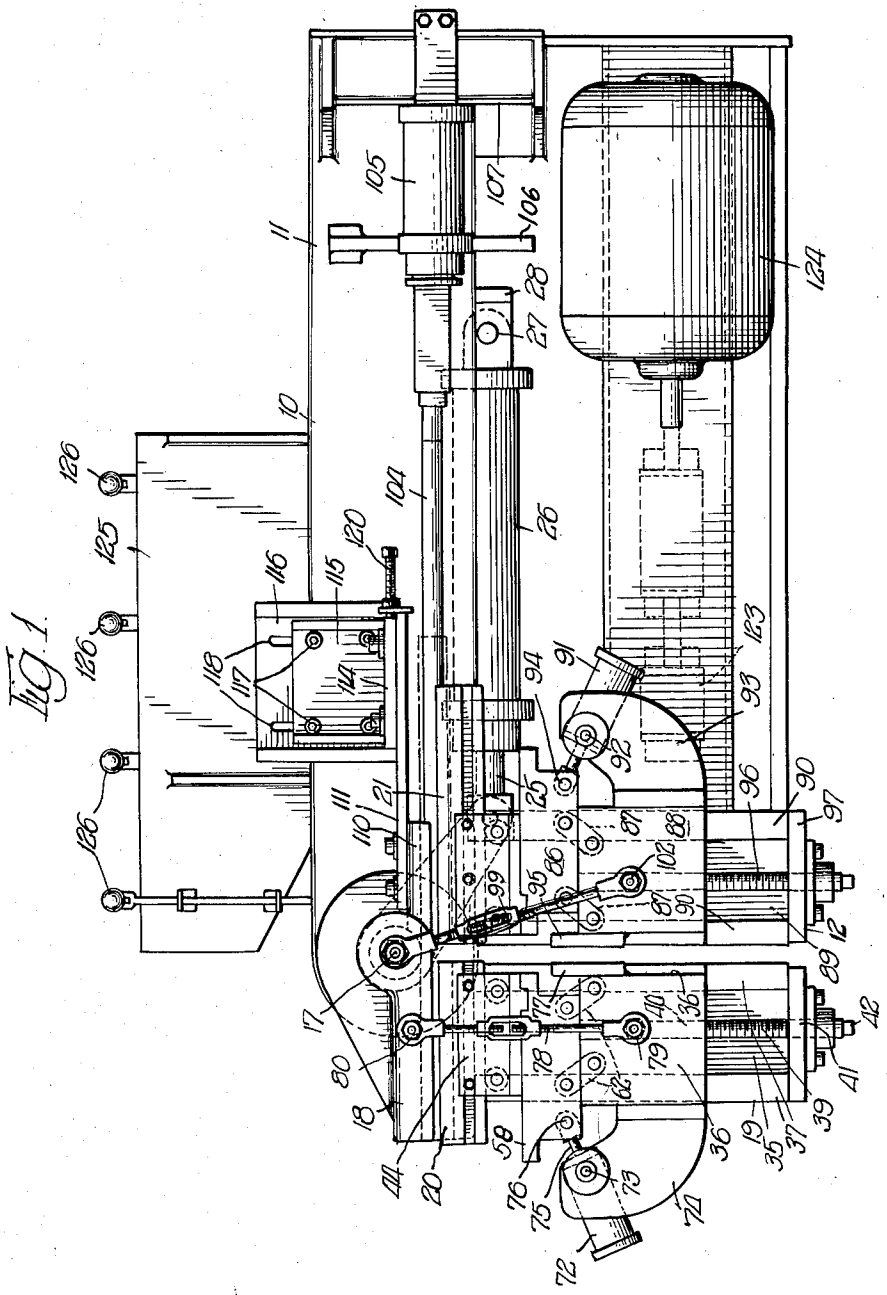
March 14, 1961 E. J. DE WITT 2,974,706

ROTARY BENDING MACHINE HAVING HYDRAULIC MEANS FOR HOLDING MOVABLE PRESSURE DIE AGAINST STOCK

Filed Feb. 26, 1957 9 Sheets-Sheet 1

Fig. 1.



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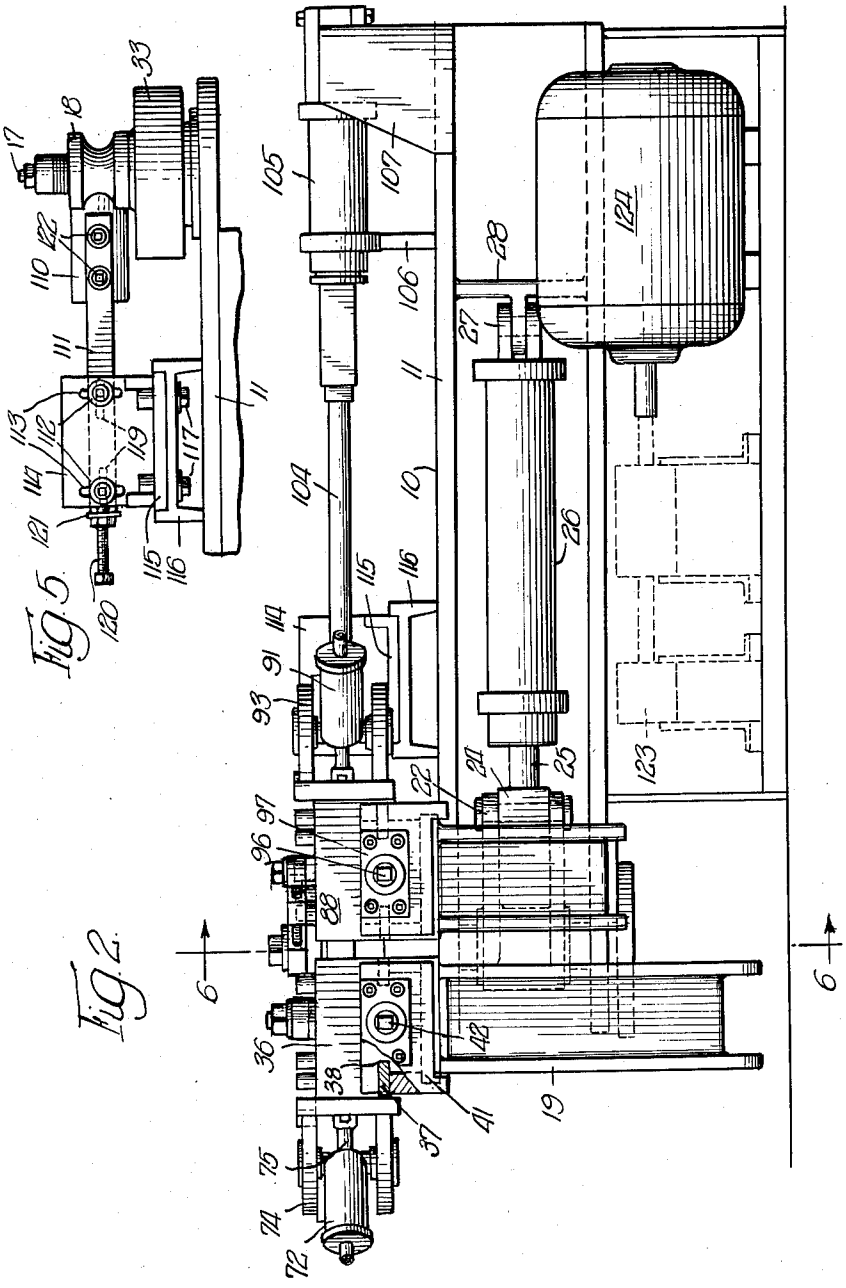

Fig. 5.

Fig. 2.

