Oct. 14, 1969 H. GOBLE 3,472,055

BENDING MACHINES FOR BENDING METAL BARS OR SECTIONS

Filed Nov. 29, 1967 3 Sheets-Sheet 1

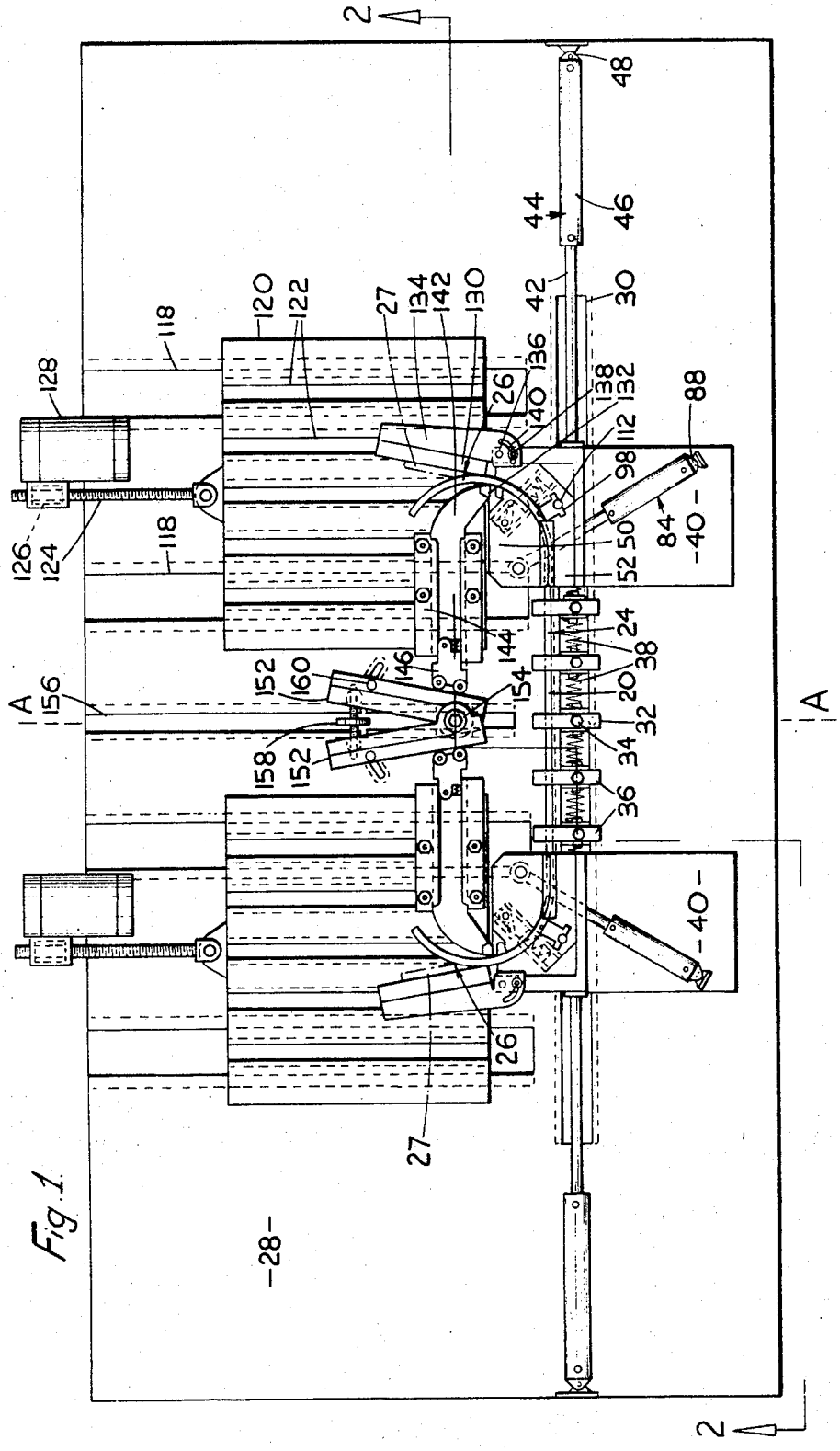

Fig. 1

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