

May 15, 1956

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2,745,385

CONTROL UNIT FOR HYDRAULIC STEEL BENDING APPARATUS

Filed April 23, 1952

2 Sheets-Sheet 1

Fig. 1.

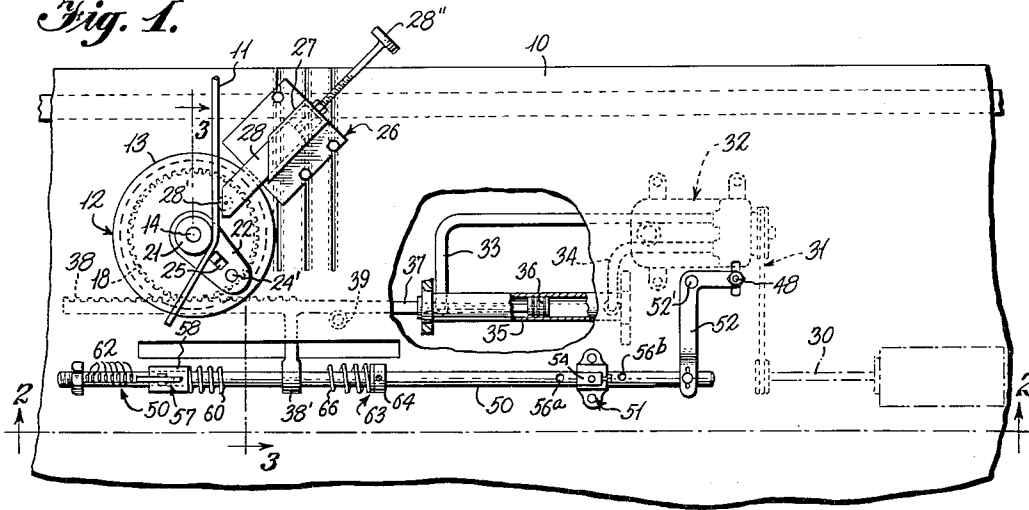


Fig. 2.

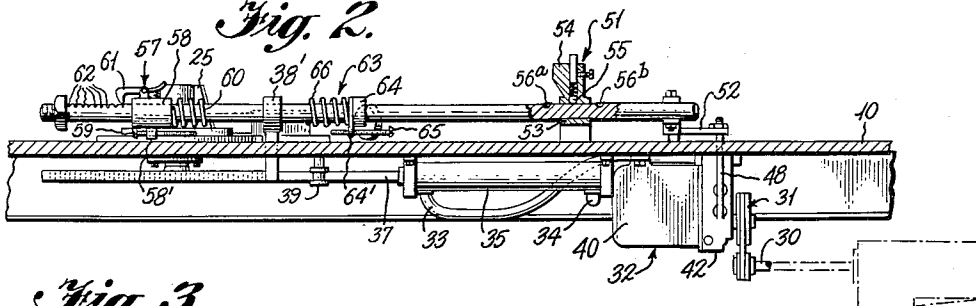
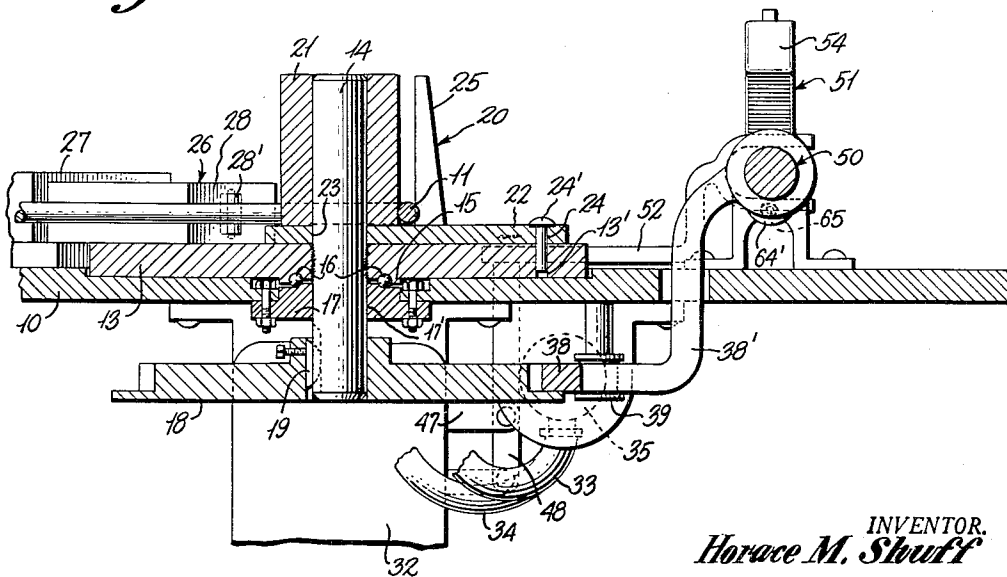


