

Oct. 22, 1968

J. L. COODY

3,406,551

PIPE BENDING MACHINE

Filed April 18, 1966

5 Sheets-Sheet 1

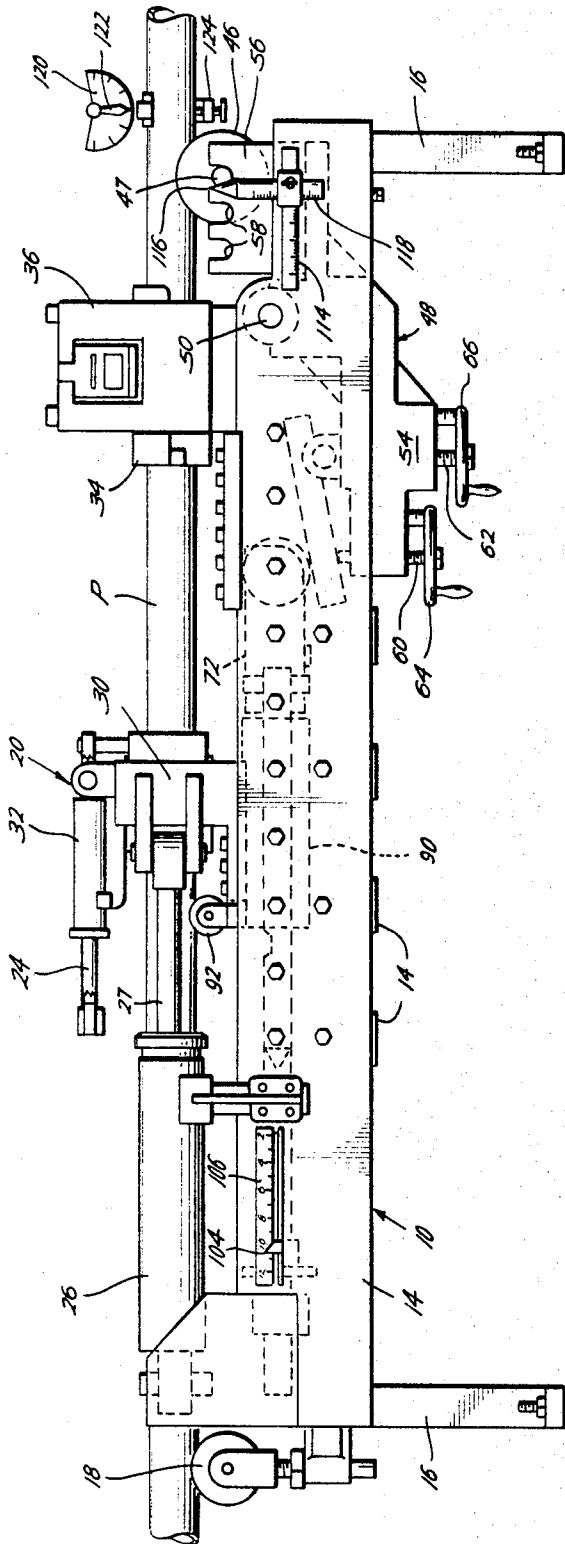


Fig. 1

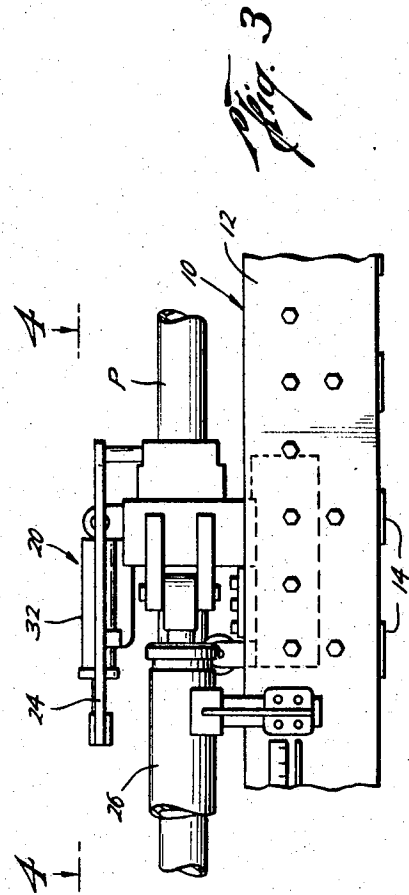


Fig. 3

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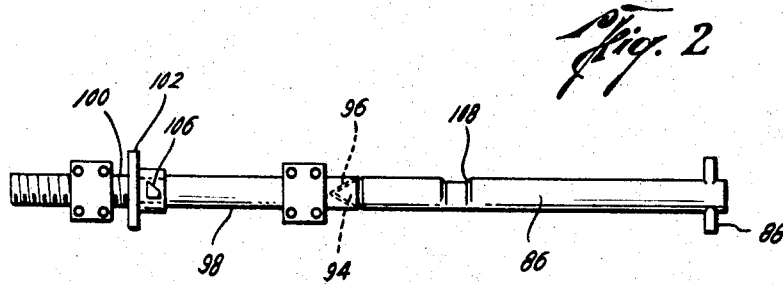


