United States Patent

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[72] Inventors **Frederick E. Munschauer, Jr. Eggertsville; George H. Trautman, Jr., Kenmore, both of N.Y.**

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[73] Assignee **Niagara Machine & Tool Works Buffalo, N.Y.**

[54] **ROLL FORMING MACHINE**
2 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **72/169**
[51] **Int. Cl.** **B21d 5/14**
[50] **Field of Search** 72/169, 166

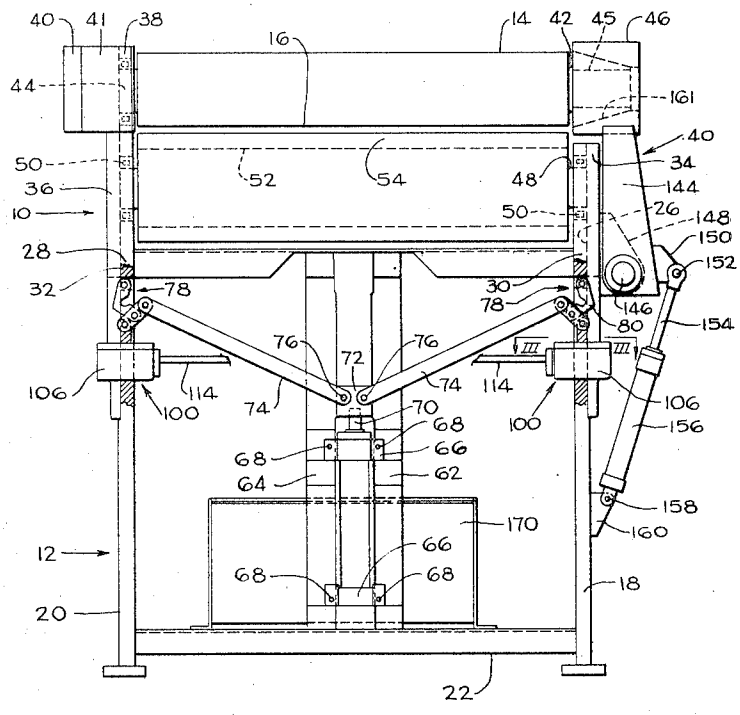
[56] **References Cited**

UNITED STATES PATENTS

3,371,513	3/1968	Achler et al.	72/166
2,432,666	12/1947	Isenberg et al.	72/169
2,838,089	6/1958	Weisner	72/169

Primary Examiner—Milton S. Mehr
Attorney—Christel & Bean

ABSTRACT: A roll forming machine comprising a pair of rolls between which sheet material is fed and bent to arcuate form. The upper drive roll is a rigid steel roll rotated by a hydraulic motor and the lower roll is of a compressible material such as polyurethane and is driven from the upper roll by the relative movement of the workpiece therethrough. A drop-end member is pivoted at its lower end about an axis located slightly below the periphery of the lower roll for movement in an arcuate path toward and away from the roll. A bearing block is provided at the upper end of the drop-end member for engagement with the free end of the upper roll for rotatably supporting the same.