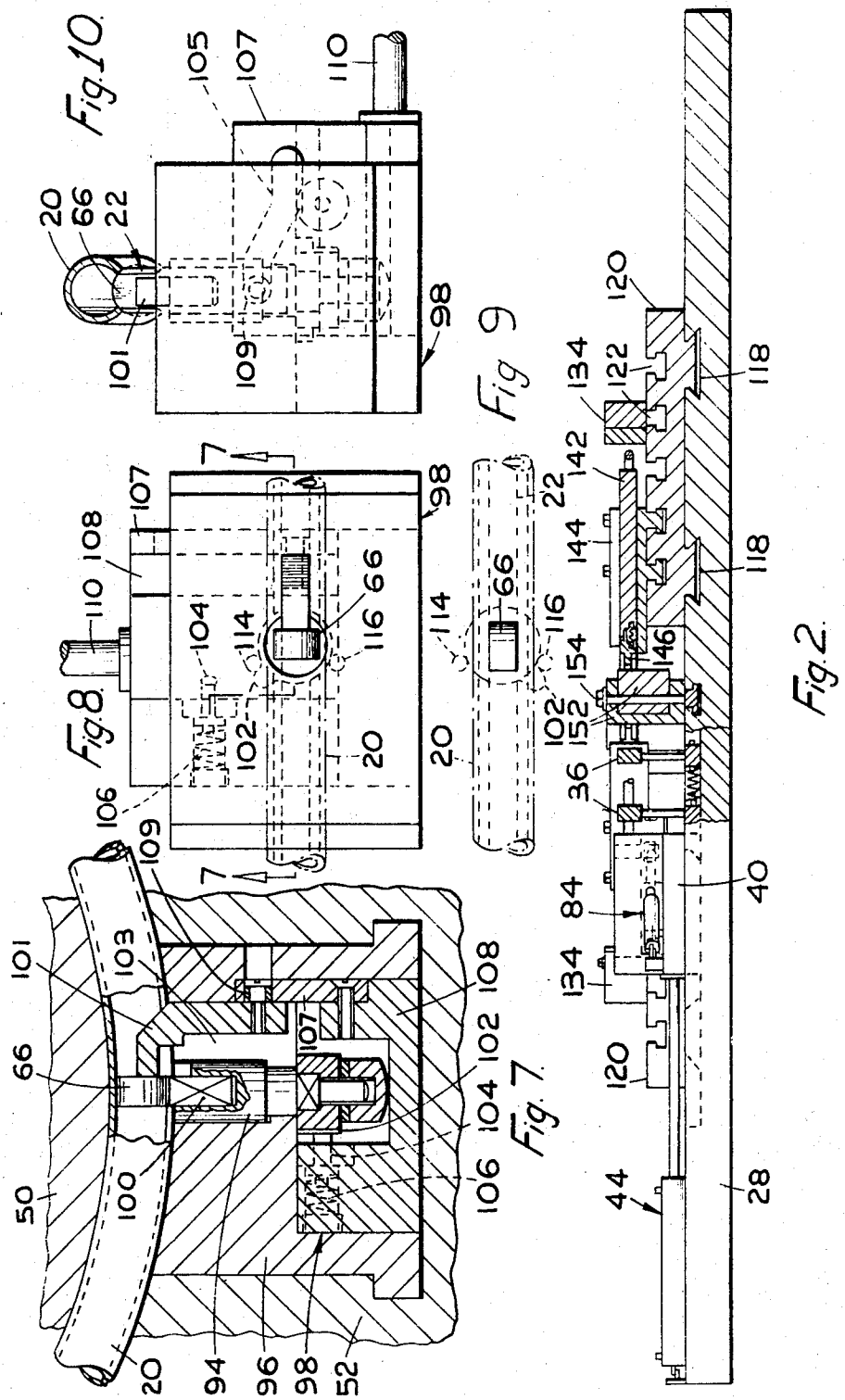

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BENDING MACHINES FOR BENDING METAL BARS OR SECTIONS

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Fig. 3.