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Fig. 6

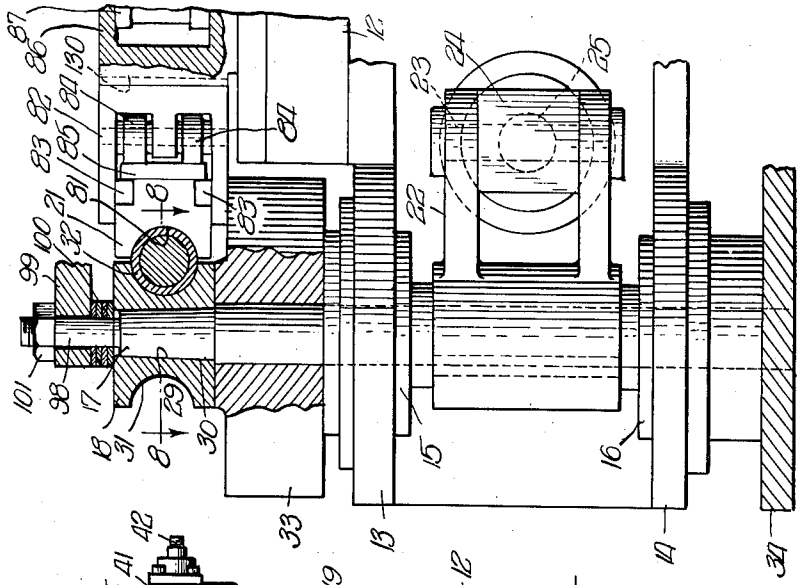

Fig. 3

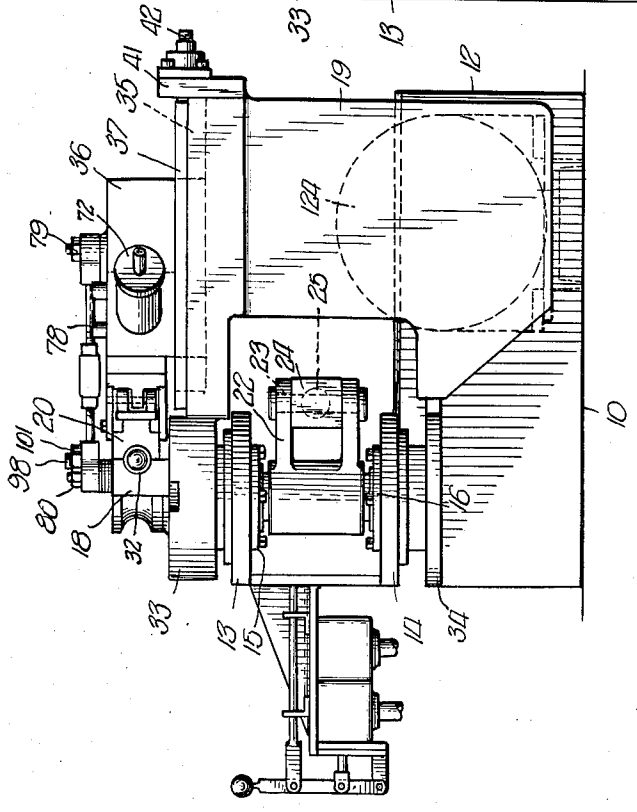

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Fig. 8

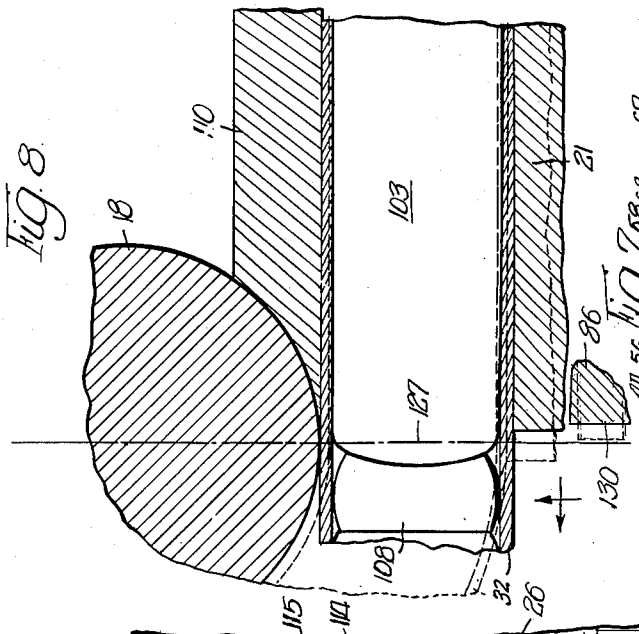


Fig. 7

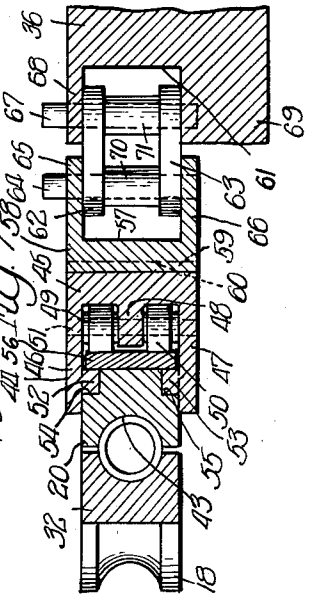
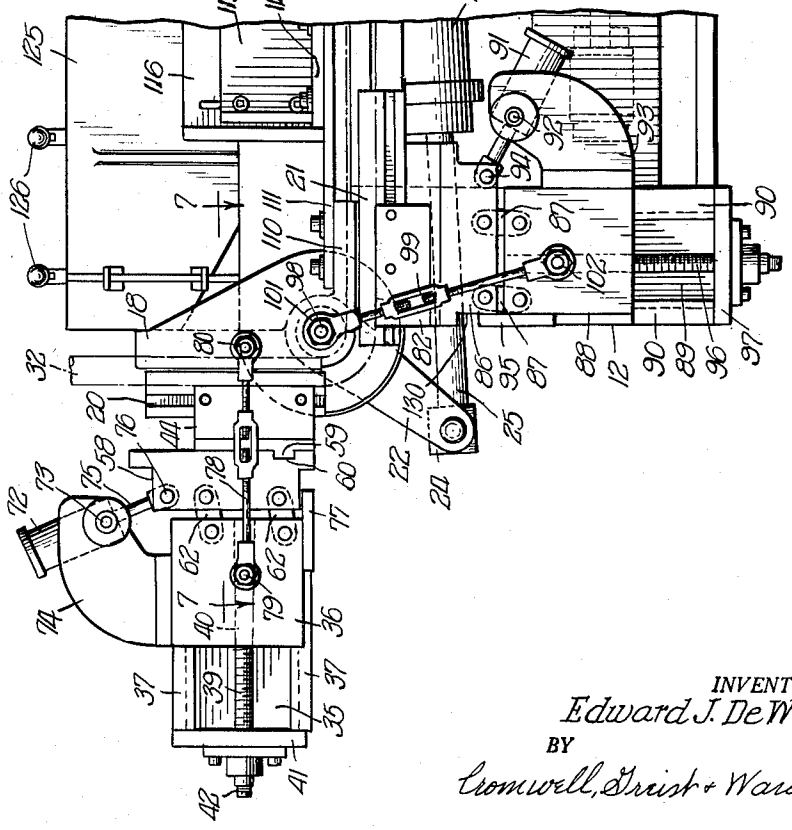


Fig. 4



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ROTARY BENDING MACHINE HAVING HYDRAULIC MEANS FOR HOLDING MOVABLE PRESSURE DIE AGAINST STOCK

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Fig. 9

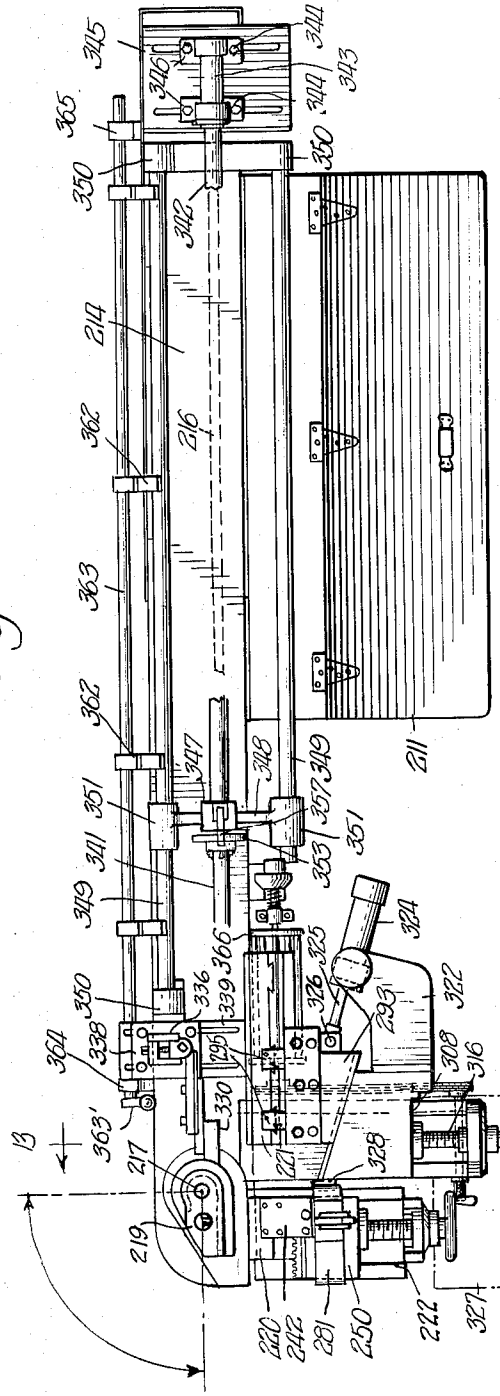
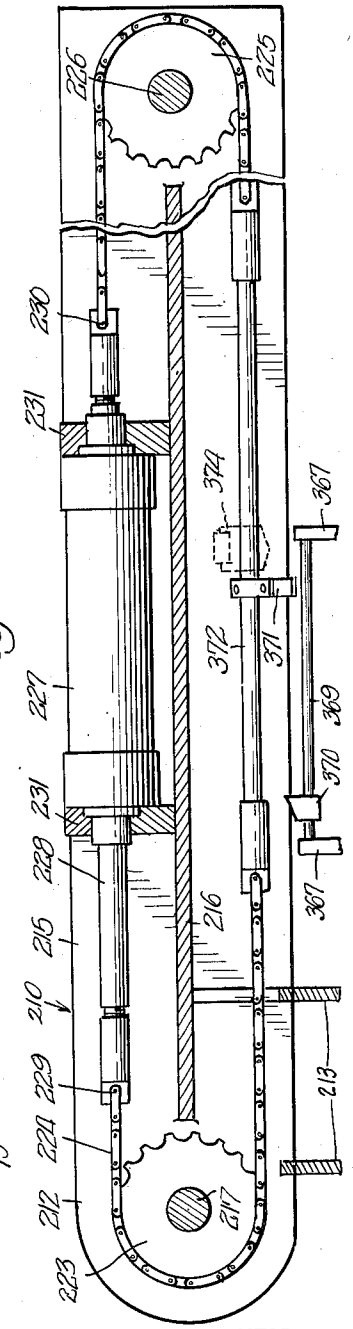


Fig. 10



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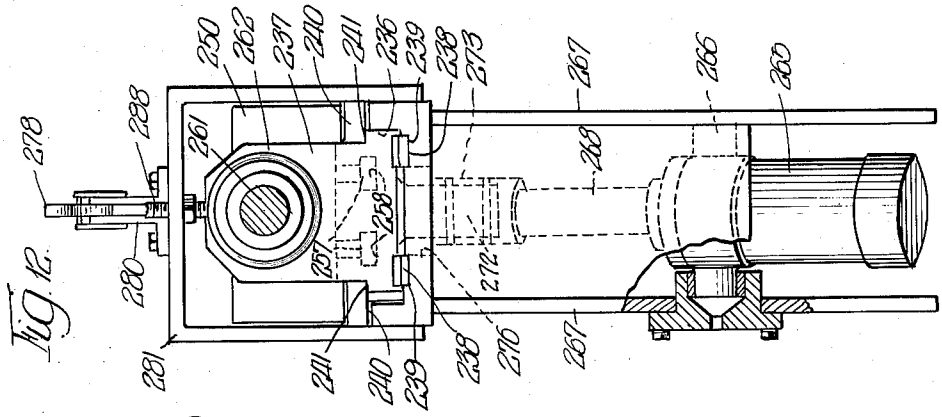

Fig. 12.

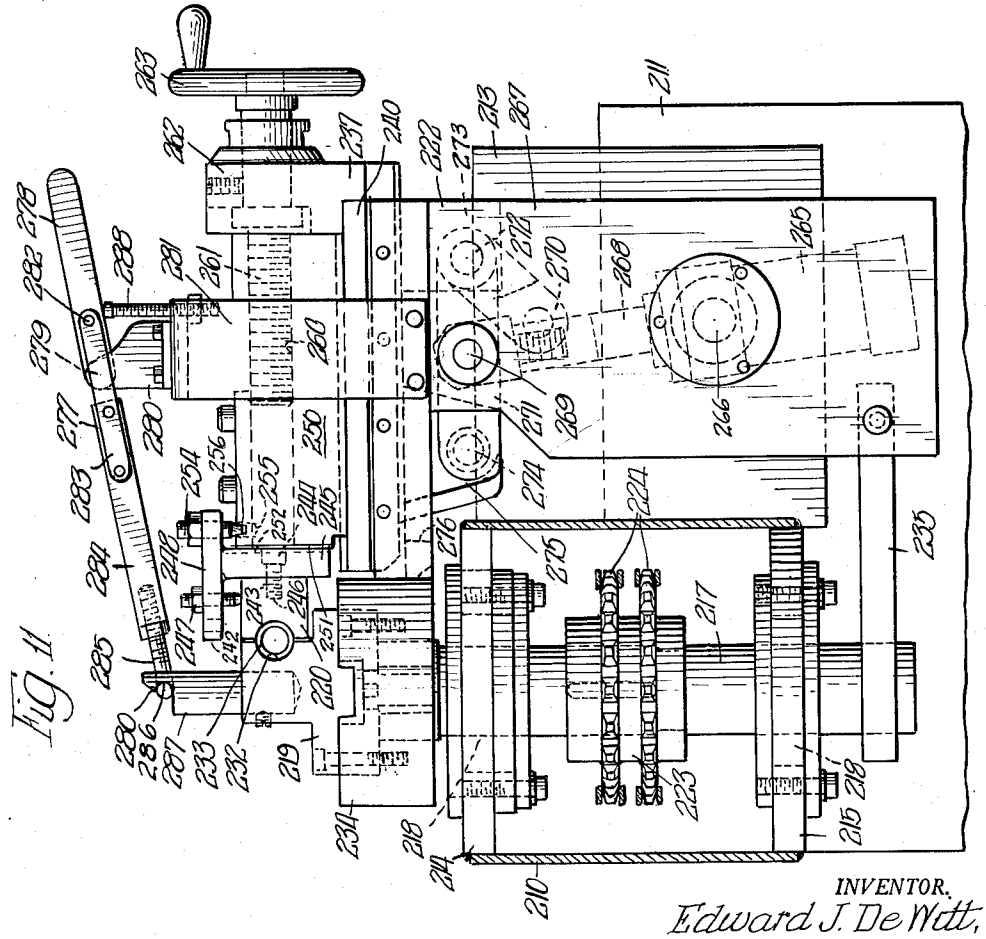

Fig. 11.

