E. KAMPER.

TUBE BENDING MACHINE.

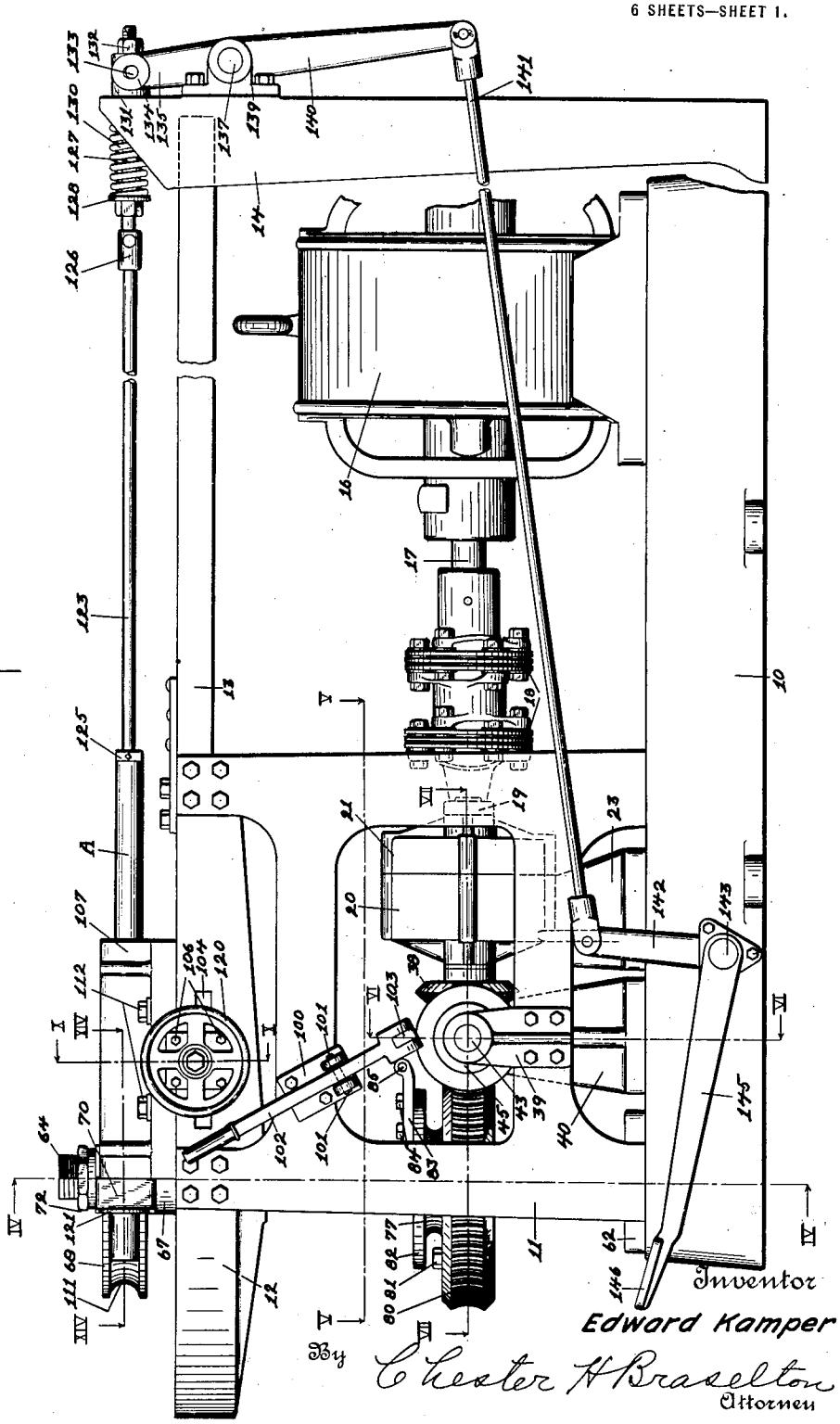
APPLICATION FILED FEB. 13, 1918.

1,376,441.

Patented May 3, 1921.

6 SHEETS—SHEET 1.

Fig. 1.



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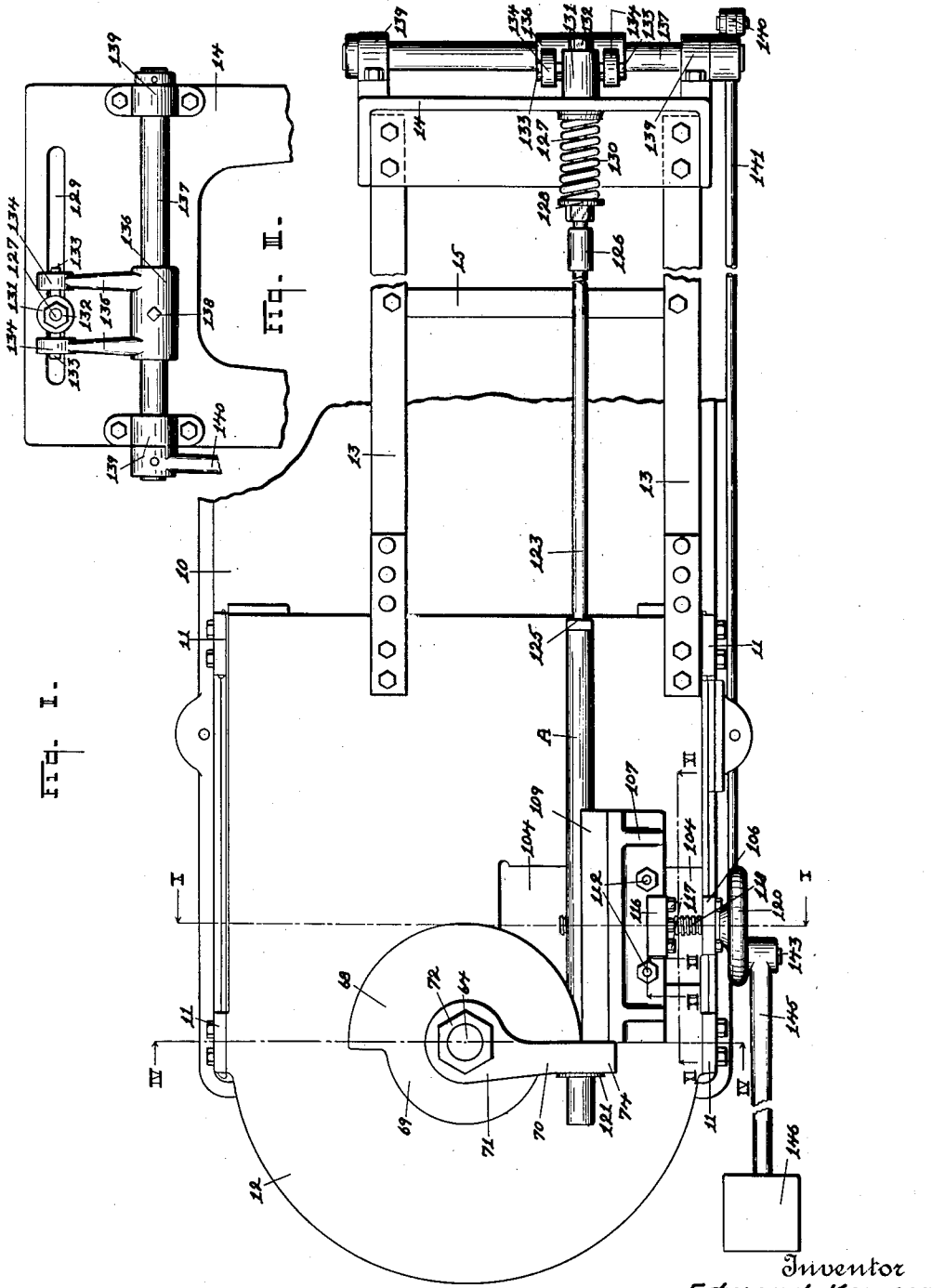