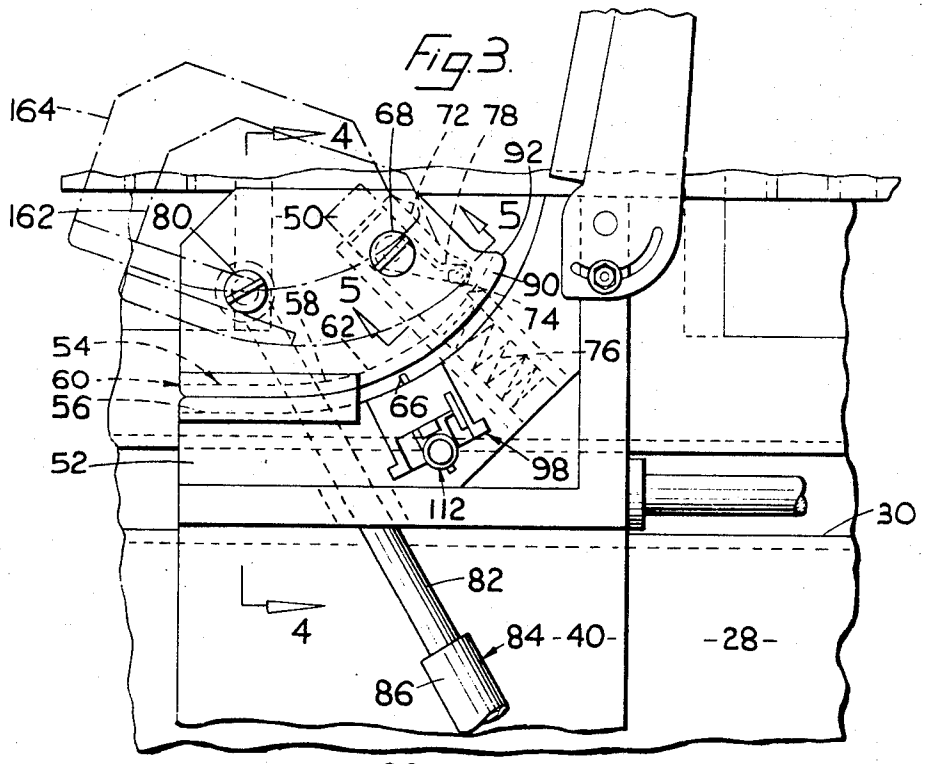
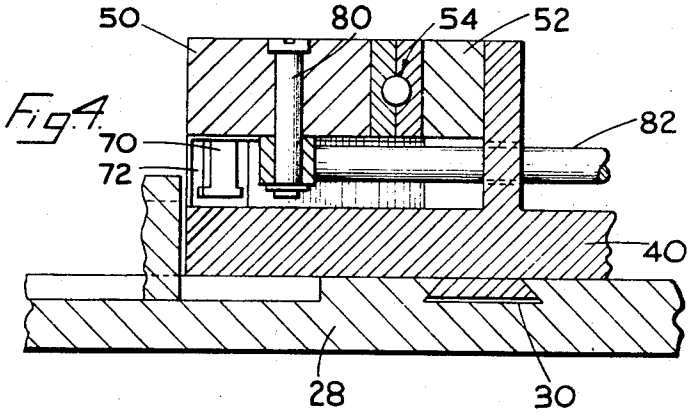


Fig. 4.



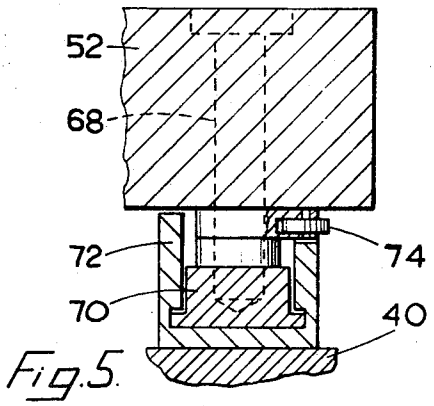


Fig. 5.

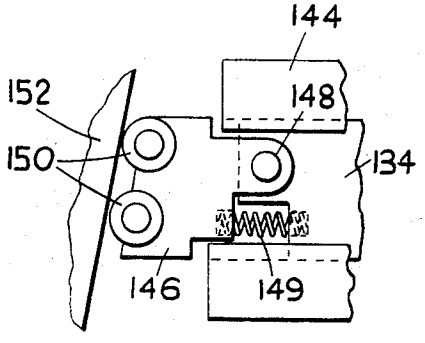


Fig. 6.

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3,472,055

BENDING MACHINES FOR BENDING METAL BARS OR SECTIONS

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Int. Cl. B21d 7/02
U.S. Cl. 72—297 19 Claims

ABSTRACT OF THE DISCLOSURE

A metal bar bending machine having bending dies in which a bar enters endwise thereof and a bending die is movable in an opposite sense to "unlock" the dies from the bent bar and a hollow slotted bar can be supported internally by a removable internal die and adjustable further bending dies are provided for straightening or further bending a bent bar.

Background of the invention

(1) The metal bar bending machine of the invention is in the field in which bending dies and a bar are relatively moved endwise to cause the bar to enter and be bent by the dies and when hollow slotted bars are being bent internal dies are employed and further bending dies are provided to operate on the previously bent bar.