Fig. 3.



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Fig. 4.

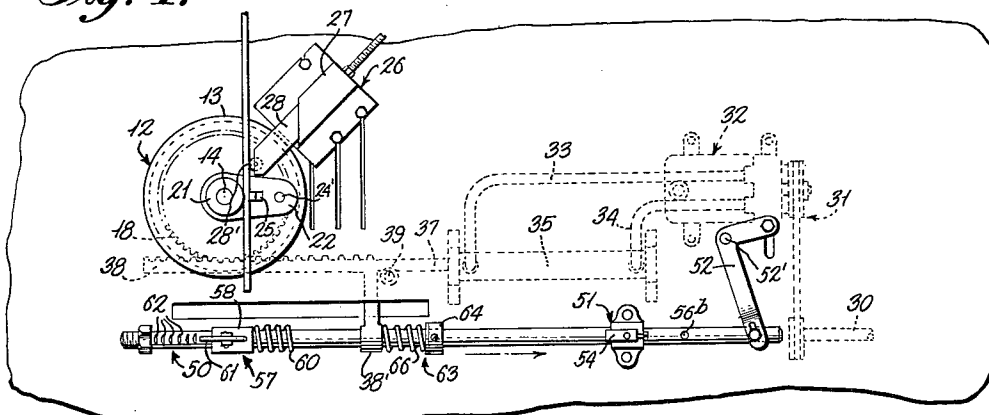


Fig. 5.

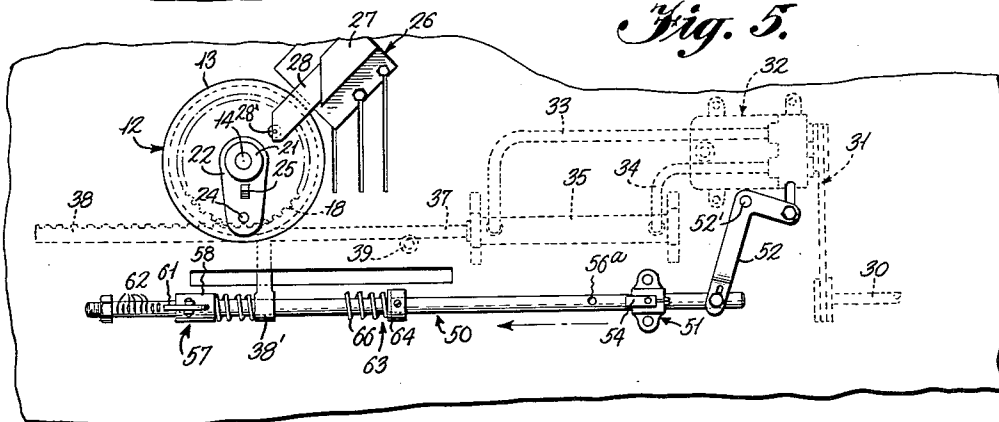
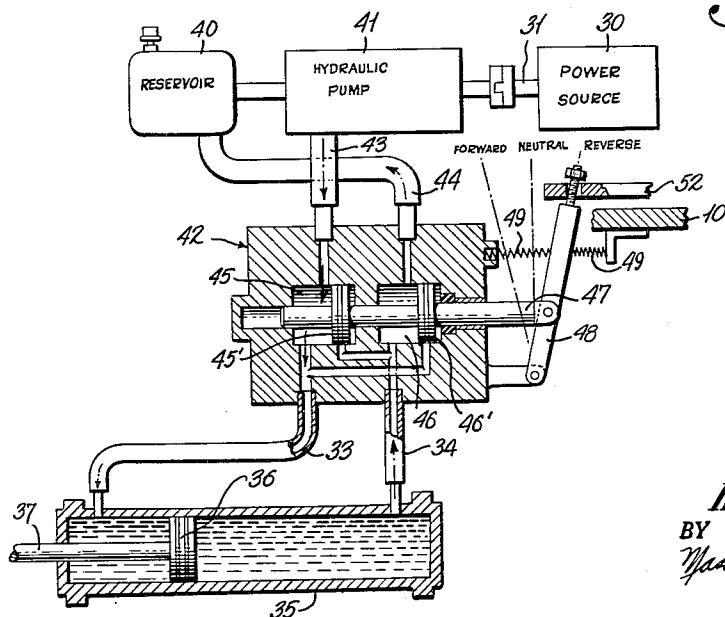