Fig. II.

Fig. III.

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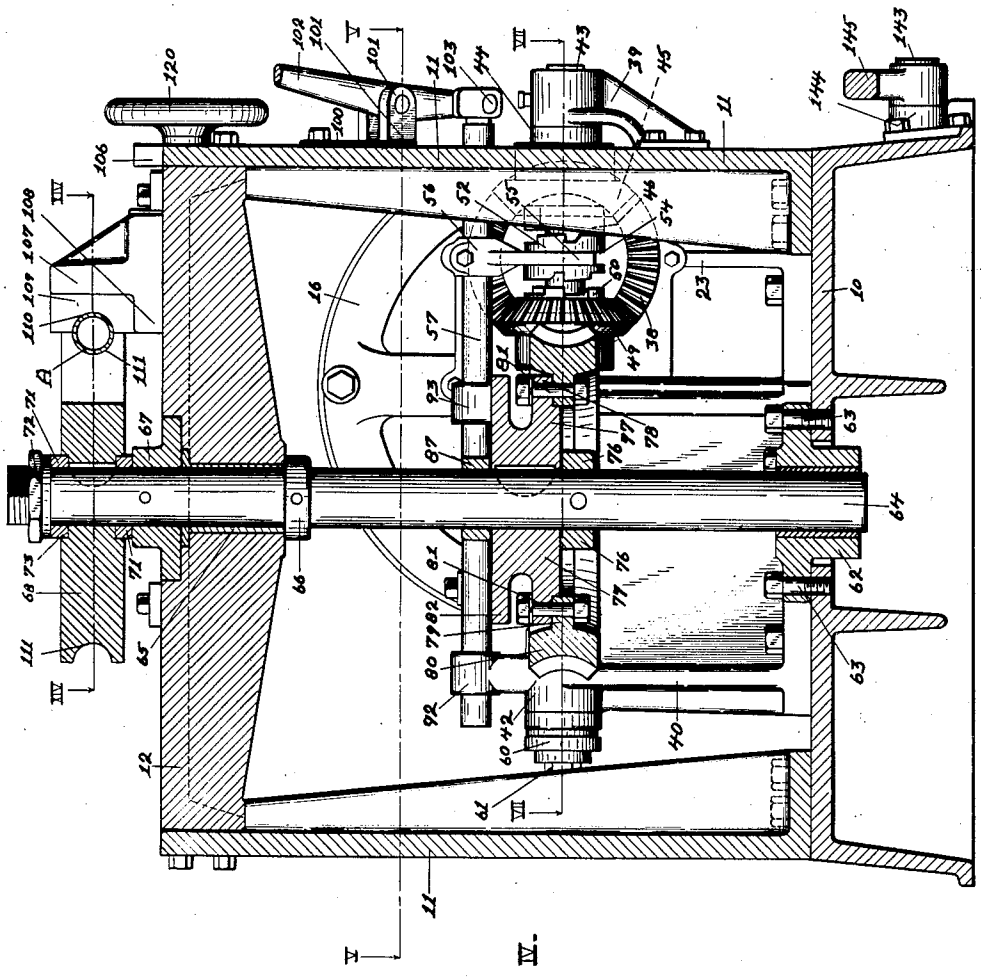


FIG. 4.

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6 SHEETS—SHEET 4.

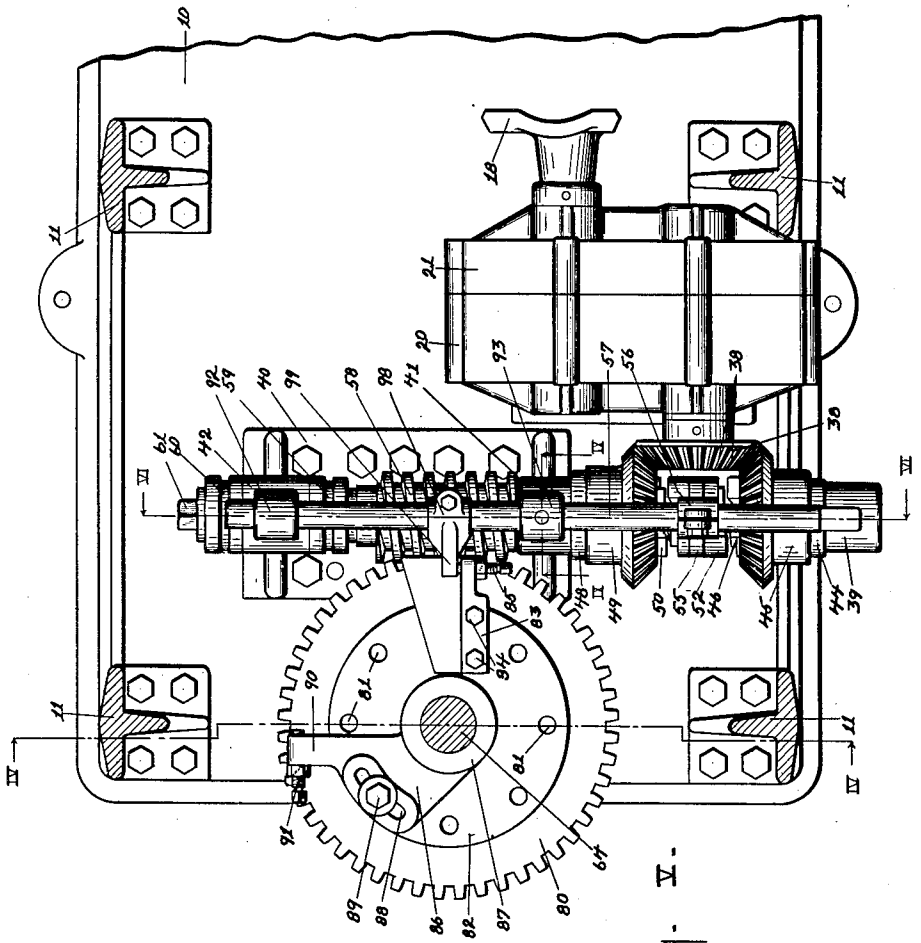


Fig. 4.