(2) In known bending machines in which the metal bar enters the bending dies endwise difficulty is encountered removing the bent bar from the dies. Also when the bar is hollow and is longitudinally slotted so as to be "undercut" interiorly it has not been possible previously to provide an internal supporting die and then easily remove the bar from the internal die. Also further adjustable bending or straightening dies have not been incorporated in the bending machine.

Summary of the invention

According to the present invention a bending machine for bending metal bars about axes disposed transversely of the bars comprises an inner bending die relative to an axis of the bend, an outer bending die relative to the axis of the bend, bar clamping means, power means connected to the bending dies to cause relative movement of the bending dies and the bar endwise thereof and thus entry of the bar into the bending dies, means on which a bending die is movably mounted so that the bending die can move in a sense substantially opposite to that of entry of the bar into the bending dies to "unlock" the bending dies from the bent bar, means on which the bending die is also mounted so that the bending die can move substantially radially of said axis to separate the bending dies and allow the bent bar to be removed therefrom and power means connected to the bending die to move said die in the said opposite sense and the substantially radial direction.

Brief description of the drawings

The invention will now be more particularly described by way of example with reference to the accompanying drawings in which

FIGURE 1 is a plan view of a bending machine constructed in accordance with the present invention,

FIGURE 2 is a side view of FIGURE 1 partly in section on the lines 2—2 of FIGURE 1,

FIGURE 3 is a plan view of a fragmentary part of FIGURE 1 showing bending dies and associated parts of the machine,

FIGURE 4 is a sectional view of FIGURE 3 on the lines 4—4 thereof,

FIGURE 5 is a sectional view of FIGURE 3 on the lines 5—5 thereof,

FIGURE 6 is a plan view of a fragmentary part of FIGURE 1 on an enlarged scale and showing a stylus and a part of a former,

FIGURE 7 is a sectional plan view of the bending dies shown in FIGURE 1 but on an enlarged scale and taken on the lines 7—7 of FIGURE 8,

FIGURE 8 is a side view of part of FIGURE 7 and with an internal bending die in an operative position,

FIGURE 9 is a similar view to FIGURE 8 but showing only a fragmentary part thereof and with the internal bending die in an inoperative position and

FIGURE 10 is an end view of a unit part of FIGURE 7.

Description of the preferred embodiment

The bending machine is intended to bend a metal bar **20** as shown in FIGURE 10 and being of hollow circular cross-sectional shape formed with a longitudinally extending slot **22** and the bar is to be bent so as to have a central straight portion **24** and a curved portion **26** at each end and the machine is shown in a condition after the bending operation has been performed and the longitudinal slot **22** is disposed on the outer convex sides of the curved portions **26**.

The bending machine comprises two sets of bending dies etc., disposed one on each side of a transverse central axis A—A of the machine as shown in FIGURE 1 and these two sets are identical with the exception that one is a right-hand set and the other is a left-hand set and one set only will be described as illustrative of both.

The bending machine comprises a horizontal bed **28** supported by any convenient means and formed in the bed is a longitudinally extending slide-way groove **30** of dove-tailed cross-sectional shape and in the groove **30** at a central position therealong is a clamp **32** which is immovable along the slot and is operative by screw means **34** to clamp the bar **20** stationarily in position mid-way between the extreme ends of the bar. Also mounted in the slide-way groove **30** on each side of the stationary clamp **32** are two slidable clamps **36** which are slidable along the bar **20** whilst supporting same against bending and the clamps **32** and **36** are urged apart by helical compression springs **38**. Mounted in the slide-way groove **30** so as to be slidable therealong is a saddle **40** to which is connected a piston rod **42** of a fluid-pressure operated piston and cylinder device **44** which thus constitutes a power means and the cylinder **46** of said device is connected to the bed **28** of the machine at **48** so that operation of the power means **44** causes reciprocation of the saddle **40** along the slide-way groove **30**.

Supported in the saddle **40** are two bending dies therebeing an inner bending die **50** and an outer bending die **52** relative to the curvature of the ends **26** of the bar and these two dies are each formed with semi-circular die grooves which combine to form a die cavity **54** of circular cross-sectional shape the diameter of which is equal to the external diameter of the bar **20** and said die cavity has a straight entrance portion **56** followed by an arcuate portion **58** of the required curvature. The entrance to the die cavity is indicated at **60** in FIGURE 3 and conveniently this part of the die cavity is provided in hardened steel inserts. The die cavity **58** is continued at **62** beyond the insert **58** in the inner bending die **50** but not beyond the insert in the outer bending die **52** although an arcuate concave wall **64** is provided to guide the bar **20**.

