Oct. 14, 1969 G. J. PERSICO ET AL 3,472,057

BENDING PRESS

Filed March 23, 1966 5 Sheets-Sheet 1

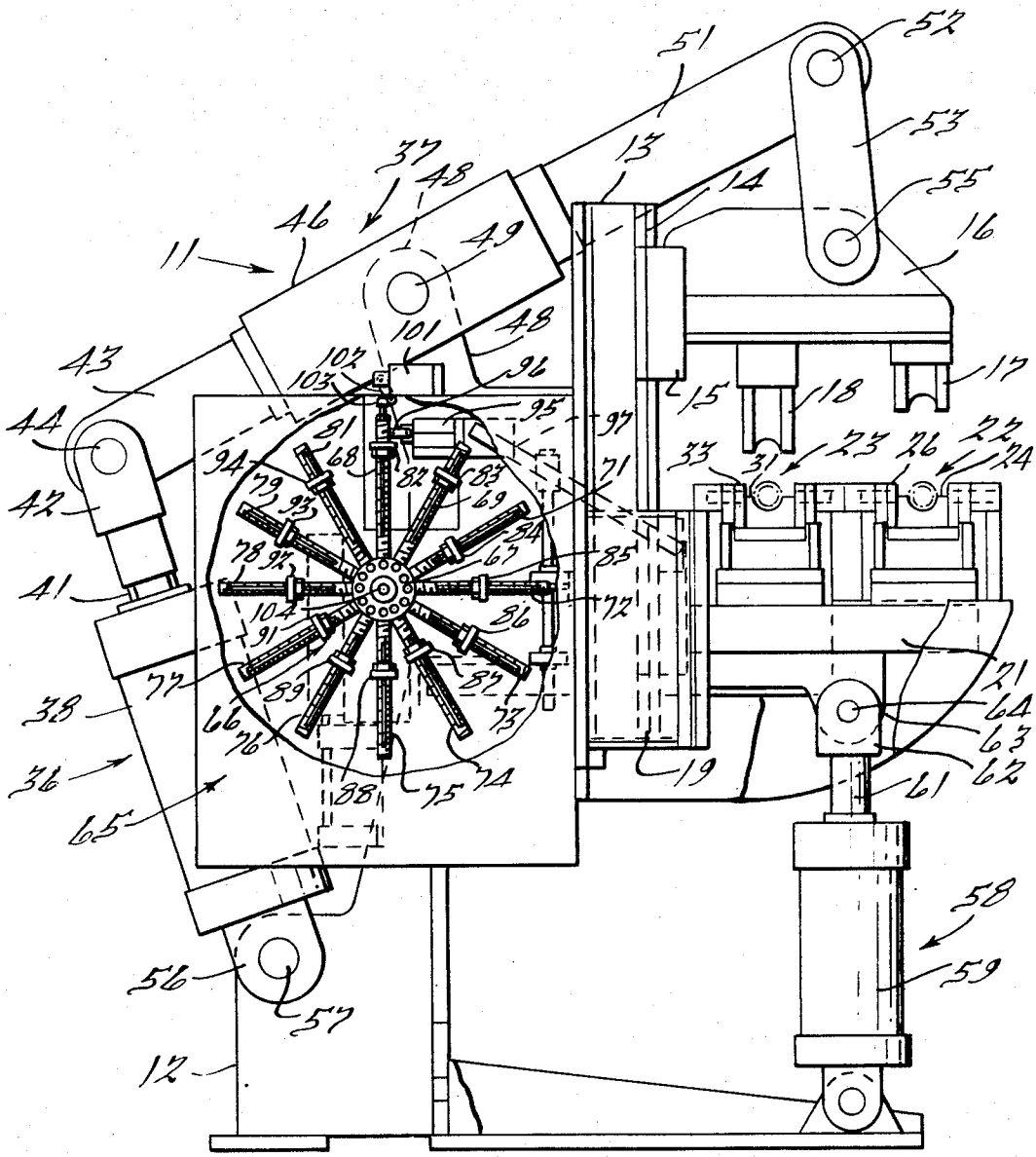


FIG. 1

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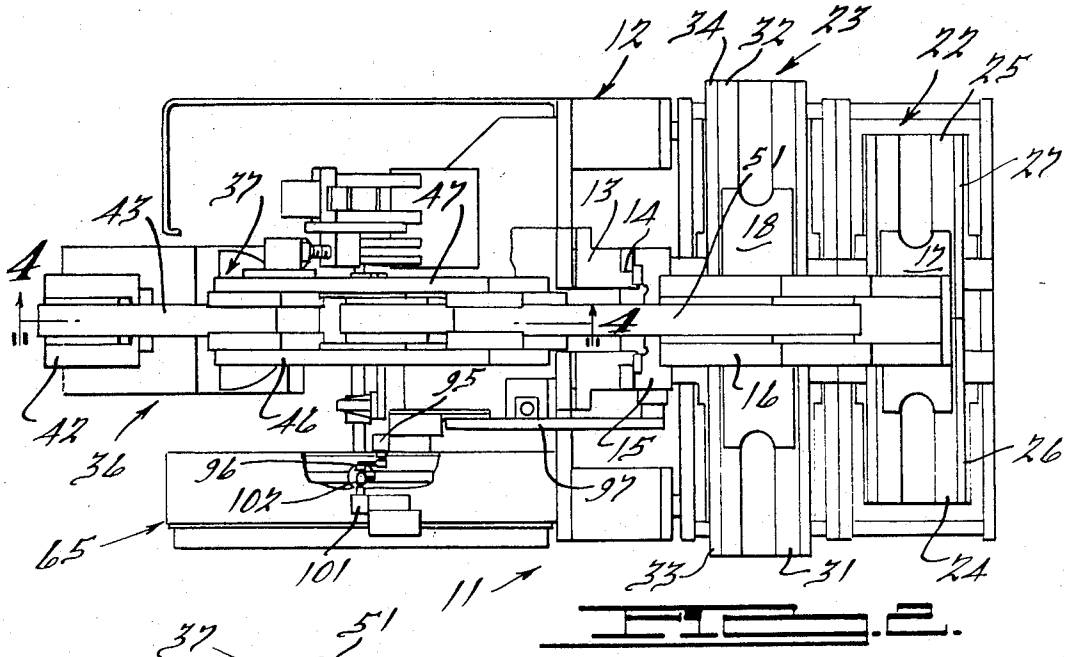