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6 SHEETS—SHEET 5.

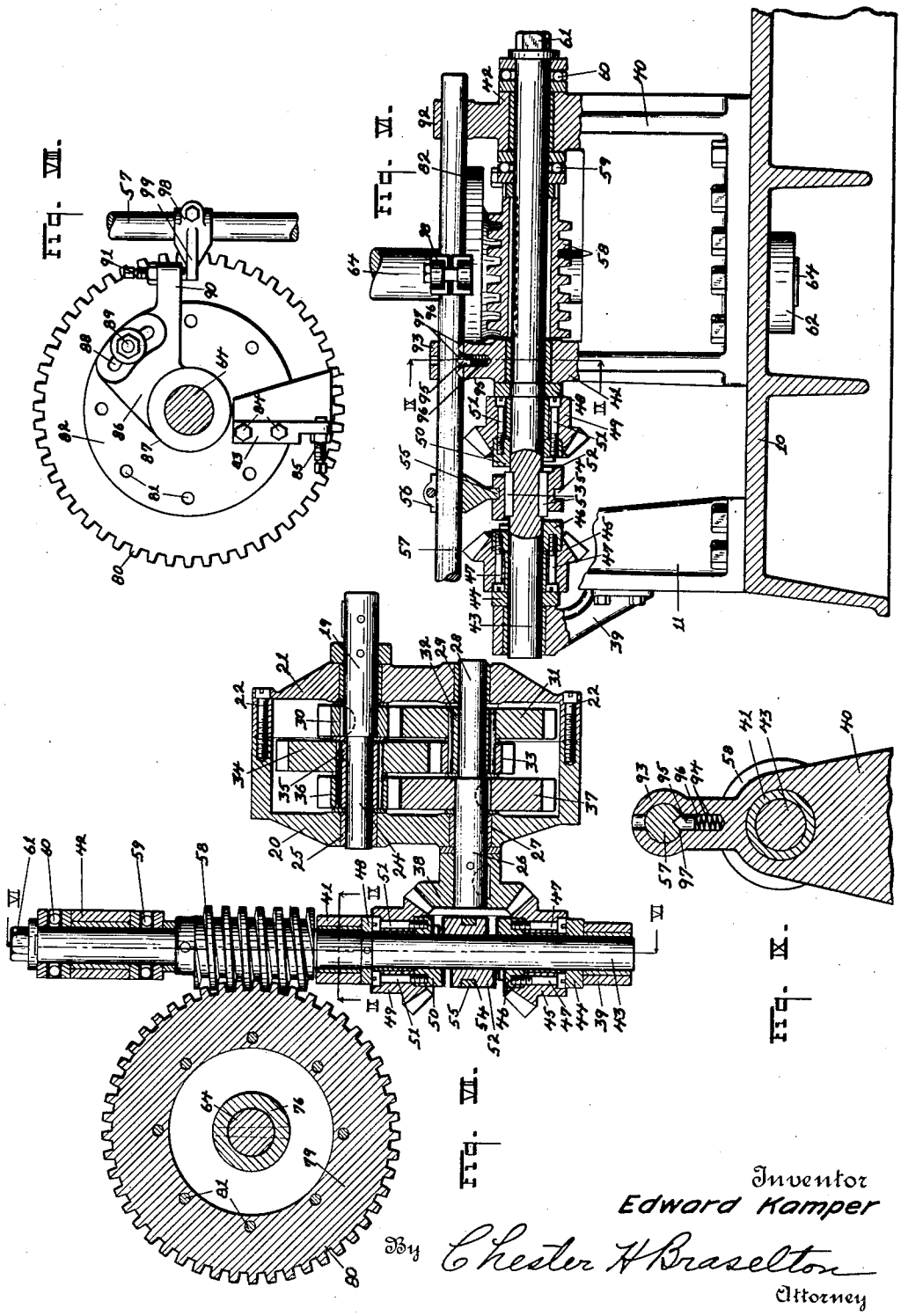


Fig. VII.

Fig. VI.

Fig. IX.

Fig. V.