An internal die head **66** of a cross-sectional shape corresponding to the internal cross-sectional shape of the

bar 20 is mounted in the outer bending die 52 to support the bar 20 during the bending operation and smooth out any wrinkles formed therein during the bending operation and this internal die head will be referred to again later.

As previously stated the inner and outer bending dies 50 and 52 are carried by the saddle 40 and whereas the outer bending die 52 is rigid with the saddle 40 the inner bending die 52 is pivotally mounted on the saddle about a vertical axis of a pivot pin 68 (see FIGURES 3 and 5) said pivot pin 68 passing vertically through the inner bending die 50 and at its lower end into a slide 70 mounted in a slide-way 72 secured to the saddle 40 and which slide and thus the inner bending die 50 is slidable radially of the pivot pin 68. Provided on the underside of the inner bending die 50 is a cam follower roller 74 which is urged by a compression spring 76 operating between an abutment on the saddle 40 and the slide 70, against a cam edge 78 formed by an opening in a side of the slide-way 72 and in this position of the cam follower 74 the dies 50 and 52 are regarded as being in their closed operative positions in which the hardened die inserts abut as shown in FIGURE 3. The roller 74 and the edge 78 thus form a movement constraining means.

Pivotally connected to a vertical pivot pin 80 mounted in the inner bending die 50 at a position off-set from the pivot pin 68 is one end of a piston rod 83 of a fluid-pressure operated piston and cylinder device 84 of which the cylinder 86 is connected at 88 to the saddle 40.

In the position shown in FIGURES 1 and 3 the device 84 is contracted to close the bending dies 50, 52 and by extending said device 84 which constitutes a power means the cam follower 74 is displaced angularly by the cam 78 so that the bending die 50 is caused to have an initial pivotal movement imparted thereto in a clockwise direction as viewed in FIGURE 3 followed by radial movement of the slide 70 and thus of the inner bending die 50 relative to the pivot pin 68 so that the bending dies 50, 52 can be opened to release a bar 20 after it has been bent.

The open position of the bending dies 50, 52 can be determined by the amount of extension permitted to the power means 84 and said bending dies are held in a closed position by the power means 84 and the abutment of a nose 90 on the inner bending die 50 against a projection 92 and the outer bending die 52, as shown in FIGURE 3. The internal die head 66 is formed as an enlargement at one end of a horizontal shank 94 rotatably mounted in the body 96 of a unit 98 mounted in the outer bending die 52 as shown in FIGURES 1, 3 and 7. Conveniently the internal die head 66 is formed on a squared extension 100 inserted into a squared socket in the shank 94 to enable a variety of internal die heads 66 to be employed corresponding to the internal cross-sectional shape of the bar being bent.

Rigid with the shank 94 is a radially extending arm 102 (see FIGURES 7 and 8) arranged to be engaged by a projection in the form of a plunger 104 which is urged by a compression spring 106 into an outermost position as shown in FIGURE 8 and this plunger is carried by a vertically movable slide 108 slidably mounted in the body 96 and connected to the lower end of a piston rod 110 of a fluid-pressure operated piston and cylinder device constituting a power means 112 (see FIGURE 3) which is vertically disposed so as to extend upwardly above the unit 98 and is supported in any convenient manner (not shown).

It should be appreciated that as the slot 22 in the bar 20 (see FIGURE 10) is narrower than the internal diameter of the bar 20 it would be impossible to remove the bar from the internal die head 66 in a direction axially of the shank 24 when the internal die head is in the operative position disposed transversely of the bar 20 as shown in FIGURE 8 and in which position the power means 112 is in a retracted position and in this position the radially extending arm 102 occupies an extreme position against a stop 114 extending downwardly from the body 96. By operating the power means 112 to extend said means the slide 108 is moved downwardly (see FIGURE 8) so that the projection 104 bears against the radially extending arm 102 and moves said arm and thus the shank 94 and the internal die head 66 through an angle of 90° such that said radially extending arm 102 bears against a stop 116 (see FIGURE 9) in which position the internal die head 66 is aligned with the slot 22 and as the thickness of the internal die head is equal to or slightly less than the width of the slot 22 the bar 20 can be removed from said internal die head in a direction axially of the shank 94. During the downward movement of the slide 108 and after the radially extending arm 102 has contacted the stop 116 the slide continues to move downwardly and the plunger 104 is depressed by the arm 102 against the action of the spring 106 and moves to the other side of said arm so that when a reverse or upward movement of the slide 108 is caused the radially extending arm 102 and thus the internal die head 66 is rotated through an angle of 90° from the inoperative position shown in FIGURE 9 to the operative position shown in FIGURE 8 in which position the plunger 104 is again depressed and passes to the opposite side of the radially projecting arm 102, as shown in FIGURE 8.

