

March 18, 1952

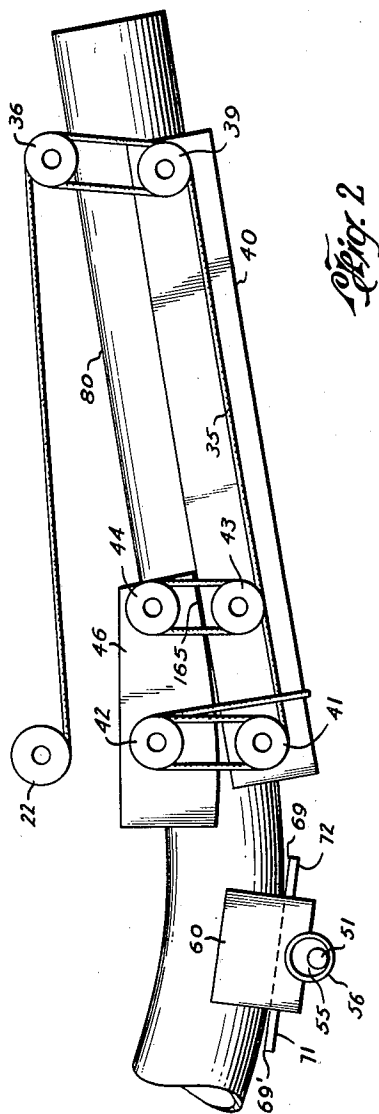
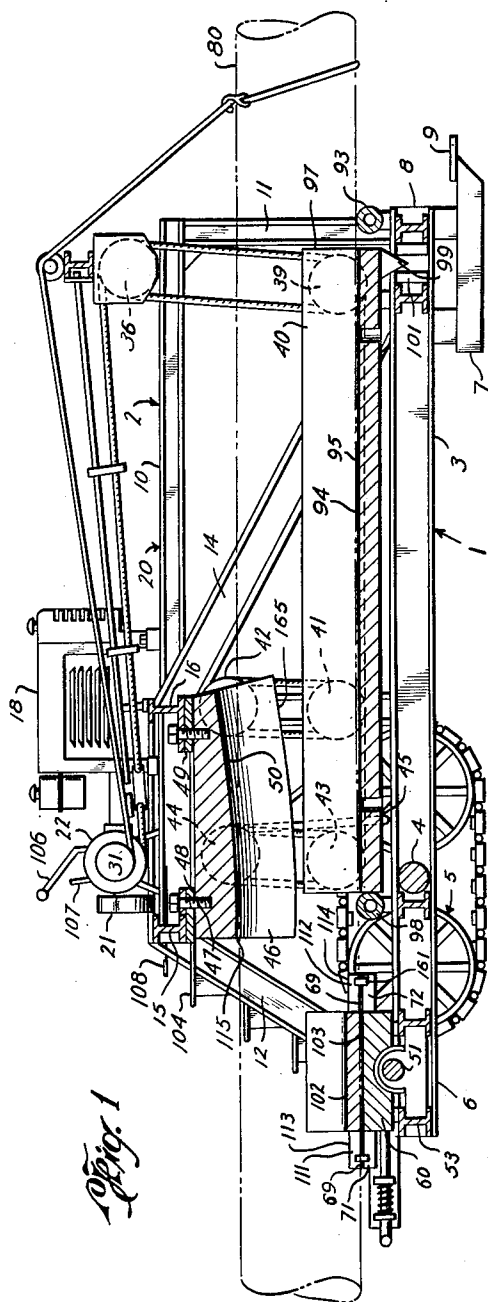
S. L. BALLARD

2,589,651

PIPE BENDING MACHINE, INCLUDING SKID LIFTING DEVICE

Filed Oct. 5, 1950

7 Sheets-Sheet 1



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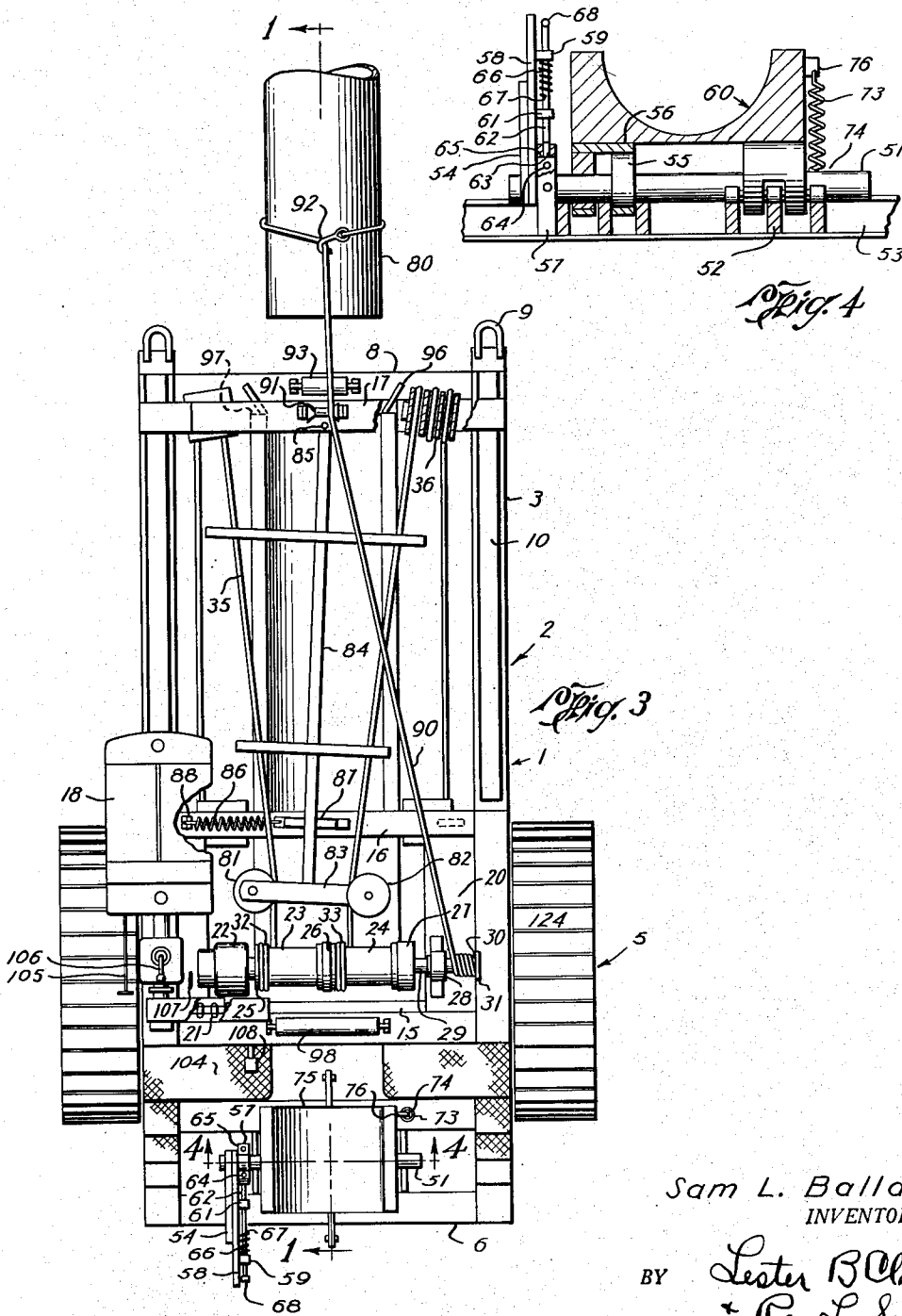
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7 Sheets-Sheet 2