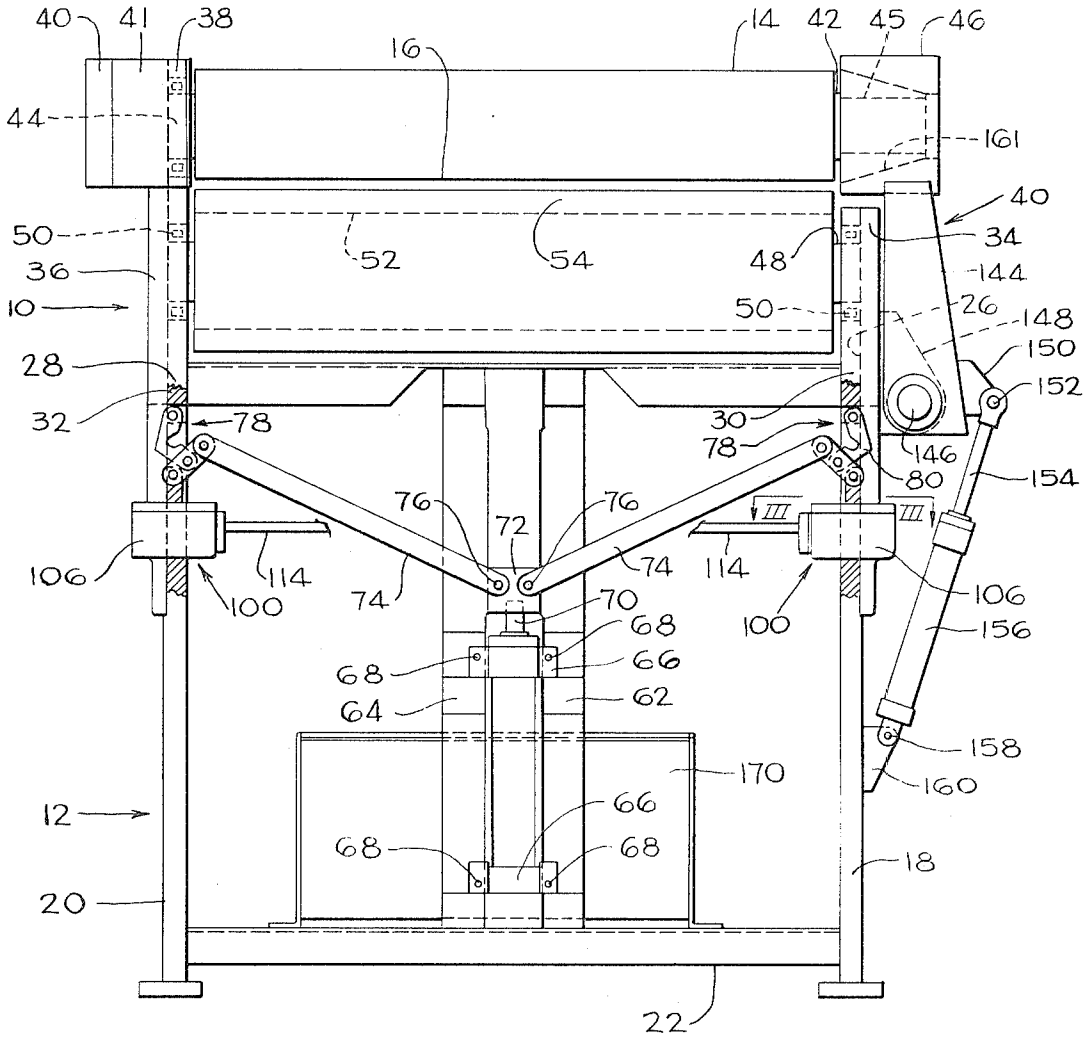


FIG. 1.

INVENTOR.
FREDERICK E. MUNSCHAUER, JR
GEORGE H. TRAUTMAN, JR.
BY
Christel & Bean
ATTORNEYS.