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Fig. 13.

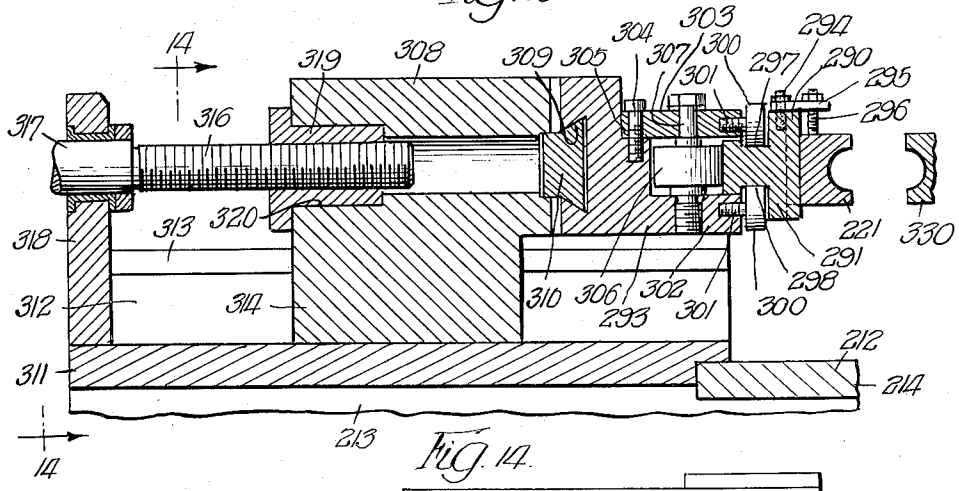
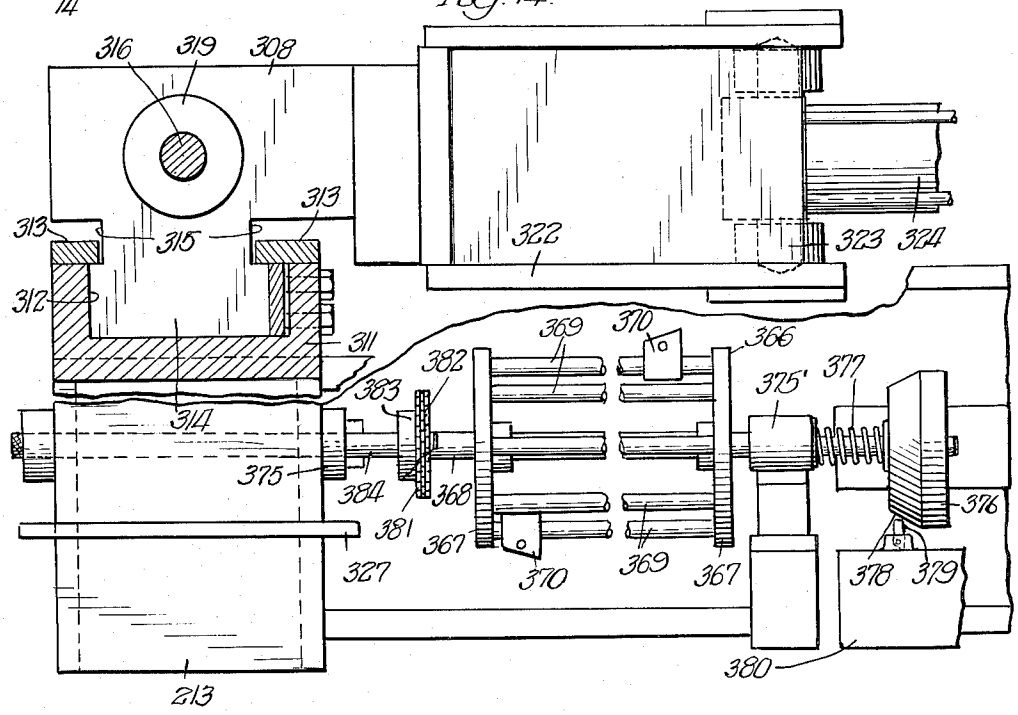


Fig. 14.



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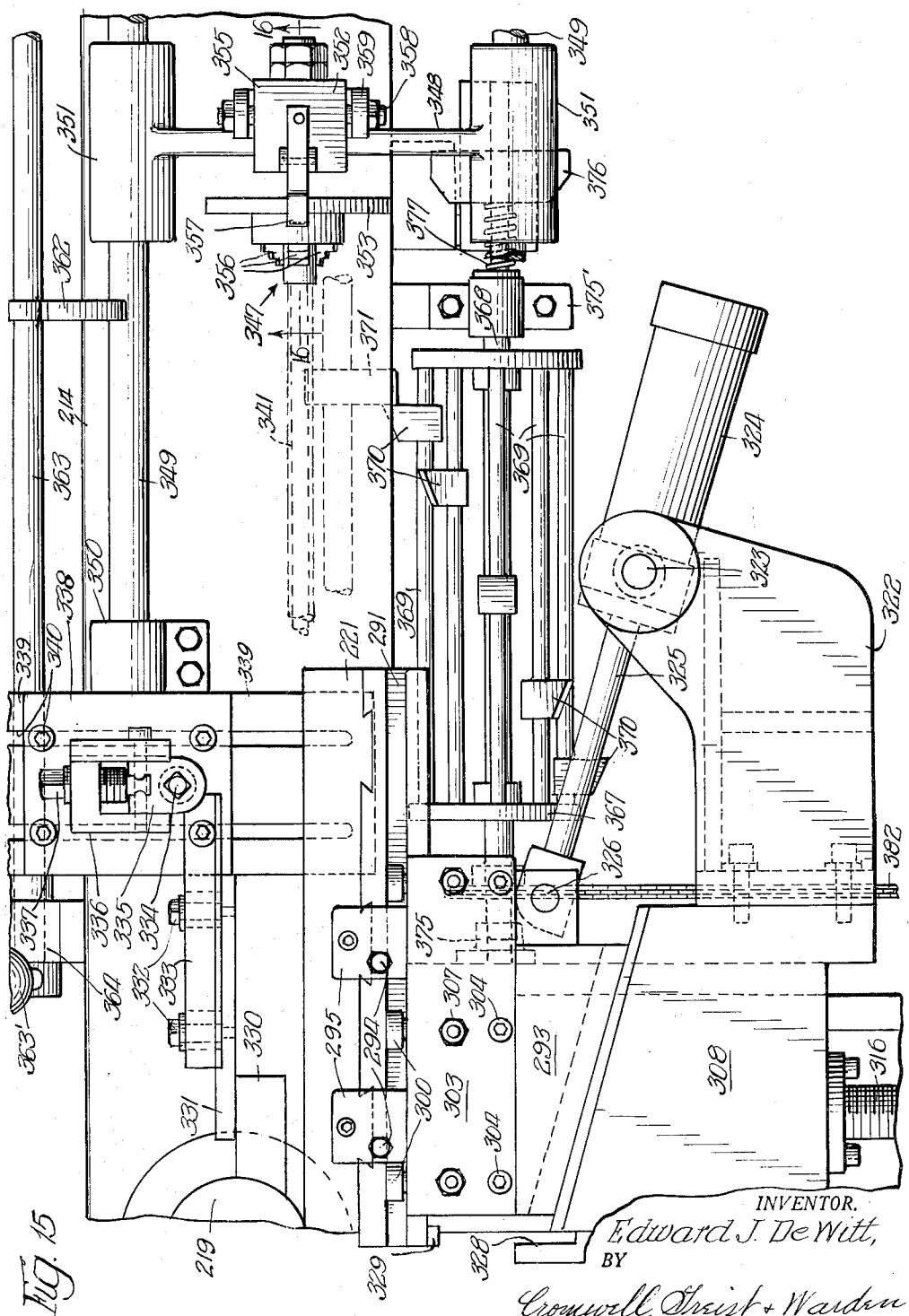

Fig. 15

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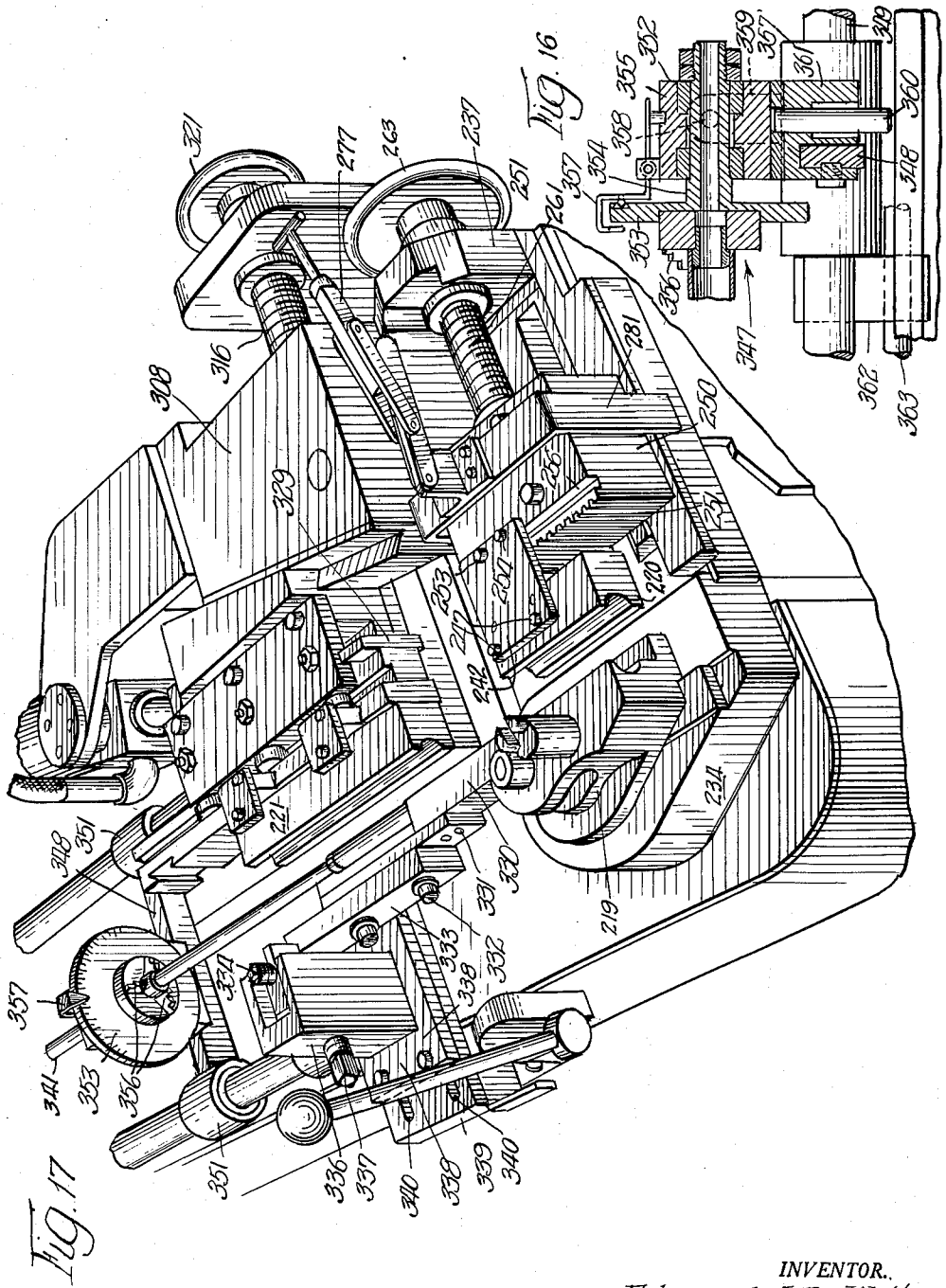

