

May 29, 1923.

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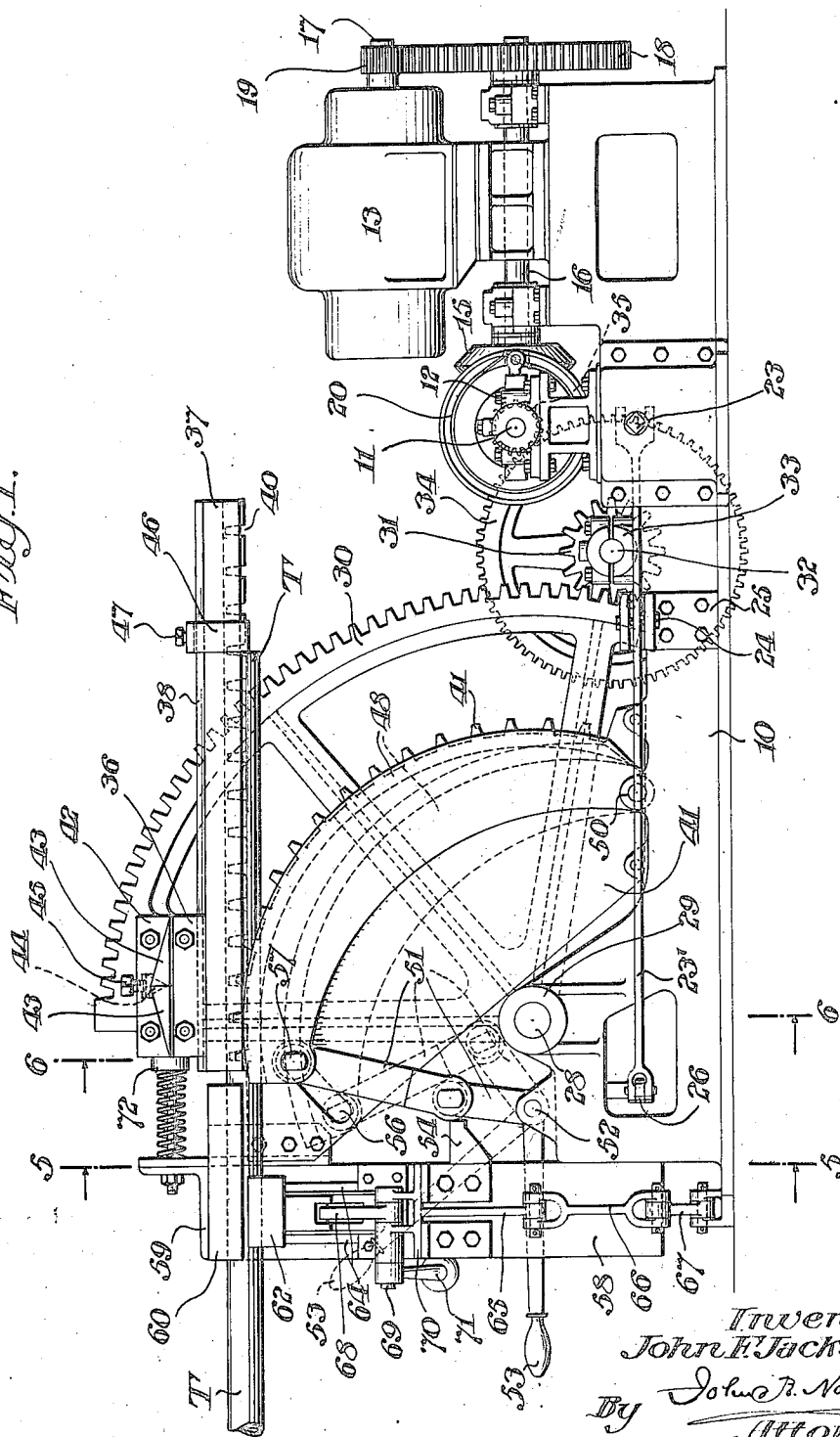
J. F. JACKSON

TUBE BENDING MACHINE

Filed Feb. 19, 1921

4 Sheets-Sheet 1

Fig. 1.



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May 29, 1923.