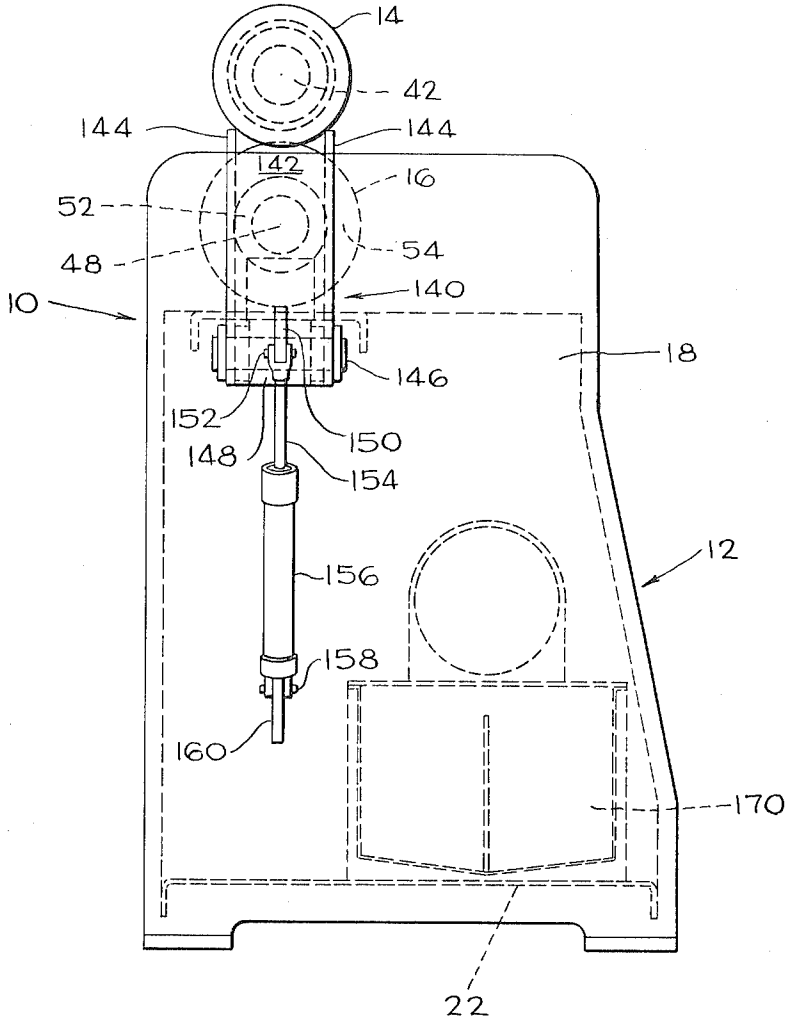


FIG. 2.

INVENTOR.
FREDERICK E. MUNSCHAUER, JR
GEORGE H. TRAUTMAN, JR.
BY
Christel & Bean
ATTORNEYS

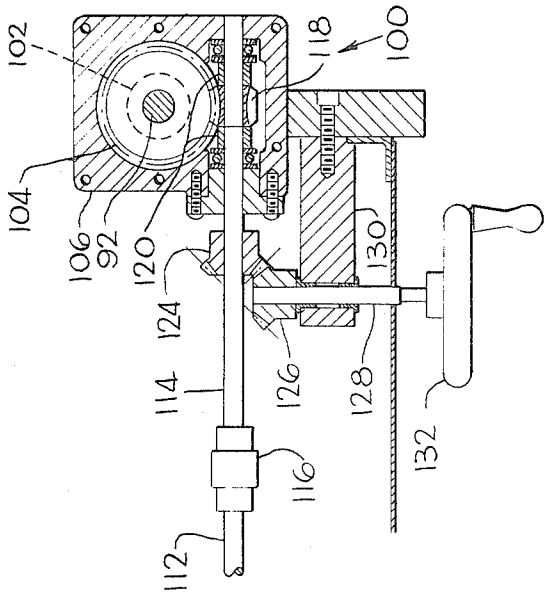


FIG. 3.

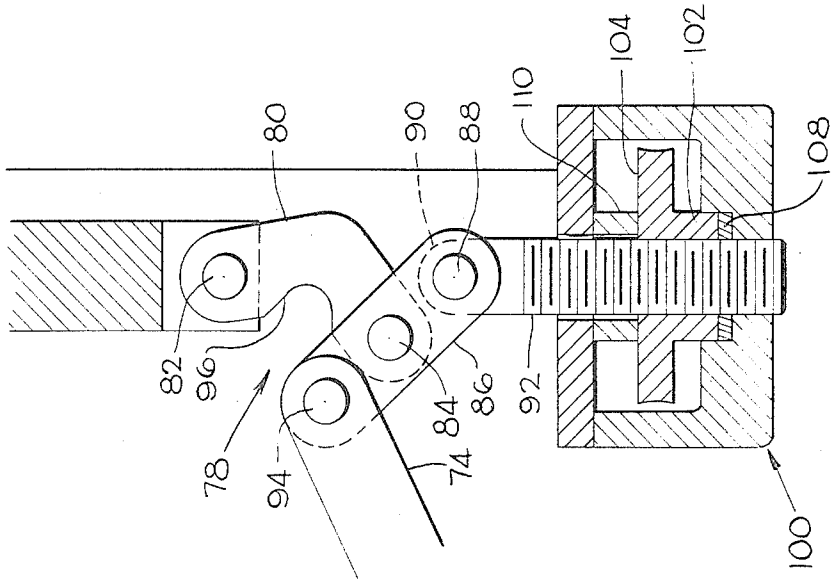


FIG. 4.