FIG. 2.

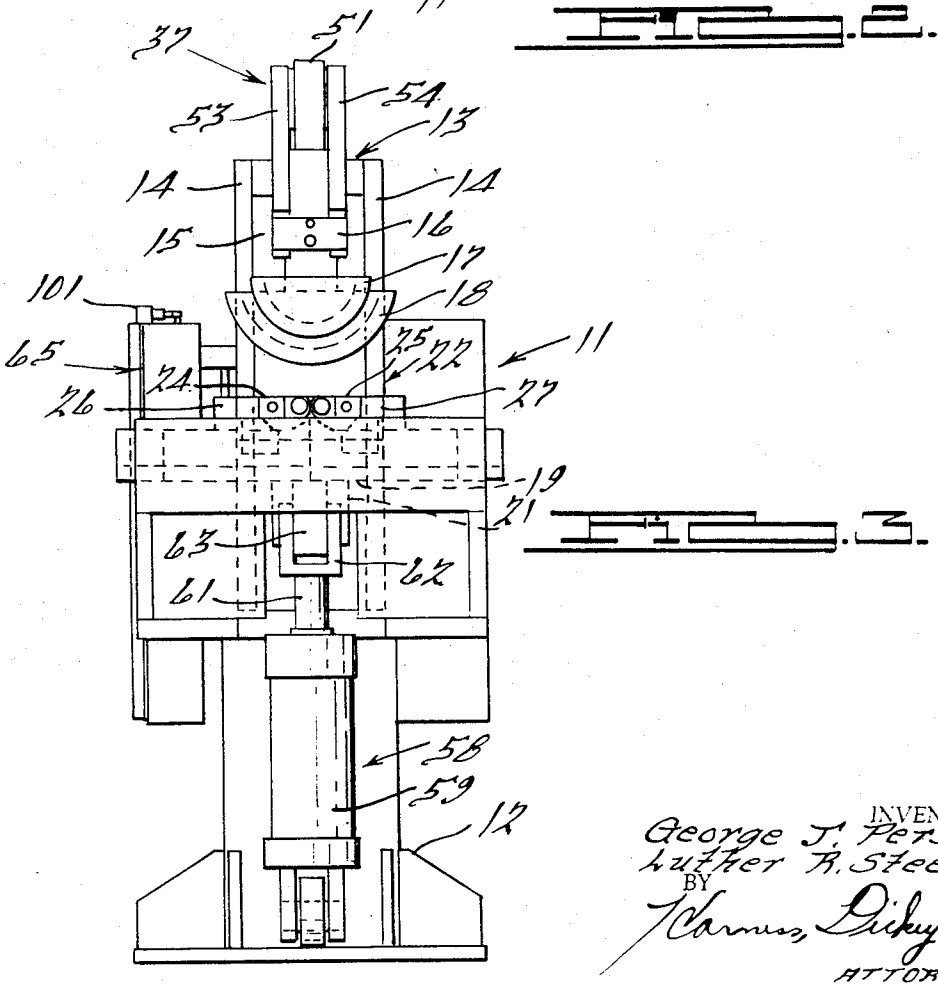


FIG. 3.