Fig. 10

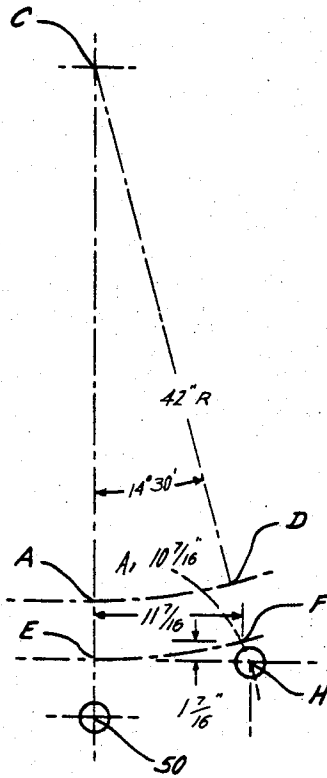
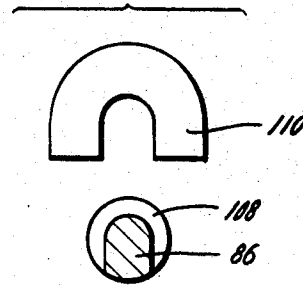


Fig. 11



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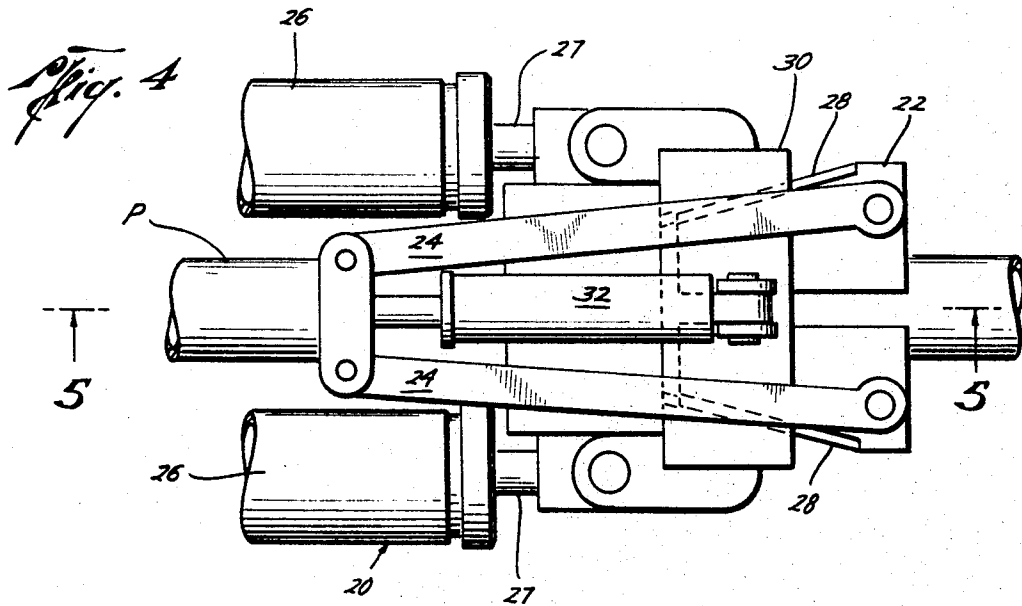