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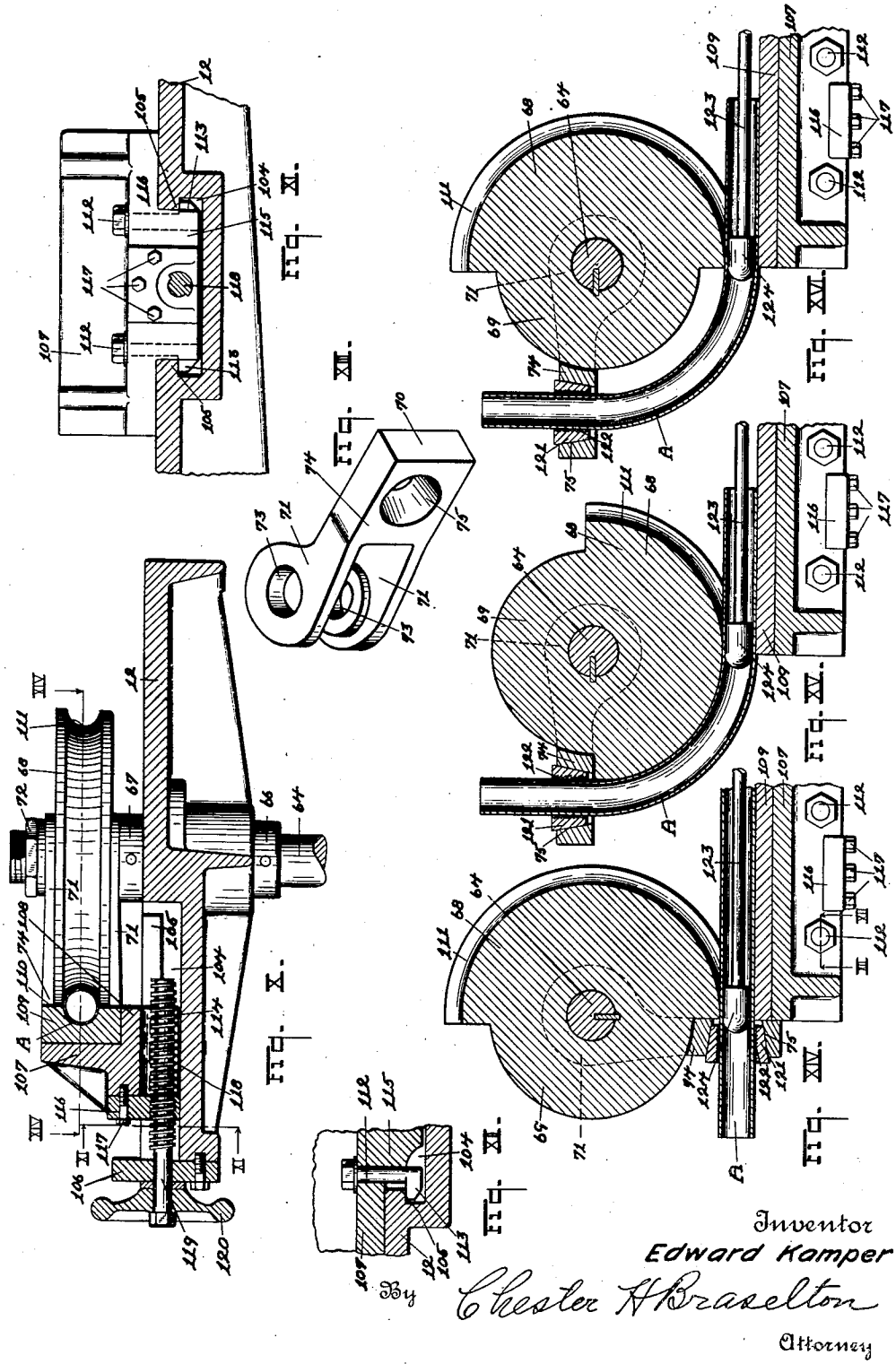
TUBE BENDING MACHINE.

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6 SHEETS—SHEET 6.



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UNITED STATES PATENT OFFICE.

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TUBE-BENDING MACHINE.

1,376,441. Specification of Letters Patent. Patented May 3, 1921.

Application filed February 13, 1918. Serial No. 216,844.

To all whom it may concern:

Be it known that I, EDWARD KAMPER, a citizen of the United States, residing at Toledo, in the county of Lucas and State of Ohio, have invented certain new and useful Improvements in Tube-Bending Machines, of which I declare the following to be a full, clear, and exact description.

This invention relates to improvements in tube bending machines.

The principal object of my invention is to provide an improved tube bending machine of very simple construction and which may be operated very efficiently, the parts of the machine being so arranged that the work may be inserted in and removed from the machine very expeditiously.

A further object of my invention is to provide a tube bending machine of the type having a bending wheel in which the forward movement of the bending wheel may be stopped at an accurately predetermined position and in which the drive may be reversed to return the bending wheel to its original position, the bending wheel being automatically stopped at its original position on the return movement.

A further object of my invention is to provide, in a tube bending machine having automatic stop mechanism for limiting the movement of the bending wheel, means whereby the bending wheel cannot be driven in the wrong direction at its limits, thus constituting an automatic safety device for the bending machine.

A further object of my invention is to provide improved means for supporting a mandrel within the tube which is being bent in the machine and means for facilitating the removal of the mandrel from the tube in removing the bent tube from the bending machine.

Further objects, and objects relating to economies of manufacture and details of construction, will definitely appear from the detailed description to follow.

I accomplish the objects of my invention by the devices and means described in the following specification. My invention is clearly defined and pointed out in the appended claims.

A structure constituting a preferred embodiment of my invention is illustrated in the accompanying drawing, forming a part of this specification, in which—

Figure I is a view in side elevation of a machine embodying my invention.

Fig. II is a top plan view of the machine illustrated in Fig. I.

Fig. III is a fragmentary end view of the machine shown in Figs. I and II.

Fig. IV is a vertical, sectional view, taken substantially on the line IV—IV of Figs. I, II and V.

Fig. V is a view, partly in section and partly in plan, taken substantially on the line V—V of Figs. I and IV.

Fig. VI is a detail, sectional view, taken substantially on the line VI—VI of Figs. I, V and VII.

Fig. VII is a detail, sectional view, taken substantially on the line VII—VII of Figs. I and IV.

Fig. VIII is a view corresponding to a part of Fig. V and showing the worm gear turned so that the stops are in the opposite positions from those shown in Fig. V.

Fig. IX is a detail, sectional view, taken substantially on the line IX—IX of Figs. V, VI and VII.

Fig. X is a detail, sectional view, taken substantially on the line X—X of Figs. I and II.

Fig. XI is a fragmentary, detail, sectional view, taken substantially on the line XI—XI of Figs. II and X.

Fig. XII is a fragmentary, detail, sectional view, taken substantially on the line XII—XII of Figs. II and XIV.

Fig. XIII is a detail, perspective view of the traveling arm.

Fig. XIV is a detail, sectional view, taken substantially on the line XIV—XIV of Figs. I, IV and X, and showing the bending wheel and traveling arm in the position they occupy before the bend is started.

Fig. XV is a view similar to Fig. XIV, showing the bending wheel and traveling arm in the position they occupy at the end of the bend, and

Fig. XVI is a view, similar to Fig. XIV, showing the traveling arm in the position shown in Fig. XV, while the bending wheel has been returned to its initial position.

In the drawing, similar reference numerals refer to similar parts throughout the several

views, and the sectional views are taken looking in the direction of the little arrows at the ends of the section lines.

Considering the numbered parts of the drawing, I have shown a machine comprising the base (10) from which the table 12 is supported by means of the uprights 11.

The horizontally extending bars 13 extend from the table 12 and are supported at one end by said table and at the other end by the leg 14, these bars 13 being connected by the cross bar 15. A suitable motor 16 is mounted on the base 10 and the motor shaft 17 is connected with the shaft 19 through the universal joint 18. A gear casing 20 is mounted on the support 23 and provided with a cover 21 held on to the casing 20 by means of the bolts 22. The shaft 19 is journaled at one end in the cover 21 and carries an extension 24 of smaller diameter, which is journaled in the bearing 25 carried by the casing 20. The shaft 26 is journaled in the bearing 27 carried by the casing 20, and provided with a reduced end 28 journaled in the bearing 29 carried by the gear casing cover 21, the shafts 19 and 26 extending substantially parallel to each other. A pinion 30 is splined on the shaft 19 and meshes with a gear 31 mounted on a sleeve 32 which turns freely on the reduced end 28 of the shaft 26. A pinion 33 is mounted on the sleeve 32 so as to turn therewith and with the gear 31, and said pinion 33 meshes with a gear 34 mounted on a sleeve 35 which turns loosely on the reduced end 24 of the shaft 19. A pinion 36 is mounted on the sleeve 35 which turns with said sleeve and with the gear 34, and said pinion 36 meshes with a gear 37 which is splined on the shaft 26. The shaft 19 is driven directly from the motor 16 and the gears 30, 31, 33, 34, 36 and 37 constitute a reducing gearing between the shaft 19 and the shaft 26, said reducing gearing being inclosed within the casing formed by the part 20 and its cover 21.