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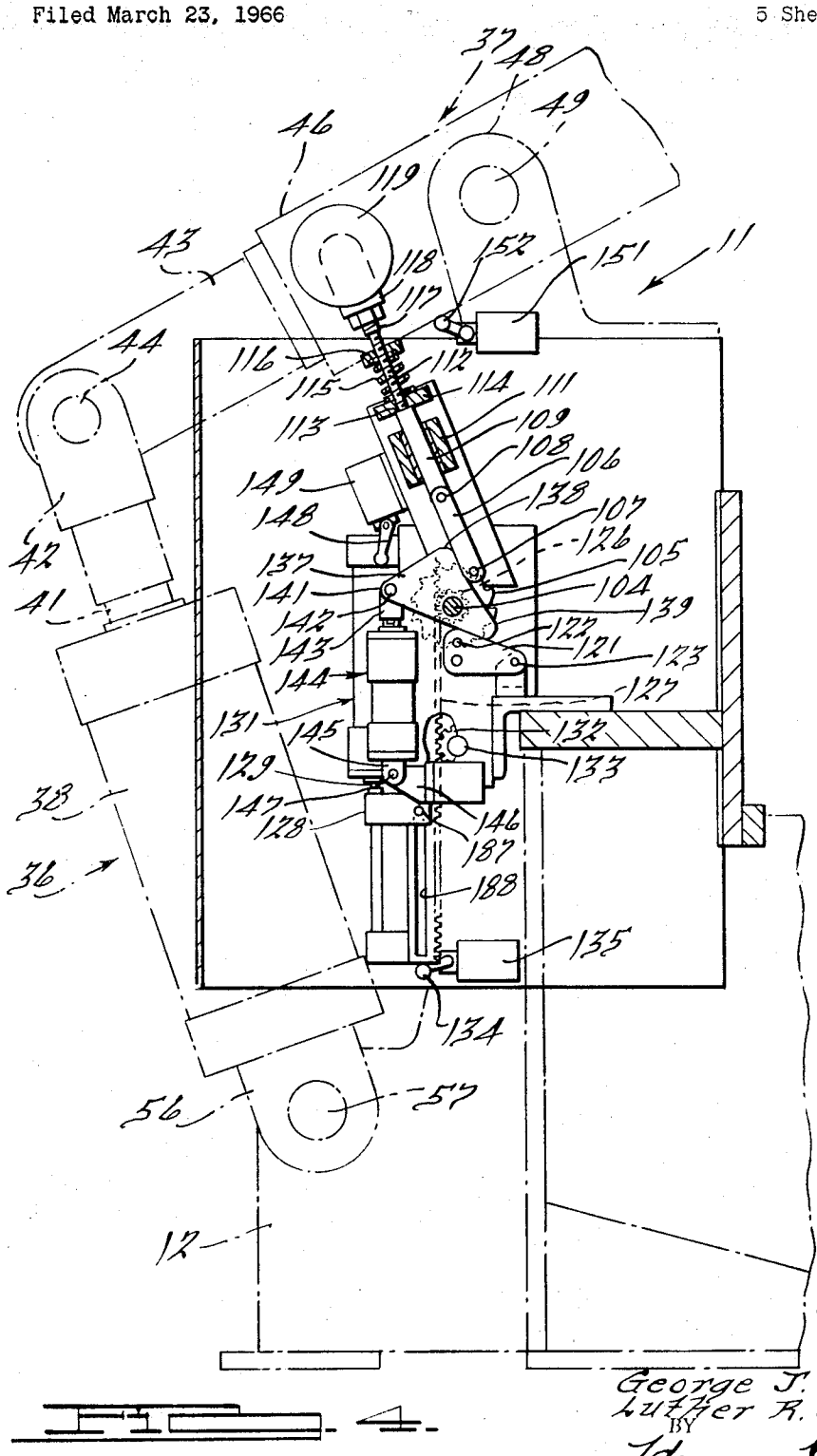