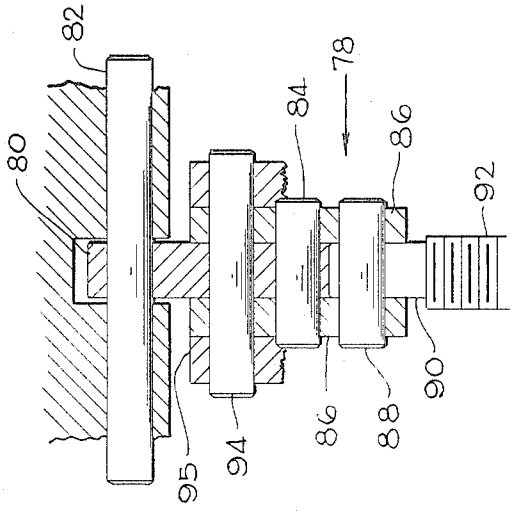


FIG. 5.

INVENTOR.
FREDERICK E. MUNSCHAUER, JR.
GEORGE H. TRAUTMAN, JR.
BY

Christel & Bean
ATTORNEYS

ROLL FORMING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to a roll forming machine and, more particularly, to a roll forming machine having two rolls for forming arcuate or curved shapes in sheet material, as in the formation of cylindrical sheet metal ducts.

Roll forming machines of the vertically aligned, two-roll type are known and conventionally employ electrical drive means for rotating the rolls and in such drives speed reducing gears of a relatively high reduction ratio are required between the electric motor and the roll driven thereby. When the electric power is cut off after completion of a forming operation, the rolls tend to coast due to the very substantial mass and high speed of the rotor of the electric driving motor, thus prolonging the forming operation longer than desired and preventing the desired degree of control of the forming operation.

These prior art machines are generally equipped with means engageable with one end of the upper roll for rotatably supporting the same during forming operations, which means is disengageable and moved out of the way after a forming operation to permit removal of a finished workpiece from the forming machine. Such means, in prior art machines, takes the form of an elongated upright member having a bearing at its upper end engageable with the free end of the upper roll and is pivoted at its lower end adjacent the bottom of the machine. Because of the excessive length of the drop end member, various auxiliary equipment, such as support and guide members, are necessary to insure proper alignment of the enlargement of the drop end member with the free end of the upper roller. Furthermore, this excessive length makes it necessary to swing the member outwardly from the machine a great distance in order to permit removal of the workpiece.

SUMMARY OF THE INVENTION

The roll forming machine of the present invention, as hereinafter described, eliminates the above disadvantages by providing a hydrostatic drive for driving the upper roller which more or less instantaneously stops rotation of the rollers upon the removal of power therefrom. This is due to the relatively low ratio of speed reduction and the relatively low speed and much smaller mass of the drive rotor as compared with an electric motor. Furthermore, the present invention employs a drop end member having a relatively short radius of extent and a correspondingly smaller arcuate path of movement for more accurate alignment with the free end of the upper roller without the necessity of additional guide members and the like.

Generally speaking, the roll forming machine of the present invention comprises a pair of vertically spaced rollers, the upper roller being operatively connected to a hydraulic motor. The lower roller is driven by the relative movement of the workpiece forced thereagainst. A drop end member having a bearing block at its upper end for engagement with the free end of the upper or drive roller is swung laterally out of the way to its inoperative position for permitting easy removal of the workpiece. The drop end member is pivotally mounted at its lower end about a pivot axis located slightly below the lower or driven roller to provide a short arcuate path of movement for the drop end member. Thus the upper end of the drop end member requires much less lateral movement to permit insertion and removal of workpieces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view, with portions broken away and in cross section, of one form of the roll forming machine of the present invention;

FIG. 2 is a side elevational view of the machine of FIG. 1;

FIG. 3 is a fragmentary horizontal sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is a fragmentary, vertical sectional view, showing the toggle linkage means and the adjustment means for varying the vertical position of the lower roller relative to the upper roller; and

FIG. 5 is a fragmentary side elevational view, with parts broken away, showing the toggle linkage means of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is shown in FIG. 1 a roll forming machine, generally designated 10, constructed in accordance with the principles of this invention, comprising a frame 12 for supporting an upper work engaging roller 14 and a lower, vertically movable, work engaging roller 16, hereinafter more fully described. Frame 12 comprises a pair of laterally spaced upright sideplates 18 and 20 joined together adjacent their lower ends by a cross brace means in the form of a platform 22. Sideplates 18 and 20 are slotted to form guideways 26 and 28 for slide blocks 30 and 32 which support opposite ends of movable roller 16 as will hereinafter become apparent.