A pinion 38 is splined upon the forward end of the shaft 26 as clearly shown in the drawing. A shaft 43 extends transversely of the machine, and is journaled in suitable bearings in the bracket 39 and the bracket members 41 and 42 extending from the supporting member 40, so that said shaft 43 has the bearings 39, 41 and 42 in which it is supported and journaled. A ring or collar 44 is mounted on the shaft 43, just inside of the bearing 39, and a bevel pinion 45 is rotatably mounted on the shaft 43 with its outer end abutting the collar 44, this pinion meshing with the bevel pinion 38 on the shaft 26. A jaw clutch member 46 is housed within the central inner part of the bevel pinion 45 and secured thereto by means of bolts 47, as clearly shown in Fig. VII of the drawing. The collar 48 is secured to the shaft 43 and abuts one edge of the bearing 41 as shown in Fig. VII, and a bevel pinion 49 is loosely mounted on the shaft 43 with its inner end abutting the collar 48 and meshing with the teeth of the bevel pinion 38. The jaw clutch member 50 is housed within the central part of the bevel pinion 49 and secured thereto by means of bolts 51, in the same manner as the jaw clutch member 46 is secured to the bevel pinion 45. The clutch member 52 is slidably but non-rotatably mounted on the shaft 43, being connected thereto by means of the spline 53, as shown in Fig. VI. The clutch member 52 is provided with a groove 54 in which the fingers 55 of the clutch-shifting member 56 are disposed, said clutch-shifting member 56 being mounted on the shaft 57, which shaft is supported above the rotatable shaft 43 in a manner which will presently be described. The worm 58 is mounted on the shaft 43 between the bearings 41 and 42, and annular thrust bearings 59 and 60 are mounted on the shaft 43 on either side of the bearing 42, the nut 61 being threaded on the extreme end of the shaft 43 and holding the thrust bearings in place.

A bearing member 62 is secured within a recess or opening provided in the base 10 by means of bolts 63, and a vertically extending shaft 64 is journaled at its lower end in said bearing member 62 while its upper end is journaled in a bearing 65 mounted in the table 12. Ring 66 is fastened on the shaft 64 and abuts the lower edge of the bearing 65, while ring 67 secured to the shaft 64 fits in a suitable recess provided in the upper surface of the table 12 and movement of the shaft 64 vertically is thus limited by means of the rings 66 and 67. A bending wheel is splined on the upper end of the shaft 64, said bending wheel having a large-radius sector 68 and a small-radius sector 69, the sector 68 being a little greater in angular dimensions than the sector 69. A traveling arm 70 is provided which is forked and has a pair of arms 71, one of them extending upon either side of the bending wheel 68, and each being provided with an opening 73 through which the shaft 64 extends. The arms 71 are connected by the shoulder 74, having a tapering opening 75 therethrough, and the distance from the center of the opening 73 to the shoulder 74 is slightly greater than the radius of the sector 69 of the bending wheel, but is less than the radius of the sector 68 of said bending wheel. The reason for this construction will presently appear from the description of the operation of this machine.

A ring 76 is fixed on the shaft 64 and a disk 77 is mounted on the shaft 64 above the ring 76, being splined to the shaft 64 so as to turn therewith. The disk 77 has a lower radially extending flange 78 which is secured to the inwardly and radially extend-

ing flange 79 of the worm gear 80 by means of the bolts 81. The worm gear 80 is disposed so as to mesh with the worm 58 on the shaft 43. The disk 77 is provided with an upper radially extending flange 82 on which is mounted a bracket 83, secured thereto by means of bolts 84. An arm extends from said bracket 83 and carries a screw pin 85, which is adjustably mounted in said arm. An arm 86 is provided, the hub 87 of which is rotatably mounted upon the shaft 64, above the flange 82. The end of the arm 86 is provided with a slot 88 concentric with the shaft 64 and a bolt 89 extends through said concentric slot 88 and adjustably connects the arm 86 to the flange 82. Said arm 86 carries a radially extending arm 90 in which the screw pin 91 is threaded and adjustably mounted.

Bearing brackets 92 and 93 extend upwardly from the bearings 42 and 41 respectively, and the rod 57 is slidably mounted in said bearing brackets 92 and 93. In one of said bearing brackets there is provided a socket 94 in which a plunger 95 having a beveled nose is slidably mounted, a spring 96 being compressed between the base of said plunger 95 and the bottom of the socket 94. The sliding rod 57 is provided with a plurality of notches 97, in any one of which the beveled nose of the plunger 95 is adapted to engage. A sleeve 98 provided with a laterally projecting arm 99 is adjustably clamped on the sliding rod 57 and said arm 99 is adapted to be engaged by either the pin 85 or the pin 91 as the worm gear revolves and drives the shaft 64 in one direction or the other. A plate 100 is fixed upon one of the side members 11 of the frame and provided with a pair of ears 101 between which is fulcrumed a lever 102, the lower end of said lever being connected to one end of the shaft 57 at 103, so that by manipulation of the lever 102 the shaft 57 may be reciprocated in its bearings 92 and 93.

The upper surface of the table 12 is provided with a transversely extending groove 104, the table being provided with the overhanging flanges 105 so that the edges of said groove 104 are undercut. A plate 106 is secured to the edge of the table 12 in line with the end of said groove 104, and the follower block 107 is slidably mounted upon the upper surface of the table 12, being provided with a forwardly projecting flange 108 upon which the follower die 109 seats, said die being provided with a semi-cylindrical groove 110 in its forward face which corresponds with the semi-cylindrical groove 111 formed in the periphery of the large-radius sector 68 of the bending wheel. Bolts 112 extend through the base of the follower block 107 and each of said bolts has a laterally-turned finger 113 at its lower end, which is adapted to engage beneath one of the flanges 105 so as to hold the follower block 107 in position upon the table. The follower block 107 has a portion 115 which is of substantially the width between the edges of the flanges 105 and which depends into the groove 104. This portion 115 has a cutaway portion 114 in which the worm 118 is disposed. A plate 116 is secured to the forward face of the part 115 by means of bolts 117 and the worm 118 is threaded through said plate 116, the forward end of said worm being disposed in the cutaway portion 114. The stem 119 of the worm 118 is journaled in the plate 106 and a handwheel 120 is provided on the forward end of the stem 119 by means of which the worm may be rotated to reciprocate the follower block 107 relative to the table 12.