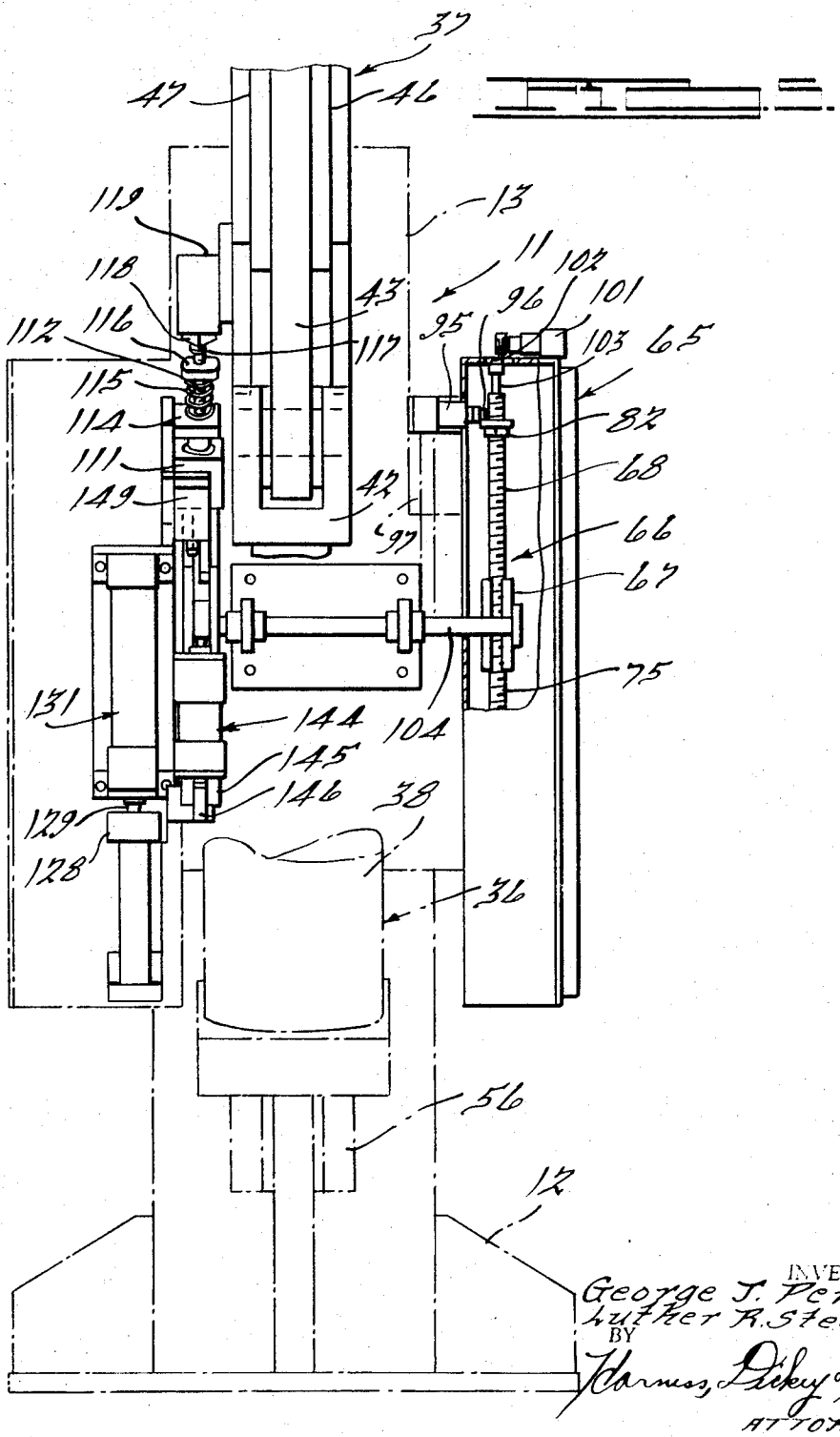
FIG. 4

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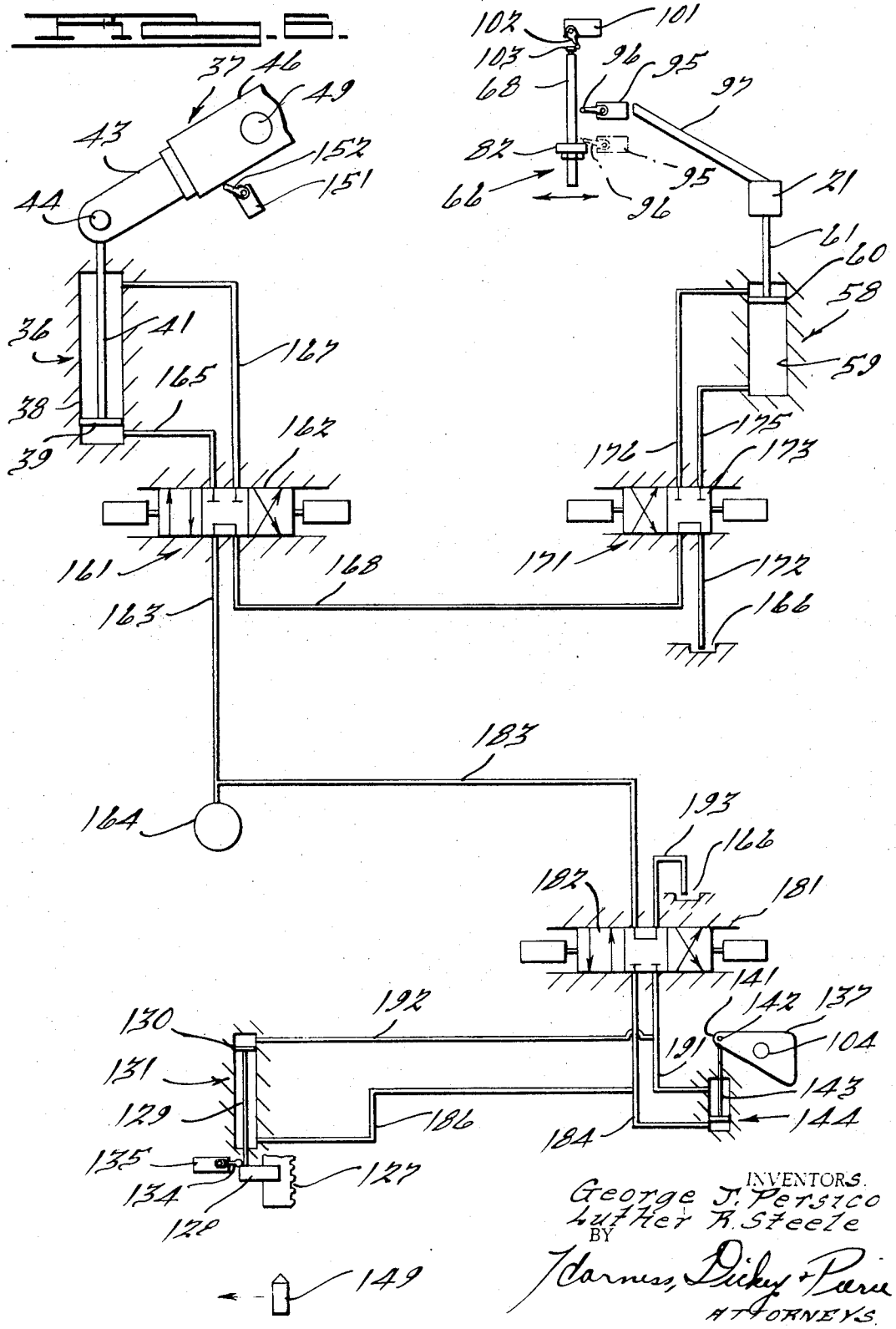


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3,472,057

BENDING PRESS

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Int. Cl. B21d 13/02
U.S. Cl. 72—396 20 Claims

ABSTRACT OF THE DISCLOSURE

A bending press for performing a succession of bends which may have different depths. The press embodies a control device that consists of a hub member and radially extending control rods that coact with a stop mechanism for controlling the depth of the bends.

This invention relates to a bending press and to a control device for a bending press.

Bending presses are used for a wide variety of purposes and may, on production line basis, perform a series of successive operations that require the same or different degrees of movement. Although various control devices have been provided for accomplishing the predetermined sequence of movements, these devices have not been fully satisfactory for all operations. It is, therefore, a principal object of this invention to provide an improved control device for a bending press.

It is another object of this invention to provide a bending press control device that permits a succession of bends to be made of selective depths.

A bending press embodying this invention includes a control device comprised of a hub member that supports a plurality of radially extending control rods. Adjustable stop means are carried by each of the control rods for adjusting the depth of bend made by the press. Ratchet means sequentially index the hub member and the control rods carried by it upon the completion of a bending cycle. Means are provided for returning the hub member to a home position after the formation of a predetermined number of bends.