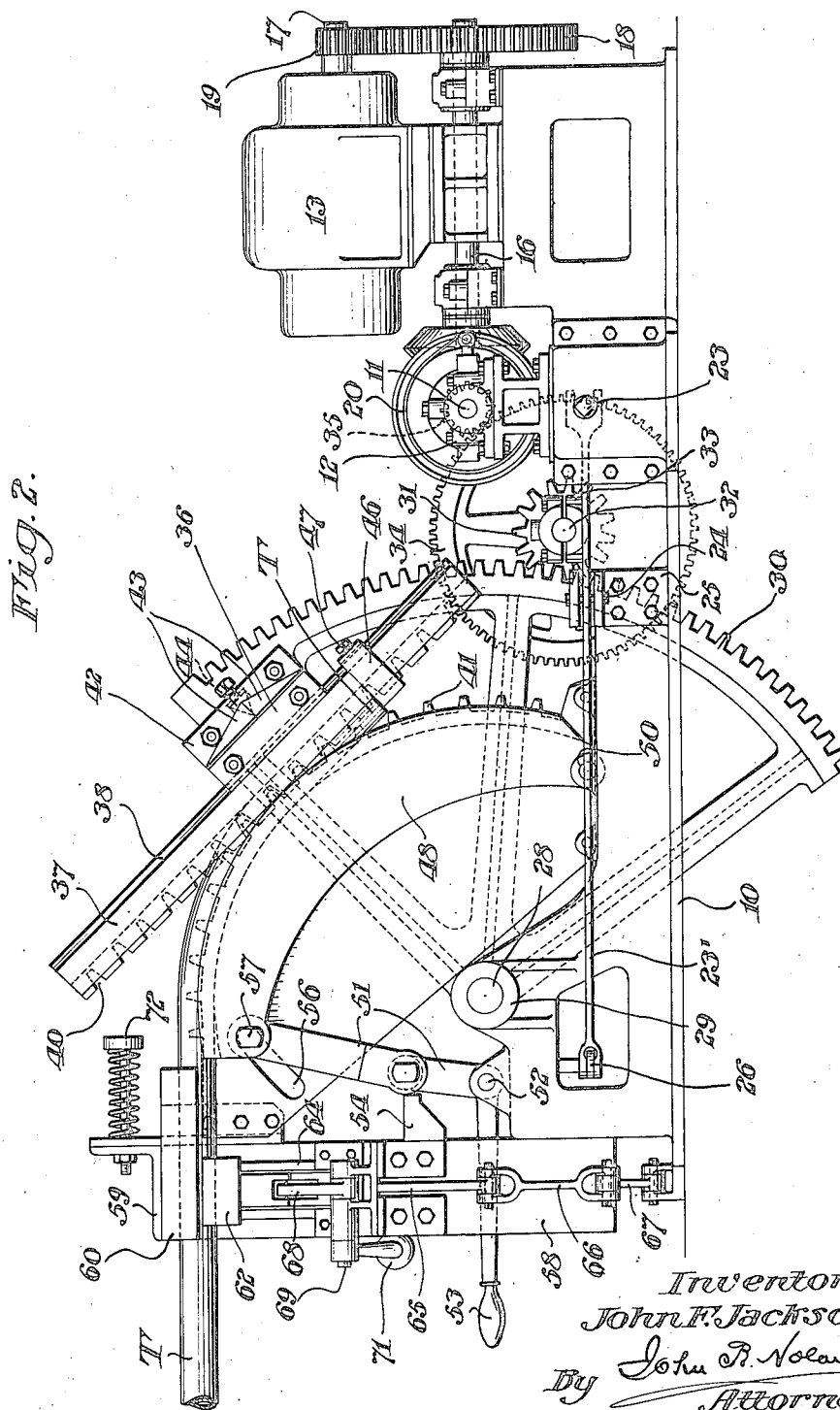
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