June 17, 1952 L. W. EVANS 2,600,628

SHEET ROLLING MACHINE

Filed Jan. 10, 1949 3 Sheets-Sheet 1

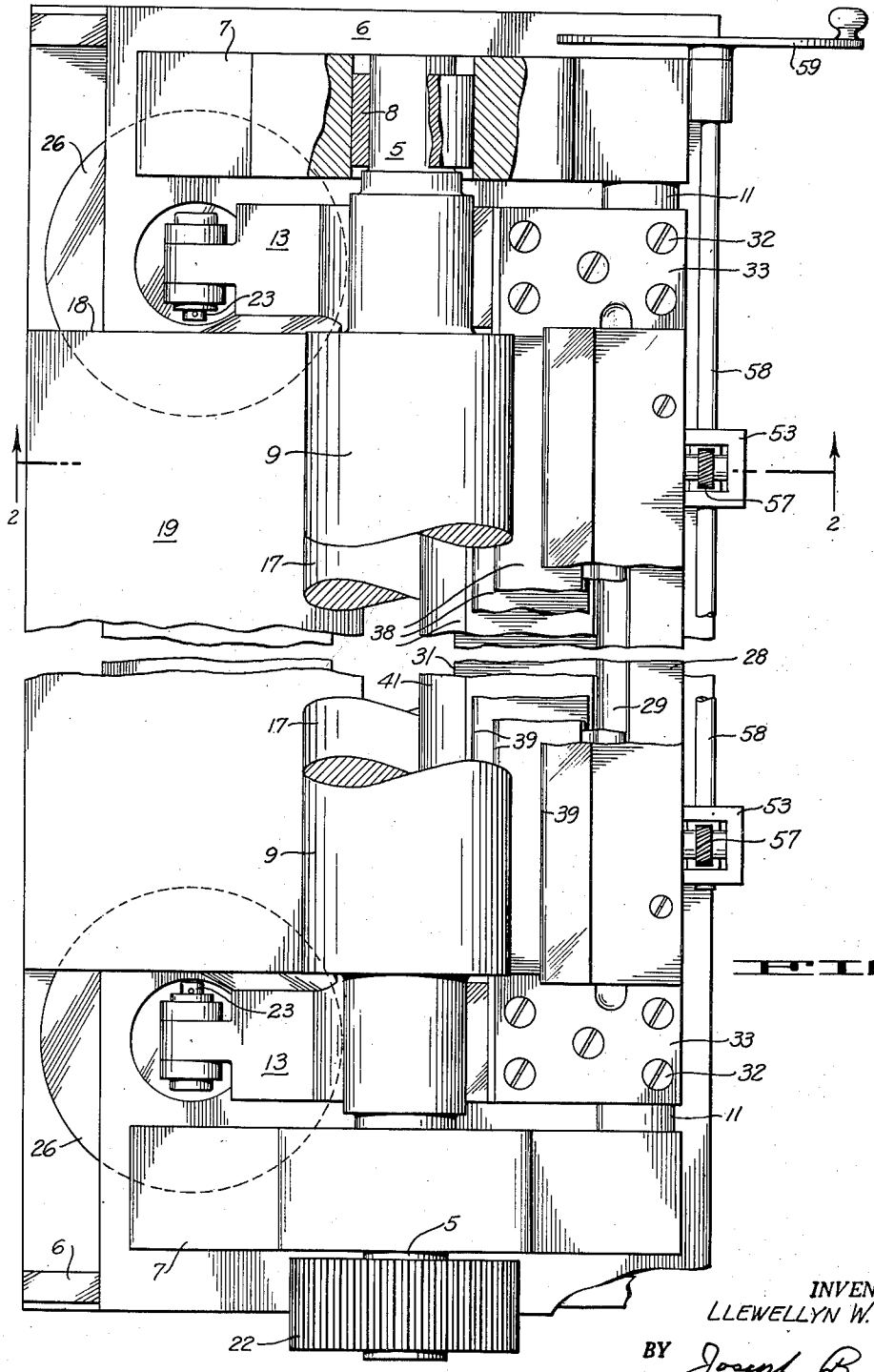



FIG. 1.

INVENTOR.
LLEWELLYN W. EVANS
BY Joseph B. Gardner
atty

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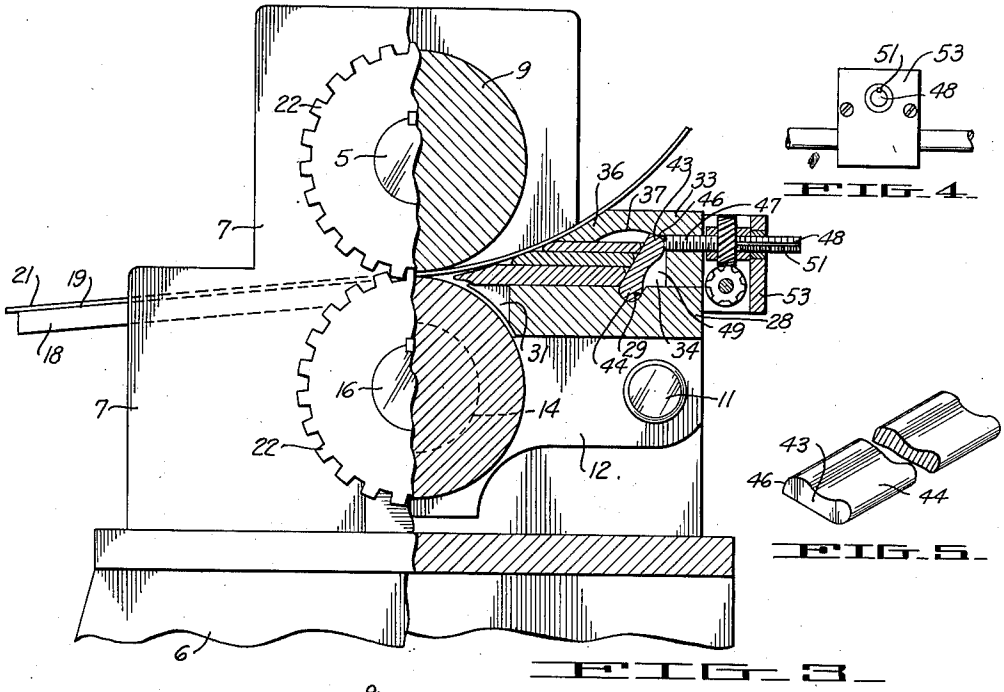