Various types of actuating devices have been employed for operating the press ram that carries its bending die. In the most common form of bending press, the bending die is actuated by a hydraulic cylinder, the piston rod of which is directly coupled to the ram that carries the bending dies. This type of construction limits the press capacity and the cylinder location obstructs access to the press.

It is, therefore, another object of this invention to provide an improved actuating mechanism for a bending press.

It is a yet further object of this invention to provide a press actuating mechanism that permits free access to the bending dies of the press.

It is another object of the invention to provide a mechanism for actuating a bending press ram that magnifies the force of the actuating element.

A bending press embodying the aforenoted features is comprised of a base upon which a pair of wing dies are supported for pivotal movement about parallel axes. The bending die is supported for reciprocal movement in a plane perpendicular to the plane defined by the wing dies axes for coaction with the wing dies. The bending die is actuated by means of a power device having two relatively movable elements. One of the power device elements is pivotally connected to the base and the other element is pivotally connected to an actuating arm. The actuating arm is pivotally supported by the base intermediate its ends and is pivotally connected at its other end to the bending die.

Other objects and advantages of this invention will become more apparent as this description proceeds, particularly when considered in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a side elevationl view, with portions broken away, of a bending press embodying this invention;

FIGURE 2 is a top plan view of the press shown in FIGURE 1 with portions broken away;

FIGURE 3 is a front elevational view of the press;

FIGURE 4 is an enlarged cross-sectional view taken generally along the line 4—4 of FIGURE 2;

FIGURE 5 is an enlarged rear elevational view, with portions broken away; and

FIGURE 6 is a schematic illustration of the hydraulic circuit of the press.

Referring now in detail to the drawings and in particular to FIGURES 1 through 5, a bending press embodying this invention is identified generally by the reference numeral **11**. The bending press **11** is particularly adapted to bend pipe to form components of an automotive exhaust system. It is to be understood, however, that this invention may be practiced with other types of presses than pipe bending presses. The press **11** includes a base assembly, indicated generally by the reference numeral **12** and having an upstanding portion **13** on which vertically extending ways **14** are formed. An upper slide **15** is slidably supported upon the ways **14** at the forward end of the press **11**. The upper slide **15** is affixed to an outwardly extending upper gooseneck **16** that carries a pair of bending dies **17** and **18**. The bending dies **17** and **18** are of different radius for a reason which will become more apparent as this description proceeds. It is to be understood that a single bending die could be carried by the upper gooseneck **16**, but the use of two bending dies gives more versatility to the press **11**.

A lower slide **19** is carried upon the ways **14** below the slide **15**. The lower slide **19** carries a lower gooseneck **21** that functions as a support for wing die assemblies **22** and **23** that cooperate with the bending dies **17** and **18**, respectively. The wing die assembly **22** comprises a pair of wing dies **24** and **25** supported in wing die nests **26** and **27** that are pivotally supported upon the lower gooseneck **21** in a known manner. In a like manner, the wing die assembly **23** is comprised of a pair of wing dies **31** and **32** supported in wing die nests **33** and **34**, respectively, which are also pivotally supported upon the lower gooseneck **21**.

The upper gooseneck **16** and bending dies **17** and **18** are actuated by means of a power device, indicated generally by the reference numeral **36** and an operating linkage including an arm assembly, indicated generally by the reference numeral **37**. The power device **36** is in the form of a hydraulic cylinder having a pair of relatively movable elements comprising a cylinder assembly **38** and a piston **39** (FIGURE 6) that operates through a piston rod **41**. The upper end of the piston rod **41** is connected to a forked clevis **42** that receives one end **43** of the arm assembly **37**. The arm end **43** is pivotally connected to the clevis **42** by means of a pivot pin **44**. The forward end of the arm assembly **43** is fixed in any suitable manner to a pair of spaced arms **46** and **47** that span an upstanding trunnion **48** formed on the press base **12**. The arms **46** and **47** are pivotally supported upon the trunnion **48** by means of a pivot pin **49**. The forward ends of the arms **46** and **47** are affixed to a common operating arm end **51** that carries a pivot pin **52** at its forward extremity. The pivot pin **52** pivotally connects the arm end **51** with a pair of spaced toggle links **53** and **54** which are in turn pivotally connected at their lower end to the upper gooseneck **16** of a pivot pin **55**.

The lower end of the cylinder assembly 38 is formed with a trunnion 56 that is pivotally supported upon the base 12 by means of a pivot pin 57. Thus, actuation of the power device 36 causes the piston rod 41 to be extended and pivot the arm assembly 37 about the pivot pin 49 and drive the uppor gooseneck 16 downwardly. The pivotal connection between the cylinder, trunnion 56 and base 12, will permit limited angular movement of the power device 36 during this operation.

The vertical position of the lower gooseneck 21 is controlled by a hydraulic cylinder assembly, indicated generally by the reference numeral 58. The cylinder assembly 58 includes a cylinder 59 that is suitably fixed relative to the base 12. A piston 60 (FIGURE 6) of the cylinder assembly 58 is connected to a piston rod 61 that carries a yoke 62 at its upper end. The yoke 62 receives a depending boss 63 formed integrally with the lower gooseneck 21 and is pivotally connected to the boss 63 by means of a pivot pin 64.