Fig. 16

Fig. 17

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Patented Mar. 14, 1961

2,974,706

ROTARY BENDING MACHINE HAVING HYDRAULIC MEANS FOR HOLDING MOVABLE PRESSURE DIE AGAINST STOCK

Edward J. De Witt, Winnetka, Ill., assignor to Wallace Supplies Manufacturing Company, Chicago, Ill., a corporation of Illinois

Filed Feb. 26, 1957, Ser. No. 642,494

11 Claims. (Cl. 153—40)

This invention relates to machines for bending tubular stock into curved form and is more particularly concerned with improvements in a rotary type tube bending machine.

This application is a continuation-in-part of application Serial No. 368,752, filed July 17, 1953.

It is a general object of the invention to provide an improved machine for cold bending tubular stock in which the tubular stock is clamped at a leading end portion thereof to a form and the form is rotated about a fixed axis while the trailing end portion of the stock is securely held against movement in a lateral direction but is free to move in an axial direction as the bending progresses.

It is a further object of the invention to provide a bending machine of the type in which tubular stock is clamped at one end to a form which rotates relative to a fixed axis and at the other end the stock is restrained against movement in a lateral direction but is permitted to move in an axial direction as the bending progresses, wherein improved mechanisms are provided for clamping the stock to the form and for restraining the stock against lateral movement.

It is another object of the invention to provide in a rotary type bending machine a more efficient mechanism for supporting the pressure die whereby the die may be moved into engaging relation with the tubular material to be bent in such a manner that a uniform and continuous pressure against the tubular material is maintained during the entire bending operation, regardless of the reduction in the outside of the diameter of the tubular material in the area adjacent the bend.

It is a still more specific object of the invention to provide a rotary tube bending machine having a pressure die which is movable relative to a fixed support toward and from the material to be bent and which is connected to the support by a power operated linkage whereby the die may be moved into engaging relation with the material to be bent along the longitudinal axis of the same by actuation of said linkage.

It is a still further object of the invention to provide in a rotary tube bending machine a pressure die which is connected by a horizontal linkage to a fixed support and which is moved into engaging relation with the tube material to be bent along the longitudinal axis of the same by an hydraulic operating mechanism.

It is another object of the invention to provide in a rotary tube bending machine a pressure die which is mounted for movement in a horizontal plane against the material to be bent and mechanism for moving the die so that upon a reduction in the outside diameter of the material in the area adjacent the bend the die is moved laterally and longitudinally relative to the long axis of the material a sufficient distance to maintain a uniform and continuous pressure against the material during the entire bending operation.

It is another object of the invention to provide in a rotary tube bending machine a pressure die and a clamping die, each of which is mounted on a support which is fixed relative to the axis of rotation of the form, with each of the dies being movable toward and from the material to be bent in a generally horizontal plane and with each of the dies connected to its fixed support by a linkage and having an hydraulic mechanism for operating the linkage to move each of the respective dies toward the material to clamp the one end of the material against the form and to apply a continuous and uniform pressure against the other end of the material and thereby restrain the movement thereof in the lateral direction during the bending operation.

It is another object of the invention to provide a bending machine having a bending form mounted on a shaft which revolves about a fixed vertical axis, a pressure die mounted by means of an extensible linkage on a support which extends laterally of and is fixed relative to the axis of rotation of the pivot shaft, a clamping die mounted by means of an extensible linkage on a support which extends laterally of and is secured to the pivot shaft, a tie bar connected at one end to the support for the clamping die and at the other end to the form, and a tie bar connected at one end to the fixed support for the pressure die and at the other end to the pivot shaft which rotates the bending form, both of the tie bars extending across the upper faces of the dies and restraining the dies and their supports against tilting movement.

It is still another object of the invention to provide in a rotary tube bending machine having a bending form mounted on a shaft which revolves about a fixed vertical axis, with the bending form moving in a horizontal plane during the bending operation, a pressure die for engaging with the trailing end portion of the work piece, and a mounting means for the pressure die, which mounting means comprises a fixed supporting frame extending laterally of the long axis of the work piece, a holder on which the pressure die is mounted for free sliding movement in the direction of the long axis of the work piece, a supporting member adjustably mounted on the supporting frame and spaced outwardly of the work piece, a connecting member between the die holder and the supporting member which is wedge shaped and which is positioned in sliding engagement with the inner face of the supporting member, and an hydraulic operator which is mounted on the supporting member with its operating piston in a horizontal plane and pivotally connected to the wedge shaped connecting member to move the latter in a horizontal plane toward the bending form and in the direction of the long axis of the work piece whereby the pressure die is held in engagement with the work piece with uniform pressure during the bending operation.

These and other objects and advantages of the invention will be apparent from a consideration of the bending machine which is shown by way of illustration in the accompanying drawings, wherein:

Fig. 1 is a plan view of a rotary tube bending machine having incorporated therein the principal features of the invention;

Fig. 2 is a rear elevation of the machine;

Fig. 3 is an end elevation of the machine, with a piece of tubular stock material in clamped relation therein, just prior to the bending operation;

Fig. 4 is a partial plan view of the bending end of the machine as the same appears at the end of the bending operation;

Fig. 5 is a fragmentary front elevation;

Fig. 6 is a partial section, to an enlarged scale, taken on the line 6—6 of Fig. 2;

Fig. 7 is a detail section, to an enlarged scale, taken on the line 7—7 of Fig. 4;

Fig. 8 is a detail section, to a greatly enlarged scale, taken on the line 8—8 of Fig. 6;

Fig. 9 is a plan view of another form of the bending machine, with portions broken away;

Fig. 10 is a horizontal section with portions broken away showing the drive for the bending arm;

Fig. 11 is an end elevation of the forward or bending end of the machine, on an enlarged scale, with a piece of tubular stock material in clamped relation therein, just prior to the bending operation;

Fig. 12 is a partial rear side elevation on an enlarged scale and with portions broken away;

Fig. 13 is a fragmentary cross section, on an enlarged scale, taken on the line 13—13 of Fig. 9;

Fig. 14 is a fragmentary cross section, on an enlarged scale, taken on the line 14—14 of Fig. 13 and with portions broken away;

Fig. 15 is a partial plan view of the machine, on an enlarged scale;

Fig. 16 is a cross section, taken on the line 16—16 of Fig. 15; and

Fig. 17 is a perspective view, on an enlarged scale, of the forward or bending end of the machine.

The machines illustrated in the drawings are adapted for use in the bending of tubular material such as copper, brass, steel or other metal tubing of substantial diameter and having a relatively thin wall structure, and to place therein circular bends up to 180°. The machines embody improved mechanism for clamping the stock material and for controlling the movement of the same during the bending operation.

The main frame of the machine illustrated in Figs. 1 to 8, comprises an L-shaped base 10 (Figs. 1, 2 and 3) which is of substantial size and which is adapted to rest on a floor or other supporting surface. The base frame 10 is provided, at the juncture of the long and short legs 11 and 12, with bracket formations 13 and 14 (Figs. 3, 4 and 6) which project outwardly from the corner of the machine, in vertically spaced relation, and which support, by means of bearing members 15 and 16, a vertical shaft 17. The rotatable shaft 17 carries a bending form 18, at its upper end, and a laterally extending supporting frame 19 beneath the horizontal plane of the bending form 18, on which there is movably mounted a clamping die 20 and associated operating mechanism. The short leg 12 of the base 10 provides a support for a movable pressure die 21 and its associated operating mechanism.

The shaft 17 is rotated in the bearings 15 and 16 by operating arm 22 which is secured to the shaft 17 between the bearings 15 and 16 and provided with a forked outer end which is connected by the pivot bolt 23 to the end block 24 on an operating ram 25 (Fig. 2). The ram 25 constitutes the piston rod of an hydraulic cylinder 26 which is pivotally mounted at 27 on an extending bracket forming portion 28 of the main frame 10.

The bending form 18 comprises an elongate member having one end enlarged and rounded into semi-cylindrical form. The semi-cylindrical end is provided with a tapered bore 29 (Fig. 6) which is received over the tapered upper end 30 of the shaft 17 on which the form 18 is removably secured. The working face of the form 18 is provided with a longitudinally extending semi-circular recess 31 of the same diameter as the tube material 32 which is to be bent, a form of different size being provided for each different size of tubular material. The semi-circular recess 31 continues around the semi-cylindrical end of the form 18 in an arcuate path with the center coinciding with the axis of the supporting shaft 17.

The clamping die 20 which cooperates with the form 18 to clamp the tubular material 32 in the recess 31 is mounted on the carrying or supporting frame 19. The rectangular supporting frame 19 extends vertically and is provided with upper and lower horizontally extending end bracket plate formations 33 and 34 (Figs. 3 and 6) which are secured to the pivot shaft 17 so that the frame 19 swings with the shaft 17 and the

form 18. The upper face of the clamping die support 19 is provided with an upwardly opening recess 35 which extends radially of the center of the pivot shaft 17 and which receives in sliding relation therein the lower portion of a slide block or member 36. The slide member 36 is retained in sliding relation on the frame 19 by guide rail forming plates 37 which extend into slots 38 provided in opposite sides of the member 36 and which are secured to the top of the frame 19 on opposite sides of the guideway forming recess 35. The slide member 36 (Figs. 2 and 4) is adjustably secured against movement relative to the frame 19 by means of an adjusting screw 39 which is threaded into a bore 40 in the slide member 36 and rotatably secured in an end bearing member 41 projecting upwardly of the outer end of the frame 19 with the end of the adjusting screw 39 having a square head 42 for receiving a tool to turn the same and move the slide member 36 relative to the frame 19.