Upper plates 34 and 36 form upper extensions of sideplates 18 and 20. It will be seen in FIG. 1 that upper plate 34 terminates short of the upper periphery of lower roll 16 whereas upper plate 36 projects above roll 16 and has a bearing block 38 attached to the upper end thereof for supporting one end of upper roll 14. A fluid actuated motor assembly 40 is affixed to the outer end of bearing block 38 and is connected to the upper roll 14 by means of a suitable gear reduction means 41 for driving or rotating the same.

Upper roll 14 is mounted on a rotatable shaft 42 suitably journaled at one end 44 in bearing block 38 and is adapted to be mounted at the other end 45 for rotation in a bearing block 46 mounted at the free end of a drop end means, hereinafter described. Shaft 42 is operatively connected to the fluid actuated motor assembly 40 and is rotated thereby. Roll 14 is formed of any suitable hard, durable metal, such as steel for example, and has a longitudinal axis fixed relative to frame 12.

Lower roll 16 is mounted on a shaft 48 suitably journaled for rotation at its opposite ends in bearings 50 mounted in slide blocks 30 and 32, respectively. Shaft 48 carries an elongated tubular metal sleeve 52 about which is mounted a sleeve of resiliently yieldable urethane rubber 54 for engaging the sheet metal to be formed by the machine.

Urethane rubber is desirable as the outer layer of roller 16 because of its toughness and because its resiliency permits temporary deformation thereof under loadings to conform to the shape of the deforming member or upper roller and the noncompressibility of such material performs similar to a confined hydraulic fluid exerting pressure substantially uniformly along its contact area with the deforming member. Of course, the outer layer of roller 16 may be formed of other suitable resiliently yieldable material, if desired. The longitudinal axis of roller 16 is movable vertically toward and away from upper roller 14 by a mechanism hereinafter described.

The means provided for moving roller 16 toward and away from roller 14 comprises a fluid actuating cylinder 60 supported on platform 22 and mounted between a pair of upright guide bars 62 and 64. Cylinder 60 is secured to guide bars 62 and 64 by means of clamp brackets 66 embracing cylinder 60 and connected at opposite ends to the guide bars 62 and 64 by suitable fasteners 68. A piston rod 70 projects upwardly from cylinder 60 and is connected to an actuator block 72 slidable vertically between guide bars 62 and 64. A pair of links 74 are pivotally mounted at one end of each as at 76 to actuator block 72 and at the other end of each to a pair of toggle linkage means, generally designated 78, located at each side of frame 12 and operatively connected to slide blocks 30 and 32.

Since both toggle linkage means 78 are identical, it is believed that a detailed description of the right hand linkage as shown in FIG. 1 will suffice, it being understood that the same reference characters will be applied to identical parts. As shown in FIGS. 4 and 5, toggle linkage means 78 comprises lever 80 pivotally mounted on a pin 82 carried by the lower end of slide block 30. The lower end of lever 80 is pivotally

connected to a pin 84 carried by a pair of short levers 86 intermediate the ends thereof. The lower ends of levers 86 are pivotally connected to a pin 88 carried by the upper end 90 of an externally threaded screw 92, hereinafter described. The upper ends of levers 86 are pivotally connected to a pin 94, which is also connected to the outer bifurcated end 95 of each link 74. The bifurcated end 95 of link 74 straddles the outer sides of levers 86. Link 80 is provided with a notch 96 for receiving pin 94 when the toggle linkage means 78 is in the rigid locked position caused by upward movement of the lower ends of links 74 effected by actuation of cylinder 60.

The toggle linkage means 78 is operative to move slide blocks 30 and 32 upwardly to move roller 16 toward roller 14 into an operative work engagement position. In order to selectively vary the pressure between rolls 16 and 14 accordingly the penetration of the periphery of steel roll 14 into the periphery of urethane roll 16, an adjustment means, generally designated 100, is provided at each side of frame 12. Adjustment means 100 comprises an externally threaded screw 92 which is threaded within a hub 102 of a worn wheel 104 disposed within a housing 106. The bottom of hub 102 seats against a thrust washer 108, as shown in FIG. 4. Worm wheel 104 is held axially in position in housing 106 by a spacer 110 disposed against the face of gear 104 and the upper wall of housing 106.