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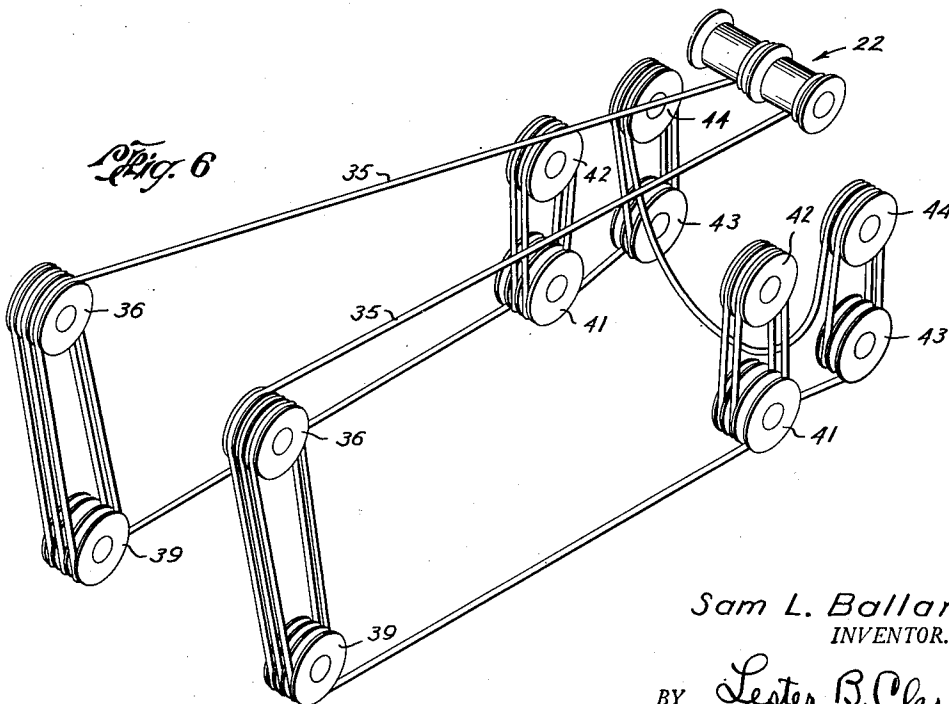
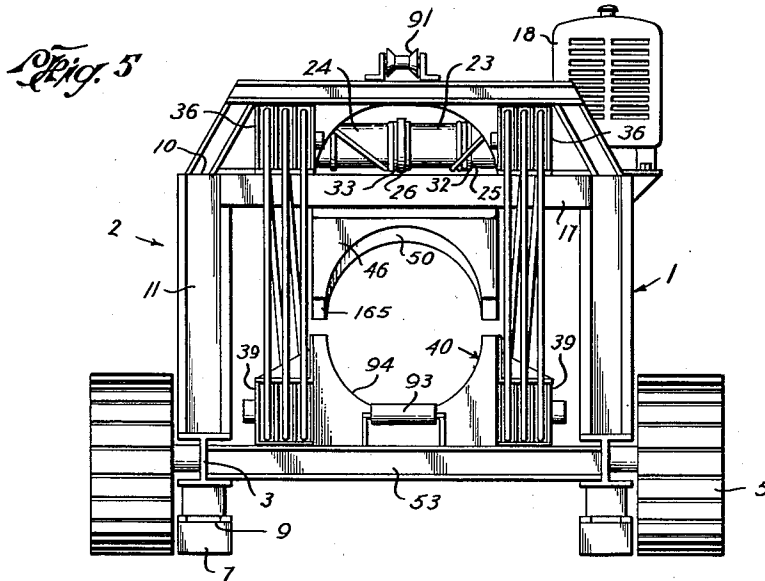
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7 Sheets-Sheet 3



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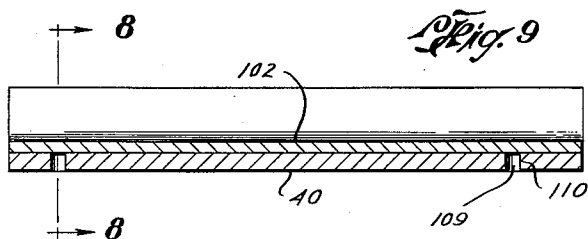
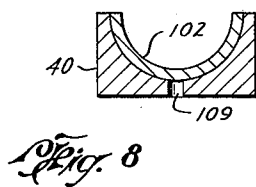
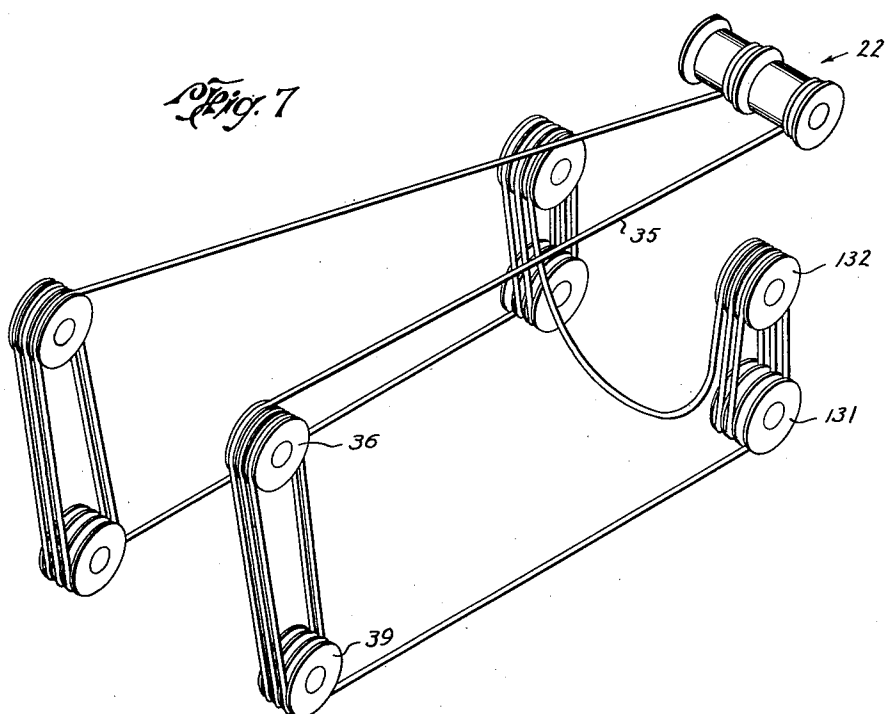
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7 Sheets-Sheet 4