The clamping die 20 (Figs. 3, 4 and 7) is located in spaced relation to the slide member 36 and is recessed at 43 on its working face to receive in clamping engagement the stock material 32 between it and the form 18. The clamping die 20 is slidably mounted in a guideway forming supporting member or block 44 which is located adjacent the face opposite the recess 43 and which is generally E-shaped in cross section, providing a back or vertical web portion 45, top and bottom plate or side members 46 and 47 and a short inwardly extending central web 48 which divides the space between the top and bottom plates 46 and 47 into two parallel longitudinally extending recesses opening toward the clamping die 20 in which there are housed pairs of longitudinally spaced, upper and lower rollers 49 and 50 mounted on vertical pins 51 extending through the top and bottom plates 46 and 47 and the intermediate web 48. The roller bearing recesses are partially closed at the free edges of the top and bottom plates 46 and 47 by oppositely disposed inwardly extending guide rail members 52 and 53 which project into top and bottom recesses 54 and 55 in the clamping die 20. A bearing plate 56 is secured to the face of the clamping die 20 which extends at its top and bottom edges over the portions of the recesses 54 and 55 and the inner portions of the guide rails 52 and 53, and which engages on its opposite face in longitudinal sliding relation with the bearing rollers 49 and 50 in the member 44.

The guideway forming supporting member 44 is positioned with its base member 45 abutted against the base member 57 of a channel-shaped operating member 58, with an interlocking vertical rib 59 on the member 45 engaging in a vertical slot 60 in the member 58, which prevents relative movement in the direction lengthwise of the members 44 and 58 but permits separation and removal of the member 44 vertically. The operating member 58 is arranged with the open side facing away from the member 44 and in opposed relation to a longitudinal recess 61 in the slide member 36. The members 58 and 36 are connected for parallel movement toward and from each other by pairs of longitudinally spaced upper and lower links 62 and 63 which are mounted at one end on supporting pins 64 extending between the upper and lower side flanges 65 and 66 of member 58 and at the other end on pins 67 extending between the upper and lower side flanges 68 and 69. Spacer sleeves 70 and 71 on the pins 64 and 67, hold the upper and lower links 62 and 63 in vertically spaced relation on the pins. The operating member 58 is moved relative to the slide member 36 by an hydraulic cylinder 72 (Figs. 1 and 4) which is pivotally mounted at 73 between laterally projecting supporting bracket members 74 and which has its piston 75 pivotally connected at 76 to the end of operating member 58. At the other end a stop plate 77 is secured to the vertical side face of slide member 36

which projects over the end of and limits the movement of member 58 in the clamping direction.

The stock 32 is adapted to be clamped between the bending form 18 and the clamping die 20 by first moving or adjusting the clamping die supporting slide member 36 relative to the frame 19 to bring the clamping die 20 closely adjacent to the form 18. Thereafter the hydraulic cylinder 72 is operated to move the member 58 on the links 62, 63 relative to the slide member 36 and force the clamping die 20 against the stock 32.

When the slide member 36 is adjusted by screw 39 to the proper distance to permit clamping action by the die 20 upon movement of the member 58 it is preferably braced against tilting movement away from the form 18 by means of a tie rod 78 which is connected to the slide member 36 at 79 and to the form 18 at 80 and which extends across the top of the clamping die 20, the rod 78 being of a type which may be adjusted to the proper length and which has sufficient strength to resist any tendency of the slide member 36 to tilt upon the application of pressure on the clamping die 20.

The pressure die 21 is arranged adjacent the form 18 (Figs. 1, 4 and 6) where it will engage and hold the trailing end of the stock 32 against lateral movement while the bend is made by moving the portion clamped against the form 18 about the pivot 17. The pressure die 21 and its supporting mechanism are mounted on the top of the short leg 12 of the frame 10 of the machine. The side wall of the pressure die 21 is recessed at 81 to engage the exterior wall of the work piece 32 and its supporting and operating mechanism may be substantially the same as the corresponding mechanism provided for the clamping die 20. It is connected in longitudinal sliding relation with an E-shaped guideway forming member 82 having opposed longitudinal guide rails 83 extending into guide recesses in the upper and lower faces of the die 21 and pairs of bearing rollers 84 engaging the outer face of the bearing plate 85 on the die 21 which permits longitudinal sliding movement of the die 21 relative to the member 82. The base of the guideway forming member 82 abuts against and is keyed to the base of a channel-shaped operating member 86 so that relative longitudinal movement is prevented but vertical movement and removal of the member 82 and die 21 is permitted. The operating member 86 is connected by upper and lower pairs of horizontal links 87 with a supporting slide member 88 which is mounted for sliding adjustment on the top of the frame member 12. The supporting slide member 88 has a depending portion extending into a recess 89 in the top of the frame member 12 and is held therein in proper alignment by the inwardly extending side rail members 90. The operating member 86 is adapted to be moved or swung away from the supporting slide member 88 on the links 87 by an hydraulic cylinder 91 which is pivotally mounted at 92 on bracket formations 93 extending laterally of the supporting slide member 88 and which has the free end of its piston pivotally connected at 94 to the operating member 86. The movement of the operating member 86 is limited in the direction of the material or the form 18 by the stop plate 95 secured on the side face of the supporting slide member 88.

The supporting slide member 88 is adjusted on the frame member 12 by means of an adjusting screw 96 which is in threaded engagement therewith and has its outer end rotatably mounted in a bearing plate 97 at the end of frame member 12, the outer end being provided with a head suitably shaped to receive a turning tool.

The supporting slide member 88 is preferably connected, when adjusted to the proper operating position, to a top end portion 98 of the vertical pivot shaft 17 by a tie rod or bar 99. The apertured end of the bar 99 is spaced above the form 18 on the shaft 17 by suitable washers 100 and held thereon by a nut 101. At its other end the bar 99 is connected to the slide member 88 by a suitable fastening bolt 102 which may be threaded into an aperture provided therein. The bar 99 is similar to tie bar 78, being adjustable as to length, and serves the same purpose of resisting any tendency of the pressure die 21 and its operating and supporting mechanism to tilt relative to the form 18.

The stock or work piece 32 is positioned on a mandrel 103 (Figs. 1, 2 and 8) for the bending operation. The mandrel 103 is supported on a shaft or bar 104 extending above the long leg 11 of the supporting frame 10 and is movable towards and from the form 18, the bar 104 constituting an extension on the end of the piston rod of an hydraulic cylinder 105 which is adjustably mounted on the upstanding brackets 106 and 107 so that the mandrel 103 may be aligned with the longitudinal axis of the work piece 32. The mandrel 103 is provided at its free end with articulated sections 108 which are positioned at the bend when the mandrel is positioned within the stock 32 and properly located for the bending operation by movement of the supporting bar 104. The use of the mandrel, of course, prevents collapse of the tube walls during the bending.

A backing shoe 110 (Figs. 1 and 5) is provided adjacent the form 18 which is mounted on a support plate or bar 111. The support plate 111 is adjustably mounted by bolt and slot connections 112 and 113 on an upstanding plate portion 114 of the angle bracket 115 which is in turn adjustably supported on a horizontal bracket 116 by bolt and slot connections 117 and 118. The support plate 111 is slotted at 119 and adjusted lengthwise of the machine by an adjusting screw 120 which extends through an end plate 121 secured on the end of plate 111 and bears against the vertical edge of the angle bracket member 114. The backing shoe 110 is detachably secured to the supporting rod or plate 111 by the bolts 122 and is provided on the face which is adapted to engage the work with a recess which is semi-circular in cross section and of the same diameter as the external diameter of the work piece. A separate backing shoe is, of course, provided for each size work piece.

The machine is provided with a suitable hydraulic system having a fluid supplied therein and pressure in the system is provided by a pump 123 which is operated by a motor 124 mounted on the base of the machine. The hydraulic system is properly connected in a conventional manner with the hydraulic cylinders 26, 72, 91 and 105. Suitable controls are provided on a control panel 125 mounted at the front side of the machine with operating handles 126 whereby power may be supplied to any one of the cylinders, as required, for operation of the machine.

In operating the machine the mandrel 103 is withdrawn by operation of the cylinder 105 and a suitable length of stock is positioned over the same after which the mandrel is moved to bring the head 108 thereof into the proper position within the stock and adjacent the form 18. The clamping die 20 is then actuated by operation of the cylinder 72 to engage the stock 32 against the form 18, the pivoted carrier frame member 19 being in the position shown in Fig. 1. The pressure die 21 is actuated by operation of the cylinder 91 to engage the stock between the die 21 and the backing shoe 110. Both the clamping die slide member 36 and the pressure die slide member 88 are initially adjusted by rotation of the adjusting screws 39 and 96 to position the dies for engagement with the stock upon operation of the cylinders 72 and 91. After the cylinders 72 and 91 are operated to move the dies 20 and 21 into engagement with the stock 32 the cylinder 26 is actuated to slowly rotate the pivot 17 and move the frame member 19 about the pivot axis and the stock about the form 18.

The movement of the pressure die 21 by means of links 87 causes the die 21 to move against the stock 32 with the working face of the die parallel to the long

axis of the stock. The die 21 is held in resilient gripping relation with the stock 32 by the fluid pressure in the cylinder 91 and any reduction in the outside diameter of the stock which occurs due to the stretching of the material at the bend is automatically taken up or compensated for by movement of the die 21. The die 21 is initially located and grips the stock 32 with the end 130 of the operating member 86 of the die spaced from a vertical plane extending through the center line or axis of the pilot shaft 17 and normal to the long axis of the stock, this plane being indicated at 127 in Fig. 8. As the bending progresses the outside diameter of the stock is reduced due to the thinning out of the material adjacent the die 21 in the formation of the outer portion of the bend. This reduction in the outside diameter of the stock does not reduce the restraining or gripping action of the die 21 but the die is moved by the pressure of the cylinder 91 a sufficient distance toward the stock to compensate for the reduced diameter of the stock and the end 130 of the operating member 86 of the die moves forwardly in the direction of the long axis of the stock closely adjacent to the plane 127 as illustrated in dotted line in Fig. 8. This movement of the die 21 and its operating member 86 in the direction along the axis of the stock occurs without changing the pressure of the die on the stock which is maintained constant due to the link mounting for the operating member 86.

The form of the machine which is illustrated in Figs. 9 to 17 includes an L-shaped main supporting frame 210 (Figs. 9, 10 and 11) which is supported above the floor or other supporting surface on a base 211. The L-shaped frame is arranged with the longer leg 212 extending longitudinally of the machine and with the shorter leg 213 extending laterally or transversely at the juncture of the two legs 212 and 213 which constitutes the bending or forward end of the machine. The longer leg 212 is in the form of an H beam in cross section with top and bottom horizontal flanges 214 and 215 separated by a connecting vertical web 216. At the forward or bending end of the frame member the web 216 is cut back and the flanges 214 and 215 of the leg 212 are apertured to receive a vertically extending shaft 217 which is mounted in suitable vertically spaced bearings 218. The rotatable bending shaft 217 carries a bending form 219 at its upper end.