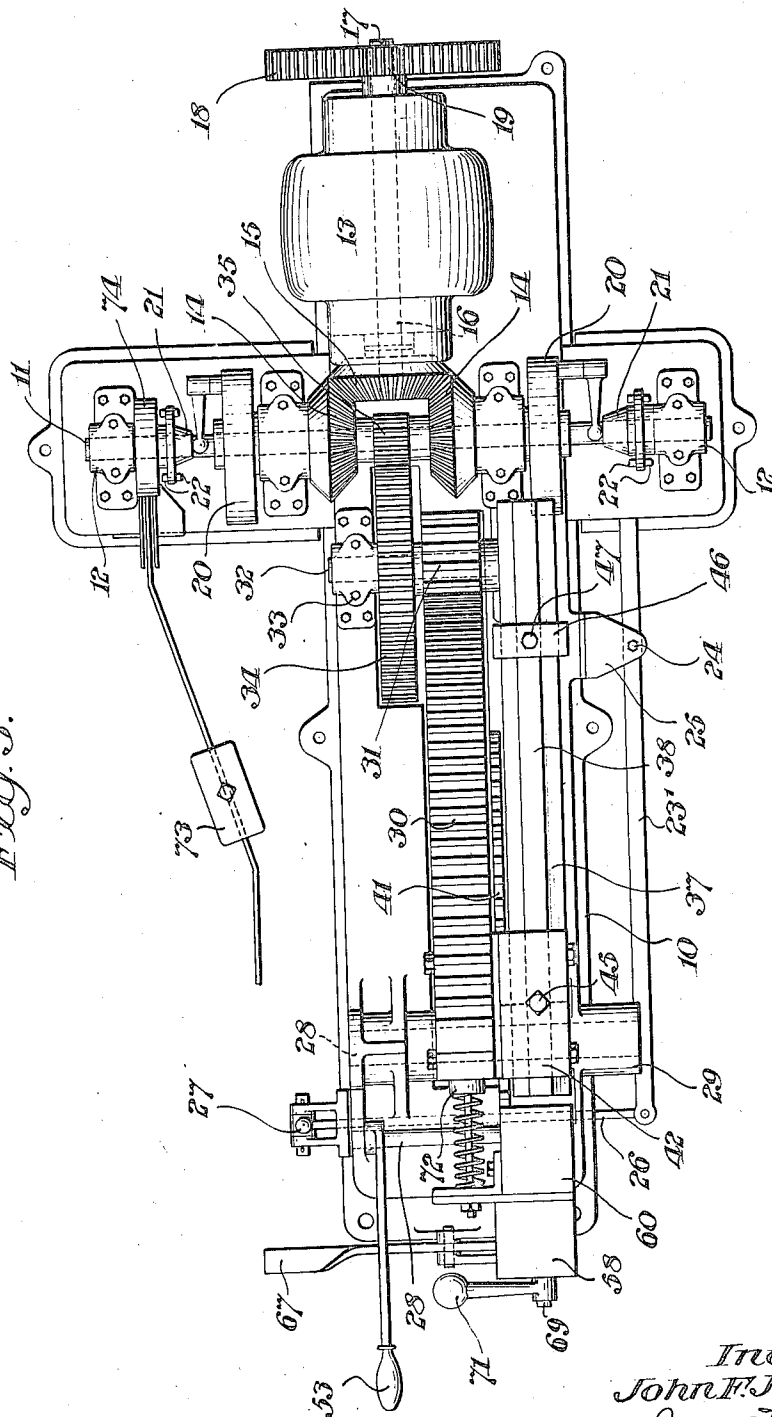
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Fig. 3.