FIG. 3




FIG. 4




FIG. 5

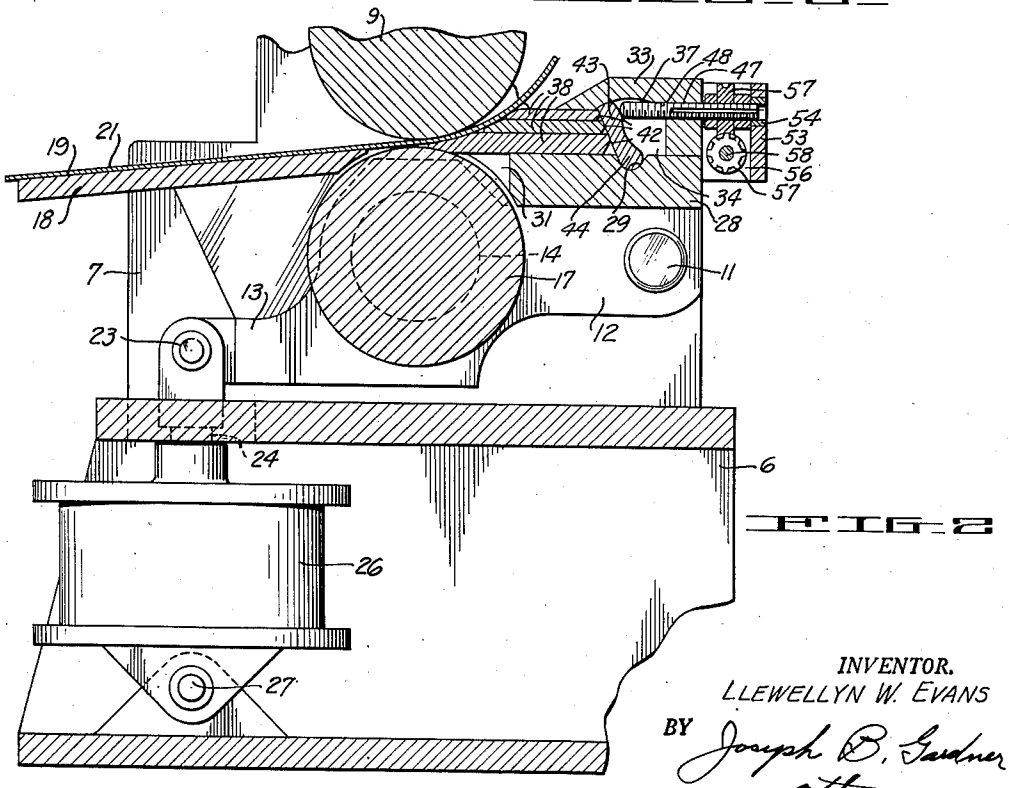



FIG. 2

INVENTOR.
LLEWELLYN W. EVANS
BY Joseph B. Gardner
atty

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SHEET ROLLING MACHINE

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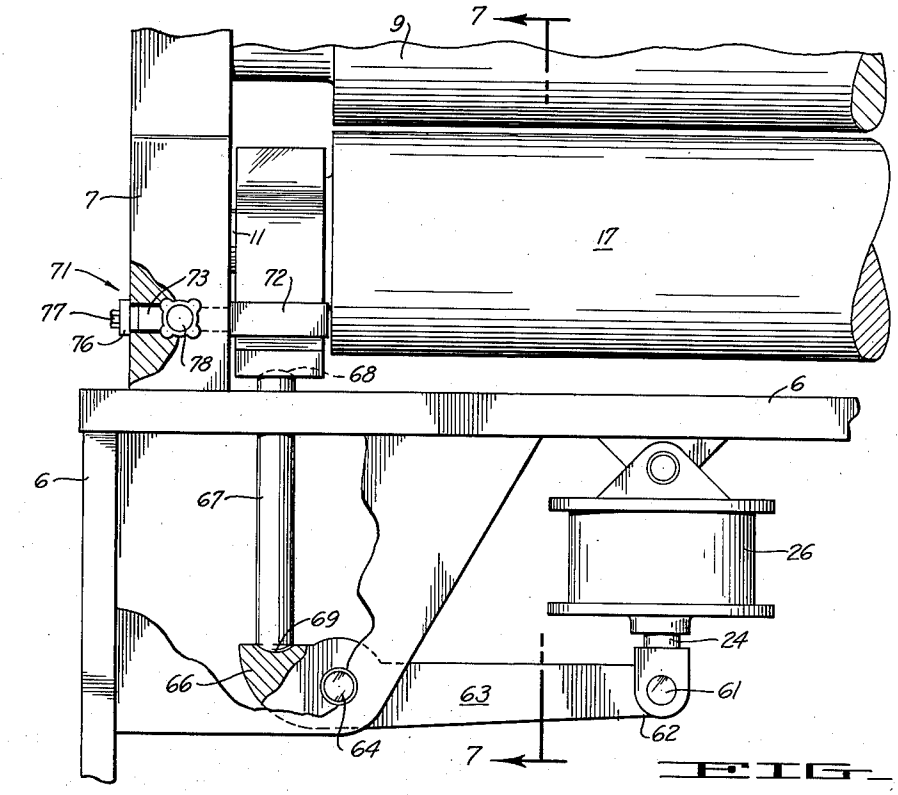



FIG. 6.