A clamping die 220 and a movable pressure die 221 are provided, at the bending end of the machine, for cooperation with the bending form 219. The clamping die 220 and its associated operating mechanism are mounted on a laterally extending supporting frame 222 which is arranged to swing with the bending form 219 while the pressure die 221 is mounted on the laterally extending short leg 213 of the main supporting frame 210.

The bending or form supporting pivot shaft 217 is provided intermediate the bearings 218 with a double sprocket 223 for receiving a double driving chain 224 (Fig. 10). The drive chain 224 is carried at the other end of the machine on a sprocket 225 supported on a vertical shaft 226 extending between the flanges 214 and 215 of the main frame member 212, the web 216 being cut back to accommodate the shaft 226. The drive chain 224 is connected to a drive mechanism which comprises an hydraulic cylinder 227 having a piston rod 228 which is connected to the chain at 229 and 230. The cylinder 227 is connected with a suitable hydraulic system which includes manually operated valves for controlling the circulation of hydraulic fluid in the cylinder to reciprocate the drive piston rod 228. The cylinder 227 is supported on longitudinally spaced brackets 231 extending from the web 216 of the frame member 212.

The bending form 219 is of the same character and is secured on the end of the bending shaft 217 in the same manner as in the previously described form of the machine. The working face of the bending form 219 is provided with a longitudinally extending semi-circular recess 232 of the same diameter as the tube material or work piece 233 which is to be bent, a form of different size being provided for each different size tubular stock or work piece. The semi-circular work receiving recess 232 extends around the semi-cylindrical end of the bending form 219 in a circular path with the center thereof coinciding with the center of the supporting shaft 217.

The supporting frame 222 (Figs. 11 and 12) which carries the clamping die 220 and its associated operating mechanism is generally rectangular and extends vertically and laterally relative to the vertical bending shaft 217. The frame 222 is connected to the vertical shaft 217, so that it rotates with the same, by means of an upper bracket member 234 and a lower brace member 235. The upper face or top of the frame 222 is provided with an upwardly opening recess 236 which extends radially relative to the vertical axis of the pivot shaft 217 and receives in sliding relation therein the lower portion of a slide member or block 237 for supporting thereon the clamping die 220 and its associated members. The slide member 237 is provided on its bottom surface with runners 238 which are received in guideway forming grooves 239 in the bottom of the recess 236. The slide member 237 is retained in sliding relation on the frame 222 by guide rail forming plates 240 which extend in edge opposed inward relation and have their inner edge portions overlying a shoulder formation 241 on the sides of the slide member 237.

The clamping die 220 is recessed on its working face to receive the work piece 233 and secured on a T-shaped mounting bracket 242 (Figs. 9, 11 and 17) which forms a leveling and holding device for the same. The T-shaped bracket member 242 has a stud bolt 243 extending through a slot 244 in the vertical leg 245 thereof and engaging in a threaded bore 246 in the die 220. A pair of studs 247 extend downwardly from the overhanging portion of the head or horizontal leg 248 of the T-shaped member which overhangs the clamping die 220 and engage with the top surface of the die. The T-shaped bracket member 242 is connected to or mounted on the front face of a block-like member 250 which forms a holder or support member for the clamping die unit and which has vertically extending teeth 251 on its forward face adapted to engage with cooperating teeth 252 on the rearward face of the vertical leg 245 of the member 242. The portion of the head 248 of bracket member 242 which overhangs the support member 250 is provided with two stud bolts 253 and 254. The former engages in a threaded bore 255 in the support member 250 while the latter has a tapered head seated in a cross groove 256 in the top surface of the support member 250. The clamp die 220 is adjusted or leveled for proper engagement with the work piece 233 by turning the fastening and adjusting bolts described. The support block 250 extends across the upper face of the frame support 222 with its bottom side margins sliding on the plate members 240 which form the top surface of the same. The support member 250 has depending inverted T-shaped rail formations 257 on its bottom face which are slidably received in inverted T-shaped guide recesses 258 or grooves in the top face of slide member 237. The support member 250 is provided with a horizontally extending threaded bore 260 which receives the inner end of an adjusting screw 261 which is journaled in an upstanding flange portion 262 of the slide member 237 and which is provided with an operating handle or wheel 263.

The slide member 237 is operated to slide toward and from the bending form 219 in the recess 236 in the upper face of the supporting frame 222 by an operating mechanism which comprises an hydraulic cylinder or motor 265 (Figs. 11 and 12) pivotally mounted at 266 between a pair of depending side frame plates 267 forming vertical side faces of the frame 222. The hydraulic piston or ram 268 is pivotally connected at 269 to a pair of link members 270 and 271. The one link member 270 is

mounted at its other end on a pivot member 272 supported in the bracket 273 depending from the top forming portion of the frame 222 between the side plates 267 adjacent the outer or free end of the frame 222. The other link member 271 is connected at its other end by pivot 274 to a depending bracket member 275 on the bottom face of the slide member 237. The top plate of the supporting frame 222 is slotted at 276 to accommodate the bracket 275 on its horizontal movement. The hydraulic cylinder 265 is connected with the hydraulic system of the machine and reciprocation of the piston 268 is controlled by a manually operated valve (not shown).

A tie bar or link 277 is provided to counteract the tilting stress on the supporting frame 222 when the clamping die 220 is moved into clamping engagement with the work piece 233. The tie bar 277 comprises a handle forming link portion or section 278 which is pivotally connected at 279 to an upstanding support bracket 280 carried on the top of an inverted U-shaped yoke or strap member 281 which has the lower ends of its leg members secured to the frame side plates 267 and straddles the support member 250 and slide member 237, permitting movement of these members beneath the same. The handle section 278 is pivoted at 282 to one end of a pair of connecting plates 283 extending at one end of a main link or bar section 284 which carries at its other end in adjustable screw threaded relation thereon a T-shaped rod 285 which is adapted to have its cross head hooked in a groove 286 on the bifurcated top portion of an upstanding post 287 carried on the bending die 219. An adjustable stop pin 288 is provided in the supporting bracket to limit the movement of the operating handle portion 278 in the clockwise direction when the hook end of the bar 285 is engaged with the post 287 and the handle is rotated on the pivot to lock the tie bar in position.

The work piece or stock 233 is adapted to be clamped between the bending form 219 and the clamping die 220 after the work piece 233 is positioned against the bending form 219 by first adjusting the position of the support member 250 relative to the slide member 237 through rotation of the screw 261 while the piston 268 is retracted and after initial adjustment and leveling of the clamping die 220 and its holder on the support member 250. The clamping die 220 is moved into clamping position with the work piece 233 by operation of the hydraulic cylinder 265 to extend the piston 268 and move the slide member 237 inwardly on the top of the supporting frame 222. This forces the clamping die 220 into clamping engagement with the work piece 233 and against the bending form 219. When the clamping die 220 has been moved into clamping position it is braced against tilting movement away from the bending form 219 by means of the tie rod 277 which extends across the top of the clamping die 220 and connects the top of the supporting frame 222 with the bending form 219.

The pressure die 221 is arranged adjacent the bending form 219 (Figs. 9, and 13 to 17) where it will engage the trailing end or portion of the work piece 233 and restrain the same against lateral movement while the bend is made by moving the leading portion of the work piece 233 while it is clamped against the bending form 219 about the pivot shaft 217. The pressure die 221 and its supporting mechanism are mounted on the top of the short leg 213 of the main frame 210. The pressure die 221 is recessed on its working face to engage the exterior wall of the work piece 233 and its supporting and operating mechanism extends laterally thereof on the top of the frame portion 213.

The pressure die member 221 carries on the face opposite the work engaging face longitudinally spaced vertically extending dovetail tongues 290 which are received in cooperating dovetail grooves in a T-shaped holder 291 which is in turn mounted in longitudinal sliding relation on a wedge shaped pressure applying member 293. The die member 221 is held in vertically adjusted position on the holder 291 by clamping and adjusting members which include screws 294 and clamping and adjusting bracket plates 295. The screws 294 engage in screw threaded bores provided in the top of the holder 291 and secure the bracket plates 295 on the top of the T-shaped holder 291 at the top ends of the dovetail tongues 290. The plates 295 carry in the portions thereof which overhang the die member 221 studs 296 which engage with the top face of the die member 221.

The T-shaped holder member 291 which has its head forming portion extending vertically and its stem forming portion extending horizontally is provided with top and bottom grooves 297 and 298 extending longitudinally in the side walls of the stem portion adjacent the head portion which are adapted to form guideways for top and bottom rollers 300 which are rotatably mounted in longitudinally spaced relation on pins 301 extending horizontally on the top and bottom edges of the vertical face of the wedge shaped pressure member 293. The pressure member 293 is rabbeted or recessed on the side thereof which carries the pressure die 221 to provide a bottom flange or leg 302 on the edge of which the bottom rollers 300 are carried. A top flange or leg forming plate 303 is secured by bolts 304 at its outer edge to a ledge or shoulder 305 formed on the member 293 in spaced relation to the bottom flange 302 and cooperates with the latter to form a longitudinally extending guideway which opens toward the die holder 291. A plurality of longitudinally spaced anti-friction rollers 306 are mounted on vertically extending shafts or pins 307 and adapted to engage with the outer or end edge or face of the stem portion of the die holder 291 so that the latter is mounted or supported in longitudinal sliding relation on the rollers 300 and 306. The wedge shaped member 293 is mounted in sliding relation on an adjustably mounted abutment forming supporting block member 308 by a longitudinally extending dovetail joint, with the wedge member having a dovetail groove 309 on its outer face in which a dovetail tongue 310 on the inwardly facing edge of the supporting block member 308 is received. The supporting block member 308 is slidably mounted on the support forming top frame member 311 of the fixed laterally extending arm or leg 213 of the main supporting frame 210. The top frame member 311 has an upwardly opening recess 312 in the uppermost surface thereof which extends at right angles laterally or transversely of the main frame member 211 and which provides the member 311 with an upwardly facing channel shaped section (Fig. 14). Top plates 313 are secured along the side edges of the recess 312 and extend inwardly to form a guideway for receiving the inverted T-shaped bottom portion 314 of the supporting block member 308, the latter having oppositely disposed aligned recesses 315 in the side edges thereof which receive the inner edges of the plates 313, the latter holding the supporting block member 308 in sliding relation in the guideway. A horizontal adjusting screw 316 is journaled at 317 in an upstanding end flange 318 on the top frame member 311 and engages in threaded relation in a sleeve 319 secured in a horizontal bore 320 in the supporting block member 308. The adjusting screw 316 is provided with an operating wheel or handle 321 for manually rotating the screw 316 to adjust the position of the support member relative to the work piece 233. The supporting block member 308 is extended at the side toward the rear of the machine and provided with a supporting frame 322 having pivoted thereon at 323 an hydraulic cylinder or motor 324. The motor piston rod 325 is pivotally connected at 326 with the wedge shaped member 293 and controls the movement of the latter in the direction longitudinally of the machine. The motor 324 is suitably connected with the hydraulic

system of the machine and actuated by a suitable manually operated valve (not shown) which may be conveniently mounted on a horizontally extending control panel 327 which is secured to the frame portion 213 of the machine and which carries other manually operated valves and switches provided for controlling the operation of the various movable elements of the machine. The supporting block member 308 is, of course, adapted to be initially adjusted by means of the operating screw 316 to place the pressure die 221 in the proper relation to the work for pressure engagement therewith upon operation of the motor 324, the movement of the wedge shaped member 293 carrying the die 221 forwardly towards the work piece 233 and longitudinally of the machine in the direction of the bending end thereof, or in a direction inclined relative to the axis of the work piece, until the die 221 engages with the work piece 233. A stop member 328 (Figs. 9 and 15) may be provided on the top frame member 311 to limit the forward movement of the wedge shaped member 293, and a stop plate 329 (Figs. 15 and 17) may be provided on the forward end of the die holder 291 for limiting the rearward movement of the latter on the wedge shaped member 293.