Fig. 6.



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CONTROL UNIT FOR HYDRAULIC STEEL BENDING APPARATUS

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Application April 23, 1952, Serial No. 283,793

1 Claim. (Cl. 121—45)

The present invention relates in general to bending machines, and more particularly to an improved bending machine for forming metal stock of various cross sections, such as metal reinforcing rods, to desired shapes without incurring wrinkling or buckling of the metal at the location of the bend, together with means for accurately controlling the degree of bend of the stock.

Heretofore, metal bending machines have been common in which the workpiece is bent to the desired shape by forming or wrapping the stock around a die member. A particular bending machine of this type is that disclosed in my earlier patent, No. 2,460,951, granted February 8, 1949, in which the bending die is carried by a rotary table. It is a difficult matter, however, to accurately and precisely control the rotary movement of the turntable on which the die is mounted to the necessary extent to produce bending of the stock to exact preselected angles.

It is, therefore, an object of the present invention to provide an improved bending machine for producing bends in metallic rods or elongated stock, in which the bending of the stock can be carried out with consistent accuracy and at a rapid rate.

Another object of the present invention is the provision of an improved bending machine for elongated metal stock in which the stock can be easily and rapidly inserted into and removed from the machine.

A further object of the present invention is to provide an improved bending machine for elongated metal stock of the type in which preset means are provided to automatically and precisely control the degree of bend imparted to the stock by the machine.

Another object of the present invention is the provision of an improved bending machine for bending elongated metal stock of the type employing a rotary turntable and die in which preset means are provided to accurately and precisely control the amount of rotation imparted to the turntable and die, to thereby accurately control the degree of bend of the stock.

Another object of the present invention is the provision of a novel manually set control attachment for hydraulically powered rotary metal bending dies for automatically controlling the extent of rotation of the die and the degree of bend of the metal stock.

Other objects, advantages and capabilities of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings wherein only a preferred embodiment of the invention is illustrated.

In the drawings:

Figure 1 is a top plan view of a metal bending machine embodying the present invention, with the control rod and hydraulic pump controlling lever intercoupled therewith shown in "neutral" position and the hydraulic cylinder rack and associated components stopped in a position intermediate its limits of travel, parts being broken away for clarity;

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Figure 2 is a vertical longitudinal section of the metal bending machine taken along the lines 2—2 of Figure 1;

Figure 3 is a vertical transverse section through the turntable and associated control components of the metal bending machine taken along the lines 3—3 of Figure 1;

Figure 4 is a top plan view of the metal bending machine illustrating the position of the various components at the beginning of the bending stroke of the machine;

Figure 5 is a top plan view of the metal bending machine illustrating the components in their relative positions at the beginning of a return stroke of the machine; and

Figure 6 is a schematic view of the hydraulic power supply components for the machine, and particularly illustrating the neutral seeking hydraulic control valve employed in conjunction therewith.