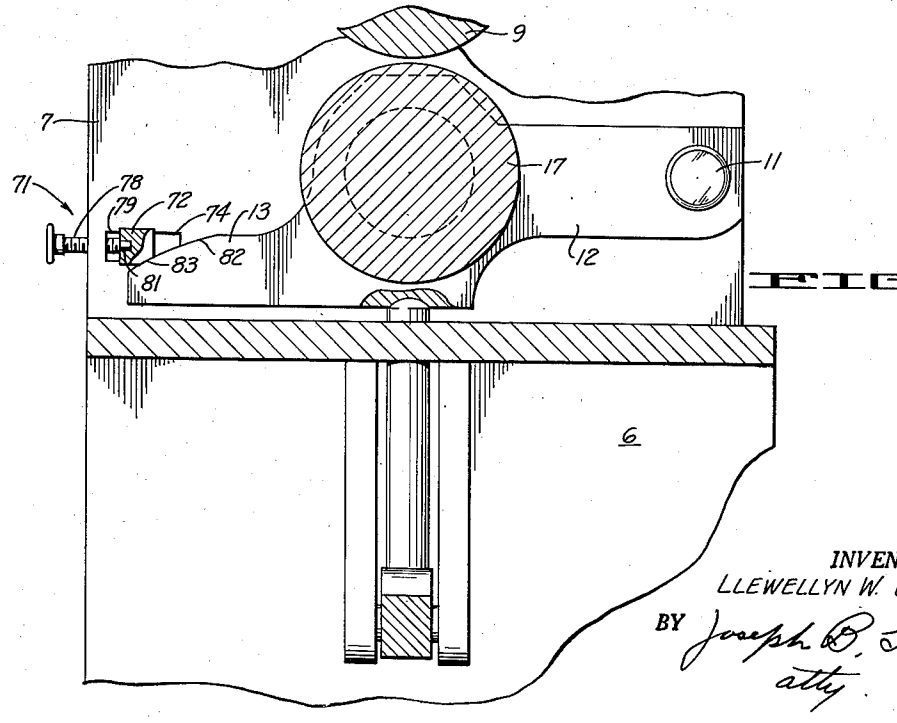



FIG. 7.

INVENTOR.
LLEWELLYN W. EVANS
BY Joseph B. Gardner
atty.

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# UNITED STATES PATENT OFFICE

2,600,628

## SHEET ROLLING MACHINE

Llewellyn W. Evans, Rivera, Calif., assignor to Rheem Manufacturing Company, Richmond, Calif., a corporation of California

Application January 10, 1949, Serial No. 70,030

13 Claims. (Cl. 153—54)

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This invention relates to machines for fabricating sheet metal and has particular reference to mechanisms for shaping initially flat sheets into articles of partial or complete tubular form.

An object of the invention is to provide, in a machine of the character described, cooperative shaping elements capable of providing a continuous uniform curvilinear bend in a sheet of material, which bend extends substantially entirely between the opposite edges of the sheet.

Another object of the invention is to provide, in a machine of the aforementioned class, a combination of form-shaping elements and sheet feeding means in which production of a substantially complete peripheral bend in the sheet is accomplished for the most part by reason of the feeding means engaging and moving the sheet entirely across the width thereof in the direction of the resulting bend.

A further object of the invention is to provide means in a sheet rolling machine capable of producing parts of partial or complete tubular form which are uniformly arcuate throughout the extent of their bends thus rendering the parts capable of ideal snug engagement with circularly or arcuately curved fittings such as, in the case of certain tubular articles, head members which may be subsequently attached to the latter articles to provide end closures therefor.

A still further object of the invention is to provide, in a machine of the character described, a group of bend-forming elements capable of ready and relatively proportional adjustment by a simple conditioning operation to produce shaped articles within a comparatively wide range of curve radii.

Yet another object of the invention is to provide, in a mechanism of the character referred to, a group of relatively positionable bend-forming elements capable of being fixed to define spaced points along a path of bend for the sheet material and operable simultaneously by means common to all of the elements of the group so as to move the latter into properly related positions to define a different path of bend for the material.

It is still another object of the invention to provide, in a machine of the class described provided with a mandrel member about which an initially flat sheet of material may be shaped to arcuate or cylindrical form, a combined drive and bend-forming unit for the sheet material which is associated with the mandrel and which is yieldably movable radially thereof so as to compensate for overall and localized variations in the

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thickness of the sheet material being passed through the machine without disturbing the bend shaping characteristics of the machine.

A still further object of the invention is the provision of a machine having a mandrel member about which an initially flat sheet of material may be shaped to arcuate a cylindrical form, and which is adapted to coact with a combined drive and bend-forming unit for the sheet material; the initial setting of the combined drive and bend-forming unit, relative to the mandrel member, being adjustable in order to accommodate materials of different thicknesses.

Still further objects and advantages of the invention will be apparent in the following description and claims considered together with the accompanying drawing, in which:

Figure 1 is a portional top plan view of the improved sheet rolling machine of my invention, a portion of the view being broken away so as to more clearly show the internal construction.

Figure 2 is a vertical sectional view taken in the plane indicated by the line 2—2 of Figure 1 and showing the relationship of the parts in the production of a bend of minimized radius.

Figure 3 is a view similar to Figure 2 showing the position of the parts in the production of a larger radius bend in the sheet material.

Figure 4 is a front elevational view of one of the positional adjustment screw gear boxes.

Figure 5 is a perspective view of the bend-forming shoe adjustment bar.

Figure 6 is a fragmentary elevation, partly in section, showing a modified form of pressure applying mechanism, and adjustable stop.

Figure 7 is a section taken on line 7—7 of Figure 6.