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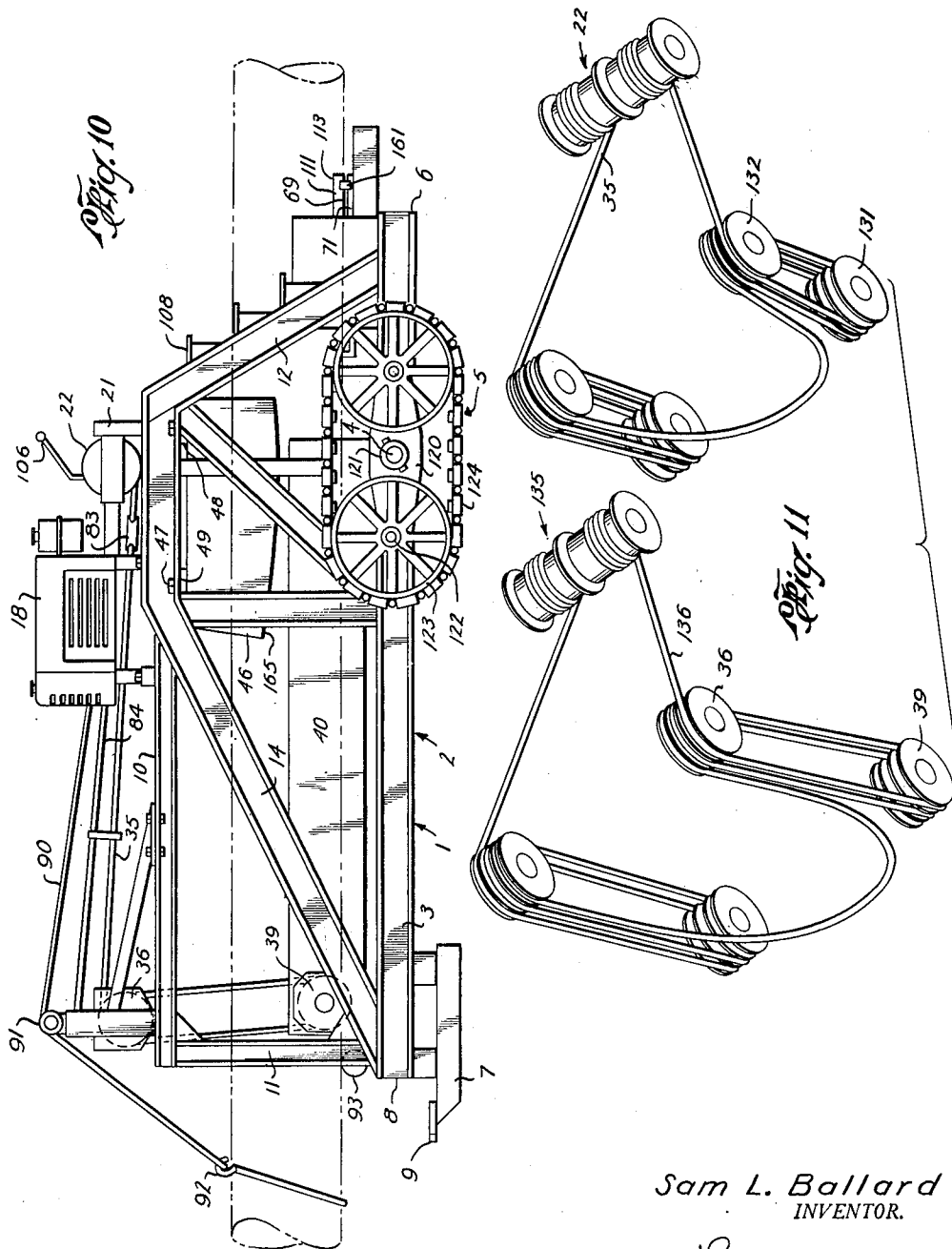
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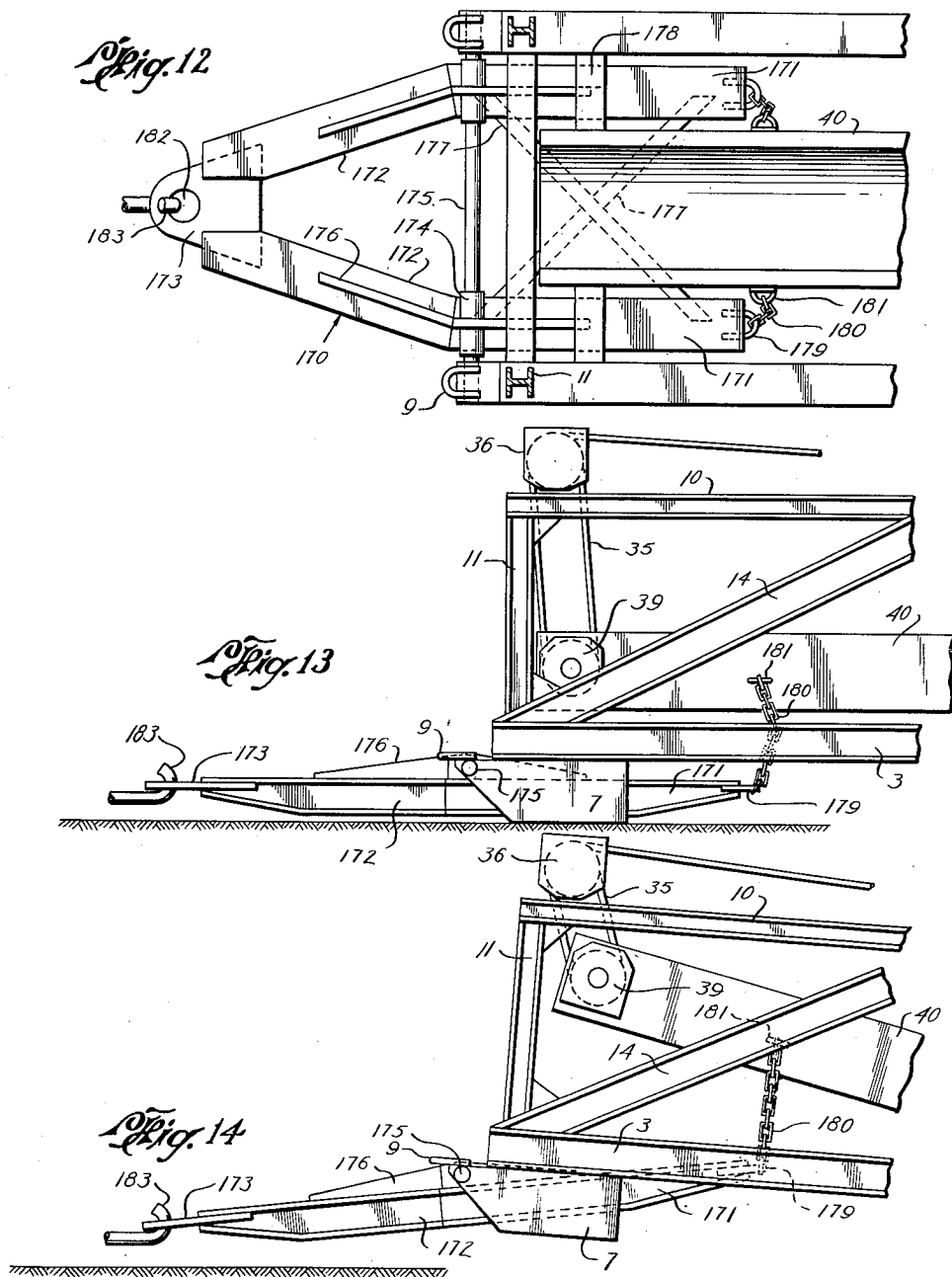
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7 Sheets-Sheet 6