The invention in general involves the use of a hydraulic power system for imparting rotation to a turntable supporting a rotary die for bending elongated metal stock, such as a reinforcing rod. The system includes a pump and control valve for regulating flow of the hydraulic fluid to and from a hydraulic jack driving a rack and pinion coupled to the turntable.

The invention is particularly concerned with the provision of an adjustable control unit arranged alongside the turntable and coupled to the control valve. The control unit is provided with stop elements having energy storage means associated with each, in which energy is stored during movement of the rack before the rack reaches its preselected limit of movement. The energy storage means and abutment stops cooperate with resilient catch means for holding the control rod in positions to establish forward or reverse flow of hydraulic fluid through the control valve so that when the control rod is set in position to establish forward or reverse flow of hydraulic fluid to the jack, the resilient catch means holds the rod in such position until a rack arm engages the abutment stop. The resulting impact disables the resilient holding means and throws the control rod and control valve to neutral position. The adjustment of the position of the abutment stops, therefore, permits accurate automatic control of the rotary movement of the turntable and the degree of bend imparted to the metal reinforcing rod by the rotary die.

The invention will be more fully understood from the following detailed description having reference to the drawings wherein like reference characters designate corresponding parts throughout the several figures. The metal bending machine of the present invention is particularly suitable for portable use, and to this end is designed to be mounted on a worktable, generally indicated by the reference character 10, which may be the platform of an automotive truck. The die mechanism for imparting the bend to the workpiece, such as the metal reinforcing rod, indicated by reference character 11, of the type used in reinforced concrete, is generally indicated at 12, and comprises a turntable 13 mounted for rotation about its center on the worktable 10.

The turntable 13 is welded to a vertical shaft 14 for imparting rotation to the turntable and is provided with a downwardly extending cylindrical projection 15 having a ball bearing race defined therein, forming a ball thrust bearing 16 with a bearing plate 17 rigidly secured as by bolts to the worktable 10. The shaft 14 extends through an accommodating aperture 17' in the bearing plate 17 and is provided with a pinion gear 18 keyed thereto as by an adjustable key and guideway 19 for imparting rotation to the die from means to be later described.

The rotary die, generally indicated at 20, is formed of a die sleeve 21 adapted to be fitted over the upwardly projecting portion of the shaft 14 extending above the

turntable 13. Sleeves of varying diameters are to be placed over the shaft 14, to vary the radius of the bend formed by the die mechanism in accordance with the radius of the die sleeve 21. A rotary die arm 22 is provided with a circular aperture 23 adapted to fit over the shaft 14, and is designed to lie flush on the turntable on a radial axis thereof. An aperture 24 is provided adjacent the outer end of the die arm 22 designed to register with a complementary aperture 13' in the turntable 13 to receive a locking pin 24' and maintain the die arm 22 at a fixed radial position on the turntable 13.

An upstanding shoulder or die pin 25 is formed on the die arm 22 with its inner end spaced from the outer periphery of the die sleeve 21 the proper distance to just accommodate the reinforcing rod 11 of the particular size desired to be bent. The die arm 22 is designed to be interchangeable so that die arms having die pins 25 spaced various distances from the center of the aperture 23 may be interchangeably employed to accommodate different sizes of reinforcing rods.

An abutment guide is provided on the work table 10, as indicated generally by the reference character 26, to hold the reinforcing rod or stock 11 against movement in the direction opposite the direction of bend imparted by the rotary die during the bending operation, but to permit such translatable or longitudinal movement of the stock as may be caused by the bending action of the die arm 22 on the stock. This guide 26 generally comprises a housing 27 which may, if preferred, be anchored in slots in the worktable 10 to render the housing adjustable on an axis parallel to that of the reinforcing rod 11. Within the housing is disposed an adjustable abutment element 28 having a bearing roller 28' on the end thereof disposed adjacent the turntable 13 and having an adjustment screw 28'' on the other end thereof threaded through the housing 27 to permit manual adjustment of the position of the bearing roller 28' relative to the reinforcing rod 11.