The most familiar and generally used machine for forming initially flat sheets of metal or other permanently deformable material into articles having a partially or completely cylindrical form comprises a group of at least three parallel rolls radially spaced with their axial centers arranged in a triangular cross-sectional pattern. Two opposed rolls forming the base of the triangle have their axes fixedly positioned but the third or upper roll is vertically adjustable relative to the fixed rolls so that the periphery of the adjustable roll may be moved to positions overlapping a material feeding path which comprises a plane tangentially intersecting the peripheries of the fixed rolls. Thus a sheet of material passed along the aforesaid feeding path will be caused to pass over one of the fixed rolls, under the vertically adjustable roll and thence over the re-

maining fixed roll, the degree of overlap of the adjustable roll with the feeding path imparting a bending strain to the sheet material sufficient to flex the latter a desired amount beyond its elastic limit so as to form a permanent bend of desired curvature in the material, one, but usually all, of the rolls are power driven in unison so that once the sheet tractionally engages all of the rolls, the sheet will be carried through the roll group and will be given a continuous uniform bend between the leading and trailing edges thereof transversely disposed relative to the direction of sheet movement.

The principal deficiency in the conventional sheet rolling machine is its inability to produce a uniform bend in the sheet material which extends entirely to the opposite edges of the latter or into such proximity thereto that the subsequent operation of joining fittings, such as circular head members in a tubular shell formed of the sheet will not require excessive welding, to fill the abnormally wide peripheral gap between the head members and the shell in the vicinity of the longitudinal butt thereof, nor subsequent hand bending operations on the shell butt to close the aforesaid gap prior to the welding operation. Such production delays, it is obvious, can seriously impair plant efficiency and unduly increase production costs.

The improved sheet rolling machine of my invention overcomes the aforesaid principal deficiency of existing machines of this character by effecting bending of the material substantially completely between the edges thereof so that extra forming operations on the finished article are eliminated and attachment fitting and welding operations are expedited to the point wherein maximum production speed may be maintained.

In the form in which I have chosen to illustrate my invention I provide a supporting frame 6 having end pillars 7 rising therefrom in which are formed bearings 8 journaling the opposite shaft ends 5 of an axially horizontal mandrel roll 9 thus maintained in constantly fixed relation with the supporting frame. Situated laterally of a vertical plane intersecting the axis of the mandrel roll 9 I provide horizontal stub shafts 11 fixedly supported in axial alignment in the supporting frame 7 and upon which are pivotally mounted rocker arms 12 extending radially of the shafts and passing under and oppositely beyond the mandrel roll 9 to terminate in integral lever arm extensions 13. Formed in the combined rocker and lever arms and substantially coinciding with the aforesaid vertical plane passing through the mandrel roll axis, are journals 14 which form bearings for the stub shaft end portions 16 of a material drive roll 17 axially paralleling the mandrel roll and adapted, upon movement of the rocker arms 12, to be caused to approach or recede from the periphery of the mandrel roll.

Preferably carried on the lever extension 13 of the rocker arm 12 is an apron 18 whose upper surface 19 is tangential with the periphery of the drive roll 17 to define a linear feeding path for the sheet material 21 which is thus introduced tangentially between the mandrel and drive rolls 9 and 17. As here shown, the shaft portions 5 and 14 of the mandrel and drive rolls 9 and 17 respectively are each provided with gears 22 relatively intermeshed to cause synchronous rotation of the rolls, and one of the shafts is connected to be power driven by suitable means which, although not shown, is commonly familiar to the average person skilled in the art. Also connected to a distal portion of each lever arm 13 by a pivot pin 23, is the piston rod 24 of an actuating cylinder 26, preferably powered pneumatically and provided at its lower end with a pivotal connection to the supporting frame as shown by the pivot pin 27. Presence of air under pressure in the cylinder 26 causes the rolls to forcibly urge toward each other and to thereby squeeze the sheet material passed therebetween with sufficient pressure to effect movement of the material along the feeding path by the tractive effort thereon of the power-driven rolls. Depending upon the surface characteristics of the material and in the force necessary to effect the subsequent bend in the sheet, the operating pressure of the cylinder 26 may be increased or decreased as desired.



Means is provided for deflecting the sheet material passed between the rolls 9 and 17 from the aforesaid linear feeding path in sufficient degree beyond the elastic limit of the sheet material that the sheet will thereafter permanently retain a form of the desired curvature ranging from only a slight bend to a complete curl wherein the edges of the sheet traversing the direction of bend will be brought together in substantially snug abutting relationship. Connected at its ends to the respective rocker arms 12 and extending above the pivot shaft 11 in parallel relation to the rolls is a rigid base bar 28 having a seating groove 29 of substantially semi-circular cross-sectional form extending along the upper surface thereof and provided with a longitudinal lip portion 31 of wedge-shaped cross-sectional form extending into the gullet defined by the relatively confronting portions of the roll peripheries so as to place the lip desirably close to the pressure point where the rolls tractionally engage the sheet material. This construction is provided to afford maximum strength of support for the bend-forming elements to be immediately described. Mounted by screws 32, or in any other suitable manner on the longitudinal edge portion of the base bar 28, is a housing 33 having a recess 34 which opens along the longitudinal side of the housing facing the rolls 9 and 17 to form a gap defined by the upper surface of the base bar 28 and by a superposed lip surface 36 of the housing 33. The recess 34 is further formed with a longitudinally extending arcuate surface portion 37 concentric with the axis of the semi-circular groove 29. Disposed for slidable movement on each other and on the upper surface of the base bar 28 is a plurality of elongated shoes 38 composed of wear-resistant metal and arranged in superposed relation to snugly occupy the gap between the said upper surface of the base bar and the lip surface 36 of the housing 33. The edges of the respective shoes 38, with the exception of the lowermost one immediately adjacent the base bar, are provided with slightly rounded and vertically inclined forward edge surfaces 39 to define bearing points along a selected path of bend for the sheet material while the corresponding forward edge 41 of the lowermost shoe is concave in form to approximate the mean curvature of the bend path between the adjustment range thereof. The rearward edge of each shoe 38 within the recess 34 is provided with a bearing ridge 42 adapted to bear against the forward flat side of an adjustment bar 43 disposed for rocking movement in the recess 34 by virtue of having a semi-circularly lower edge portion 44 seated in the groove 29 and an arcuately curved upper edge portion 46 snugly engaged with and slidable along