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PIPE BENDING MACHINE, INCLUDING SKID LIFTING DEVICE

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7 Sheets-Sheet 7

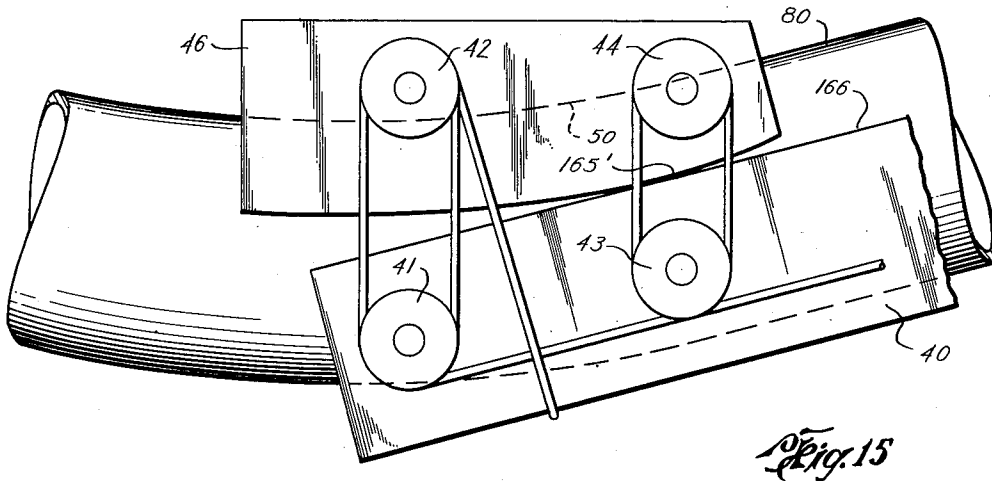


Fig. 15

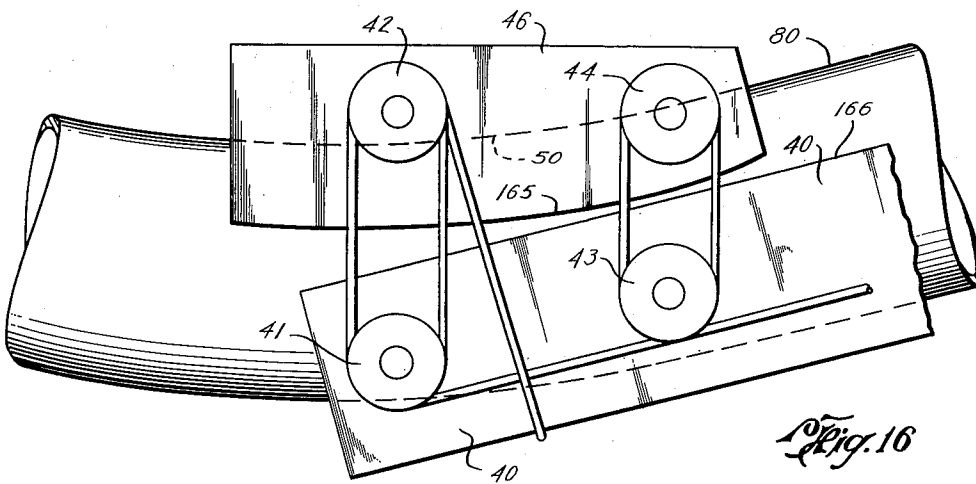


Fig. 16

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UNITED STATES PATENT OFFICE

2,589,651

PIPE BENDING MACHINE, INCLUDING SKID
LIFTING DEVICE

Sam L. Ballard, Houston, Tex.

Application October 5, 1950, Serial No. 183,603

3 Claims. (Cl. 153—32)

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This application is a continuation-in-part of my co-pending application Serial Number 152,252, filed March 27, 1950. It relates to a pipe bending machine adapted to bend pipe vertically upward; it also relates to a pipe bending machine adapted to bend pipe against a fixed die as a fulcrum by actuating a strongback to move the pipe into the fixed die and to apply a bending force to one end of the pipe while the pipe is held on the opposite side of the fixed die from said bending force by a holding shoe; and it also relates to the employment of cable and pulley means to move the strongback to bend the pipe. It also relates to pipe bending machine, as described hereinabove, which have self-contained therewith means for lifting the skid end of the machine when the machine is to be transported.

It is an object of this invention to provide a pipe bending machine having a fixed die as a bending fulcrum to receive an upper portion of the pipe, a holding shoe spaced from the fixed die to receive a lower pipe portion, and a strongback suspended below the fixed die and underextending the fixed die opposite the holding shoe and adapted to move the pipe upwardly into the fixed die, and to have a bending force applied to the underextending portion to bend the pipe.

It is a further object of this invention to provide a pipe bending machine having a fixed die as a bending fulcrum, a holding shoe spaced from the fixed die, and a strongback positioned parallel to the fixed die and extending beyond the fixed die opposite the holding shoe, and cable means adapted to move the strongback to carry pipe therein against the fixed die, and to move the extending strongback portion to bend the pipe around the fixed die as a fulcrum while the shoe holds the pipe.

It is another object of this invention to provide a machine of this class in which the strongback is moved by a driven drum actuated cable loops extending on either side of the frame over bending pulleys on the frame and extending strongback end, fulcrum pulleys on the strongback and frame adjacent the inner die end, and snubbing pulleys on the frame and strongback end adjacent the outer die end; the loop being completed below the strongback between the snubbing pulleys.

It is still another object of this invention to provide a machine of this class in which the strongback is moved by a driven drum actuated cable loop extending on either side of the frame over bending pulleys on the frame and extending strongback end, and fulcrum pulleys on the

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frame and strongback end adjacent the die; the loop being completed below the strongback between the fulcrum pulleys.

It is still a further object of this invention to provide a machine of this class having a holding shoe which may be adjusted and locked to hold successive sections of bent pipe moved thereinto, and which shoe has means thereon to protect the pipe from being marred by the shoe while unlocked during adjustment.

It is yet a further object of this invention to provide a pipe bending machine of this class which is equipped with liners for the strongback and holding shoe to convert these elements to accommodate pipe of lesser than the maximum diameter for which the machine is designed, and which has rollers on either end of the strongback vertically adjustable to permit various diameter pipe to be loaded over the strongback when in lowered position, the inner roller complementing stop means on the other end of the strongback to position the lowered strongback.

It is still a further object of this invention to provide a pipe bending machine of this class having cable ends maintained to extend parallel from flange separated driven drum sections into contact with spacer pulley sheaves mounted on a spring connected bracket pivoted to the frame.

It is yet another object of this invention to provide a pipe bending machine of this class equipped with means thereon for handling the pipe to be bent, as by successively loading portions of pipe into the machine.