The arm 70 is provided with a tapered opening 75 therethrough. A split tapered ring 121 fits within the tapered opening 75 of the arm 70, the inner surface of said split ring 121 being roughened as at 122 so as to give it a firm grip upon the exterior of the tube "A" which is to be bent. The ring 121 is tapered in such a direction that the movement of the traveling arm 70, in the forming of the bend in the tube, tends to fix the split ring 121 more securely within the tapered opening 75 and tends to draw the sections of the split ring 121 toward each other to cause them to more tightly grip the tube "A".

Rod 123 is provided with a mandrel 124 which extends within the tube to be bent. The forward edge of the follower block 107 and the die 109 is located in line with the axis of the shaft 64 and the mandrel 124 has its forward end hemispherically curved on a radius corresponding to the internal radius of the tube which is to be bent, and the center of said curved mandrel end is in line with the axis of the shaft 64 and the edge of the die 109, as clearly shown in Figs. XIV, XV and XVI of the drawing. The mandrel 124 may differ according to the kind of tubing which is to be bent and depends, of course, upon the diameter of the pipe. The mandrel serves to support the tube and prevent its crushing as the bend is formed. A stop 125 is mounted on the rod 123 against which the end of the tube "A" abuts when it is first placed in the machine preparatory to making the bend therein. This stop is adjustable and by adjusting it on the rod 123 the position of the bend made in the tube may be very accurately determined. The rear end of the rod 123 is connected through the joint 126 to a stem 127 which carries a washer 128 thereon. The end of the stem 127 projects through a slot 129 in the end member 14 of the machine framework, and a spring 130 is compressed between said member 14 and the washer 128. A sleeve 131 is mounted upon

the extreme end of the stem 127, being secured thereon by means of a nut 132, and said sleeve 131 carries the projecting pins 133 which are mounted in the heads 134 of arms 135 projecting from the sleeve 136 which is mounted on the cross shaft 137 and secured thereto by means of a set screw 138. The cross shaft 137 is journaled in suitable bearings 139 mounted on the supporting leg 14 of the machine, and a lever 140 fixed to said shaft is connected by means of a link 141 to the upper end of the lever arm 142 which is mounted on the stub shaft 143 journaled at 144 in the base 10 of the frame. The pedal lever 145 is mounted on the stub shaft 143 and provided with a pedal 146 so disposed as to be convenient to the operator of the machine.

From the description of the parts given above, the operation of this machine should be very readily understood. In the drawings, I have illustrated the machine in neutral position and with the tube inserted ready to begin the operation of forming a bend therein. Referring to Fig. II of the drawing, it will be seen that a tube is first inserted through the central tapered opening of the split ring 121 and through the opening 75 of the traveling arm 70 until the end of the tube "A" engages the stop 125 on the mandrel carrying rod 123, the forward end of the mandrel 124 and of the rod 123 being disposed within the tube and the body of the tube lying in the groove 110 formed in the follower die 109. The edge of said die 109 is in line with the axis of the shaft 64 of the forming or bending wheel 68, and the portion of the tube "A" opposite the groove 110 lies, at a point in line with the axis of the shafts 64, in the groove 111 formed in the periphery of the portion 68 of the bending wheel. The disposition of the tube to be bent with relation to the bending wheel 68 and the traveling arm 70 and the mandrel 124 is very clearly shown in Fig. XIV of the drawing. The motor 16 drives the shaft 17 and the shaft 19 through the universal joint 18. The bevel pinion 38 is continuously driven from the motor 16, the speed of the pinion 38 being considerably reduced from the speed of the motor shaft 17 through the reducing gearing inclosed in the gear casing 20. The bevel pinions 45 and 49, which are loosely mounted on the shaft 43, are continuously in mesh with the bevel pinion 38 and are driven thereby in opposite directions on the shaft 43. In Fig. V, the parts are shown in neutral position, in which position the shaft 43 is not driven. The operator having inserted a tube in place over the mandrel 124, as shown in Figs. I and II of the drawing, shifts the rod 57 to the left in Fig. V by means of the lever 102 which is fulcrumed on the side of the machine. It will be seen that it is impossible for the operator to shift the rod 57 to the right in Fig. V because the stop 85 prevents it, and, since the shaft 57 is shown in neutral position, the movement of the shaft to the left will serve to throw the clutch member 52 into mesh with the clutch member 50 carried by the bevel pinion 49 so that the shaft 43 will be driven from the bevel pinion 49. The result is that the worm 58 mounted on the shaft 43 will be driven in such a direction as to drive the forming wheel 68 from the position shown in Fig. XIV to that shown in Fig. XV. It will be seen that shoulder 74 of the traveling arm 70 abuts against the shoulder formed at the junction between the small-radius sector 69 of the forming wheel and the large-radius sector 68, and the engagement of this shoulder with the shoulder 74 of the traveling arm, carries the arm 70 with the forming wheel as it moves to the position shown in Fig. XV from that shown in Fig. XIV. The traveling arm 70 is loosely mounted on the shaft 64 and the engagement of the exterior of the tube "A" with the roughened inner surface 122 of the longitudinally split ring 121 in the tapered opening 75 connects the arm and tube. The fact that the opening 75 in the arm 70 is tapered, and the exterior of the ring 121 is correspondingly tapered, causes the movement of the arm 70 to cause the split ring 121 to grip the tube "A" more tightly, and a very strong gripping engagement between the arm and the tube "A" is effected. When the forming wheel 68 reaches the position shown in Fig. XV of the drawing, the stop mechanism carried by the flange 82, which is in fact a part of the worm gear 80, has reached the position shown in Fig. VIII, so that the stop pin 91 carried by the arm 90 engages the arm 99 extending from the sleeve 98 mounted on the rod 57 and moves the rod 57 to the right in Fig. V, so that the clutch member 52 is brought into neutral position and the drive of the forming wheel and the shaft 64 is disconnected. When the driving mechanism has been brought to a stop in this manner, the operator manipulates the lever 102 to shift the rod 57 still farther to the right, so that the clutch member 52 is brought into engagement with the clutch member 46 carried by the bevel pinion 45, and the shaft 43 is driven from the bevel pinion 38 through the bevel pinion 45 and the clutch member 52, so that the direction of rotation of the shaft is reversed and the consequent direction of rotation of the shaft 64 is reversed. The forming wheel is consequently driven in the reverse direction and brought into the position shown in Fig. XVI, in which position the stop mechanism has been turned to the position shown in Fig. V and the rod 57 is again shifted to the left and

