventional practice the lathe head 12 is rigidly secured to a lathe bed 13 provided at its upper surface with the usual guide rails 14 and 15.

Mounted for sliding movement on the rails 14 and 15 is a flat horizontally arranged stand 16 having suitable grooves in its lower surface in register with the ridges of the respective guide rails. The stand 16 may be secured in adjusted position with respect to the lathe bed 13 by suitable clamps 17. Bolts 19 extend through the respective clamps and may be adjustably threaded into the stand 16 to produce the required clamping or locking action.

As best shown in Figure 2, a roller 18 comprising a metallic body 20 to which a layer 22 of rubber or similar resilient material, is vulcanized. In a typical example where the roll body is 2½" in diameter, a rubber layer having a hardness of 40 (Shore) and a thickness of ⅜" is satisfactory. The roll body 20 is provided at one end with a recess 24 having threads which match those of the lathe spindle 10. At its opposite end the metallic

roll body 20 is provided with a stub shaft extension 26 adapted to be rotatably received in a bearing 28 mounted in an upright 30, a flanged portion 32 of which is secured to the stand 16 by means of bolts 34. The roll body is provided with four spaced recesses 36 adapted to receive a suitable tool for tightening the roll on the lathe spindle.

A flat base member 40 having opposite lateral flanges 42 and 44 is guided for movement on the smooth upper surface of the stand 16 in a direction normal to the axis of the roller 18 in opposed gib plates 46 and 48, respectively, which are secured to the upper surface of stand 16 at opposite sides of the base member 40 by a plurality of bolts 50. Sufficient clearance is provided between the cooperating faces of the gib plates and the flanges of the base member 40 so that the latter may slide freely in the former which thus act merely as guideways.

Attached to the opposite ends of the member 40 as by bolts 52 and 54, respectively, are vertically extending frame members 56 and 58. The members 56 and 58 are of generally the same configuration, the member 58, however, being shorter than the member 56. An upper base member 60 extends between and is secured to the upper edges of the vertical support members 56 and 58 by bolts 62 and 64, respectively, the member 60 having notches to accommodate the upper edges of the support members 56 and 58 to dispose the upper surface of the member 60 at an angle with respect to the stand 16.

Rigidly secured to the upper sloping surface of the upper base member 60 by bolts 65 is a contour block 66. As best shown in Figure 4 the contour block 66 comprises rectangular supporting section 70 substantially coextensive with the upper base block 60. The contour block 66 also includes a work guiding and forming section 72, the bottom surface of which is an extension of the bottom surface of section 70 and the upper surface of which is inclined downwardly with respect to the upper surface of the section 70 so that the section 72 is wedge shaped terminating at its forward seide in a relatively narrow work forming edge 74 normally parallel to, that is, making an angle of zero degrees with the axis of roller 18. As hereinafter explained, edge 74 may be disposed at an angle other than zero degrees with respect to the axis of roller 18. The forming edge 74 of the contour block is illustrated in enlarged section in Figure 5, 6, 7 and 8.

As thereshown the forming edge 74 is disposed at an angle of approximately 10° with respect to a plane normal to the lower surface of the contour block 66 so that the juncture between the upper surface of the contour block 72 and the forming edge 74 constitutes a relatively sharp edge, in practice having a radius of 1/32 of an inch where the roller has the above-described dimensions. Opposite the rearward or upper edge of the section 72 of the contour block an idler roll 80 is rotatably mounted on a shaft 81 mounted at its opposite ends in lugs 82 and 84 suitably attached to the section 72. The lugs are provided with slots in which the opposite ends of the roll shaft are received for adjustment to and away from the section 72. The roll may be locked in adjusted position by nuts 85 threaded onto the roll shaft.

An endless belt 86 of canvas, or similar flexible, tough material, passes around the section 72 over the front forming edge 74 and over the roller 80 for a purpose to appear. The support of the side of the contour block adjacent the lathe head is provided by a bracket 88 secured by bolts 90 to the lathe head proper. An adjusting screw 92 extends adjustably upward through the block 88 and its upper end bears on a lug 94 welded to the side of the contour block 66. The free end of the block 88 is provided with an upwardly extending arm 96, the upper end of which extends above the upper surface of the contour block section 72 to guide the canvas belt 86 on the contour block.

As stated above the base member 40, on which the contour block assembly is mounted, is slidably movable

in a direction normal to the axis of the roller 18. The adjusted position of the entire contour block assembly may be determined by an adjusting screw 98 which extends freely through the support 56 and is threadedly received in an upstanding arm 100 attached to the stand 16 by means of bolts 102. A lock nut 104 is provided on the adjusting screw 98 to lock the contour block in its adjusted position. Movement of the contour block to the right, as seen in Figure 1, is effected by turning the screw 98 into the arm 100 urging a shoulder of screw 98 against the block 56. Movement of the contour block to the left is effected by threading screw 98 out of arm 100 urging a pin 106 which extends through the inner reduced end of the screw 98 against the inner side of block 56. Due to the provision of the heavy gib plates 48 the forming edge 74 at the forward end of the contour block will remain in constant parallelism with the axis of the roller 18.