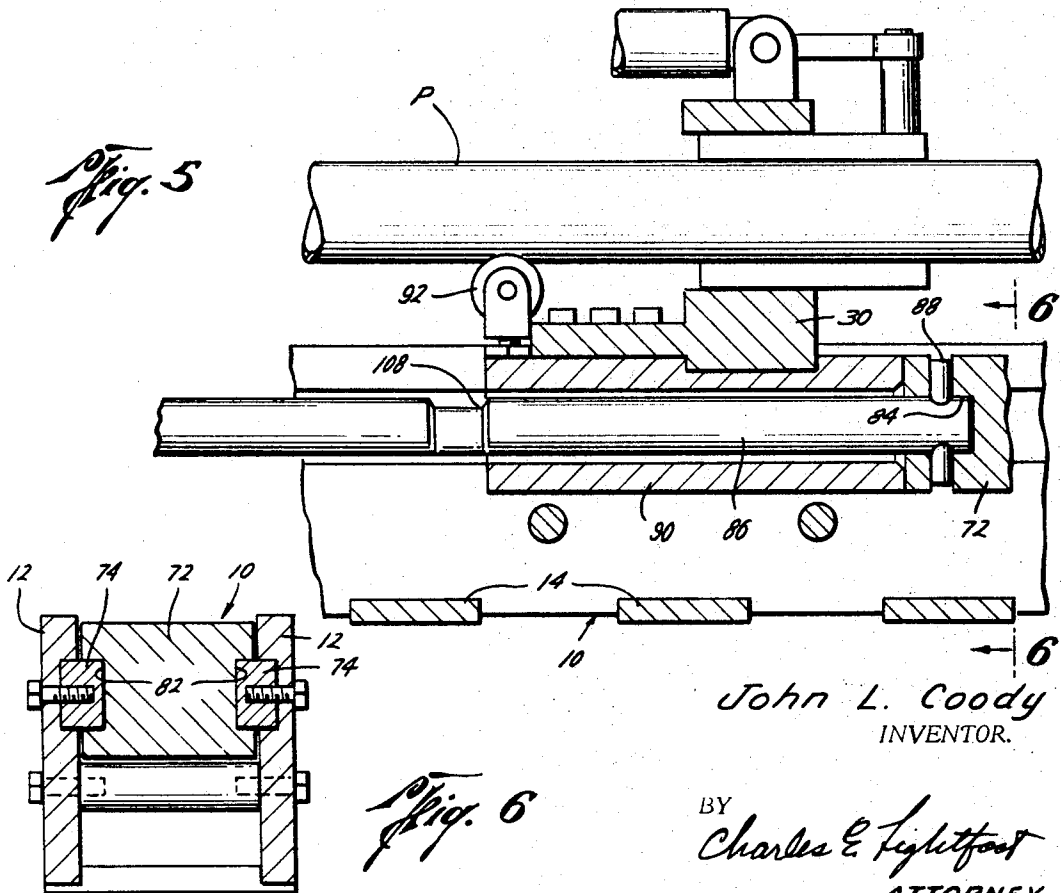
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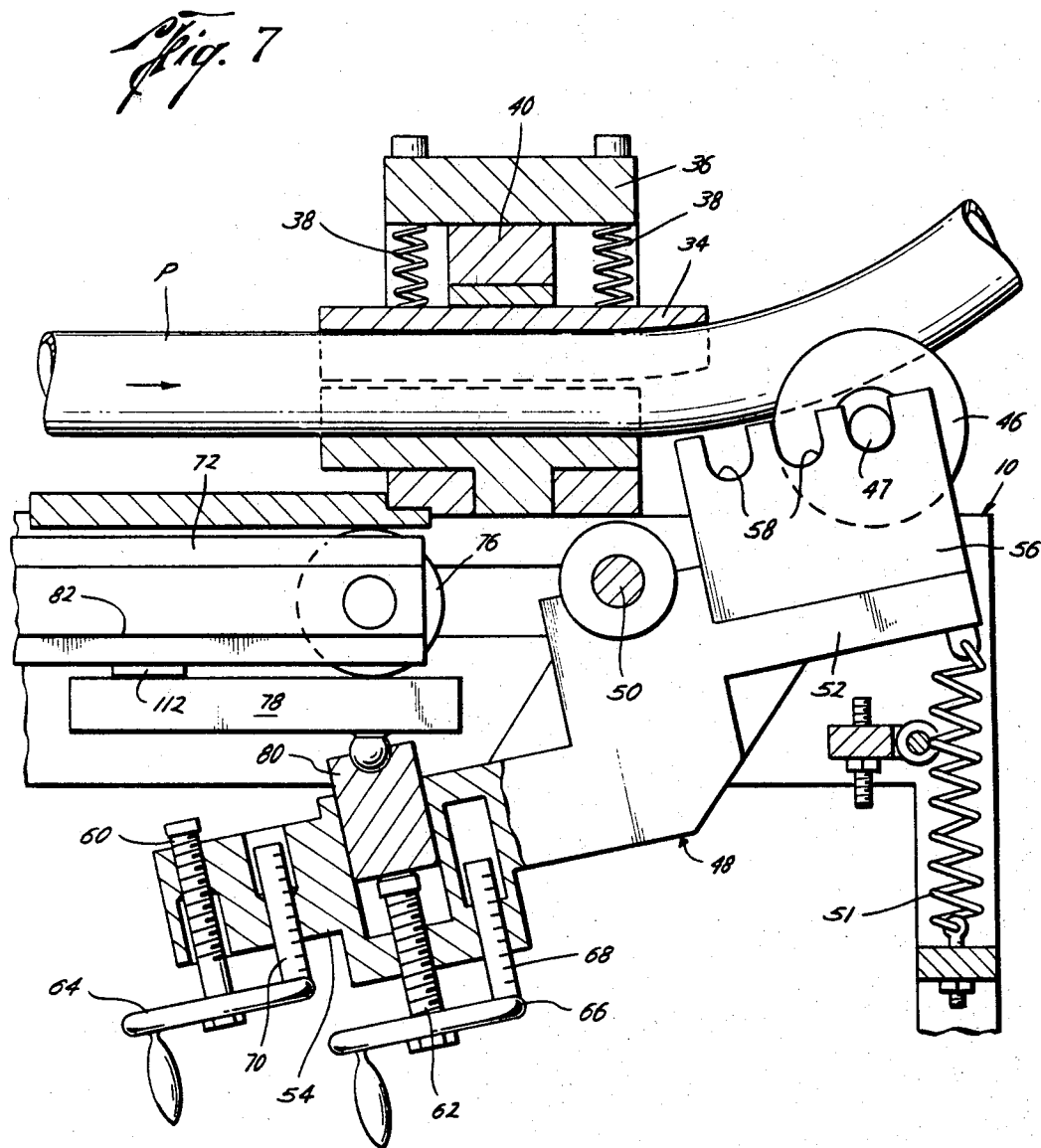
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Fig. 8