Contained within a control panel, indicated generally by the reference numeral 65 (FIGURE 1) at one side of the machine is a control device 66 for limiting the successive depth of bends made by the press 11. The control device 66 is comprised of a hub portion 67 from which a plurality of limit stop control rods 68, 69, 71, 72, 73, 74, 75, 76, 77, 78, 79 and 81 radiate. The control rods 68, 69, 71–79 and 81 are screw threaded members upon which stop nuts 82 through 89 and 91 through 94, respectively, are threaded. The stop nuts coact with a limit switch, indicated generally by the reference numeral 95 and having a contact arm 96. The limit switch 95 is carried by a diagonal strut 9, one end of which is affixed to the lower gooseneck 21 in any suitable manner.

A limit switch 101 having a contact arm 102 is supported at the top of the control panel 65 adjacent the outer end of the control rods. The limit switch contact arm 102 is adapted to be contacted by a reset screw 103 that is threaded into the outer end of the control rod 68. The limit switch 101 coacts to return the control device 66 to a reset or home position, as will become more apparent as this description proceeds.

The hub member 67 of the control device 66 is affixed to a shaft 104 that extends across the press 11 and has a ratchet wheel 105 affixed to its opposite end (FIGURE 4). A pawl 106 carries a detent 107 at its lower end that is adapted to coact with the ratchet wheel 105 to selectively index the shaft 104 and control device 66 at the completion of each bending operation. The pawl 106 is pivotally connected, by means of a pivot pin 108 at its upper end to a pusher shaft 109 that is supported by a guide 111 formed in the base 12. At the upper end of the pusher shaft 109 a smaller screw threaded portion 112 is formed and defines a shoulder 113. A spring retainer 114 is formed on the base 12 and has a forked end that extends toward the threaded end 112 adjacent the shoulder 113. A coil spring 115 bears against the spring retainer 114 and a nut 116 that is threaded onto the upper end of the pusher shaft 109. A stop member 117 is threaded into a collar 118 that is affixed to an arm attachment 119 carried by the arm assembly 37. Contact between the stop member 117 and the pusher shaft portion 109 functions to sequentially index the ratchet wheel 105, as will become more apparent as this description proceeds.

Bounce-back of the ratchet wheel 105 is precluded by means of a stop lever 121 that carries a stop pin 122 at its outer extremity. The lever 121 is pivotally supported at its opposite end by means of a pivot pin 123 that is affixed in any suitable manner to the base 12. The lever 121 is normally biased in a clockwise direction by means of a spring (not shown) so that the pin 122 will be received in the recesses of the ratchet wheel 105 to preclude reverse rotation.

A pinion gear 126 is affixed to the shaft 104 adjacent the ratchet wheel 105. The pinion gear 126 meshes with a vertically extending rack 127 which cooperates with an actuating arm 128 in a manner that will become apparent as this description proceeds. The arm 128 is operatively coupled to a piston rod 129 of a piston 130 of a hydraulic cylinder assembly 131. The cylinder assembly 131 is affixed in any suitable manner to the base 12. An idler gear 132 is supported upon a stub shaft 133 and engages the rack 127 below the pinion 126 to guide its movement. The lower end of the arm 128 is adapted to engage a contact arm 134 of a limit switch 135. The rack 127 and pinion 126 serve to rotate the control device 66 back to its home position, in a manner which will become more apparent as this description proceeds.

A camming lever 137 is journaled upon the shaft 104 and has a pair of apexes 138 and 139 which are adapted to engage the pawl 106 and the lever 121, respectively. The other apex 141 of the camming lever 137 is pivotally connected, by means of a pivot pin 142, to a piston rod 143 of a hydraulic cylinder assembly 144. The lower end of the cylinder assembly 144 is formed with a boss 145 that is pivoted to a bracket 146 by means of a pivot pin 147. The bracket 146 is fixed to the press base 12.

The upper end of the arm 128 carries a projection (not shown) that is adapted to engage a contact arm 148 of a limit switch 149 to limit the stroke of the arm 128 in one direction. A further limit switch 151 is affixed to the base 12 adjacent the arm assembly 37 and has a contact arm 152 that is adapted to be engaged by the arm assembly 37.

Operation

The drawings illustrate the press 11 as it appears at the end of a full bending cycle and after the control rod 68 has been positioned so that the limit stop screw 103 contacts the contact arm 102 of the limit switch 101 to initiate the return of the control device 66 to its home position. The recycling operation will be described below. It is assumed for the present time that the control device 66 has been reset at its home position and the machine 11 is ready to perform the next bend.

To initiate a bending operation, the operator places a pipe onto the appropriate pair of wing dies 22 or 23, depending upon the radius bend which is to be formed. An operating switch (not shown) is then closed to initiate a cycle operation. Initiating the cycle of operating causes a solenoid valve, indicated generally by the reference numeral 161 (FIGURE 6) to be actuated causing its slide 162 to move to the right as seen in this figure. This movement of the solenoid valve slide 162 connects a conduit 163, that is fed with hydraulic fluid under pressure from a pump 164 or other sutiable source to a conduit 165 that extends to the hydraulic cylinder assembly 37 on the lower side of the piston 39 to urge the piston rod 41 ouwardly and rotate the arm assembly 37 in a clockwise direction about the pivot pin 49. The hydraulic fluid that is driven from the cylinder 38 is returned to a sump 166 by means of a conduit 167 and conduit 168. The conduit 168 is connected to the sump 166 through a solenoid valve 171 and return line 172.