The structure thus far described, with the exception of the specific ball thrust bearing for the turntable 13 and the pinion gear 18 on the shaft 14, corresponds to the rotary die mechanism and abutment guide disclosed in my earlier Patent No. 2,460,901.

The means for rotating the pinion gear 18 to drive the turntable 13 and rotary die arm 22 is derived from the truck power takeoff or other suitable power takeoff, indicated generally by the reference character 30, and is indicated generally in Figures 1 and 2. The power takeoff 30 is coupled through a belt and pulley coupling indicated at 31 to a conventional integrated power pack 32. This power pack, in accordance with conventional practice, comprises a hydraulic pump, a reservoir, and a hydraulic control valve, formed into an integrated unit, to be driven from a suitable rotary power takeoff, such as available on conventional automotive trucks. The output of the power pack 32 is coupled through hydraulic fluid conduits 33 and 34 to opposite ends of a hydraulic jack or cylinder 35. A piston 36 is provided in the cylinder housing, a piston rod 37 projecting outwardly through one end of the cylinder 35. A rack 38 is integrally formed on the outer end of the piston rod 37, with the teeth of the rack held in engagement with the teeth of the pinion gear 18, to drive the gear on linear movement of the piston 36, by means of a conventional roller bearing, such as is indicated at reference character 39 in Figures 1 and 3.

The hydraulic system for actuating the hydraulic jack 35 and driving the piston 36, piston rod 37 and rack 38 relative to the pinion 18, is schematically illustrated in Figure 6. The integral power pack 32 is composed of a reservoir 40, a hydraulic pump 41 and control valve 42. Control valve 42 is provided with a supply and return conduit 43 and 44, respectively, coupled from the pump 41 and reservoir 40, respectively, to chambers 45 and 46 formed within the control valve body. The outlets

of each of the chambers 45 and 46 are coupled through suitable conduits to each of the hydraulic fluid conduits 33 and 34 coupling fluid to opposite ends of the hydraulic cylinder 35.

The control valve 42 is of the neutral seeking or self-centering type and to this end is provided with disc valves 45' and 46' disposed within the chambers 45 and 46, respectively, and are mounted on a single valve stem 47 loosely coupled as by a pin and slot connection to the control lever 48 pivoted to the valve housing and biased as by means of springs 49 to dispose the valve discs 45' and 46' in an intermediate position within their respective chambers, blocking the input and return conduits 43 and 44. When the control lever 48 is shifted laterally against the bias of the springs 49 to the position marked "forward," the valve discs 45' and 46' are positioned to couple the input conduit 43 with the fluid conduit 34, and the fluid conduit 33 with the return conduit 44, to pump fluid into the left-hand end of the hydraulic cylinder 45 and force the piston 36 and rack 38 to the left as viewed in Figure 6. When the lever 48 is shifted to the "reverse" position, the valve discs 45' and 46' are shifted to couple the input conduit 43 with fluid conduit 33 and fluid conduit 34 with return conduit 44 to reverse direction of movement of the piston 36 and the rack 38.

The control means for automatically controlling the degree of rotation of the rotary die mechanism 12 comprises essentially a control rod 50 disposed longitudinally on the worktable 10 in parallel relation to the rack 38 and piston rod 37. The control rod 50 is guided for sliding movement along its axis by a spring catch and guide unit 51, and by a laterally projecting follower arm 38' integrally formed with the rack 38 and having its end formed into an annular ring snugly accommodating the rod 50. The inwardly disposed end of the rod 50 is pivotally coupled to one end of a bell crank 52 which is pivotally supported at 52' on the integral power pack housing 32 and which is coupled at its opposite end to the valve control lever 48. The purpose of the bell crank 52 is to translate the longitudinal sliding movement of the rod 50 into movement transversely of the worktable 10 and control valve 42 to shift the control valve lever 48 between the forward and reverse positions.