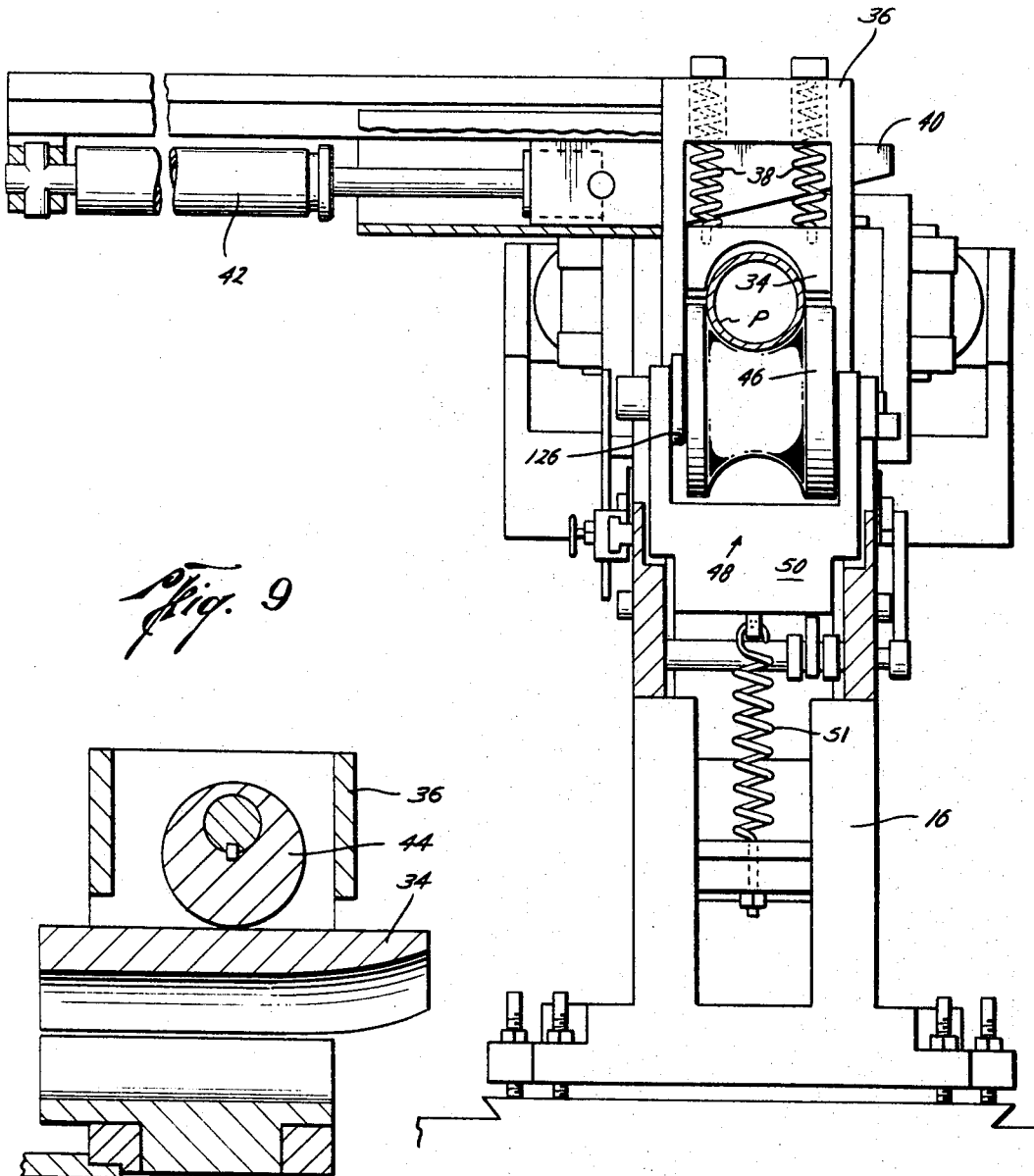


Fig. 9

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PIPE BENDING MACHINE

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5 Claims. (Cl. 72-166)