The arm assembly 37 rotates in a clockwise direction causing the toggle links 53 and 54 to exert a downward pressure upon the upper gooseneck 16 until the appropriate bending die 17 or 18 contacts the pipe. When the arm assembly 37 begins this movement, the stop nut 117 (FIGURE 4) will move away from the respective end of the pusher shaft 109. The coil spring 115 then urges the pusher shaft upwardly drawing the pawl 106 with it. The pawl detent 107 then rides over the lobes of the ratchet wheel 105 until it registers with its next recess. The detent 107 is urged into this recess by means of a spring (not shown). Contact of the shoulder 113 with the spring retainer 114 limits the upward movement. The stop nut 117 will move away from the pusher shaft end 112 on further movement.

When the pipe is contacted by the bending die, the downward force exerted upon it will cause a downward reaction on the lower gooseneck 21 causing the lower slide 19 to move downwardly and follow the operation of the

upper gooseneck **16**. The downward movement of the lower gooseneck **21** is permitted by fluid leakage past the piston **60** of the cylinder assembly **58**. This movement is transmitted through the bracket **97** to the limit switch **95** until its contact arm **96** contacts the respective stop nut **82** on the control rod presented to it by the control device **65**.

When the switch **95** is closed, the solenoid valve **161** is actuated to cause its slide **162** to move to the left and the solenoid valve **171** is actuated causing its slide **173** to move to the right, both as viewed in FIGURE 6. When the valves **161** and **171** are in these positions, the pump **164** supplies fluid under pressure through the conduit **167** to the hydraulic cylinder **36** causing the piston **39** to be retracted and draw the control piston rod **41** downwardly. The hydraulic fluid is driven from the cylinder **38** and is discharged through the conduits **165** and **168** and valve slide **173** into a conduit **175**. The piston **60** is then urged upwardly along with its piston rod **61** to return the lower gooseneck **22** to its normal, at rest position. Fluid is discharged from the opposite side of the cylinder **59** to the sump **166** via a conduit **176** and the solenoid valve slide **173**.

The counterclockwise rotation of the arm assembly **37** upon its return stroke brings the stop nut **117** into engagement with the end of the pusher shaft **109**. The shaft **109** and pawl **106** are then urged downwardly compressing the coil spring **115** and rotating the ratchet wheel **105**. The stop pin **122** of the stop lever merely rides over the ratchet wheel during this movement. Rotation of the ratchet wheel **105** turns the shaft **104** to bring the next successive control rod of the control device **66** into a vertical position since the angular spacing of the control rods is equal to that of the ratchet wheel recesses.

When the ratchet wheel **105** and shaft **104** are indexed, the pinion **126** incrementally raises the rack **127**. When the arm assembly **37** is returned to its normal at rest position, the contact arm **152** of the switch **151** is engaged and the solenoid valves **161** and **171** are returned to the neutral position shown in FIGURE 6.

As has previously been noted, each operation of the arm assembly **37** and lower gooseneck assembly **21** causes the control device **66** to be indexed. This brings a new depth of bend control into operation. When the control device is moved to its last position, the stop nut **103** contacts the arm **102** of the limit switch **101**. When this occurs, a solenoid valve indicated generally by the reference numeral **181** is actuated so that its slide **182** moves to the right. Hydraulic fluid under pressure then flows from the pump **164** through a conduit **183** and valve slide **182** to a conduit **184** that extends to the lower side of the piston of the cylinder assembly **144**. This causes its piston rod **143** to be urged upwardly rotating the camming lever **137** in a clockwise direction as viewed in FIGURES 6 and 4. The clockwise rotation of the camming lever **137** causes the ratchet pawl **107** and locking pin **121** to be rotated free of the ratchet wheel **105**. At the same time, hydraulic fluid is delivered through a line **186** to the cylinder assembly **131** causing its piston rod **129** to move upwardly as viewed in FIGURE 6 and downwardly as viewed in FIGURE 4.

The movement of the piston rod **129** is transmitted to the rack **127** through a pin **187** that is received in a slot **188** formed in the rack **127**. At the beginning of this movement, the previous movement of the rack **127** caused by rotation of the shaft **104** and pinion **126** will have caused the slot **188** to be traversed by the pin **189** and it will be in direct engagement with the rack **127**. As the piston **130** moves through the stroke, the rack **127** will be moved and shaft **104**, which is now free to rotate, will be turned. The control device **66** will thereby be returned to its home position. The fluid driven from the cylinders **144** and **131** is returned to the sump **166** through conduits **191** and **192**, respectively, as well as through valve slide **182** and a return conduit **193**. The aforedescribed movement of the piston rod **129** and rack **127** occurs until the contact arm **134** of the switch **135** is engaged. When this occurs, the solenoid valve **181** is actuated so that its slide **182** moves to the left through the neutral position. This movement will have occurred at the point when the control device **66** is returned to its home position. When the valve slide **182** is moved all the way to the left, hydraulic fluid will flow under pressure from the line **183** to the line **191** above the piston of the assembly **144**. This causes the locking cam **137** to be rotated back to its engaged position as shown in the drawings. In addition, hydraulic fluid flows under pressure through the line **192** to the piston assembly **131** causing the piston **130** and its piston rod **129** to be moved upwardly as viewed in FIGURE 4 and downwardly as viewed in FIGURE 6. When this happens, the pin **187** will traverse the slot **188** so that the rack **127** is retained in its home position. When the piston rod **129** is fully retracted, switch **149** will be closed causing the valve slide **182** to be returned to its neutral position. The press **11** is now ready for another complete cycle.

The hydraulic circuit and mechanism for the press has been described only generally. It is to be understood that the exact hydraulic construction is believed to be within the scope of one skilled in the art. That is, given the general disclosure contained herein, one skilled in the art could readily select the appropriate prior art components to achieve the stated function. In a like manner, the electric circuit has not been described other than by means of the sequence in which the various devices are operated. The location and operation of the necessary electrical switches has been described and the design of the circuit or circuits required to perform the stated function are within the scope of those skilled in the art.