As the internal die element 66 is subjected to a heavy load due to friction developing between said internal die head and the interior of the bar 20 there is a tendency for the head and the squared extension 100 to be bent particularly as the cross-sectional dimensions of these parts are determined by the width of the slot 22 in the bar 20 and in order to counteract this tendency there is provided a backing support 101 which is mounted behind the internal die head 66 in the direction of advance of the bar 20 through the bending dies and said backing support is mounted in a guide opening 103 in the body 96 so as to be movable in a direction parallel with the axis of the shank 94 into an operative position behind the internal die head 66 as shown in FIGURE 7 and into an inoperative position in which the backing support is withdrawn away from the head through the slot in the bar 20. Movement of the backing support 101 is obtained by cam means provided by a cam track 105 formed in a cam plate 107 secured to the slide 108 to move therewith and the cam track 105 is engaged by a roller cam follower 109 carried by the backing support 101 so that oscillation of the internal die head 66 and reciprocation of the backing support 101 are synchronized and result from reciprocation of the slide 108 by the power means 112. It should be appreciated that withdrawal of the backing support from the internal die head 66 and out of the bar 20 is necessary prior to said head 66 being rotated from its operative position in FIGURE 8 to its inoperative position shown in FIGURE 9.

Formed in the table 28 on each side of the axis A—A and parallel therewith are two dovetail slideway grooves 118 and mounted in these slideway grooves are slides of a table 120 formed with a plurality of T-shaped tenon grooves 122 extending parallel with the axis A—A and the table is connected to a lead screw 124 engaged by a nut 126 which is rotable by an electric motor 128 mounted on the bed 28 so that said motor, nut and screw constitute a power means for reciprocating the table 120.

In order to straighten or bend in any other required manner the previously bent end 26 of the bar there are provided further bending dies 130, 132 (see FIGURE 1) of which the die 130 constitutes an anvil die and the die 132 constitutes a wiper die. The anvil die 130 is mounted on a bracket 134 pivoted at 136 about a vertical axis to the saddle 40 so as to be reciprocated therewith. The bracket and thus the anvil die are angularly adjustable about the vertical axis of the pivot 136 and can be secured in the adjusted position by a screw clamping means 138 which extends through an arcuate slot 140 in the bracket

134 and is secured in the saddle 40 or a part rigid therewith.

The wiper die 132 is secured to one end of a slide 142 mounted in a slideway 144 secured by bolts anchored in the tenon slots 122 to the table 120 so that the slide is capable of movement horizontally in a direction transverse to the axis A—A in the slideway 144 and parallel with said axis A—A when the table 120 is moved.

Carried by the end of the slide 142 remote from the wiper die 132 is a stylus 146 which is pivoted at 148 about a vertical axis to the slide 134 and is urged in an anti-clockwise direction as viewed in FIGURE 6 by a compression spring 149 operating between the slide and the rockable stylus.

Mounted on the stylus 146 are two rollers 150 rotatable about vertical axes and arranged to cooperate with a former 152 which is pivotally mounted on a vertical clamping bolt 154 of which the lower end is provided with a T-head engaging a T-shaped tenon slot 156 formed in the bed 28 centrally between the ends thereof and coincident and parallel with the axis A—A. Conveniently the two formers 152 are mounted on the common clamping bolt 154 and said two formers are also connected together by screw means 158 to enable the formers to be angularly adjusted about the vertical axis of the clamping bolt 154 and afterwards said formers can be clamped in position by tightening the clamping bolt 154 and further clamping bolts 160 engaging arcuate T-grooves in the bed 28.

Thus a former 152 and a complementary anvil die 130 on the same side of the axis A—A can be adjusted to identical angles so as to be parallel and to enable the previously bent end 26 of the bar 20 to be straightened and set at any required angle relative to the central straight portion 24 of the bar.

It should, however, be appreciated that the anvil die 136 can be of any convenient required shape dependent upon the required shape of the end portion 26 of the bar and the former 152 will be a shape replica of the anvil die.

The operation of the bending machine will now be described from an initial position in which a bar 20 which is initially straight from end-to-end is firstly bent into the shape shown in FIGURE 1 in which the end portions 26 are arcuate and which end portions are then partially straightened in dotted lines at 27.