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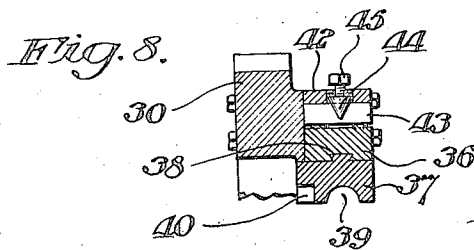
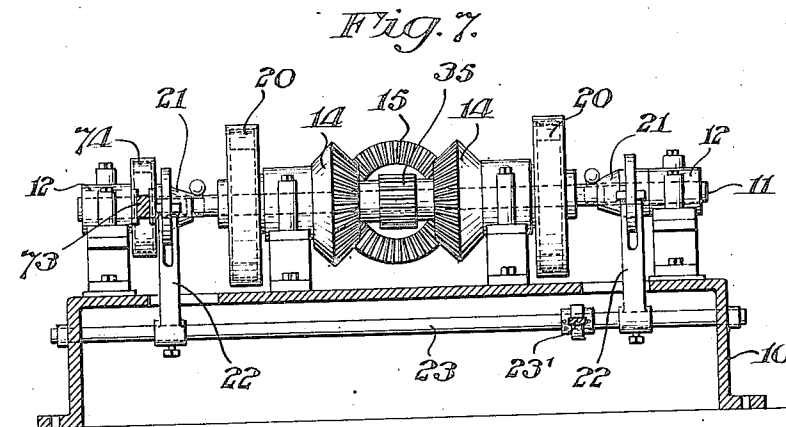
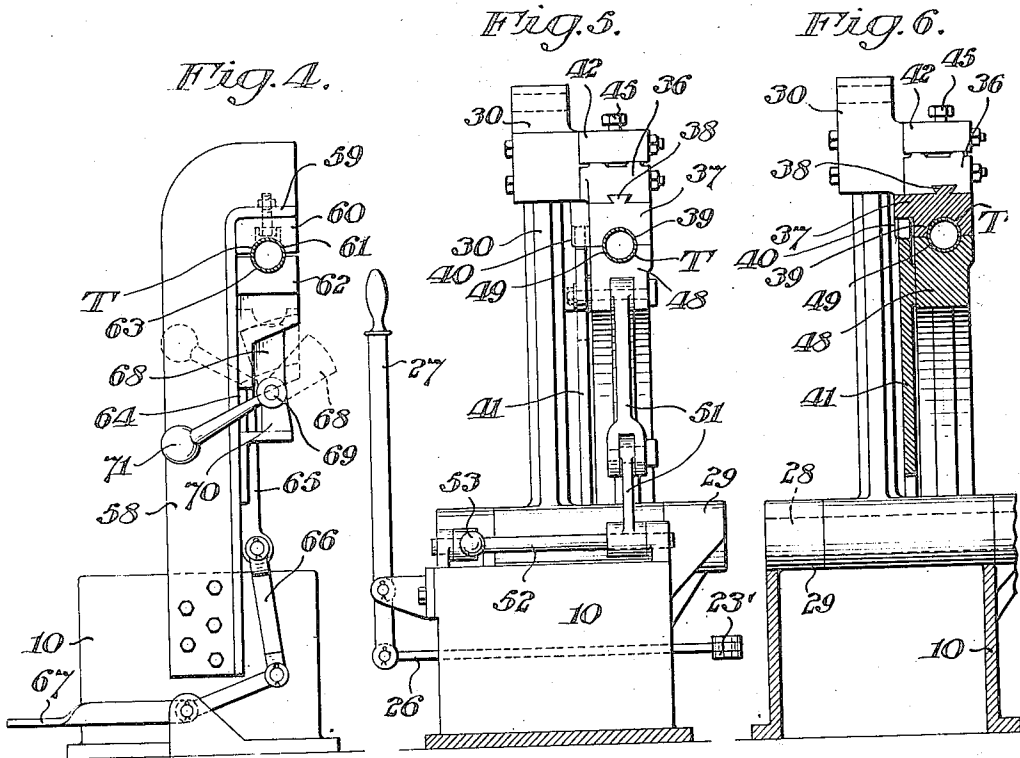
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TUBE BENDING MACHINE