A drive shaft 112 extending across frame 12 is operatively connected at opposite ends to shafts 114 by suitable coupling means 116. For convenience of description, only the drive arrangement and adjustment means 100 appearing on the right-hand side of FIG. 1, as shown in FIG. 3, will be described in detail, it being understood that the drive and adjustment arrangement for the other side is identical. Shaft 114 is provided with a worm 118 mounted between spacers 120 for engagement with worm wheel 104.

Shaft 114 is journaled for rotation in spaced bearings 122 mounted in housing 106. As shown in FIG. 3, shaft 114 carries a bevel gear 124 driven by a mating bevel gear 126 secured to a cross-shaft 128 journaled in a bracket 130 projecting inwardly from sideplate 18. The free end of cross-shaft 128 is provided with a handwheel 132. Thus, by manipulating wheel 132, screw 92 and slide blocks 30 and 32 may be vertically moved to effect vertical adjustment of roll 16 relative to roller 14 and thereby adjust the pressure between rolls 16 and 14.

In order to permit insertion and removal of sheet metal workpieces between rolls 14 and 16, a drop end means, generally designated 140, is provided on sideplate 18. The drop end means 140 comprises a pivoted upright member 142 having a pair of spaced arms 144 pivotally mounted at their lower ends on a pivot pin 146 carried by a support bracket 148 secured to and extending outwardly from upper plate 34. Drop end member 142 is adapted to be swung between the operative position shown in FIG. 1 and an inoperative position in which member 142 is swung outwardly away from frame 12.

Pivot pin 146 defines a pivot axis located slightly below lower roll 16. A bracket 150 extends outwardly from member 142 and carries a pivot pin 152 to which a piston rod 154 of a fluid cylinder 156 is pivoted. The lower end of cylinder 156 is pivotally mounted on a pin 158 carried by a bracket 160 projecting outwardly from sideplate 18. The upper end of member 142 carries bearing block 46 having a conical recess 161 for rotatably receiving the free end of shaft 42. Due to the relatively short radius of the arm of member 142 as opposed to the long radius of conventional drop end members which pivot on an axis located adjacent the bottom of the machine frame, a relatively short arc of movement is required by member 142 to more easily control and accommodate swinging movement and facilitate accurate alignment of bearing block 46 with the free end of roll shaft 42 without the need for any auxiliary guide or support means. Also, the conical recess 161 in bearing block 46 permits self alignment of roll shaft 42 when the drop end member 142 is swung into the operative position shown in FIG. 1.

In operation, a sheet of metal or other material is fed between rollers 14 and 16 in a direction normal to the longitudinal axes of the rollers. Alternatively, a workpiece may be started between rolls 14 and 16 by inserting the same laterally in a direction parallel to the longitudinal axes of the rollers. Of course, in the latter method, drop end member 142 is disposed in its inoperative position wherein baring block 46 is disengaged and spaced from the free end of roller shaft 42 so that the workpiece can be inserted laterally. Thereafter, drop end member is swung to its operative position wherein bearing block 46 embraces the free end of roller shaft 42.

Lower roll 16 is moved vertically toward roll 14 by actuating cylinder 60 which projects piston rod 70 upwardly to raise the lower ends of links 74 and actuate toggle linkage means 78. Pins 94 swing into the notches 96 of levers 80 in a slightly overcenter position to lock the toggle linkage means 78 in a rigid position with pins 82 extended relative to pins 88, thereby forcing slide blocks 30 and 32 upwardly to bring lower roll 16 into an operative work engaging position.

If required or desired, the adjustment means 100 through control wheel 132 and the associated gearing arrangement may be manipulated to selectively move roll 16 vertically relative to roll 14 for adjustment of the pressure between rollers 14 and 16. The sheet workpiece can now be formed. Fluid motor assembly 40 is activated for driving upper roll 14 while the lower roll 16 is driven by the friction of the workpiece thereagainst, thus forming the sheet workpiece into an arcuate shape. The curvature of the sheet is varied by adjusting the pressure between rolls 14 and 16.