The two power means 44 are retracted and the clamps 34 and 36 are released and a straight bar 20 is placed in position and the central clamp 32 is tightend to hold the bar against endwise movement and the clamps 36 are applied over the bar to have a sliding engagement therewith. In this position the extreme ends of the bar 20 are aligned with and closely adjacent the entrances 60 to the bending dies 50 and 52 which are held in closed positions by the retracted power means 84. The internal die head 66 and the backing support 101 are in their operative positions as shown in FIGURES 7 and 8.

The two power means 44 are then extended to traverse the saddles 40 towards each other so that the two ends of the bar 20 enter the bending dies and advance therein and are bent to the curvature as shown as 26 and during this time the slidable clamps 36 are moved towards each other whilst being spaced apart by the springs 38 so that the central straight portion 24 of the bar does not buckle during the bending operation. During this bending operation any crinkles formed in the bar are smoothed out by the internal die head 66.

The bent portions 26 of the bar have advanced between the anvil dies 130 and the wiper dies 132 as shown in FIGURE 1 and in order to straighten the bent portions 26 to the form indicated at 27 the power means 128 are operated to draw the tables 120 away from the bending dies 50 and 52 whereupon the wiper dies 132 are caused by the formers 152 to move in directions parallel with the complementary anvil dies 130 whereby the ends of the bar 20 are bent or straightened into the form indicated at 27 and preferably the wiper dies 132 move a short distance beyond the ends of the bar 20.

In order to remove the bent bar 20 from the machine the power means 84 are extended and this causes an initial pivotal movement of the bending dies 50 in senses opposite to that of the entry of the bar into the respective bending dies into positions 162 to "unlock" the bending dies from the bent bar and further extension of the power means 84 causes the bending dies 50 to be moved substantially radially of the pivot axis of said dies into positions 164 to separate the bending dies 50 from the complementary bending dies 52 a sufficient distance to enable the bar to be removed from said bending dies.

To enable the bar to be removed from the internal die heads 66 the power means 112 are then extended to withdraw the backing support 101 from behind the internal die head 66 and then to rotate said internal die head 66 through an angle of 90° into the position shown in FIGURE 9.

The bent bar 20 is now free of the various dies and can be easily removed therefrom.

The various parts of the machine can now be returned to their initial positions preparatory to other bars being bent.

It should be appreciated that the various power means are preferably coupled together so as to operate in the required sequence and to enable the operation of the machine to be entirely automatic between loading and unloading a bar into and out of the machine.

I claim:

1. A bending machine for bending metal bars about axes disposed transversely of the bars comprising
   (a) an inner bending die (50) relative to an axis of the bend,
   (b) an outer bending die (52) relative to the axis of the bend,
   (c) bar clamping means (32, 36),
   (d) power means (44) connected to the bending dies to cause relative movement of the bending dies and the bar endwise thereof and thus entry of the bar into the bending dies,
   (e) means (68) on which a bending die is movably mounted so that the bending die can move in a sense substantially opposite to that of entry of the bar into the bending dies to "unlock" the bending dies from the bent bar,
   (f) means (70) on which the bending die is also mounted so that the bending die can move substantially radially of said axis to separate the bending dies and allow the bent bar to be removed therefrom and
   (g) power means (84) connected to the bending die to move said die in the said opposite sense and the substantially radial direction.

2. A bending machine according to claim 1 comprising a pivot pin (68) on which the bending die is pivotally movable to "unlock" the bending dies from the bent bar.

3. A bending machine according to claim 2 comprising
   (a) a slide (70) to which the pivot pin (68) is secured,
   (b) a stationary slideway (72) in which the slide (70) is mounted so as to move radially of said axis,
   (c) a pivot pin (80) mounted in the bending die at a position off-set from the said axis and connected to the power means (84) and
   (d) movement constraining means (74), (78) to cause when the bending dies are being opened, initial pivotal movement followed by radial movement of the bending die and vice-versa when the bending dies are being closed.

4. A bending machine according to claim 3 wherein the movement constraining means comprises
   (a) a cam (78) formed on the slideway (72) and
   (b) a cam follower (74) carried by the bending die

(50) and co-operative with the cam to control the pivotal and sliding movements of the bending die.

5. A bending machine according to claim 4 comprising spring means (76) operative between a stationary abutment and the slide (70) to urge the bending die (50) towards an open position of the bending dies.

6. A bending machine according to claim 3 wherein the inner bending die (50) is mounted on the pivot pin (68) so as to be pivotally and slidably movable relative to said axis.