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

JOHN F. JACKSON, OF MILWAUKEE, WISCONSIN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO KIDWELL BOILER COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

TUBE-BENDING MACHINE.

Application filed February 19, 1921. Serial No. 446,208.

To all whom it may concern:

Be it known that I, JOHN F. JACKSON, a citizen of the United States, and resident of Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Tube-Bending Machines, of which the following is a specification.

This invention relates to a machine for bending metal tubes, and more especially boiler tubes which are made of relatively thin and ductile metal. It is essential that the bend of a boiler tube be absolutely smooth throughout its length, without any distortion on either the convex or the concave side of the tube, as the uniformity of the bore must be maintained along the bend in order to permit a tube cleaner to pass through the bore without obstruction. It is also essential that the integrity of the surface of the tube be maintained, as any scratching or shearing of the metal may later develop into a rupture.

The object of my invention is to provide a machine of simple yet efficient construction and operation whereby tubes can be readily and properly bent to a given radius and with any length of arc on the bend that may be desired.

To this end my invention, generally stated, comprises, in a tube bending machine, co-related former and presser members between which the portion of the tube to be bent is interposed, and means for operating said members in such relation to each other and to the tube that pressure is uniformly applied by rolling contact progressively along the interposed tube portion.

The invention also comprises various features of construction and combinations of parts which will be hereinafter described and claimed.

In the drawings—

Figure 1 is a side elevation of a tube-bending machine embodying my invention, showing a tube as clamped in place, and illustrating the various elements of the machine in the relative positions which they occupy preparatory to the tube-bending operation.

Fig. 2 is a similar view showing relative positions of the parts during the bending operation.

Fig. 3 is a plan of the machine,

Fig. 4 is a front end elevation thereof.

Fig. 5 is a transverse vertical section of the machine, on the line 5—5 of Fig. 1.

Fig. 6 is a similar section of the same, on the line 6—6 of Fig. 1.

Fig. 7 is a transverse vertical section adjacent the main shaft, showing the gearing and clutch-devices thereon.

Fig. 8 is a sectional detail of the presser bar, its guide and thrust heads and the adjacent part of the sector gear, showing adjustable wearing shoes between said heads.

Referring to the drawings, 10 designates a substantial supporting bed; 11 a power driven shaft journaled in suitable bearings 12 adjacent one end of the bed, and 13 an electric motor supported in proximity to the shaft and operatively geared therewith in such a manner that the shaft may be rotated in either forward or reverse direction as desired. In the present instance the shaft 11 has loosely mounted thereon a pair of oppositely-disposed bevel wheels 14 in mesh with a similar wheel 15 fast on a shaft 16 which is driven from the motor shaft 17 through meshing gears 18, 19 respectively. Suitable clutches 20 are provided whereby either of the wheels 14 can be affixed to the shaft 11, or whereby both wheels can be disengaged at the same time, thus permitting rotation of the shaft in either forward or reverse direction, or stopping its rotation, as desired. Ordinary clutches of the band and lever type operated by sliding cone-heads 21 on the shaft 11 are illustrated; said heads being connected to up-standing arms 22 on a shifter-rod 23 mounted beneath the bed. This rod is connected to one arm of a long horizontal lever 23' which is pivoted, as at 24, to a bracket 25 on one side of the bed, the forward arm of the lever being connected by means of a link 26 to a suitably-disposed hand-lever 27. By properly operating the hand-lever, the lever 23' can be moved to shift the rod 23 transversely of the bed and thus position the cone-heads to effect the clutching of either bevel wheel 14 to the shaft 11, or the disengagement of both wheels, as desired.

Fast on a transverse shaft 28 which is journaled in suitable bearings 29 on the bed, near the forward end of the latter, is a sector gear 30 which is operatively connected through a suitable train of gears with the

power driven shaft 11. In the present instance, the sector gear meshes with a pinion 31 fast on a transverse shaft 32 which is journaled in bearings 33 on the bed. Fast on the shaft 32 is a spur wheel 34 in mesh with a pinion 35 on the shaft 11. Hence during the forward or the reverse motion of the shaft 11, as determined by the relative position of the clutch mechanism, corresponding motion is transmitted to the sector gear. Bolted to the upper portion of the sector gear, laterally thereof, is a head block 36 in the lower face of which is slidably fitted a relatively long steel bar 37, preferably by a dove-tail connection 38 as shown most clearly in Figs. 5, 6 and 8. The under-face of this bar is provided throughout its length with a groove 39, which is semi-circular in cross-section correspondingly with the curvature of the top of the tube (T) to be operated upon. The bar is provided on its under side, laterally of the grooved portion, with a longitudinal gear rack 40 in mesh with a stationary segment gear 41 concentric with the sector gear 30, whereby when the latter gear is actuated the rack rolls upon the teeth of the segment gear and thus gradually tilts the bar 37, the connection 38 between the head-lock 36 and the bar permitting relative sliding movement between the sector gear and the bar to compensate for the varying angularity of the latter as it progresses along the form, as illustrated in Fig. 2. A thrust block 42 for the head-block is bolted to the sector gear, and a pair of wearing pieces 43, preferably oppositely-disposed wedges, are interposed between the blocks. The under face of the block 42 is properly beveled to receive the respective wedges and maintain their flat faces upon the head-block. A cone 44 is fitted between the adjoining ends of the wedges, and a set-screw 45 entered in the top of the thrust block 42 bears upon the cone. By manipulating the screw the cone can be advanced to a greater or less extent in order to spread the wedges apart and thus take up any lost motion due to wear between the same and the adjacent blocks.