It should be readily apparent that the described press lends itself to the performance of a predetermined sequence of bends. The successive bends may be of the same depth or different depths as determined by adjusting the control device **68**. In addition, various radius bends may be made on any sequence since both bending dies **17** and **18** are carried by a common gooseneck.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the sub-joined claims.

What is claimed is;

1. A control mechanism for controlling the successive depths of bends made by a bending press comprising a hub member, a plurality of control rods extending radially outwardly from said hub member, adjustable stop means carried by each of said control rods for adjusting the depth of bend, ratchet means for sequentially indexing said hub member upon the completion of a bending cycle, and means for returning said hub member to a home position after the formation of a predetermined number of bends.

2. A bending press control device as set forth in claim **1** wherein the ratchet means comprises a ratchet wheel, pawl means for sequentially indexing said ratchet wheel and locking means for precluding reverse rotation of said ratchet wheel.

3. A bending press control device as set forth in claim **1** wherein the means for returning the hub member to its home position comprises a stop device carried by one of the control rods, a hydraulic motor actuated by said stop device and a rack and pinion for transmitting motion from said hydraulic motor to said hub member.

4. A bending press control device as set forth in claim **2** wherein the means for returning the hub member to its home position includes means for releasing the ratchet wheel locking device and for moving the pawl out of engagement with the ratchet wheel.

5. A bending press control device as set forth in claim **4** wherein the means for releasing the ratchet wheel locking device and for moving the pawl out of engagement with the ratchet wheel comprises a pivotally supported

triangular cam member and a hydraulic motor for pivotally moving said cam member.

6. A bending press control device as set forth in claim 5 wherein the means for returning the hub member to its home position comprises a stop device carried by one of the control rods, a second hydraulic motor actuated by said stop device, and a rack and pinion for transmitting motion from said second hydraulic motor to said hub member.

7. A bending press having a base, a pair of wing dies supported upon said base for pivotal movement about parallel axes, a bending die supported for reciprocal movement in a plane perpendicular to the plane defined by said axes for coaction with said wing dies, a hydraulic actuator having two relatively movable elements, means pivotally connecting one of said elements to said base, an actuating arm pivotally supported by said base, means pivotally connecting the other of said hydraulic actuator elements to one end of said actuating arm, and means pivotally connecting the other end of said actuating arm to said bending die for movement of said bending die in its plane upon relative movement between said power device elements.

8. A bending press as set forth in claim 7 wherein the means pivotally connecting the other end of the actuating arm to the bending die comprises at least one link pivotally connected at one of its ends to said arm end and having an operative pivotal connection at its other end to said bending die.

9. A bending press as set forth in claim 8 wherein two bending dies of different radius are supported for simultaneous movement, the other link end having its operative pivotal connection to both of said bending dies, and two sets of wing dies for cooperation with the respective bending die.

10. A bending press as set forth in claim 8 wherein the hydraulic actuator has a cylinder element and a piston element, the cylinder element being pivotally connected to the base and the piston element being pivotally connected to the actuating arm.

11. A bending press as set forth in claim 7 wherein the wing dies are supported for pivotal movement upon a lower ram, and further including a power device having relatively movable elements, one of said power device elements being supported by said base and the other of said elements being connected to said lower ram.

12. A bending press as set forth in claim 11 including control means for sequentially actuating the hydraulic actuator for actuating the binding die and permitting the power device to retract until said bending die has travelled a predetermined degree of movement, and for returning said bending die and said power device at the completion of the movement.

13. A bending press as set forth in claim 12 wherein the control means is effective to perform a sequence of movements of the bending die, the movement in each sequence being selectively adjustable for altering the depth of bend.

14. A bending press as set forth in claim 10 wherein the hydraulic unit is supported at the rear of the base and the bending die is supported at the front of the base, the actuating arm extending substantially from the rear of the base to the front of the base for providing free access to the wing dies.

15. A bending press as set forth in claim 13 wherein the control means comprises a hub member, a plurality of control rods radiating from said hub member, adjustable stop means carried by each of said control rods for adusting the depth of bend, ratchet means for sequentially indexing said hub member upon the completion of a bending cycle, and means for returning said hub member to a home position after the formation of a predetermined number of bends.

16. A bending press as set forth in claim 15 wherein the ratchet means comprises a ratchet wheel fixed for rotation with the hub member, pawl means for sequentially indexing said ratchet wheel, means for interconnecting the actuating arm with said pawl means for actuating said pawl means upon operation of said actuating arm, and locking means for precluding reverse rotation of said ratchet wheel.

17. A bending press as set forth in claim 15 wherein the control means is effective to perform a sequence of movements of the bending die, the movement in each sequence being selectively adjustable for altering the depth of bend.

18. A bending press as set forth in claim 16 wherein the means for returning the hub member to its home position includes means for releasing the ratchet wheel locking device and for moving the pawl out of engagement with the ratchet wheel.

19. A bending press as set forth in claim 18 wherein the means for releasing the ratchet wheel locking device and for moving the pawl out of engagement with the ratchet wheel comprises a pivotally supported triangular cam member and a hydraulic motor for pivotally moving said cam member.

20. A bending press as set forth in claim 19 wherein the means for returning the hub member to its home position comprises a stop device carried by one of the control rods, a second hydraulic motor actuated by said stop device, and a rack and pinion for transmitting motion from said second hydraulic motor to said hub member.

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U.S. Cl. X.R.

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