It is still a further object of this invention to provide a pipe bending machine of this class having a power means, as an engine thereon for actuating the cable winch, with a platform adjacent thereto from which an operator may control engine and winch.

It is also an object of this invention to provide a pipe bending machine of this class having a fixed die with bed radially curved upwardly and toward the pipe bending end of the machine, the radially extending side surfaces of the die adjacent the bed also being curved upwardly and toward the bending end to avoid contact with the strongback as the pipe is bent.

It is a further object of this invention to provide pipe bending machines of this class having the cable through the bending pulleys actuated by one driving means, as a winch, and having the cable through the fulcrum pulleys, or the combined fulcrum and snubbing pulleys actuated by a separately controlled driving means.

It is also an object of this invention to provide

a pipe bending machine of this class having a fixed die with bed radially curved upwardly and toward the bending end of the machine, and also having the radially extending side surfaces of the die adjacent the bed curved upwardly and toward the bending end of the machine, but curved with such a radius of curvature as to permit the strongback side surfaces to contact, and roll along, the side surfaces of the die during the bending operation.

It is an additional object of this invention to provide a pipe bending machine of this class which has, as a part thereof, means for lifting its skid end above its base level so that it may be more easily transported.

It is a further object of this invention to provide a pipe bending machine of this class which may employ its pipe bending apparatus to lift its skid end.

It is yet another object of this invention to provide a pipe bending machine of this class which may lift its skid end at the same time that it bends pipe.

Other and further objects will be obvious when the specification is considered in connection with the drawings in which:

Fig. 1 is a side elevation of one modification of the machine taken along line 1—1 of Fig. 3.

Fig. 2 is a fragmentary, partially diagrammatic side elevation showing bending carried out by the machine of Fig. 1.

Fig. 3 is a plan view of a machine.

Fig. 4 is a sectional elevation taken along line 4—4 of Fig. 3.

Fig. 5 is a forward end view of a machine.

Fig. 6 is a diagram of the bending apparatus of the machine of Fig. 1.

Fig. 7 is a diagram of an optional bending apparatus.

Fig. 8 is a sectional elevation taken along line 8—8 of Fig. 9.

Fig. 9 is a sectional elevation through a lined die, shoe, or strongback.

Fig. 10 is a side elevation from the opposite side of the machine shown in Fig. 1.

Fig. 11 is a diagrammatic view showing still another optional form of bending apparatus.

Fig. 12 is a plan view of a lifting beam as installed on a pipe bending machine.

Fig. 13 is an elevation of a lifting beam when installed on a pipe bending machine prior to lifting the skid thereof.

Fig. 14 is an elevation of a lifting beam when installed on a machine shown when the skid has been lifted.

Fig. 15 is an enlarged fragmentary elevation showing the strongback in rolling contact with the fixed die.

Fig. 16 is an enlarged fragmentary elevation showing the fixed die relieved to avoid contact thereof by the strongback during the bending operation.

The pipe bending machine 1 has a frame 2 with the lower beams 3 thereof connected by means of the axle 4 to a supporting traction means, as the caterpillar 5 near the rear end of the frame, while the skids 7 support the forward end 8 of the frame. The ring 9 is provided at this end 8 so that a connection may be made to the machine, as when it may be desired to move it.

The uprights 11, slanted columns 12, and cross-braces 14 support the frame top beams 10 above the beams 3, and as shown in Fig. 3, cross-beams 15, 16, and 17 cross-connect the beams 19 while

suitable corresponding members therebelow cross-connect the beams 3.

The power means, as a suitable internal combustion engine 18, is mounted on the frame top 20, and connected by the drive belt 21 to drive the winch 22. The winch 22 has two drum sections 23 and 24 separated by the flanges 25, 26, and 27, and outwardly of the journal 28 for the shaft 29 it has a smaller diameter drum section 30 terminating outwardly in the end flange 31.

The cable end 32 is connected to the drum section 23 adjacent the flange 25 and the cable end 33 is connected to the drum section 24 adjacent the flange 26. From each drum the cable 35 extends over a pulley or pulley block 36 on the frame end 8 to the pulley 39 on the strongback 40 to a pulley 41 on the strongback to a pulley 42 thereabove on the frame 2 back to the pulley 41 and from thence to the pulley 43 on the strongback and up to the pulley 44 on the frame thereabove, and finally the cable extends under the strongback 40 to complete the loop 45 between the pulleys 44 on opposite sides of the frame 2.

The die or radially curved shoe 46 is removably fixed to the frame below the frame top 20 by means of the cap screws 47 which pass through the flange feet 48 and 49 of the cross-beams 15 and 16 respectively. The bed 50 of the die is formed to receive substantially the upper semi-periphery of a pipe portion bent longitudinally to conform to the radius of curvature of the bed.

On the rear portion 6 of the frame 2, the eccentric shaft 51, as shown most clearly in Fig. 4, is journaled in the longitudinally extending journal members 52 between the lower cross-beams 53 and in the journal bracket 54. This eccentric shaft 51 has the eccentric members 55 rigidly connected thereto to turn in the rings 56 which are rigidly connected to the holding shoe 60.

On one side of the shoe 60 a ring 57 is provided and connected to the frame to extend around the shaft 51. An arm 58 is rigidly connected to the shaft 51 adjacent to, and just outwardly of the ring 57. The arm 58 has the bearing lug 59 thereon and also the guide lug 61. The pointed rod 62 slidably extends through these lugs 59 and 61 so that the point 63 may be partially inserted into the spaced radial holes 64 in the ring rim 65. A compression spring 66 is connected at 67 into the rod 62 and extends around the rod to bear against the lug 59 and to normally urge the rod 62 into the ring 57. The handle 68 on the rod 62 is provided for lifting the rod from one hole 64 so that it may be spaced in another hole.

As demonstrated most clearly in Fig. 2, the shoe 60 has lugs 71 and 72 extending on either side thereof with the top sides 69 and 69' of these lugs being substantially parallel extensions of a horizontal plane through the lowest point of the bed 70 of the shoe 60. Also, as shown in Fig. 2, the shoe is substantially straight and substantially shorter in length than the fixed die 45. The spring 73 is connected to the frame 2 at 74, as shown in Fig. 4, and to the inner end 75 of the shoe at 76 near the top thereof as shown in Fig. 3 and Fig. 4.

The rotation of the winch shaft 29 in a clockwise direction, as viewed from the right hand end of the shaft in Fig. 3, winds up the cable ends 32 and 33 on the drum sections 23 and 24 respectively. As shown in Fig. 2, after the cable has been actuated to raise the strongback

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44 so as to lift the pipe 80 into contact with the die 46, further winding up of the cable bends the pipe into the curvature of the die.

In order to insure that the cable winds up evenly, the pulleys 81 and 82 are provided and mounted on the bracket 83 with disc faces to extend in a horizontal plane; the bracket arm 84 being pivoted at 85 on the cross-beam 17 at the frame end 8. The cable 35 extends from the drum sections 23 and 24 into contact with the innermost points of the pulley sheaves, the cable end portions extending parallel to each other a distance apart equal to the distance between the cable connections adjacent the flanges 25 and 26. This spacing tends to insure that the cable winds up evenly on the drum sections.