The spring catch and guide unit 51 is rigidly mounted on the work table 10 and is provided with a tubular portion 53 accommodating the rod 50 and upstanding portion 54 housing a spring biased ball 55 which is adjustably tensioned by means of a suitable set screw. The spring biased ball 55 is adapted to cooperate with a pair of notches 56a and 56b. When the spring pressed ball 55 is fitted in the notch 56a the control rod 50 is held by the resilient locking action of the ball 55 in an inwardly projecting position to hold the hydraulic valve control lever 48 in "forward" position and pump hydraulic fluid through the conduit 34, forcing the rack 38 outwardly of the cylinder 35 and rotating the turntable 13 in a clockwise direction as viewed in Figures 1, 4 and 5, to impart a suitable bend to the reinforcing rod 11. This is the position of the components shown in Figure 4 when the notch 56a is in registry with the spring biased ball 55, and the rod 50 and bell crank 52 are in their innermost position, with the hydraulic valve control lever 48 held in "forward" position.

An adjustable abutment stop 57 forming the outer limit stop for the control system is associated with the control rod 50 and comprises a tubular sleeve 58 having a depending lug 58' housing an abutment screw 59 which is threaded therein and projects inwardly of the inner end of the annular sleeve 58. A coil spring 60 is suitably fixed to the inner end of the sleeve 58 and projects beyond the end of the abutment screw 59. A suitable spring biased pawl 61 is pivotally mounted on top of the sleeve 58 and is adapted to cooperate with a series of notches 62 on the control rod 50, which are calibrated in terms

of degrees of rotation of the turntable 13 from zero position.

A similar reset limit stop 63 is provided inwardly of the limit stop 57 and comprises a tubular sleeve 64 surrounding the rod 50 and fixedly positioned thereon by means of a suitable set screw, the reset stop 63 being provided with a threaded lug 64' housing through which is threaded an abutment screw 65 projecting forwardly of the inner end of the sleeve 64. A coil spring 66 is likewise secured to the inner face of the sleeve 64 and projects toward the stop 57 beyond the end of the abutment screw 65.

The purpose of these two abutment stops 57 and 63 is to cooperate with the arm 38' formed on the rack 38 to automatically limit the range of movement of the rack and the degree of rotation of the gear 18, and therefore the degree of bend imparted to the reinforcing rod 11. Assuming that the follower arm 38, and the control rod 50 and lever 52 are in the position illustrated in Figure 4, the hydraulic valve control lever 48 will be in the "forward" position to pump fluid to the cylinder 35 and move the piston rod 37 and rack 38 outwardly of the cylinder, thus rotating the turntable 13 in a clockwise direction and moving the follower arm 38' toward the limit stop 57. The rod 50 will be held in the position shown in Figure 4 by the engagement of the resiliently biased ball 55 and the detent 56a. It will be apparent from Figure 2 that the annular ring of the follower 38' will engage the coil spring 60 before it engages the abutment screw 59, thus compressing the coil spring 60 until the arm 38' engages the end of the abutment screw 59. The shock of impact of the arm 38' with the abutment screw 59 will disengage the notch 56a of the rod 50 from the spring biased ball 55, and the energy stored up in the coil spring 60 will shift the rod 50 and bell crank 52 to dispose the valve control lever 48 in "neutral" position, assisted by the springs 49 normally biasing the lever 48 to such "neutral" position.

The control rod 50 may then be pulled toward the left, as illustrated in Figure 5, to shift the valve control lever 48 to "reverse" position and return the rack 38 and turntable 13 to "zero" position shown in Figure 4. The turntable 13 and arm 22 are returned precisely to "zero" or starting position during this reverse movement of the rack 38 by the reset limit stop 63 as the stop 63 effects disengagement of the notch 56b from the spring pressed ball 55 and returns the lever 48 to "neutral" in the same manner that the limit stop 57 returns the control lever to "neutral."