brought into neutral position so that the drive is disconnected. In view of the fact that the arm 74 turns loosely on the shaft 64, it is not returned to its initial position when the drive of the forming wheel is reversed but remains in the position which it occupies in Fig. XV. The longitudinally split ring 121 can now be removed by tapping the end of the arm 70 with a hammer so as to drive it away from the split ring 121, an operation that is quite simple because of the fact that the arm turns loosely on the shaft 64. In this manner the split ring 121 may be removed, the arm 70 swiftly and easily swung back to its initial position, and the tube which has been bent, removed from the machine by a straight pull therefrom. In case the mandrel 124 should stick within the tube, the operator depresses pedal lever 145 and this throws the rod 123 which carries the mandrel 124 rearwardly against the tension of the spring 130. The spring 130 automatically returns the rod 123 to its normal position. The bracket 86 is adjustable upon the flange 82 and the stop pins 85 and 91 which are carried by the brackets 83 and 86, are also adjustable in the arms 83 and 90, so that the precise point at which the drive mechanism shall be disconnected can be very accurately determined. This is essential as this point determines the extent to which the bend shall be carried, as it determines the amount of movement of the forming or bending wheel. It will be observed that I have provided means for automatically disconnecting the drive at predetermined points in order to stop the bending movement. Furthermore, the mechanism is so arranged that the drive may be reversed so as to carry the bending wheel back to its initial position where it is automatically stopped at the precise point. The plunger 95 serves to prevent the rod 57 moving past either the neutral, direct or reverse drive positions and insures the accurate positioning of the rod 57 in order to secure the proper drive. It will be observed that, when the parts are in the position shown in Fig. VIII, it is impossible to so shift the rod 57 as to secure additional forward driving of the worm gear, but the rod 57 may be so shifted as to reverse the drive of the worm gear and, conversely, when the parts are in the position shown in Fig. V, the only movement of the rod 57 which may be effected, is that necessary to secure a forward drive of the worm gear and a reverse drive cannot be effected.

The arrangement of the traveling arm which grips the tube so that it turns loosely on the shaft 64 is one which enables the tube or pipe to be bent to be readily inserted in position and to be very quickly and conveniently removed after the bend has been completed. This arrangement affords very simple means for gripping the pipe.

I am aware that the particular embodiment of my invention, which I have here shown and described, is susceptible of considerable variation without departing from the spirit thereof, and, therefore, I desire to claim my invention broadly, as well as specifically, as indicated by the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A machine of the class described, comprising the combination of a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a wheel fixed on the upper end of said shaft above said table, and provided with a groove in its periphery; an arm loosely journaled on the upper end of said shaft adjacent to said wheel rotatable independently thereof, and provided with tube gripping means in the end thereof; a block mounted on said table; and a die carried by said block, and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel.

2. A machine of the class described, comprising the combination of a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel provided with a groove in the periphery thereof, said wheel being fixed on said shaft above said table; an arm journaled on said shaft adjacent to the wheel and rotatable independently thereof, the end of said arm being provided with tube gripping means; a block mounted on said table, and a die carried by said block and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel, the forward end of said die being in line with the axis of said shaft and said die extending in a direction tangent to the grooved portion of the bending wheel.

3. A machine of the class described, comprising the combination of a frame; a table supported thereby; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel, provided with a groove in the periphery thereof, fixed on the upper end of said shaft; a traveling arm journaled for free rotation on said shaft; said bending wheel having a shoulder adapted to engage said arm to turn the same in one direction; tube gripping means carried by the extremity of said arm; a block mounted on said table; and a die carried by said block and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel.

4. A machine of the class described, comprising the combination of a frame, provided with a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel fixed on the upper end of said shaft above said table, said wheel being provided with a groove in its periphery and a portion of the periphery of said wheel being cut away; an arm loosely mounted on the upper end of said shaft for rotation independently of said wheel and provided with a shoulder to engage the end of the cutaway portion of said bending wheel for turning the arm in one direction; tube gripping means carried by the end of said arm; a block mounted on said table; and a die carried by said block and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel.

5. A machine of the class described, comprising the combination of a frame, including a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a wheel having a sector of large radius and another of small radius, said large radius sector being provided with a groove in its periphery; an arm loosely mounted on the upper end of said shaft and provided with a shoulder extending in position to be engaged by the end of the large radius sector of said bending wheel; tube gripping means carried by the end of said arm; a block mounted on said table; and a die carried by said block and provided with a groove in its inner face mating with the groove in the periphery of the large radius sector of said bending wheel.

6. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel on the upper end of said shaft, comprising a large radius sector and a small radius sector, the large radius sector being provided with a groove in its periphery; a block mounted on said table; a die carried by said block and extending in a line tangent to the large radius sector of said wheel, said die being provided with a groove in its inner face mating with the groove in the large radius sector of said bending wheel, the forward end of the die being in line with the axis of said shaft; an arm loosely mounted on said shaft and provided with a shoulder extending in the path of the end of said large radius sector of the wheel; and tube gripping means carried by the end of said arm in line with the periphery of the large radius sector of said wheel.

7. A machine of the class described, comprising the combination of a frame, including a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel fixed on the upper end of said shaft and comprising a small radius sector and a large radius sector, said large radius sector being provided with a peripheral groove; a block mounted on said table and adjustable transversely thereof; a die carried by said block and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel; an arm loosely mounted on the upper end of said shaft adjacent said bending wheel and provided with a portion extending in position to be engaged by the end of the large radius sector of said wheel; and tube gripping means carried by said arm in line with the periphery of said large radius sector of said bending wheel.

8. A machine of the class described, comprising the combination of a frame provided with a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel fixed on the upper end of said shaft and comprising a small radius sector and a large radius sector, the latter sector being provided with a peripheral groove; a block mounted on said table and adjustable transversely thereof; a die carried by said block and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel; an arm loosely mounted on the upper end of said shaft, said arm being provided with a tapered opening having its center in line with the periphery of said large radius sector of the wheel; a portion extending from said arm in position to be engaged by the end of the large radius sector of the bending wheel; and a split tapered sleeve fitting in the tapered opening in the end of said arm.