Additionally, the spring 86 is connected to the bracket arm 84 at 87 and to the side of the frame at 88 to normally pull the pulleys in the opposite direction from the direction in which the cable winds up on the drum. This further insures that the cable does not jump about on the drum sections when the winch is first started up.

In operation pipe may be loaded into the machine from either end, but is usually loaded in from the forward end 8. To aid in positioning the pipe axially of the frame 2, the line 90 on the drum section 30 is led over the guide pulley 91 on the top portion of the frame end 8 and extended around the pipe end and connected by means of the hook 92. The winch 22 is then rotated to wind up the cable on the drum section 33 to draw the pipe 93 toward the machine 1.

After the pipe 89 has been placed on the roller 93, it is guided into the frame over the strongback 40 with the strongback bed 94 lowered, as shown in Fig. 1, below the lowermost point 95 of the pipe periphery. To insure that the pipe enters the strongback 49 the guide plates 96 are provided on either side of the strongback end 97. The line 90 is successively disconnected from the pipe 89 and moved outwardly thereon to be re-connected from time to time to assist the operation of loading the pipe into the machine. If, for any reason it might be desirable to load pipe from the end 6 instead of the end 8, an arrangement similar to the guide pulley 91 might be installed at some point on the end 6 outward of the winch 22, or optionally a separately driven winch might be installed on the end 8.

When the pipe has been loaded in over the strongback 40 it makes contact with the vertically adjustable roller 98 at the opposite end of the strongback from the roller 93. In passing it is pointed out that this roller 98 also acts as a positioning stop for the strongback when in lowered position to complement the lug 99 of triangular cross-section fixed beneath the strongback which locates the strongback between the locating plates 104 on the forward part 8 of the frame 2.

After the pipe 80 contacts the roller 98 it may be slid farther on through the machine and into the shoe 60. As the spring 73 tilts the shoe 60 downwardly and inwardly when it is in unlocked position, the lower inner edge 75 of the shoe bed is below the entering end of the pipe, so the pipe passes into the shoe 60 without marring and delaying end to end contact between the pipe and shoe.

When finally loaded and extending outwardly

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from the shoe 60, the pipe is seen in the position shown by dotted lines in Fig. 1. However, in this regard it should be considered that the liner 102, shown installed in the shoe 60 in Fig. 1, would be omitted to receive the pipe 80 so that the pipe, of the largest diameter for which the machine has been designed, will rest within the bed 103 of substantially semi-peripheral contour of the largest pipe diameter.

The liners 102 are designed for installation in the basic beds of the holding shoe, and of the strongback to convert these elements to receive pipe of smaller diameters. These liners have location pins or dowels 109 thereon to fit corresponding holes 110 in the liners. As shown in Fig. 1 each liner for the shoe 60 has the lugs 111 and 112 thereon to correspond with the lugs 71 and 72 on the bed thereunder. The top sides 113 and 114 of the lugs 111 and 112 extend substantially parallel to the horizontal plane through the lowest point of the liner 102. The liner lugs 111 and 112 have the bars 161 welded on either side thereof to extend below and align these lugs with the shoe lugs 71 and 72.

With the pipe loaded, the operator on the platform 104 actuates the bending operation, the platform being located so that the operator can reach the engine clutch 105, the gear shift 106, the winch hand clutch 107, and the winch foot brake 108, as well as any other engine or winch controls and brakes, not shown.

It can be presumed that for ordinary bending by vertical machines of this class, that broadly six essential elements are required, namely, a frame, a fixed radial die supported from the frame top with bed downwardly, a holding shoe spaced longitudinally of the frame from the fixed die with bed upwardly, a strongback suspendable with bed upwardly sufficiently beneath the fixed die to permit pipe to be loaded between the fixed die and holding shoe and underextending the fixed die in a direction therefrom opposite the holding shoe, a means to lift the strongback with pipe therein upwardly to bring the pipe into contact with the fixed die, and a means to pull upwardly near the outer end of the strongback to bend the pipe into the curved bed of the fixed die while the first means holds up the opposite end portion of the strongback to maintain the pipe therein against the fixed die bed while the holding shoe anchors the pipe portion therein against downward motion as the pipe is bent.

However, when a pipe bending machine is considered which must bend a wide variety of ranges in both wall thickness, pipe material and temper, and diameter, it often happens that a machine designed to bend thick walled pipe has to be modified to bend thin walled pipe. Also, when it is considered that in certain usages of pipe, as in buried pipe lines which are processed externally against corrosion and other factors, and which are subjected internally to excessive fluid pressures, pipe must be employed which is free of bulges and wrinkles, it can be seen that a delicate control must be provided to bend thin walled pipe without bulging or wrinkling its surface.

In the type of machine shown in Figs. 1, 2, and 6, the bending means employed consists of the pulleys 36 and 39 which may be termed the pulling or bending block; the pulleys 41 and 42, which may be termed the "squeezing" or fulcrum block; and the pulleys 44 and 43 which may be termed the "snubbing" or wrinkle control block. More generically, the combination of pulleys 41, 42, 44,

and 43 may be termed the "squeezing" or fulcrum block.

When the winch 22 is first rotated, the pulleys 41, 42, 44, and 43 remain in the vertical plane positions of Fig. 1 as the strongback 40 is lifted upwardly to bring the pipe 80 into contact with the die 46 at the end 115 of its periphery. After this contact is established the strongback begins to bend the pipe into the fixed die and the point of greatest application of the bending moment moves successively upward and to the right along the bed 50 of the die, as shown in Figs. 1 and 2.

When contact between die and pipe has first been established and bending begins, the increased tension on the cable 35 tightens the cable throughout its length and this increase causes the cable, to move to the right, as final slack is taken up. Then, as the strongback 40 is pulled upwardly toward the right, the cable between pulleys 43 and 41 can be observed to move slowly to the left as the distance between pulleys 44 and 43 increases faster than the distance between pulleys 42 and 41 decreases.

The bending force increases as the strongback approaches the end of its upward travel to the right, since, in any one gear, the R. P. M. of the winch remains constant, and consequently the bending moment remains constant. As a result, the bending force increases as the bending radius or arm decreases. At this point the upwardly curved radially extending sides 165 of the fixed die 46 should be noticed, as this feature prevents interference with the strongback. As the point of application of the bending moment moves constantly to the right, as shown in Fig. 2, and toward the pulley 39 on the underextending end of the strongback, the downward pivoting of the pulley 43 with the strongback end 116 opens out the distance between pulleys 44 and 43. This increased cable length is drawn from the right of pulley 43, as explained hereinabove, and in opposition to the pull to the right which the winch exerts to bend the pipe.

Then, since the strongback is not completely rigid, but has a certain flexibility therein, the pull of the winch, which resists the spread between pulleys 44 and 43, tends to wrap the slightly flexible strongback against the pipe to the left of the theoretical point of application of the bending moment, thereby spreading the area of bending, and protecting the thin walled pipe from the wrinkling which otherwise often occurs due to the application of an excessive moment in a very localized area.

As successive lengths or portions of pipe are bent, the pipe is handled by the line 90, or by any other conventional handling means, as from an A-frame on the top 20 of the frame 2, or by a tractor on the ground in front of the machine 1, and is moved rearwardly through the frame 2 and shoe 60. When this is done, the shoe 60 is unlocked until the next adjustment is completed.