A suitable guard or shield 126, which is coextensive with the roller 18, is secured to the upper surface of the portion 70 of the contour block as by screws 128. It will be noted that there is substantial clearance between the lower edge of the guard 126 and the upper surface of the canvas belt 86 so that a workpiece may pass freely therebetween.

The mechanism above described may be readied for operation by adjusting the forming edge 74 of the contour block so that it is in pressure forming contact with the resilient surface of the roller to deform the resilient surface to the extent required to perform the necessary bending operation. A precut sheet metal blank is then placed on the canvas belt 86 with its leading edge in exact parallelism with the axis of roller 18. The lathe mechanism is then started to rotate the roller 18 in a counterclockwise direction as viewed in Figure 1. Because of the pressure contact between the canvas belt and the surface of the roller 18 the former will be caused to pass around the contour block in a clockwise direction as viewed in Figure 1, thus drawing the workpiece between the forming edge 74 and the surface of the roller.

The workpiece is initially bent as shown in Figure 5. The bending operation then continues until the leading edge of the workpiece contacts the belt 86 as shown in Figure 6 at which time the leading edge of the work blank may be carried away from the axis of the roller 18 to the point shown in Figure 7. However, experience has shown that this action does not continue to the point where the work blank is stressed beyond its elastic limit. On the contrary, the forming operation progresses to the point shown in Figure 8 where the leading edge of the work blank is no longer carried by the belt 86. The forming operation is then continued to form the work blank over its entire surface. The blank springs into a perfect cylindrical shape as soon as the trailing edge has passed between the forming edge 74 and the roller 18.

It has been found that the degree of bending of the workpiece and consequently at the radius of the finished product depends upon the initial deformation of the resilient surface of the roller 18 by the forming edge 74. Accordingly, by simple adjustment of the screw 98, the apparatus can be easily regulated as required to produce cylindrical pieces of widely varying diameters or to remedy a temporary oversize or undersize condition caused by wear of the components or a change in resiliency of the rubber layer on the roller 18.

It is also to be particularly noted that at the completion of the forming operation the finished workpiece drops away from the mechanism permitting the production of a series of cylinders in rapid sequence as opposed to presently known apparatus of this type. The above described apparatus is also capable of bending sheet metal into shapes other than those having circular section. For example, by mounting the roller 18 with a slight eccentricity, the pressure between the forming edge 74 and the outer resilient surface of the roll will

be varied during the forming operation thus changing the rate of bending and producing a tubular workpiece having an elliptical or other non-circular section.

Also, by disposing the forming edge **74** of the contour block at a slight predetermined angle with respect to the axis of the roller **18**, the forming pressure and accordingly the rate of bending will be varied uniformly along the length of the workpiece thus producing conical shapes. The predetermined angle may be zero degrees in which case the edge **74** would be parallel to the axis of roller **18** as hereinabove described.

Thus the invention attains the objects above stated and provides extremely simple, versatile and inexpensive apparatus capable of producing tubular workpieces of varying size and section at low cost and high speed.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A mechanism for forming bendable material comprising a movable element having a deformable portion, a relatively stationary member having a rigid forming edge disposed in deforming pressure contact with said deformable portion, and means movably mounted on said member and movable with and to facilitate passage of a sheet of said bendable material between said element and said forming edge of said relatively stationary member to deform said material into an arcuate shape.

2. The mechanism of claim 1 together with means to adjust the contact pressure between said forming edge and said deformable portion to vary the deformation of said material.

3. In a sheet metal bending apparatus, a member having a fixed edge, a conveyor sheet mounted to move over said edge with a blank thereon, and a resiliently surfaced member mounted to engage the side of the blank opposite said conveyor under pressure and move therewith past said edge.

4. A mechanism for forming sheet material comprising a roller having a deformable outer surface, a substantially flat contour block having a forming edge substantially parallel to the axis of said roller, means mounting said block to dispose said forming edge a distance from the axis of said roll less than the normal radius of said roller, and means movably mounted between said sheet and said block to facilitate feeding said sheet material over said contour block between said forming edge and said roller to deform said material into an arcuate shape.

5. A metal forming attachment for a lathe having a driven spindle and a bed provided with guide-ways, comprising, a stand adapted to be supported on said guideways; means on said stand rotatably supporting one end of a deformable roller, the other end of said roller being supported on said spindle for rotation therewith; a contour block having a substantially straight forming edge; means on said stand for supporting said block with said forming edge in deforming pressure contact with the surface of said roller, whereby when said roller is rotated a work blank will be drawn between said roller and said forming edge to deform said work blank into an arcuate shape, and means to move said forming edge in a direction normal to the axis of said roller to vary the deformation of said work blank.

6. A mechanism for forming bendable sheet material comprising a roller having a deformable surface, a relatively stationary contour block having a substantially straight forming edge disposed in deforming pressure contact with said roller, an endless carrier encircling said contour block and adapted to pass thereover in a direction normal to the axis of said roller, and means to rotate said roller whereby a sheet of said material will be drawn between said roller and the forming edge of said guide block to deform said material into an arcuate shape.

7. In a sheet metal bending apparatus, a member having a fixed edge, means movably mounted on said member adapted to move over said edge with a work blank thereon, and a member having a deformable surface mounted to engage the side of the work blank opposite said edge under pressure and move therewith past said edge to bend said work blank.

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