the arcuate surface portion 37 of the recess. Threadedy engaged with suitable axially horizontal apertures 47 formed in the housing 33 is a plurality of relatively spaced adjustment screws 48 having their forward ends bearing against the crowned rearward surface 49 of the adjustment bar 43, at points spaced from the pivotal center of the latter, and having their opposite ends exteriorly of the housing provided with longitudinally extending keyways 51. The arrangement of the parts is such that the screws 48 provide backing for the adjustment bar 43 to hold the latter in a selected position within its rocking range within the recess 34 while the thus secured adjustment bar establishes and maintains the shoes 38 in selected positions of relative horizontal displacement so as to locate the bend-defining surfaces 39 and 41 of the shoes along a curvilinear path with relation to the linear feeding path for the sheet material.

Means are provided for simultaneously moving the screws 48 so as to effect adjustment of the various shoes 38 in unison. Connected to the outer vertical faces of the housing 33, by screws 52 or by other suitable means, are brackets 53 having bushings 54 therein journaling the outer ends of the screws 48 and having recesses 56 therein enclosing pairs of intermeshed helical gears 57 one of which is keyed to its associated screw 48 so that the latter may slide axially in the gear and the other of which is fixed to a longitudinally extending control shaft 58 fitted at one end with a hand crank 59. By manipulation of the hand crank to rotate the shaft 58, corresponding rotation will be imparted through the gears 57 to the various adjustment screws so as to retract or advance the shoes 39 and 41 from or toward the rolls 9 and 17.

Figures 6 and 7 illustrate a modified method of applying the pressure to the drive roll 17, and also disclose means of adjusting the initial setting of the rocker arms 12, and the mechanism mounted thereon, relative to the mandrel roll 9. In this embodiment the pressure cylinders 26 are pivotally mounted, in an inverted position, to the underside of the supporting frame 6 and are spaced longitudinally inwardly relative to the complete machine from their respective rocker arms 12. The description will proceed further in the singular, both combinations of rocker arms and pressure applying mechanism being physically and functionally identical. The downwardly extending piston rod 24 is pivotally connected by a pin 61 to the power end 62 of a toggle lever 63, which is mounted on the frame 6 by means of a fulcrum pin 64.

Thrust is transmitted from the load end 66 of the lever 63 by means of relatively heavy push rod 67 which is formed with rounded ends adapted to seat in complementary depressions 68 and 69 in the confronting surfaces of the rocker arm 12 and end 66 of lever 63 respectively. The depressions 68 and 69 are in substantially vertical alignment and the push rod 67 which is maintained in position therebetween is normally perpendicular to both the rocker arm 12 and the toggle lever 63. As the point of application of thrust transmitted by the rod 67 to the rocker arm 12 is located some distance from the stub shaft 11 a turning movement is exerted on the rocker arm the force of this movement being greatly multiplied by the added leverage of the toggle lever 63. This additional pressure exerted on material passing between the rolls, provides the traction necessary to handle sheets of relatively heavy gauge.

In order to provide a means of establishing an initial relative location of the fixed mandrel roll on the one hand and drive roll and material feeding and forming elements on the other hand, I provide an adjustable stop 71 in each of the end pillars 7. The stop 71 which is adapted to horizontally adjustable movement in a direction longitudinal to the respective rocker arm 12 extends horizontally from the inner face of the end pillar 7, and projects under the lever arm extension 13 adjacent the end thereof and in movement limiting contact therewith. It comprises a bar of generally square section having a stop portion 72 extending into the arcuate path of the lever arm extension 13 and a reduced portion 73 adapted to slide in a parallel slot 74 in the end pillar 7. A flanged cap 76 is provided for fixed engagement with the inserted end 73 of the stop 71 and a bolt 77 locking the two members together prevents lateral displacement of the stop relative to the slot 74. An adjusting screw 78 mounted in a tapped hole in the edge of the pillar 7 in alignment with the slot 74 extends therein and engages the slot fitting portion 73 of the stop 71. The screw 78 is formed with a plain end 79 of reduced diameter adapted for thrust seating engagement in a flat bottomed hole 81 in the stop 71. The extending portion 72 of the stop 71 has been formed with a contacting surface 82 on its upper side which is parallel to the stop longitudinally, but slopes downwardly toward the rocker arm 12 at an angle of approximately 30°, and the contiguous end of the lever arm extension is also beveled to form a face 83, which although substantially complementary to the surface 82, is slightly convex whereby line contact only is possible between the two surfaces.

In the preparation of the machine for operation the action of the pressure cylinders will cause the rocker arms 12 to pivot about the shafts 11 until contact is established between the lever arm extensions 13 and the stops 71; the location of the stops in their respective slots determining the initial relative positions of the fixed and movable sheet forming elements. Adjustment of the screws 78 effecting advancing movement of the stops 71, will create a wedging action between the surfaces 82 and 83 forcing the end of the arm 13 in a downward direction, and thereby adjusting the plate forming elements for the accommodation of heavy material. Conversely, retractive movement of the screws 78 permits the action of the pressure cylinders to force the stops outward thus bringing the fixed and movable plate forming elements into closer relationship. The line contact between the surfaces 82 and 83 of the stop 71 and lever arm extensions 13 facilitates the retractive movement of the stops.