A backing shoe 330 (Figs. 9, 15 and 17) is positioned adjacent the bending form 219. The backing shoe 330 is secured to a bracket or mounting plate 331 which is in turn adjustably mounted by bolt and slot connections 332 on a supporting arm 333 extending longitudinally of the machine and forming one arm of an angular supporting bracket. The arm 333 is secured by a vertical clamp pivot screw 334 to a bracket arm 335 which extends transversely of the machine and is adjustably supported in an upstanding inwardly facing channel shaped supporting bracket member 336. The shoe supporting arm 333 is vertically adjusted in the upright bracket member 336 by the pivot clamp screw 334 and horizontally adjusted by the adjusting and supporting screw 337. The bracket member 336 is secured on a base plate 338 (Figures 15 and 17) which is in turn secured to a support plate 339 fixed on the top of the main frame member 214, the base plate 338 being connected for sliding adjustment transversely of the machine on the support plate 339 by bolt and slot connections 340. The shoe 330 is, of course, adapted to be adjusted lengthwise of the machine and in a vertical direction to bring the work receiving recess, which is provided on the operating face thereof, into proper alignment with the work receiving slot or recess 232 on the bending form 219.

Mechanism is provided on the machine for facilitating the bending of successive work pieces 233 and for placing of repeat bends in successive work pieces of the same degree and in the same location. This requires that the operator be able to properly position each work piece for repeat bending operations. A part of this mechanism is associated with the work supporting mandrel 341 (Figs. 9, 15 and 17) which has one end mounted at the rearward end of the machine on the longitudinally extending piston rod 342 of an hydraulic cylinder 343. The cylinder 343 is mounted on brackets 344 which are supported for lateral adjustment on an inverted channel shaped support bracket 345 by means of bolt and slot connections indicated at 346. The mandrel 341 extends above the top frame member 214 and has associated therewith an indicator or indexing mechanism 347 to indicate the degree of axial rotation of the work piece, the latter being turned about its axis to position it for making bends in different axially extending planes. This mechanism also has associated with it manually operated stop means for locating the bends lengthwise of the work piece 233. The plane of rotation indexing mechanism 347 comprises a carriage 348 (Figs. 9, 15 and 16) which extends transversely above the frame member 214 and which is slidably mounted on a pair of transversely spaced guiding and supporting rails or rods 349 extending lengthwise of the machine above the frame member 214. The guide rails 349 are supported at opposite ends of the machine in fixed brackets 350. The carriage 348 is provided at its opposite ends with bearing formations 351 having parallel bores for receiving the guide rails 349 so that the carriage 348 is freely slidable beneath the mandrel 341 lengthwise of the machine. A supporting bracket structure 352 extends upwardly of the carriage 348 and a chuck holding disc 353 is rotatably mounted thereon. The disc 353 has a hub portion 354 journaled in a block-like bracket member 355 which is provided with an axial bore extending in concentric relation with the axis of the mandrel 341 and of somewhat larger diameter than the mandrel with a work piece thereon. The disc 353 carries a manually operated universal chuck 356 which is adapted to be operated to grip a workpiece 233 when it is arranged on the mandrel 341 so that when pull is exerted on the workpiece in the axial direction the carriage 348 and the mechanism carried thereon will move lengthwise of the mandrel, while rotation of the work piece will rotate the disc 353, the latter having a peripheral scale indicating the degree of rotation relative to a fixed pointer 357 which is secured on the mounting block 355. The mounting block 355 is pivoted on the pivots 358 between the upstanding legs of a U-shaped bracket member 359 which has a depending pivot pin 360 seated in a cooperating socket formation in a bracket member 361 which rides on the cross bar of the carriage 348 and is adjustably secured thereon so that the position of the chuck carrying disc 353 may be adjusted to effectively grip the work piece and the entire mechanism 347 moved along the mandrel by pull on the leading end of the work piece. A latch (not shown) may be provided between the disc 353 and the pointer 357 to hold the former in any position to which it is turned.

The location of the carriage 348 on the rails 349 is determined by a series of swingably mounted plates 362 which are adjustably secured on a longitudinally extending shaft 363, with the latter rotatably mounted in the bearing brackets 364 and 365 at the forward and rearward ends of the machine. The shaft 363 is parallel with the guide rails 349 and extends along the outermost one of the latter. It is provided with an operating lever or handle 363' at the bending end of the machine which permits the same to be rotated to swing the stop plates 362 into and out of the path of the carriage 348, with the plates 362 being adapted to rest against the outermost rail 349 when they are in operative position. By properly setting the stops 362 along the shaft 363 and initially locating the carriage 348 at the rear end of the machine, the axial position of each successive bend may be located by manually pulling the carriage 348 toward the bending end of the machine until it engages the proper stop member 362. After each bend the shaft 363 may be rotated to swing the stop members 363 out of the path of the carriage 348 and permit the latter to be advanced. The shaft 363 is then rotated in the proper direction to position the next stop member 363 in carriage blocking position. With this arrangement repeat bends may be accurately located in each of a plurality of successive work pieces.

The machine is also provided with a mechanism for controlling the degree of bend for each successive bending operation on a work piece which mechanism is arranged so that a plurality of bends may be made in a work piece and the same bends accurately duplicated in successive work pieces. This mechanism comprises a station degree selector which is in the form of a cage-like cylindrical frame or turret unit 366 (Figs. 9, 14 and 15). The turret unit 366 comprises a pair of end plate 367 secured in spaced relation on an elongate shaft 368 and connected by a plurality of peripherally spaced parallel bars or rod members 369, each of which carries a stop dog member 370 adjustably secured thereon and having a portion extending in one position of the turret 366 into the path of a cooperating dog 371 carried on a rod or link forming member 372 which is part of the

operating chain 224 for the shaft 217. The rod 372 may be slidably mounted in a bearing bracket 374 on the frame member 215. The shaft 368 for the turret 366 is slidably and rotatably mounted in an end bearing 375 secured on the side wall of the fixed frame member 213 and in a second bearing 375' fixed on the frame member 212 adjacent the other end, the shaft 368 being slidable in the direction of its axis in the two spaced bearings 375 and 375'. At its rear end the shaft 368 carries a valve operating wheel 376 which is secured on the shaft in spaced relation to the bearing 375' with a compression spring 377 being provided between the bearing 375' and the valve operating wheel 376. The wheel 376 has a tapered peripheral surface 378 which engages with a valve operating arm 379 on a valve 380 supported on the frame member 212 beneath the wheel 376 and controlling the flow of fluid to the operating cylinder or motor 227 for the chain 224. When the motor 227 is operated to start the bending operation the stop member 371 moves forwardly until it engages with the stop dog 370 which moves the turret 366 forwardly in the direction of the axis of the supporting shaft 368 and operates the valve 380 through movement of wheel 376 to shut off the motor 227. The shaft 368 carries a sprocket 381 which is connected by a chain 382 with a sprocket 383 on an operating shaft 384. The shaft 384 is journaled in the fixed frame 213 and carries a suitable knob or handle at the other end to provide for manual rotation of the turret 366 to position the proper stop dog 370 for engagement by the stop member 371 on the chain 224, thus controlling the degree of bend as desired and permitting the same bends to be made repeatedly and accurately on successive work pieces.

This form of the machine is provided with a suitable mechanism for supplying fluid to the hydraulic system which includes the various hydraulic cylinders or motors and with manually operated valves for initiating and controlling the successive operations.

The operation of the form of the machine shown in Figs. 9 to 17 is the same as in the form previously described. The work piece 233 is placed on the mandrel 341 and the carriage 348 for the plane of bend indicator mechanism 347 is moved to the initial position at the rear of the machine. The stop members 362 on the length determining bar are positioned as required and the stop members on the rods 369 of the degree of bend turret 366 are also adjusted to provide the degree of bend desired. The bending operations are then carried out in succession with the work being positioned and the various mechanisms operated as described in connection with the detailed description of the machine. A chart of the successive operations and the settings of the stop members etc. required to provide for the desired bends may be furnished to the operator so that successive pieces may be bent in an identical manner quickly and accurately. The mounting for the pressure die 221 which includes the wedge shaped member 293 operates to apply uniform pressure to the work piece which is held constant throughout the bending operation with the pressure die unit free to move with the work piece. Applying the pressure to the die 221 through the wedge member 293 insures uniform pressure between the die and the work during the bending operation regardless of movements of the work piece.

I claim:

1. A rotary bending machine having a main supporting frame, a bending form mounted on said main frame for rotation about a vertical axis, means on said main frame connected to said bending form for rotating the same, a clamping die, a supporting frame for said clamping die connected to said bending form for rotation therewith about said vertical axis and extending laterally of said axis, pressure applying mechanism connected to the top of said clamping die supporting frame and to said clamping die, said pressure applying mechanism and said clamping die being mounted for movement in a horizontal plane to bring said clamping die into clamping engagement with a work piece positioned against said bending form, a pressure die having a work face for engaging the trailing portion of said work piece which extends adjacent the clamping die, a support for said pressure die on said main frame which extends laterally of the bending form adjacent said vertical axis, and for pressure applying mechanism connected to said support and said pressure die which pressure applying mechanism comprises a block member mounted on said support for horizontal adjustment toward and from said work piece in a direction normal to the long axis of the work piece, a pressure applying member mounted on said support between said block member and said pressure die, means connecting said pressure applying member and said pressure die for relative horizontal movement in a direction parallel to the long axis of the work piece which connecting means includes bearing rollers and a cooperating bearing guide forming a free sliding and rolling connection between said pressure die and said pressure applying member, means connecting said block member and said pressure applying member which limits the movement of said pressure applying member to a direction inclined relative to the longitudinal axis of the work piece when force is applied in the horizontal plane of said pressure applying member, and means connected to said pressure applying member for applying thereto a constant force directed toward the leading portion of the work piece so as to urge said pressure die into engaging relation with the trailing portion of the work piece and to hold the same against the work piece with lateral pressure being exerted uniformly throughout the work engaging face of the pressure die during the bending operation.