7. A bending machine according to claim 1 wherein
(a) the bar clamping means (32) is stationarily mounted to hold the bar stationary and
(b) the bending dies (50, 52) are mounted on
(c) a saddle (40) slidably mounted in
(d) a slideway (30) and
(e) the power means (46) are connected to the saddle (40) to move the saddle and thus the dies towards the clamping means to cause the bar to enter the bending dies endwise of the bar.

8. A bending machine according to claim 7 wherein
(a) the clamping means (36) are slidably mounted in the slideway (30) and
(b) compression springs (38) are provided between the clamping means to urge said clamping means apart and afford support for the bar during the bending operation.

9. A bending machine according to claim 1 comprising further bending dies (130, 132) disposed after the said bending dies (50, 52) to further bend the previously bent bar into a straight or other desired formation.

10. A bending machine according to claim 9 wherein
(a) an anvil die (130) is normally stationary and
(b) a wiper die (132) is movable and is connected to
(c) a power means (126, 128) to move the wiper die along the anvil die and thus to wipe along the bar and further bend the bar to conform with the form of the anvil die.

11. A bending machine according to claim 10 wherein
(a) the movable wiper die (132) is connected to a stylus (146) which co-operates with
(b) a former (152) to cause the wiper die to move in conformity with the form of the anvil die and former.

12. A bending machine according to claim 11 wherein
(a) the anvil die is adjustable and can be secured in the adjusted position by
(b) clamping means (138) and
(c) the former (152) is adjustable and can be secured in its adjusted position by
(d) clamping means (154), (160).

13. A bending machine according to claim 12 wherein
(a) the bending dies (50, 52) are mounted on
(b) a saddle (40) slidably mounted in
(c) a slideway (30) formed in
(d) a bed (28) between which and the saddle (40) is disposed
(e) a power means (46) to move the saddle and cause the bar to enter the bending dies,
(f) the anvil die (130) is adjustably mounted by
(g) a pivot pin (136) on the saddle,
(h) the former (152) is adjustably mounted on a pivot pin (154) secured to the bed,
(i) a table (120)is mounted in
(j) a slideway (118) in the bed and the power means (126, 128) is connected between the table and the bed,
(k) a slideway (144) is mounted on thet table and
(l) a slide (142) is mounted in the slideway and carries
(m) the wiper die (132) and
(n) the stylus (146) which co-operates with the former (152) along which it is moved as a result of movement imparted to the table by tthe power means (126, 128).

14. A bending machine according to claim 1 wherein
(a) a bending die (50, 52) incorporates
(b) a shank (94) at one end of which is
(c) an enlargement forming an internal die head (66) corresponding to the internal shape of a bar having a longitudinally extending slot through which the shank passes, said internal die head being not greater in thickness than the width of the slot and
(d) means (102, 104) to rotate the shank and thus the internal die head from an operative position in which it supports the bar and in which the internal die head is disposed transversely of a die cavity and thus of the bar to an inoperative position aligned with the die cavity and thus with the slot to enable the bar to be removed from the die head in a direction axially of the shank.

15. A bending machine according to claim 14 wherein
(a) the means (102) is a radially extending arm of the shank (94) arranged to be engaged by
(b) the means (104) in the form of a projection carried on
(c) a slide (108) connected to
(d) power means (112) to reciprocate said slide whereby the arm, shank and internal die head are oscillated between operative and inoperative positions of the latter.

16. A bending machine according to claim 15 wherein
(a) the projection (104) is slidable and is urged by a
(b) spring (106) towards engagement with the arm (102) so that during movement of the slide (108) in one sense said projection bears on one side of the arm to move said arm in one direction up to
(c) a stop (116) and by continued movement of the slide is depressed by the arm and moves to the other side thereof prior to a reverse movement of the slide which causes the projection to move the arm in the other direction up to
(d) a stop (114).

17. A bending machine according to claim 14 comprising
(a) a backing support (101) for the internal die head (66) and
(b) means (96) in which the backing support is movably mounted so as to be movable axially of the shank (94) from an extended supporting position behind said internal die head (66) when the latter is in an operative position to a retracted position withdrawn from behind said internal die head to enable the latter to be rotated to the inoperative position and vice-versa.

18. A bending machine according to claim 17 wherein the backing support (101) is associated with
(a) the slide (108) through
(b) cam means (105, 109) whereby reciprocation of the slide causes the backing support to be extended and retracted.

19. A bending machine according to claim 18 wherein
(a) the clamping means (32) is disposed centrally of the bending machine and
(b) two sets of dies (50, 52) and other associated parts are provided one on each of the two opposite sides of said clamping means to enable both ends of a bar to be bent simultaneously.

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RONALD D. GREFE, Primary Examiner

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