During the positioning of the pipe in the shoe, and when it is unlocked, the pipe may tend to bind at some point in the bed of the shoe, with the result that the shoe may tilt and tend to bring either one or the other edge of the shoe into biting contact with the pipe. The lugs 71 and 72 on the shoe 60 are provided to avoid this as the top sides 69 and 69' of these lugs pivot upwardly, dependent on the direction of tilt, to contact the under side of the pipe. In cases where the shoe is lined, the lugs 111 and 112 on the liner 102 serve the same purpose, as the top sides 113 and

114 will contact the pipe, dependent upon the tilt.

When the pipe has been shifted, an operator lifts the handle 68 of the rod 62 against the pressure of the spring 66 and places the rod point 63 in the rim hole 64 corresponding to the higher tilted position of the shoe 60. The pipe is then in position for the next portion in the die to be bent.

The bracket 120 of the caterpillar 5 is trunnioned at 121 on the axle 4, and has the trunnion pins 122 at either end upon which the wheels 123 are mounted to rotate. The caterpillar track 124 is belted about the wheels 123 to supply the rear traction contact. Other traction devices, as wheels, may be employed in place of the caterpillar.

This invention is not limited to a machine having the cable and pulley arrangements hereinabove described, but any other arrangement operable on the holding shoe-fixed die-movable strongback principle is considered, as that shown in Fig. 7. In such an arrangement the winch 22 on the frame 2 has the cable 35 thereon which extends on each side of the frame, over a pulley 36 on the frame top 20 to a pulley 39 on the strongback 40, to a pulley 131 on the strongback below the fixed die 46, up to the pulley 132 on the frame adjacent the fixed die 46, back to the pulley 131, up again to the pulley, 132, and under the strongback 40 to complete the loop of the cable between the pulleys 132.

This arrangement is most applicable to machines for bending thick walled pipe, as such is not likely to wrinkle or buckle when an excessive bending moment may be applied at a very localized point. In such arrangement the pulley 132 is best located on the fixed die at some point relatively intermediate the pulleys 44 and 42 as shown in Figs. 1 and 2.

As shown in Fig. 11, the arrangement of Fig. 7 may be connected to be actuated by two separately controlled winches 22 and 135. In this case the winch 22 has the cable 35 extending therefrom over the pulley 132 on the frame adjacent the fixed die 46 and preferably centrally thereof, downwardly to the pulley 131 on the strongback 40, upwardly again to the pulley 132, and downwardly under the strongback 40 to complete the loop between the pulleys 132.

The winch 135 has the cable 136 extending therefrom to the pulley 36 on the frame end 8, then downwardly to the pulley 39 on the strongback 40, upwardly to the pulley 36, and then downwardly under the strongback 40 to complete the loop between the pulleys 36. When two winches are thus employed it is obvious that the number of cables on the bending end is greater between pulleys than on the "squeezing" or fulcrum end. It is also obvious that the independently operated winches should be synchronized, at least by co-operation between the two operators of the winches.

The arrangement of Fig. 6 can also be connected to be driven by two separately controlled winches. This arrangement, being obvious, is not shown in the drawings. In such case the winch 22 has cables extending therefrom on either side of the frame to the "squeezing" or fulcrum pulley 42 on the frame adjacent to the forward part of the die 46, and from this pulley the course of Fig. 6 between the pulleys 42, 41, 43, and 44 is followed. The cable path from the forward winch is the same as hereinabove described for the arrangement of Fig. 11.

Throughout the description, the path of the cable between pulleys has been broadly discussed without giving consideration to the reeving of the pulley sheaves. Obviously, this invention is not limited to any specific number of cables, it being pointed out only that preferably a greater number of cables should be required between the pulleys 36 and 39 at the point the pulling force of the winch is applied to the bending arm of the strongback. For instance, in the arrangement of Fig. 6 there are, on each side, five cables between the pulling or bending pulleys, four cables between the fulcrum pulleys, and four cables between the "snubbing" pulleys.

It has been stated that the radially extending sides 165 of the fixed die 46 are upwardly curved to prevent interference with the strongback 40 during the bending operation. Fig. 16 shows this feature in enlarged detail and accentuates the curvature of the die to show that there is no contact with the strongback at any point during bending. This is a desirable feature for the ordinary wall thicknesses of pipe, and for pipe of conventional hardness, as with such pipe it is desirable to employ the total force of the cables to roll the strongback along the pipe.

However, in some cases, illustrated by Fig. 15, with pipe of certain wall thickness, and of certain hardness, there may be danger of wrinkling the pipe should the full force of the strongback be applied directly to bend the pipe. In such cases, the side surfaces 165' of the fixed die 46 are relieved along a radius of curvature which parallels the curvature of the die bed 50. The spacing is such that the strongback 40, will first move the pipe into constraining contact with the fixed die 46, and then, as further force is applied, the slight compression of the substantial semi-periphery of the pipe in the strongback responsive to this further force, will permit the strongback sides 166 to contact the die surfaces 165' to limit further compression of the semi-periphery.

The extent of compression has to be relatively minute or the pipe will wrinkle, and therefore the distance the strongback moves after it forces the pipe into the die bed 50 until it contacts the die surfaces 165' is a minute distance measurable in fractions of an inch. From this point of contact the strongback sides 166 roll along the die sides 165' and the bending force is divided between the frictional force expended in effecting this rolling contact, and the force going to bend the pipe.

When a proper relationship exists, the compression of the pipe by the strongback prior to establishing contact with the die 165', will tend to thicken the pipe wall in the strongback and thereby counteract the natural stretch of the outer semi-periphery of pipe from the center of curvature.

This invention includes both the construction shown in Fig. 15 and that shown in Fig. 16. The latter construction, in which the strongback rolls along the pipe, has a more universal application, however, since the bending force may be controlled, even in bending pliable, thin walled pipe, especially when the pulley arrangement of Fig. 6 is employed. However, the other pulley arrangements may be employed as well with the construction of Fig. 16, and pipe may be bent without the safeguard of a surface contact between strongback sides 166 and die surfaces 165.

In this respect it is pointed out that the construction of Fig. 15 has special applications, and

provides a definite safeguard against wrinkling certain types of pipe. This safeguard is obtained by the addition of another variable to the bending combination in the nature of the spacing of the die surfaces 165' within fractional limits.

Pipe bending machines of the type hereinabove described as well as other machines which have one end supported by skids 7 and the other end supported by a traction means, as by a caterpillar 5, may be equipped to lift their skid ends, as shown in Figs. 12-14.

A beam 170 comprising two spaced apart, parallel extending members 171 and members 172 converging therefrom to a connection member 173, has the sleeves 174 thereon, through which extends the axle 175 between the skids 7. Gusssets 176 may be provided to reinforce the sleeves 174 and the members 171 and 172. Cross-braces 177 and 178 are also provided to tie together the members 171.

Rings 179 are provided at the inner ends of the members 171 into which are connected means, such as chains 180, which may connect the beam ends to the strongback 40, as at the ring 181. The connection member 173 has the opening 182 into which may be connected the hook 183 of a prime mover, not shown, such as a tractor or any other vehicle adapted to pull a heavy machine.