2. A rotary bending machine as recited in claim 1, and said means connecting said block member and said pressure applying member comprising a dovetailed tongue on one of said members, and a cooperating dovetailed groove on the other of said members, with said tongue and groove extending in said horizontal plane and in said direction inclined to the longitudinal axis of the work piece and the leading end of the latter.

3. In a rotary bending machine wherein a section of tubular stock is positioned on a horizontally disposed mandrel and clamped to a bending form and the bending form is rotated in a horizontal plane about a fixed vertical axis for bending the stock, a main supporting frame, a horizontal mandrel mounted in longitudinally extending relation on said main frame, a bending form mounted on a fixed vertical axis on said main frame adjacent the leading end of said mandrel, and means for restraining the trailing portion of the stock which is positioned on the mandrel against movement laterally of the bending form, said movement restraining means comprising a pressure die having a work face for engaging the stock, a holder for said pressure die having longitudinally extending guideway formations on the top and bottom faces which are parallel with the work face of the pressure die, a movable block member, means connected to said block member and forming a guideway for a portion of said die holder, anti-friction guide members on said guideway forming means which are arranged in the guideway formations in said die holder to slidingly connect said die holder to said block member for linear movement in a horizontal plane, a support member for said block member mounted in a relatively fixed position on said main supporting frame, means for adjusting said block member on said support member in a direction laterally of said stock receiving mandrel, said block member and said guideway forming means having a sliding tongue and groove connection with said connection extending in a horizontal direction inclined toward the leading end of said stock receiving mandrel so that the lateral component of the inclined and forward movement of said

guideway forming means carries the pressure die toward said mandrel, and hydraulic means connected to said guideway forming means for imparting said forward movement to said guideway forming means and thereby engaging the stock with said pressure die so as to apply lateral pressure on the stock uniformly along the work face of said pressure die regardless of change in diameter of the stock and thereby restrain the lateral movement thereof with the sliding connection between the die holder and the block member permitting limited movement of the pressure die with the stock in the direction of the longitudinal axis of the stock and toward the portion of the stock which is being bent.

4. A rotary bending machine comprising a main supporting frame, a vertical shaft journaled at one end of the main frame, a bending form secured on said vertical shaft and rotatable in a horizontal plane, a clamping die supporting frame secured on said main frame for rotation of said bending form, a clamping die mounted on said clamping die supporting frame, means connecting said clamping die and its supporting frame for adjustably supporting the clamping die in opposed relation to said bending form and for moving the clamping die in a horizontal plane into clamping engagement with the work piece positioned between said bending form and said clamping die, a backing shoe supported on said main frame in fixed position adjacent said vertical shaft for engagement with the trailing end portion of said work piece, said main frame having a portion thereof extending laterally of said backing shoe, a pressure die, a pressure die support on said laterally extending main frame portion for supporting said pressure die with the work engaging face thereof in opposed relation to said backing shoe and said bending form, an abutment forming supporting member adjustably mounted on said laterally extending frame portion, a pressure applying member mounted on said laterally extending frame portion between said pressure die support and said supporting member and which is simultaneously movable in a horizontal plane in a direction inclined to the long axis of the work piece, means forming a free sliding and rolling connection between said pressure die support and said pressure applying member including guideway formations and anti-friction roller members seated in said guideway formations, a bracket extending horizontally of said abutment forming supporting member, an hydraulic cylinder pivotally mounted on said bracket with its piston rod extending in a horizontal plane and pivotally connected with the pressure applying member whereby said pressure die is moved by operation of said piston rod into engagement with the work piece and held against the same with uniform pressure being exerted along the portion of said pressure die which engages with the work piece and with the pressure die being free to move with the work piece a limited distance along the axis of the work piece to compensate for reduction in diameter and axial movement of the work piece during the bending thereof without changing the pressure applied to the work piece.

5. A rotary bending machine comprising a main supporting frame, a vertical shaft journaled adjacent one end of the main frame, a bending form secured on said vertical shaft and rotatable in a horizontal plane, a clamping die supporting frame secured on said main frame for rotation with said bending form, a clamping die mounted on said clamping die supporting frame, means connecting said clamping die and its supporting frame for adjustably supporting the clamping die in opposed relation to said bending form and for moving the clamping die in a horizontal plane into clamping engagement with the work piece positioned between said bending form and said clamping die, a backing shoe supported on said main frame in fixed position adjacent said vertical shaft for engaging the trailing end of said work piece, said main frame having a portion thereof extending laterally of said backing shoe, a pressure die supported on said laterally extending frame portion with the work engaging face thereof in opposed relation to the backing shoe and said bending form, means on the opposite face of said pressure die forming a pair of parallel oppositely opening vertically aligned guideways and a bearing surface extending in a vertical plane which is parallel with said guideways and with the longitudinal axis of the work piece, an abutment forming support member mounted in fixed relation on said laterally extending frame portion and laterally spaced from said pressure die, a pressure applying member mounted between said support member and said pressure die, means connecting opposed faces of said support member and said pressure applying member and guiding said pressure applying member for movement in a horizontal plane, means on the opposite face of said pressure applying member for connecting the same with said pressure die including guide members engaging in sliding relation in said vertically aligned guideways, and anti-friction rollers engaging with said vertical bearing surface, a bracket forming horizontal extension on said support member, and an hydraulic cylinder pivotally mounted on said bracket, said cylinder having its piston rod extending in a horizontal plane and pivotally connected with the pressure applying member whereby said pressure die is moved by operation of said piston rod into engagement with the work piece and held against the same with uniform pressure being exerted on the portion of said pressure die which engages with the work piece and being free to move with the work piece a limited distance in the direction parallel to the long axis of the work piece to compensate for reduction in diameter and axial movement of the work piece during the bending thereof without changing the pressure applied to the work piece.

6. In a machine for cold bending tubular stock which is characterized by a bending form mounted on a supporting frame for rotation in a horizontal plane about a fixed vertical axis, a clamping member, a support for said clamping member mounted for rotation with the work about said vertical axis, said clamping member being movably mounted on said support and having means for moving the same toward and from said bending form, a pressure die for restraining the trailing end portion of the stock against lateral movement relative to a vertical plane extending through said trailing end, said supporting frame having a horizontally extending portion adjacent said bending form, a supporting member for the pressure die mounted on said frame portion for adjustment toward and from said bending form, means forming a slidable horizontal connection between said pressure die and said supporting member whereby the pressure die is free to move a limited distance with the stock in the axial direction of the stock during the bending thereof, said connecting means including a wedge shaped pressure applying member having sliding connection with said supporting member, said sliding connection extending in a horizontal direction inclined toward the leading end portion of the stock, and hydraulic operating means mounted on said supporting member and having a horizontal piston rod operably connected with said wedge shaped pressure applying member to move said wedge shaped pressure applying member along a path parallel to said inclined direction toward the stock and to hold the pressure die against the stock with uniform pressure being exerted along the portion of said pressure die which engages with the stock while the bending form moves about its axis and places the bend in the stock.

7. In a rotary tube bending machine, a main supporting frame, a horizontal mandrel mounted in longitudinally extending relation on said main frame, a bending form rotatably mounted on a fixed vertical axis on said main frame adjacent the leading end of said mandrel, means

for clamping the leading end portion of the stock which is positioned on the mandrel against the bending form, and means for restraining the trailing portion of the stock against movement laterally of the bending form, said movement restraining means comprising a pressure die, a holder for said pressure die having longitudinally extending recesses on the top and bottom faces and a longitudinally extending vertical bearing surface, a wedge shaped member having a guideway forming portion with longitudinally spaced roller guide members arranged to extend into the recesses in said die holder and slidingly connect said die holder thereto for longitudinal movement in a horizontal plane, anti-friction rollers in said guideway forming portion of said wedge shaped member and engaging with said vertical bearing surface, a supporting member for said wedge shaped member which supporting member is mounted in a relatively fixed position on said main frame, means for adjusting said supporting member in a direction laterally of said stock receiving mandrel, said wedge shaped member and said supporting member having a sliding tongue and groove connection with said connection extending horizontally in a direction inclined toward the leading end of said stock receiving mandrel so that forward horizontal movement of said wedge shaped member carries the pressure die toward said mandrel, an hydraulic cylinder pivotally connected to said supporting member, said hydraulic cylinder having its piston rod extending in a horizontal plane and pivotally connected to said wedge shaped member for moving said wedge shaped member forwardly whereby said pressure die is engaged with the stock by operation of said piston rod and held against said stock with uniform lateral pressure being exerted along the portion of the pressure die which engages with the stock thereby to restrain the lateral movement thereof while permitting limited movement of the pressure die with the stock in the direction parallel to the longitudinal axis of the stock while the bending form moves about its axis and places the bend in the stock.

8. A rotary bending machine as recited in claim 1, and said means connecting said pressure applying member and said pressure die including a pressure die holder member having a horizontal guideway and rollers mounted therein, said pressure die having a guide forming portion engaging in said guideway and bearing against said rollers and said means for applying a constant force to said pressure applying member including an hydraulic cylinder pivotally mounted on said block member, and said cylinder having its piston rod extending in a horizontal plane including the longitudinal axis of said work piece, and pivotally connected with the pressure applying member.

9. A rotary bending machine as recited in claim 1 and said means connecting said block member and said pressure applying member comprising pairs of horizontally extending, longitudinally spaced, parallel links having their corresponding ends connected to the block member and the pressure applying member, respectively, and extending generally transversely of the long axis of the work piece and inclined toward the trailing end portion of the work piece when the pressure die is moved out of engaging relation with the work piece.

10. A rotary bending machine as recited in claim 1, and said means connecting said pressure applying member and said pressure die comprising a guideway forming die holder member connected by a vertically extending key to said pressure applying member and roller bearings in said guideway forming die holder member for engaging the surface of said pressure die which is opposite the stock engaging surface thereof, and said means connecting said block member and said pressure applying member comprising horizontally extending, longitudinally spaced, parallel links arranged to limit the movement of said pressure applying member to a direction inclined relative to the longitudinal axis of the work piece when force is applied in the horizontal plane of said pressure applying member.

11. A rotary bending machine as recited in claim 1 and said means connecting said pressure die and said pressure applying member comprising a guideway forming block having a vertically extending key and slot connection with said pressure applying member permitting separation by relative movement in a vertical direction, and a longitudinally extending recess opening in the direction of the work piece with oppositely disposed, vertically spaced, longitudinal guide rails and anti-friction rollers therein, and said pressure die having means forming longitudinally extending recesses on its top and bottom faces for receiving said guide rails, and said means for connecting said block member and said pressure applying member comprising pairs of longitudinally spaced, horizontal links which are arranged to limit the movement of the pressure applying member to a direction inclined relative to the longitudinal axis of the work piece when force is applied in a horizontal plane of said pressure applying member and in a direction toward the leading portion of the work piece.

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