As the sheet material 21 passes between the rolls 9 and 17 from the linear feeding plane defined by the upper surface of the apron 19, the leading edge of the sheet will engage, successively, the portions 41 and 39 of the shoes 38 and will be flexed thereby relative to the feeding path to strain the material sufficiently beyond its elastic limit that the sheet will thereafter retain a continuous arcuate curvature depending upon the abruptness of the bend that is imparted to the material. When the shoes 38 are caused to approach closely to the periphery of the mandrel roll 9 the maximum bending of the material will be secured and consequently the radius of bend will be minimized. On the other hand, if the

shoes 38 are moved to remote positions with respect to the mandrel roll periphery, the bend imparted to the material will be much less severe and consequently the radius form of the resulting product will be much greater. It will be noted that regardless of what degree of bend is being imparted to the sheet material by the shoes, the points of engagement of the shoes with the material are always very close together so that, in effect, the points provide a substantially continuous bending path for the material which results in the formation of smoothly and uniformly curved products. It will be further noted that the shoes although affording a plurality of bearing points against which the material is directed to effect bending of the latter, occupy a comparatively small overall height and in being all slidable in planes substantially coinciding with the feeding path of the initially flat material permit the bearing points to be accurately and micrometrically positioned along and to define a selected path of bend even though the lateral movements between the various shoes appears to be comparatively great. It should also be carefully noted that the lowermost shoe which bears the concave introductory surface 41 of the bending path has its point of contact with the adjustment bar 43 very closely positioned relative to the pivotal center of the latter while the points of contact of the upper shoes are proportionately spaced upwardly along the adjustment bar. This means that the various shoes are not moved an equal distance laterally at each positional adjustment of the bar 43 but rather in differing degrees to effect proper proportionate positioning of the material contact points to produce the smoothest continuity of the bending path. The lower shoe in moving the least of any during all positional displacements maintains the surface 41 always sufficiently close to the point of emergence of the sheet material from between the rolls 9 and 17 that bending of the material is practically immediately obtained. This is of the utmost importance since the arcuate bending of the material is started from the introductory or leading edge of the sheet and continues uniformly to the opposite trailing edge thereof thus eliminating the flat end portions which characterize sheets rolled in conventional machines.

Attention is also directed to the fact that the apron 18, which provides the linear feeding plane for the material, is tangential with the periphery of the lower of feeding roll 17 and continues in fixed alignment into the curved bending path defined by the material contact surfaces of the shoes. These elements it will be noted are all carried by the rocker arm 12 and 13 and are movable unitarily therewith. Thus regardless of overall or localized variations in thickness of the sheet material being passed through the machine, the outer or convex surface of the finished product will be identical in all cases. In the conventional types of rolling machines such variations in thickness of the material create differences in cross-sectional form in the finished articles with the result that such odd-sized articles must be given special and delay-creating treatment in the course of subsequent fabrication.

Although I have illustrated the power-driven mandrel and feeding rolls 9 and 17 as affording the means for introducing the sheet material from the linear feeding path into the curvilinear forming path, it is within the scope of the invention to utilize other means afford confining of the material to said linear feeding path, such as an enclosing passage for the sheets, and separate means for moving the sheets which may be in the form of a movable follower for forcibly pushing the sheets through the passage to enter the forming passage.

I claim:

1. In a machine for curve-bending material, means defining a linear feeding path along which initially straight material may be moved, a plurality of horizontally offset superimposed and substantially flat bend-forming elements engageable by and to laterally flex said material and to define a curvilinear forming path comprising a continuation of said linear feeding path, means for moving said bend-forming elements in unison and in relatively varying degrees to vary the degree of horizontal offset and to alter the curvature of said forming path, and means for moving said material along said feeding and forming paths.

2. In a machine for curve-bending material, means defining a linear feeding path along which a length of initially straight material may be moved toward a terminal point of said feeding path, a plurality of horizontally offset superimposed bend-forming elements disposed closely adjacent said terminal point of the feeding path engageable by and to laterally flex said material as the latter is moved past said terminal point and to direct said flexed material along a curvilinear forming path comprising a continuation of said linear feeding path from the terminal point thereof, said elements being of bar-like form and having leading edge portions successively engageable with said material, means for moving said bend-forming elements in unison and in relatively varying degrees to selectively vary the degree of horizontal offset and to alter the curvature of said forming path, and means for moving said material along said feeding and forming paths.

3. In a machine for curve-bending material, a fixedly positioned mandrel, means defining a linear feeding path disposed adjacent said mandrel and along which initially straight material may be moved past said mandrel in tangential relation thereto, feeding means engaging said material for moving the latter along said feeding path and past said mandrel, a plurality of individually adjustable superimposed bend-forming elements disposed closely adjacent the point of tangency of the material with said mandrel, said bend-forming elements having portions thereon being engageable by and arranged to laterally flex said material as the latter is moved past said point of tangency and to direct said flexed material along a curvilinear forming path comprising a continuation of said linear feeding path from said point of tangency, and means remote from said material engaging portions for moving said bend-forming elements in unison and in planes substantially paralleling said linear feeding path and in relatively proportionate degrees to selectively rearrange said elements to provide forming paths of altered curvatures.

4. In a machine for curve-bending material, a fixedly positioned mandrel, means defining a linear feeding path disposed adjacent said mandrel and along which initially straight material may be moved past said mandrel in tangential relation thereto, a power-driven feeding roll disposed adjacent said mandrel and for tractionally engaging said sheet material to move the latter along said feeding path and past said mandrel.

a plurality of superposed relatively movable bend-forming elements disposed in an intimate group closely adjacent the point of tangency of the material with said mandrel, said bend-forming elements being engageable by and arranged to laterally flex said material as the latter is moved past said point of tangency and to direct said flexed material along a curvilinear forming path comprising a direct continuation of said linear feeding path from said point of tangency, means for moving said bend-forming elements in unison and in relatively proportionate degrees to selectively rearrange said elements to provide forming paths of altered curvatures, and means supporting said feeding path defining means, said feeding roll and said bend-forming elements as a unit whereby said unit may be moved bodily toward and away from said mandrel.