ABSTRACT OF THE DISCLOSURE

A pipe bending machine of the type having a supporting bed, along which a pipe is movable along its longitudinal axis and having a bending die positioned for engagement with the pipe and about which the pipe may be bent, and including a bending roller movably mounted for movement toward and away from said longitudinal axis, to position the roller for coaction with the pipe and die to bend the pipe as the pipe moves longitudinally in one direction along said axis. The invention further includes means for moving the pipe longitudinally in said one direction, and means positioned for coaction with the pipe moving means and the roller to move the roller in a direction transversely of said axis in engagement with the pipe, during an initial longitudinal movement of the pipe, to position the roller for such coaction with the die to bend the pipe, and thereafter to hold the roller in its adjusted position during subsequent longitudinal movement of the pipe.

This invention relates to a machine for bending pipe and tubular articles, and more particularly to a machine which may be adjusted to perform a bending operation on pipe whereby bends of predetermined shape and extent may be accurately reproduced.

The invention has for an important object the provision of pipe bending apparatus which is adjustable to produce bends having predetermined characteristics and whereby bends of such character may be accurately and easily reproduced.

A further object of the invention is to provide pipe bending apparatus by which the "cold spring" characteristics of pipe may be determined prior to the bending of the pipe and including means whereby such "cold spring" may be compensated for in forming the bend.

Another object of the invention is the provision of a pipe bending machine which is easily adjusted for use with pipes of widely varying diameters, which is of simple design and rugged construction, and wherein the parts are easily replaceable for purposes of maintenance and repair.

The above and other obvious advantages of the invention will be apparent from the following detailed description of a preferred embodiment of the same, when considered in conjunction with the annexed drawings, wherein—

FIGURE 1 is a side elevational view of the pipe bending machine of the invention, showing the same with a pipe inserted therein preliminary to the performance of a bending operation;

FIGURE 2 is a fragmentary, side elevational view of a portion of the bending machine, as illustrated in FIGURE 1, removed from the surrounding structure of the machine, and showing details of structure of the mechanism by which the longitudinal movement of the pipe in the machine is regulated and indicated;

FIGURE 3 is a fragmentary, side elevational view, on a somewhat enlarged scale, of a portion of the machine, as illustrated in FIGURE 1, showing the mechanism by which the pipe is gripped and advanced longitudinally in the machine, the mechanism being shown in its re-

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tracted condition preliminary to an advancing movement of the pipe;

FIGURE 4 is a top plan view, on an enlarged scale of the pipe gripping and advancing mechanism of FIGURE 3, as viewed along the line 4-4 of FIGURE 3, looking in the direction indicated by the arrows;

FIGURE 5 is a cross-sectional view, taken along the line 5-5 of FIGURE 4 looking in the direction indicated by the arrows;

FIGURE 6 is a cross-sectional view taken along the line 6-6 of FIGURE 5, looking in the direction indicated by the arrows;

FIGURE 7 is a fragmentary, side elevational view, partly broken away, and partly in cross-section and on a greatly enlarged scale showing details of structure of the bend forming and regulating mechanism of the machine, the mechanism being shown with a pipe in position therein and with the parts in the relative positions which they occupy at the end of an advancing movement of the pipe during a bending operation;

FIGURE 8 is a fragmentary, end elevational view of the mechanism of FIGURE 7, looking at the right hand end of the same;

FIGURE 9 is a fragmentary, longitudinal, central, cross-sectional view on a greatly enlarged scale, illustrating a somewhat modified structure of the removable bending die supporting means of the machine;

FIGURE 10 is a diagram illustrating the method by which the adjustment of the bending mechanism is determined preliminary to the setting of the same to carrying out of a bending operation to form a bend of predetermined character; and

FIGURE 11 is a transverse cross-sectional view, on a greatly enlarged scale, showing details of structure, of a portion of the mechanism by which the advancing movement of the pipe is regulated and adjusted.

Referring now to the drawings in greater detail the bending machine of the invention includes a bed or frame generally designated 10 of usual construction, which may be formed with parallel, spaced apart side members or rails 12, as best shown in FIGURE 6, suitably secured together at longitudinally spaced intervals, as by means of cross ties 14, and provided with legs 16, by which the bed is supported at a desired elevation above the floor.

Longitudinally spaced pipe supporting rollers 18 and 19 are rotatably mounted on the bed in position to support a pipe P thereon for longitudinal movement along the bed, and pipe gripping and moving mechanism, generally designated 20 in FIGURES 1, 3 and 4 is also mounted on the bed by which the pipe is progressively moved along a longitudinal axis during the bending operation.