After machines of the heavy nature of the pipe bending machines shown hereinabove, have settled in operation, the skids may become bogged in, so that it may task the ordinary prime mover to loosen them to start them in motion. Also, even with the skids resting on a smooth surface, a considerable initial force is required to overcome the inertia thereof.

With a machine equipped as hereinabove described, the hook 183 may be connected into the ring 182, so that the outer beam end may be supported above skid base level, as by the prime mover to which the hook 183 extends. Then the chains 180 may be connected at 181, to the strongback 40. Upon actuation of the winch 22, the strongback 40 moves upwardly to contact the fixed die 46 and then pivots at the fixed die and moves further upwardly at its end which is connected to the inner beam end. The inner beam end is thereby lifted upwardly as the sleeves 174 of the beam pivot rotationally on the axle 175 and as the outer beam end is supported above skid base level. This obviates overcoming the inertia of the skids by the forward motion of the prime mover, as it previously transfers the machine to be supported by the prime mover means at its forward end, and by its rear end support, as the caterpillar 5.

In cases where it may be desirable to bend a section of pipe and then leave it in the machine to be transported, the pipe section may be loaded into the machine and strongback, and the chains 180 connected to the strongback, so that the operation which completes the operation of bending the pipe will also lift the skid end of the machine.

The theory of the beam lift applies to machines other than pipe bending machines of the type described. The strongback, or equivalent, in such machines need not roll upon a curved die, but may be lifted up against a stop member, as a horizontal bar across the machine, and the inner end of the strongback equivalent may pivot against such bar as the outer end is moved further upwardly. In effect, this invention includes any means which will move the

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inner beam end upwardly with relation to the top of the frame of the machine, while the outer beam end is supported above skid base level by external means.

Broadly, therefore, this invention includes any type of machine adapted to lift its skid end by lifting the inner end of a beam pivoted at the skid end while the outer end of the beam is supported above skid base level.

This invention also broadly considers a vertical pipe bending machine in which a downwardly facing fixed die acts as a fulcrum, an upwardly facing shoe holds the pipe at one end of the frame, and an upwardly facing strongback is moved to place the pipe in the fixed die and then is moved upwardly, near the frame end opposite the holding shoe, to bend the pipe.

This invention also broadly considers a pipe bending machine in which a strongback is rocked against pipe in a longitudinally curved fixed die to apply a bending moment against the pipe along a constantly changing point of bending application as the bending arm shortens toward the end of the bend.

This invention also broadly considers a pipe bending machine in which winch operated cables and pulleys, or similar means, may be employed to bend the pipe so that the point of bending moment application moves by infinitesimal lengths along the pipe to be bent.

It is herein pointed out that the locking ring for the holding shoe is subject to variation in construction. For instance, whereas the ring 57 is shown fixed to the frame this ring optionally might be fixed to the side of the holding shoe and equally satisfactory results obtained. In such case the only difference in operation would rest in the fact that the ring would be substantially concentric with the center of the eccentric 55 rather than concentric with the axis of the shaft 51.

In this specification it has been stated hereinabove that the strongback and holding shoe are equipped to have liners installed therein. No mention has been made of installing liners in the fixed die as in practice it has been found more convenient to provide and install a fixed die 46 for each diameter of pipe to be bent rather than to line a basic fixed die of largest diameter each time a smaller diameter of pipe is being bent. However, this practice is optional and the provision of liners in a basic die might be advantageous under certain conditions.

What is claimed is:

1. In a pipe bending machine, the combination of, a frame, means supporting said frame for movement including, a first support means connected to one end of said frame and a second support means connected to said frame and spaced from said first support means, pivot means mounted on said frame above the level of the base of said first support means and adjacent said first support means, a beam structure pivotally mounted on said pivot means with an end thereof extending outwardly from said pivot means beyond said frame, connection means on said outwardly extending end of said beam structure designed to bear upon a support carried by a traction device, a pipe bending mechanism mounted on said frame and including, a force applying means for bending a pipe section, and means for connecting the other end of said beam to said force applying means whereby the actuation of said force applying means will lift said first support means by causing said beam struc-

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ture to pivot about said pivot means when said connection means is caused to bear upon a support means as aforesaid.

2. In a pipe bending machine, the combination of, a frame, means supporting said frame for movement including, a first support means connected to one end of said frame and a second support means connected to said frame and spaced from said first support means, pivot means mounted on said frame above the level of the base of said first support means and adjacent said first support means, a beam structure pivotally mounted on said pivot means with an end thereof extending outwardly from said pivot means beyond said frame, connection means on said outwardly extending end of said beam structure designed to bear upon a support carried by a traction device, a pipe bending mechanism mounted on said frame and including, a force applying means for bending a pipe section, and means for connecting the other end of said beam to said force applying means whereby the actuation of said force applying means will lift said first support means by causing said beam structure to pivot about said pivot means when said connection means is caused to bear upon a support means as aforesaid, said pipe bending mechanism including, a curved bending die anchored to said frame and having a bend forming face portion, a holding shoe mounted in opposed relation to said die and adjacent one end of said die, a separate, independently mounted straight bending shoe having a part extending toward said holding shoe past the central point of the face of, and directly opposing said bend forming face portion of said die and a part extending beyond said bend forming face portion in a direction away from said holding shoe, said bending shoe being free to move toward and from said die, said force applying means being adapted to urge a part of said bending shoe directly toward said die to substantially and tightly embrace a pipe held therebetween and to roll said bending shoe along said pipe.

3. In a pipe bending machine, the combination of, a frame, means supporting said frame for movement including, a first support means connected to one end of said frame and a second support means connected to said frame and spaced from said first support means, pivot means mounted on said frame above the level of the base of said first support means and adjacent said first support means, a beam structure pivotally mounted on said pivot means with an end thereof extending outwardly from said pivot means beyond said frame, connection means on said outwardly extending end of said beam structure designed to bear upon a support carried by a traction device, a pipe bending mechanism mounted on said frame and including, a force applying means for bending a pipe section, and means for connecting the other end of said beam to said force applying means whereby the actuation of said force applying means will lift said first support means by causing said beam structure to pivot about said pivot means when said connection means is caused to bear upon a support means as aforesaid, said pipe bending mechanism including, a curved bending die anchored to said frame and having a bend forming face portion, a holding shoe mounted in opposed relation to said die and adjacent one end of said die, a separate, independently mounted straight bending shoe below said die and having a part extending toward said holding shoe past the central

point of the face of, and directly opposing said bend forming face portion of said die and a part extending beyond said bend forming face portion in a direction away from said holding shoe, said bending shoe being free to be moved upwardly toward, and downwardly from, said die, said force applying means being adapted to urge a part of said bending shoe directly toward said die to substantially and tightly embrace a pipe held therebetween and to roll said bending shoe along said pipe.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,530,261	Hawes -----	Mar. 17, 1925
1,662,131	Schonfield -----	Mar. 13, 1928
1,741,840	Harmon et al. -----	Dec. 31, 1929
1,943,594	Flatley -----	June 16, 1934
2,546,531	Vultz -----	Mar. 27, 1951