5. In a machine for curve-bending material, a fixedly positioned mandrel, means defining a linear feeding path disposed adjacent said mandrel and along which initially straight material may be moved past said mandrel in tangential relation thereto, a power-driven feeding roll disposed adjacent said mandrel and for tractionally engaging said sheet material to move the latter along said feeding path and past said mandrel, a plurality of superposed relatively movable bend-forming elements disposed in an intimate group closely adjacent the point of tangency of the material with said mandrel, said bend-forming elements being engageable by and arranged to laterally flex said material as the latter is moved past said point of tangency and to direct said flexed material along a curvilinear forming path comprising a direct continuation of said linear feeding path from said point of tangency, means for moving said bend-forming elements in planes substantially paralleling said feeding path and intersecting said forming path and in relatively differing degrees to dispose the points of engagement of the bend-forming elements with said material along a prescribed forming path, and means supporting said feeding path defining means, said feeding roll and said bend-forming elements as a unit whereby said unit may be moved bodily toward and away from said mandrel.

6. In a machine for curve-bending material, a fixedly positioned mandrel, means defining a linear feeding path disposed adjacent said mandrel and along which initially straight material may be moved past said mandrel in tangential relation thereto, a power-driven feeding roll disposed adjacent said mandrel and for tractionally engaging said sheet material to move the latter along said feeding path and past said mandrel, a plurality of superposed relatively movable bend-forming elements disposed in an intimate group closely adjacent the point of tangency of the material with said mandrel, said bend-forming elements being engageable by and arranged to laterally flex said material as the latter is moved past said point of tangency and to direct said flexed material along a curvilinear forming path comprising a direct continuation of said linear feeding path from said point of tangency, a member mounted for rockable movement adjacent said bend forming elements and engaging the latter to move them in unison and in relatively proportionate degrees to selectively rearrange said elements to provide forming paths of altered curvatures, means engaging said rockable member for moving the latter to selected positions of rocking movement, and means supporting said feeding path defining means, said feeding roll and said bend-forming elements as a unit movable bodily toward and away from said mandrel.

7. In a machine for curve-bending material, a fixedly positioned mandrel, means defining a linear feeding path disposed adjacent said mandrel and along which initially straight material may be moved past said mandrel in tangential relation thereto, a power-driven feeding roll disposed adjacent said mandrel and for tractionally engaging said sheet material to move the latter along said feeding path and past said mandrel, a plurality of superposed relatively movable bend-forming elements disposed in an intimate group closely adjacent the point of tangency of the material with said mandrel, said bend-forming elements being engageable by and arranged to laterally flex said material as the latter is moved past said point of tangency and to direct said flexed material along a curvilinear forming path comprising a direct continuation of said linear feeding path from said point of tangency, a member mounted for rockable movement adjacent said bend forming elements and engaging the latter to move them in unison and in relatively proportionate degrees to selectively rearrange said elements to provide forming paths of altered curvatures, means engaging said rockable member for moving the latter to selected positions of rocking movement, means supporting said feeding path defining means, said feeding roll and said bend-forming elements as a unit movable bodily toward and away from said mandrel, and yieldable means for forcibly urging said unit toward said mandrel to maintain tractional engagement between said mandrel, feeding roll and said material.

8. In a machine for curve-bending material, a supporting frame having an axially horizontal rotatable mandrel roll journaled thereon, rocker arms mounted for pivotal movement on said supporting frame and positioned adjacent said mandrel roll, guide means on said rocker arms for supporting initially straight material and along which said material may be moved in a feeding path tangentially toward and over said mandrel roll, a material feeding roll journaled on said rocker arms and arranged in axially parallel relation with said mandrel roll, said feeding roll being movable upon rockable movement of said rocker arms toward said mandrel roll to engage said material tractionally between the confronting peripheries of the feed and mandrel rolls and to move said material along said feeding path, means connecting said feed and mandrel rolls for unitary rotary movement, pressure means for urging said feed and mandrel rolls together to effect said tractional engagement of the rolls with said material, a bend-forming shoe comprising a plurality of superposed bars slidable on said rocker arms in planes substantially paralleling the feeding path of said material, said bars each having thereon a portion positionable to form a point along a curvilinear bending path for the material which comprises a direct continuation of said feeding path, as the latter is moved to laterally flex the material a predescribed amount beyond its elastic limit to impart a permanent curvilinear bend to said material, and means for moving said bars in unison and in proportionately varying degrees to establish bending paths of selected different curvatures.

9. In a machine for curve-bending material, a supporting frame having an axially horizontal

rotatable mandrel roll journaled thereon, rocker arms mounted for pivotal movement on said supporting frame and positioned adjacent said mandrel roll, guide means on said rocker arms for supportnig initially straight material and along which said material may be moved in a feeding path tangentially toward and over said mandrel roll, a material feeding roll journaled on said rocker arms and arranged in axially parallel relation with said mandrel roll, said feeding roll being movable upon rockable movement of said rocker arms toward said mandrel roll to engage said material tractionally between the confronting peripheries of the feed and mandrel rolls and to move said material along said feeding path, means connecting said feed and mandrel rolls for unitary rotary movement, pressure means for urging said feed and mandrel rolls together to effect said tractional engagement of the rolls with said material, a bend-forming shoe comprising a plurality of superposed bars slidable on said rocker arms in planes substantially paralleling the feeding path of said material, said bars each having thereon a portion positionable to form a point along a curvilinear bending path for the material which comprises a direct continuation of said feeding path, said points being successively engageable with said material as the latter is moved to laterally flex the material a predescribable amount beyond its elastic limit to impart a permanent curvilinear bend to said material, a rocker bar on said rocker arms and engaging said bars, and means for moving said rocker bar to move the shoe bars in unison and in proportionately varying degrees to establish bending paths of selected different curvatures.