The pipe moving mechanism 20 includes pipe gripping jaws 22, best shown in FIGURE 4, carried on pivotally mounted arms 24 for movement into and out of gripping engagement with the pipe P and spaced apart parallel power cylinders 26 are provided by which the jaws are moved longitudinally of the bed in gripping engagement with the pipe to move the pipe along the bed. The jaws 22 are formed with external tapering faces 28 with which an actuating block 30 having correspondingly tapering faces is slidably engageable to move the jaws laterally into gripping engagement with the pipe. The jaws are operatively connected to a jaw actuator cylinder 32 to move the jaws longitudinally in one direction, relative to the block 30 to grippingly engage the jaws with the pipe and in the other direction to release the pipe.

In the operation of the equipment, the pipe P is supported on the rollers 18 and 19 for longitudinal movement between the jaws 22 and the jaws are moved into

gripping engagement with the pipe by actuation of the cylinder 32, whereupon the pipe may be moved longitudinally to the right as viewed in FIGURES 1, 3 and 4 by actuation of the power cylinders 26. When the pipe has been thus moved longitudinally along the bed by extending the piston rods 27 of cylinders 26, the power cylinders may be actuated to retract the piston rods, thus releasing the jaws 22 and allowing the same to be moved back to position the jaws for regripping with the pipe to again move the pipe longitudinally.

A bending die 34 is suitably supported on the bed in position for engagement with the pipe and about which the pipe is bent during the longitudinal movement of the pipe along the bed. The die 34 is preferably of a removable type and is supported in position for engagement with the pipe in a usual manner by conventional means.

The bending die 34 may be removably carried in a supporting block 36, suitably attached to the bed, the die being connected to the block by means of coil springs 38, and being held in a desired position of adjustment in the block by a slidable wedge 40, actuated by a pressure cylinder 42, whereby the die is rigidly held in contact with the pipe by advancing the wedge in the block and released therefrom by retracting the wedge.

A somewhat different form of the die adjusting mechanism is illustrated in FIGURE 9, wherein the die 34 is held in engagement with the pipe by means of a cam or eccentric 44, rotatably mounted on the block 36' and which may be rotated to one position to securely hold the die against the pipe and to another position to release the die from the pipe.

The pipe bending mechanism also includes a bending roller 46 mounted for lateral adjustment relative to the die 34 at a location spaced longitudinally therefrom, as best shown in FIGURE 7. The roller 46 is carried on an adjustable support member generally designated 48 which is pivotally mounted on the bed, as shown at 50, and formed with an arm 52 upon which the roller is rotatably mounted, and an arm 54 by which the member is rotated about the pivot 50 to position the roller at a desired location. The support member 48 is yieldingly urged in a clockwise direction of rotation on its pivot 50, as viewed in FIGURE 7, by suitable means, such as the coil spring 51. The arm 52 has a bearing block 56 thereon which is provided with longitudinally spaced notches 58 by which the longitudinal position of the roller 46 on the arm may be varied.

The arm 54 carries adjusting screws 60 and 62, operated by hand wheels 64 and 66, respectively, for the purpose of adjusting the position of rotation of the support member 48, in a manner to be hereinafter described, whereby the position of the roller 46 is adjusted to bend the pipe. Each of the screws 60 and 62 is provided with a suitable scale, such as those shown at 68 and 70, respectively, by which the setting of the screws may be accurately indicated.

For the purpose of actuating the support member 48 a longitudinally movable carriage block 72 is provided, which is mounted for movement along inside trackways 74 on the side members 12 of the bed, as seen in FIGURE 6, and which carries an actuating roller 76 at its forward or advanced end, in position for engagement with a rocker plate 78, rockably mounted on a support block 80 adjustably carried on the arm 54 of the member 48 and adjustable laterally thereof by the screw 66, as best shown in FIGURE 7.

The carriage block 72 has longitudinal grooves 82 in its opposite sides in which the trackways 74 are slidably fitted. At the end of the block opposite that upon which the roller 76 is carried, the block 72 has an end bore 84, within which one end of a rod or shaft 86 is fitted, the rod being secured to the block by a cross pin 88, for longitudinal movement therewith, as best seen in FIGURE 5. The rod 86 is slidably extended through an actuating sleeve 90 attached to the actuating block 30 for movement therewith longitudinally of the bed. The block 30

and sleeve 90 may also carry a roller 92 positioned for engagement with the pipe P to further support the pipe.

The rod or shaft 86 is formed at its other end with a tapered point 94 which fits into a similarly shaped socket 96 in the forward or advanced end of an adjustable stop member 98, movably carried on the bed for longitudinal adjustment thereon, as by means of a screw 100 having an adjusting wheel 102 and provided with a pointer 104 by which the position of adjustment of the stop member may be indicated on a scale 106 on the bed, as best seen in FIGURE 1.