9. A machine of the class described, comprising the combination of a frame provided with a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel fixed on the upper end of said shaft and comprising a small radius sector and a large radius sector, the latter sector being provided with a peripheral groove; a block mounted on said table and adjustable transversely thereof parallel to one diameter of said bending wheel; a die carried by said block and provided with a groove in its inner face mating with the peripheral groove of said bending wheel; a traveling member comprising a body having a tapered opening therein, a pair of separated arms, the ends of the arms being loosely journaled on said shaft, one of said

arms being disposed above and the other below said bending wheel, and the length of said arms being less than the radius of said large radius sector and greater than the radius of said small radius sector; and a longitudinally split tapered sleeve disposed in the tapered opening in said member.

10. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel fixed on the upper end of said shaft and comprising a small radius sector and a large radius sector, the latter sector being provided with a peripheral groove; a block mounted on said table; a die carried by said block and provided with a groove in its inner face mating with the peripheral groove of said bending wheel; an arm loosely mounted on said shaft and having a portion adapted to be engaged by the end of said large radius sector; tube gripping means carried by the end of said arm; a mandrel disposed in the forward end of the groove in said die; and a rod carrying said mandrel.

11. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; means for driving the shafts; a bending wheel fixed on the upper end of said shaft and including a small radius sector and a large radius sector, the latter sector having a peripheral groove; an arm loosely mounted on the upper end of said shaft and having a portion adapted to be engaged by the end of said large radius sector; tube gripping means carried by the end of said arm; a block slidably mounted on said table; a die carried by said block and provided with a groove in its inner face; and a mandrel mounted in the forward end of said groove between said die and said bending wheel.

12. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel fixed on the upper end of said shaft and provided with a small radius sector and a large radius sector, the latter sector being provided with a peripheral groove; an arm loosely mounted on said shaft and having a portion extending in the path of the end of the large radius sector; tube gripping means carried by the end of said arm; a block mounted on said table and adjustable transversely thereof; a die carried by said block and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel; a mandrel supporting rod; a mandrel carried by said rod and disposed between the end of the groove in said die and the periphery of said bending wheel; a stop on said rod and means for retracting said mandrel supporting rod.

13. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; means for driving said shaft; a bending wheel fixed on said shaft and provided with a peripheral groove; an arm mounted on said shaft and movable in one direction with said bending wheel, the end of said arm being provided with a tapered opening; a split sleeve tapered to correspond to and fitting in said opening; and a fixed die provided with a groove in its inner face mating with the groove in the periphery of said bending wheel.

14. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft extending through said table; means for driving said shaft; a bending wheel, provided with a peripheral groove, fixed on the upper end of said shaft; an arm rotatably mounted on said shaft; tube gripping means carried by the end of said arm; coöperating stops on said arm and bending wheel respectively, adapted to carry said arm with said bending wheel in one direction; and a die mounted on said table and provided with a groove in its inner face mating with the groove in the periphery of said bending wheel.

15. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; a bending wheel on the upper end of said shaft; a traveling tube gripping arm rotatably mounted on the shaft and moving in one direction with said bending wheel; a fixed die having a groove to receive the tube; means for driving the shaft in a forward direction; an automatic stop to limit the forward driving movement; means for driving the shaft in the reverse direction; and an automatic stop for limiting the reverse driving movement.

16. A machine of the class described, comprising the combination of a frame including a table; a driving shaft; a vertically disposed shaft having its upper end extending through said table; a bending wheel fixed on the upper end of said shaft; a traveling arm rotatably mounted on the shaft and moving in one direction with said bending wheel; a fixed die provided with a groove in its inner face adapted to receive the tube; forward and reverse drive connections between said driven shaft and said vertical shaft; automatic stops for disconnecting said for-

ward and reverse drive connections at predetermined points in the revolution of said vertical shaft; and manually operable means for connecting said forward and reverse drive connections.

17. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; a bending wheel fixed on the upper end of said shaft; a traveling arm rotatably mounted on the shaft and moving in one direction with said wheel and provided with tube gripping means at the outer end; a fixed die provided with a groove adapted to receive the tube; means for driving said shaft in the forward direction; a stop adjustably fixed relative to said shaft and adapted to limit the drive in a forward direction; means for driving the shaft in the reverse direction; and a second stop adjustably fixed relative to the shaft and adapted to limit the drive in the reverse direction.

18. A machine of the class described, comprising the combination of a frame including a table; a vertically disposed shaft having its upper end extending through said table; a bending wheel fixed on the upper end of said shaft; a traveling arm rotatably mounted on the shaft and moving in one direction with said bending wheel and provided with tube gripping means at its outer end; a fixed die provided with a groove adapted to receive the tube; a transversely mounted shaft geared to said vertical shaft; a pair of pinions mounted on said shaft; means for simultaneously driving said pinions in opposite directions; a clutch member non-rotatably and slidably connected with said shaft; and means for shifting said clutch member into engagement with one or the other of said pinions to drive the shaft in the forward or the reverse direction.

19. In a machine of the class described, a table, a shaft having one end extending through the table, a bending wheel fixed to said shaft above the table, an arm loosely journaled on the upper end of said shaft above the table, and means carried by the bending wheel for engaging the arm and causing it to rotate therewith during a portion of the rotative movement of the bending wheel.

20. In a machine of the class described, a table, a shaft having one end extending through the table, a bending wheel fixed to said shaft above the table, an arm carried by the upper end of said shaft above the table, and means including a split ring for gripping a tube, said ring being detachably supported in a conical bearing in the free end of the arm.

21. In a machine of the class described, a table, a shaft having one end extending through the table, a bending wheel fixed to said shaft above the table, an arm carried by the upper end of said shaft above the table, and tube gripping means comprising a split ring provided with a roughened interior surface and a conical outer surface carried by one end of the arm.

22. In a machine of the class described, a table, a shaft having one end extending through the table, a bending wheel fixed to said shaft above the table comprising a large radius sector and a small radius sector, an arm loosely mounted upon the upper end of the shaft and engageable by the large radius sector of the wheel whereby the arm may be rotated simultaneously with or independently of the wheel.

23. In a machine of the class described, a table, a shaft having one end extending through the table, a bending wheel fixed to said shaft above the table, an arm loosely mounted on the upper end of the shaft, and means for rotating the arm simultaneously with the wheel and at the same angular speed during a part of the rotation of the wheel, said means permitting the wheel to rotate independently of the arm for limited distances during the rotation of the wheel.

24. In a machine of the class described, a table, a vertically positioned driving shaft extending through the table, means for driving said shaft, a bending wheel fixed to said shaft above the table, an arm loosely journaled on said shaft and rotatable thereon independently of said wheel, and means carried by the bending wheel for engaging said arm and causing it to rotate therewith during a portion of the rotative movement of the bending wheel.

In testimony whereof, I affix my signature.

EDWARD KAMPER.