After the sheet workpiece has been formed to its desired curvature, fluid pressure supplied to fluid motor 40 is removed to inactivate motor 40 and stop rotation of rolls 14 and 16. The hydrostatic drive incorporated in this invention more or less instantaneously stops rotation of drive roll 14 and thereby driven roll 16, as opposed to conventional electric motor drives where the rollers tend to coast after the motor is deactivated. Thus, the forming operation is more positively controlled by the hydrostatic drive of the present invention.

After the forming operation, cylinder 156 is actuated to retract piston rod 154 and effect outward swinging movement of drop end member 142 to disengage bearing block 46 from the free end of roller shaft 42 and permit removal of the formed workpiece. Also, cylinder 60 may be actuated to retract piston rod 70 and move actuator block 72 downwardly to the position shown in FIG. 1 and thereby operate the toggle linkage means 78 for unlocking the same and effecting downward movement of slide blocks 30 and 32 and lower roll 16 to an inoperative position to release roller 16 from its pressure applying relation with roller 14. The joint operation of cylinders 60 and 156 may be automatically controlled by conventional sequence switching means.

Reference numeral 170 indicates a hydraulic power control unit incorporating a fluid control system having various control valves for driving motor 40, actuating cylinder 60 and cylinder 156. The system includes the usual pump, pressure regulator, relief valves and the like, well known in the art. Accordingly, no detailed showing or amplification thereof is believed necessary. If desired, a timing control arrangement can be included in the system to actuate the various fluid actuators in a sequential timed relationship whereby cylinder 60 is actuated after the drop end member 142 is swung into its operative roll shaft engaging position so that the drop end member is actuated prior to operation of the toggle linkage means which raises roll 16. The sequence is reversed after the forming operation to move the roll 16 and drop end member 142 into their inoperative positions.

As a result of this invention, an improved roll forming machine is provided for forming sheet material in an improved and more efficient manner. By the provision of a hydrostatic drive, coasting of the forming rolls after the power is removed therefrom is prevented. By the provision of a relatively short drop end member, the roll engaging end thereof is restricted to a short arcuate path of movement for more accurate align-

ment with the free end of the roller. Moreover, no auxiliary guides or support members are required for guiding and supporting the drop end member.

A preferred embodiment of this invention having been described and illustrated in the drawings, it is to be realized that modifications thereof may be made without departing from the spirit and scope of this invention.

We claim:

1. A roll forming apparatus for sheet metal workpieces comprising: a frame; an upper roll and a lower roll rotatably mounted on said frame; said lower roll having a periphery of resilient material such as polyurethane and said upper roll having nonresilient periphery; hydraulic motor means for rotating said upper roll; means mounting said lower roll for movement toward and away from said upper roll; hydraulic cylinder means operable for thus moving said lower roll; means for adjusting rolling pressure between said upper and lower rolls; said upper roll having one end rotatably mounted in said frame; and drop end means pivoted at its lower end about an axis located slightly below said lower roll for arcuate movement toward and away from said upper roll; bearing means at the upper end of said drop end means for engagement with the other end of said upper roll for rotatably supporting the same; said drop end means having a lateral extension at its lower end; and hydraulic cylinder means connected at its lower end to said frame and at its upper end to said lateral extension and operable to pivot said drop end means between engaging and disengaging positions with respect to said other end of said upper roll.

2. A roll forming apparatus for sheet metal workpieces comprising: a frame, a pair of superposed rolls rotatably mounted on parallel axes; the lower roll being of resiliently compressible material such as polyurethane; the upper roll being substantially incompressible and having one end rotatably mounted in said frame; hydraulic motor means mounted coaxially with said upper roll at said one end thereof and connected for imparting driving rotation thereto; means mounting said lower roll for movement toward and away from said upper roll; hydraulic cylinder means operable for thus moving said lower roll; drop end means pivoted about an axis transverse to the roll axes for arcuate movement toward and away from said upper roll; and hydraulic power means for pivoting said drop end means to and from said upper roll; and support means at the upper end of said drop end means for engagement with the end of said upper roll opposite to said one end for rotatably supporting the same.

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