By this arrangement it will be apparent that upon movement of the pipe gripping mechanism to the right as viewed in FIGURE 5, the sleeve 90 will move therewith in engagement with the actuator block 72 to move the actuator block to the right, and upon retracting movement of the pipe gripping mechanism to the left, as viewed in FIGURE 5, the sleeve 90 will be moved out of engagement with the block 72 leaving the block in its advanced position.

The shaft 86 is also formed with an annular groove 108 into which a removable stop 110 of inverted U-shape may be positioned for engagement with the left end of the sleeve 90, as viewed in FIGURE 5, to cause the actuator block 72 to move to the left with the sleeve upon retracting movement of the pipe gripping mechanism when desired.

The rocker plate 78 is positioned for engagement with the roller 76 to rotate the plate toward a horizontal position, as seen in FIGURE 7. When the actuator block 78 moves to the right and when the actuator block reaches its most advanced position to the right it will be past the pivot point of the rocker plate so that the plate will remain horizontal as long as the block is in its advanced position.

Suitable means, such as the stop piece 112 is positioned on the bed for engagement with the plate 78 to limit tilting movement of the plate toward its horizontal position.

A longitudinal, suitably graduated scale 114 is positioned on the bed below the roller 46, along which a vertically adjustable pointer 116 is movable, which pointer may be adjustably clamped to the scale at any position of longitudinal adjustment thereon, the pointer being also adjustable vertically and being provided with a graduated scale 118 by which the vertical position of the pointer is indicated.

In the operation of the machine, the pipe to be bent is supported on the bed by the rollers 18 and 92, the die 34 being released and the pipe extended through the die support 36. The pipe gripping mechanism will be in its retracted and released position, the stop member 110 being in position in the groove 108 of shaft 86 and the sleeve 90 and actuator block 72 being in their retracted positions to the left as viewed in FIGURES 1 and 5.

The radius of the bend to be formed having been given, the positioning of the bending roller 46 may be determined diagrammatically by a diagram such as that shown in FIGURE 10, wherein the radius of the bend to be formed is represented by the distance from the point C to the point A. Using the point C as center, an arc is then drawn from point A to a point D which arc represents the number of degrees of the bend to be formed by one stroke of the pipe gripping mechanism. The radius from point C to point A is then continued radially outwardly for a distance equal to the external diameter of the pipe P to a point E, which represents diagrammatically the point at which the roller 46 engages pipe P at the beginning of a bending stroke of the machine. The radius from point C to point D is similarly extended to point F, which then represents the point at which the bending roller 46 will engage the pipe P at the end of the bending stroke. The distance from the point F to the radius through the point A will then be the longitudinal distance through which pipe P will move during one stroke, while the distance of the point F from a line at right angles to the radius

through point E will be the vertical distance through which the roller 46 will move during one stroke.

The arcuate distance from point A to point D is the length of the arc of the bend formed during one stroke of the machine.

The position of the center 47 of the roller 46 at the beginning of a bending stroke is represented by the point H which will be on a line passing through point E and parallel to the axis of the pipe P, and the position of the center 47 of the roller 46 at the end of the stroke is represented by point F, down from the center of the pivot pin 50 through point H.

At the beginning of the initial bending stroke of the machine the roller 46 will be in the position shown in FIGURE 1 and at the end of the stroke the roller will occupy the position of FIGURE 7 which is somewhat above and to the left of the position of FIGURE 1. By suitably positioning the pointer 116 on the scale 114 and adjusting the vertical position of the pointer by the scale 118, the pointer may be set to indicate the position to which the center of the roller will move when the pipe reaches the end of a bending stroke. In setting the point of the pointer 116 at the proper location the pointer is moved to a position on scale 114 representing the distance between points E and F on the diagram of FIGURE 10, after which the pointer is moved vertically until the distance between points H and F on the diagram is represented on scale 118.

Having determined by the above described means the position to which the bending roller 46 will be moved upon completion of the first pipe advancing stroke of the machine, the pipe gripping mechanism is actuated to move the block 30 and sleeve 90 to the right, as viewed in FIGURE 1, to advance the carriage block 72 and the roller 76 therewith to the position of FIGURE 7 in engagement with plate 78, whereupon hand wheel 66 is rotated to cause the arm 52 of support member 48 to swing upwardly to move the roller 46 to the desired position as indicated on the scale 68. During such adjustment of the roller 46 the pipe P will be lifted by the roller, the die 34 being free to move upwardly with the pipe.

With the roller 46 thus adjusted to its uppermost position, the pipe gripping mechanism is retracted to move the roller 76 therewith to the left, as viewed in FIGURE 7, thus allowing the plate 78 to tilt counter clockwise and the roller support 48 to rotate clockwise under the influence of the spring 51 to retract the roller 46. As the roller 46 is retracted the pipe P moves downwardly to its horizontal position on the bed and the die 34 is then tightened into engagement with the pipe by operation of the wedge 40. With the pipe thus positioned the hand wheel 64 is rotated to engage the screw 60 with plate 78.