10. In a machine for curve bending material, a supporting frame having an axially horizontal rotatable mandrel roll journaled thereon, rocker arms mounted for pivotal movement on said supporting frame and positioned adjacent said mandrel roll, guide means on said rocker arms for supporting initially straight material and along which said material may be moved in a feeding path tangentially toward and over said mandrel roll, a material feeding roll journaled on said rocker arms and arranged in axially parallel relation with said mandrel roll, said feeding roll being movable upon rockable movement of said rocker arms toward said mandrel roll to engage said material tractionally between the confronting peripheries of the feed and mandrel rolls and to move said material along said feeding path, means connecting said feed and mandrel rolls for unitary rotary movement, pressure means for urging said feed and mandrel rolls together to effect said tractional engagement of the rolls with said material, a bend-forming shoe comprising a plurality of superposed bars slidable on said rocker arms in planes substantially paralleling the feeding path of said material, said bars each having thereon a portion positionable to form a point along a curvilinear bending path for the material which comprises a direct continuation of said feeding path, as the latter is moved to laterally flex the material a predescribed amount beyond its elastic limit to impart a permanent curvilinear bend to said material, a base bar carried by said rocker arms and extending longitudinally parallel with said rolls and said shoe bars, a rocker bar mounted for pivotal movement on said base bar and engaging said shoe bars, and means engaged with said rocker bar for moving the latter to selected positions of rocking movement and to move the shoe bars in unison and in proportionately varying degrees to establish bending paths of selected different curvatures.

11. In a machine for curve-bending material, a supporting frame having an axially horizontal rotatable mandrel roll journaled thereon, rocker arms mounted for pivotal movement on said supporting frame and positioned adjacent said mandrel roll, guide means on said rocker arms for supporting initially straight material and along which said material may be moved in a feeding path tangentially toward and over said mandrel roll, a material feeding roll journaled on said rocker arms and arranged in axially parallel relation with said mandrel roll, said feeding roll being movable upon rockable movement of said rocker arms toward said mandrel roll to engage said material tractionally between the confronting peripheries of the feed and mandrel rolls and to move said material along said feeding path, means connecting said feed and mandrel rolls for unitary rotary movement, pressure means for urging said feed and mandrel rolls together to effect said tractional engagement of the rolls with said material, a bend-forming shoe comprising a plurality of superposed bars slidable on said rocker arms in planes substantially paralleling the feeding path of said material, said bars each having thereon a portion positionable to form a point along a curvilinear bending path for the material which comprises a direct continuation of said feeding path, said points being successively engageable with said material as the latter is moved to laterally flex the material a predescribed amount beyond its elastic limit to impart a permanent curvilinear bend to said material, a base bar carried by said rocker arms and extending longitudinally parallel with said rolls and said shoe bars, said base bar having therein a longitudinally extending groove, a rocker bar disposed in said groove and pivotally mounted thereby on said base, said rocker bar engaging said shoe bars, a housing carried by said base bar and engaging said shoe bars, and an adjustment screw threadedly engaged in said housing and bearing against said rocker bar for moving the latter and the shoe bars in unison and in proportionately varying degrees to establish bending paths of selected different curvatures.

12. In a machine for curve-bending material, a supporting frame having an axially horizontal rotatable mandrel journaled thereon, rocker arms mounted for pivotal movement on said supporting frame and positioned adjacent said mandrel roll, guide means on said rocker arms for supporting initially straight material and along which said material may be moved in a feeding path tangentially toward and over said mandrel roll, a material feeding roll journaled on said rocker arms and arranged in axially parallel relation with said mandrel roll, said feeding roll being movable upon rockable movement of said rocker arms toward said mandrel roll to engage said material tractionally between the confronting peripheries of the feed and mandrel rolls and to move said material along said feeding path, means connecting said feed and mandrel rolls for unitary rotary movement, pressure means for urging said feed and mandrel rolls together to effect said tractional engagement of the rolls with said material, a bent-forming shoe comprising a plurality of superposed bars slidable on said rocker arms in planes substantially paralleling the feeding path of said material, said bars each having there-

on a portion positionable to form a point along a curvilinear bending path for the material which comprises a direct continuation of said feeding path, said points being successively engageable with said material as the latter is moved to laterally flex the material a predescribed amount beyond its elastic limit to impart a permanent curvilinear bend to said material, a base bar carried by said rocker arms and extending longitudnally parallel with said rolls and said shoe bars, said base bar having therein a longitudinally extending groove, a rocker bar disposed in said groove and pivotally mounted thereby on said base bar, said rocker bar engaging said shoe bars, a housing carried by said base bar and having a portion thereof overlying said shoe bars to define with a surface of the base bar an opening through which said shoe bars may slidably move, said housing also having therein a recess extending parallel to and confronting the groove of said base bar, said recess having a transverse cross-sectional contour which is an arc centered in said groove, a rocker bar having an edge portion thereof engaged in said groove and an opposite edge portion slidably engaged in the housing recess, said rocker bar also being disposed in engagement with said shoe bars, and a screw engaged in said housing and bearing against said rocker bar for moving the latter and the shoe bars in unison and in proportionately varying degrees to establish bending paths of selected different curvatures.

13. In a machine for curve-bending material, means defining a generally horizontally disposed linear feeding path along which initially straight material may be moved, a plurality of movable bend-forming elements engageable by and to laterally flex said material and to define a curvilinear forming path comprising a continuation of said linear feeding path, means for moving said bend forming elements in unison in solely a horizontal direction and in relatively varying degrees to alter the curvature of said forming path, additional means for moving said bend forming elements in unison in substantially a vertical direction and in relatively fixed degrees to accommodate materials of different thicknesses, and means for moving said material along said feeding and forming paths.



LLEWELLYN W. EVANS.


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