In using this device to effect bending of metal stock such as steel reinforcing rods and the like, the die sleeve 21 and die arm 22 of appropriate size for the reinforcing rod and the radius of bend desired are put in place on the turntable 13. With the turntable in zero or starting position as illustrated in Figure 4, and the spring biased pawl 61 set in the appropriate notch 62 for the degree of bend desired, for example 90°, the control rod 50, which is assumed to be in neutral position as in Figure 1, is then forced to the right as illustrated in Figure 2, shifting the hydraulic valve control lever 48 to "forward" position, pumping fluid to the hydraulic cylinder 35 and driving the rack 38 outwardly of the cylinder 35 to rotate the turntable 13 and die arm 22.

The rod 50 is held in this position by seating of the spring pressed ball 55 in the notch 56a until the rack follower arm 38' engages the abutment screw 59 of limit stop 57. This impact upseats the ball 55 from the notch 56a to neutralize the system. At the time the follower arm 38' engages the abutment screw 59, the rack 38 will have moved the exact distance necessary to rotate the turntable 13 and follower arm 22 through a 90° arc from the zero position illustrated in Figure 4.

The rod 11 is then lifted out from between the die arm 25 and sleeve 21 and the control rod 50 is pulled to the left as illustrated in Figure 5, to shift the control valve

lever 48 to "reverse" and return the rack 38 and turntable 13 to zero position.

Abutment of the rack follower arm 38' with the screw 65 of reset stop 63 unseats the spring pressed ball 65 from the notch 56b and through the bell crank 52, returns the valve control lever 48 to "neutral" position.

It will be apparent from the foregoing description that a novel control system for metal bending machines has been provided which may be preset for desired degrees of bend of the metal stock and which precisely and rapidly bends the rods to the precise angle desired.

While but one specific embodiment of this invention has been particularly shown and described, it will be apparent that various modifications may be made therein within the spirit and scope of the invention, and it is desired, therefore, that only such limitations shall be placed thereon as are imposed by the prior art and are set forth in the appended claim.

What is claimed is:

20 A control unit for a hydraulic cylinder motor and piston actuated rack reciprocated thereby, and a control valve therefor having a neutral seeking control lever, said control unit comprising a manually adjustable rod for actuating said control valve to start and stop said 25 hydraulic cylinder motor and control the direction of movement of said rack, means supporting said rod for reciprocal axial movement parallel to said rack, a pivoted bell crank lever intercoupling one end of said rod with said neutral seeking control lever for positioning said control lever to terminate hydraulic supply to said 30 motor and establish forward and reverse flow supply thereto in accordance with displacement of said rod, resiliently biased catch means cooperating with notches in said rod for holding said rod in positions disposing said control lever in said forward and reverse hydraulic 35 supply positions, and means associated with said rod from a position supplying fluid to said motor to a hydraulic supply terminating position when said rack reaches predetermined outer and inner positions of travel, said last-named means including a pair of abutment means supported in spaced relation on said rod and an integral arm 40 extending from said rack and having a collar thereon surrounding and slidable along said rod between said abutment means, said abutment means each comprising an annular ring surrounding said rod having a stop element projecting therefrom to be engaged by said collar to shift said rod and decouple the same from said catch means and a coil spring projecting from said ring and beyond said stop element to be compressed by said collar and 45 store up energy immediately prior to contact of said collar with said stop elements and to release the stored up energy upon decoupling of said catch means from said rod to shift said rod and control lever to hydraulic supply terminating position, one of said abutment means being fixed on said rod to be contacted by said collar 50 when said rack is at a preselected inwardly drive-initiating position and the other of said abutment means being adjustably positioned on said rod outwardly of said first abutment means and adjacent the free end of said rod to be contacted by said collar at a selected point in its travel outwardly of said cylinder motor, said rod having transverse notches adjacent the free end thereof graduated in terms of degrees of movement of said rack, and said adjustably positioned abutment means includes 55 a pawl pivotally supported on the annular ring thereof and resiliently biased to dispose the nose of said pawl into engagement with said transverse notches for resiliently holding said adjustable abutment means at selected positions of adjustment.

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