The adjustments having been made, as described above, the pipe gripping mechanism is then actuated to advance the pipe P to the right through the initial stroke of the machine, the plate 78 and the roller 76 in engagement therewith coacting to move the bending roller 46 upwardly during longitudinal movement of the pipe to the right, as seen in FIGURE 7, to bend the pipe about the die 34.

At the end of the first bending stroke of the machine the stop member 110 is removed from the groove 108 of shaft 86, so that the carriage block 72 and roller 76 will remain in advanced position when the gripping mechanism is retracted, thus holding the bending roller 46 in its uppermost position during subsequent pipe advancing strokes of the machine. By then repeating pipe advancing strokes of the machine a bend of any desired extent, of a predetermined radius may then be produced in the pipe.

For the purpose of determining the angular extent to which the pipe is bent, a suitable gauge having a circular dial 120, graduated in degrees, and provided with a pivotally supported gravity actuated pointer 122 is suitably supported on the pipe P outwardly beyond the roller 46, as by means of a releasable clamp 124 in position to indicate the angular extent of the bend produced.

Under some circumstances, such as in the bending of pipe which is made of resilient or springy material, such as steel pipe, it may be desirable to accurately determine the tendency of such pipe to straighten when released after the production of a bend, such tendency being commonly referred to as "cold spring." To measure the "cold spring" of the pipe, a bend is formed in the pipe by the method described above, the extent of the bend being noted on the dial 120, whereupon the bending roller 46 is retracted somewhat to allow the bend to relax, the "cold spring" being then indicated by the resulting change in the position of the pointer 122 on the dial.

Having thus determined the amount of the "cold spring" for the particular pipe under treatment, it is only necessary to adjust the machine to produce a bend which exceeds the desired bend by the amount of the "cold spring" as shown on the dial 120 and the pipe will assume the desired bend when released.

To enable the machine to be readily employed for the production of coils or helices of pipe, suitable means, such as the washer 126, shown in FIGURE 8, may be positioned on the shaft which supports the roller 46 between the roller and the adjacent inside face of the bearing block 56 to position the roller in laterally offset relation to the axis of the pipe P, whereby the pipe will be formed into helical turns by a continuance of the bending operation.

Suitable means, such as control valve mechanism, not shown, may, of course, be provided in the hydraulic supply lines of the power cylinders 26 and the jaw actuating cylinder 32, whereby the operation of these cylinders may be coordinated to grip and advance the pipe P longitudinally during a bending stroke of the machine and to release the same upon retracting movement of the pipe gripping mechanism.

It will thus be seen that the invention constructed and operated as described above provides a pipe bending machine which may be employed for the bending of pipe of various sizes and materials and wherein means is provided for adjusting the machine to accurately reproduce bends throughout a wide range of shapes and sizes.

The invention is disclosed herein in connection with a particular construction and arrangement of the parts, which it will be understood is intended by way of illustration only, it being evident that various modifications can be made therein within the spirit of the invention and the scope of the appended claims.

Having thus clearly shown and described the invention, what is claimed as new and desired to secure by Letters Patent, is:

1. In a machine for bending pipe a supporting frame, means for supporting a pipe for movement along a longitudinal axis, a bending die positioned to be engaged by the pipe and about which the pipe may be bent, a bending roller movably supported on the frame for movement toward and away from said axis to move the roller into and out of a position for coaction with said die in engagement with the pipe to bend the pipe upon longitudinal movement of the pipe along said axis, pipe gripping means movably mounted on the frame for movement therealong in parallel relation to said axis and for movement into and out of gripping engagement with the pipe and means for moving said gripping means into gripping engagement with the pipe to impart longitudinal movement to the pipe in one direction along said axis with said gripping means, and out of such gripping engagement to allow longitudinal movement of said gripping means in the other direction independently of the pipe.

2. The pipe bending machine of claim 1 including means for moving said bending roller into said position for coaction with said die and means positioned for coaction with said roller moving means and said pipe gripping means to move the roller into said position upon movement of said pipe gripping means in said one direction.

3. The pipe bending machine of claim 1 including means for holding said bending roller in said position for coaction with said die during movement of said pipe gripping mechanism in said other direction.

4. The pipe bending machine of claim 1 including means for limiting the longitudinal movement of said pipe gripping means to cause said roller to be moved to a predetermined position relative to said die upon longitudinal movement of said gripping means in said one direction.

5. The pipe bending machine of claim 1 including means for moving said roller toward said axis in response to longitudinal movement of said gripping means in one direction in gripping engagement with said pipe.

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