Slidably mounted on the bar 37 is a gauge or stop 46 which can be adjusted to any desired position along the bar, and then be secured in its position of adjustment by means of a set-screw 47.

Adjacent the grooved surface of the bar is a segmental form 48 having in its periphery a groove 49 corresponding in cross-section with the groove of the bar and having the same radius as the tube portion to be bent, whereby when the form is supported in close relation to the bar the two proximate grooves provide at the point of tangency a circular opening corresponding with the curvature of the tube in cross-section.

Provision is had whereby the segmental

form may be raised and lowered and its grooved periphery thus be moved into close relation to or dropped below the path of the grooved surface of the tangentially-disposed presser bar as desired. In the present instance the form is pivoted at its lower end to the bed, as at 50, the upper end of the form being connected to the bed by a pair of toggle-links 51. The pivot connection 52 of the lower toggle link with the bed is provided with a hand-lever 53, by the manipulation of which the toggle can be swung forward to lower or backward to raise the form. A suitably-disposed stationary stop 54 limits the backward movement of the toggle. When in that position the links are slightly off center, thus rigidly holding the form in place. Said form is laterally-supported by the body of the stationary segmental gear 41, which body is provided with a suitably-disposed arcuate slot 56 that receives a guide pin 57 at the upper end of the form. At the forward end of the bed, adjacent the form, is a standard 58 having at its upper end an overhang 59 to which is bolted a horizontally-disposed clamp block 60 having in its under surface a groove 61 corresponding in cross-section with that of the bar and in axial alinement with the latter groove when the bar is in the raised or horizontal position, seen in Fig. 1. Immediately below this block 60 is a complementary clamp block 62 which is grooved in its upper surface, as at 63, similarly to the block 60. The block 62 is vertically grooved and is slidably fitted to a guide rib 64 on the standard. This block is provided with a depending rod 65 which is connected by means of a link 66 to the rearwardly extending arm of a foot lever 67, by the operation of which lever the block 62 can be quickly raised or lowered; the vertical throw of the block being sufficient in extent to permit a tube to be passed sideways between the two blocks, either for insertion therebetween or removal. When the tube is inserted between the blocks and the lower block is raised as just mentioned, the tube is thereby clamped in place, but, in the actual operation of the machine, a still more effective clamping of the tube is desirable. Accordingly I provide an auxiliary clamp comprising a cam head 68 fast on a shaft 69 journaled in a bracket 70 on the standard. Shaft 69 is provided with an operating handle 71 and the cam head is mounted to be swung in a transverse slot in the base of the block and forcibly against the latter when the block is in its raised or clamping position.

The operation of the machine above described is briefly as follows: Assuming both the clamp block 62 and the form 48 to be lowered, and the presser bar 37 to be in horizontal position, the end of the tube, T, to

be bent is positioned in the alining grooves of the block 60 and bar 37 respectively. The free end of the tube is moved into contact with the gauge 46 which has been previously
 5 adjusted in accordance with the length of the arc to be formed on the tube. The body of the tube is then clamped between the blocks 60, 62 and the auxiliary clamping cam 68 is moved into locking position. The
 10 form 48 is then raised by the operation of the toggle devices so as to clamp the end portion of the tube between the form and the presser bar. This done, the operator properly shifts the clutch mechanism in
 15 order that the motion and power transmitted to the shaft 11 from the motor shall effect, through the gearing described, the downward motion of the sector gear 30. This gear bodily carries the presser bar 37
 20 therewith, which bar performs is gradually and positively tilted during its travel, as seen in Fig. 2, its rack 40 steadily turning on the succeeding meshing teeth of the gear 41 and the grooved portion 39 of the bar
 25 bearing uniformly upon the opposing top of the tube and exerting thereon a progressive rolling non-sliding pressure in a manner to bend the tube in a curve corresponding with the radius of the periphery of the form and to any length of arc within the prescribed
 30 limits. When the bend of the tube is completed the operator shifts the clutch mechanism to effect the reversal of the direction of motion of the shaft 11, whereupon the
 35 sector gear and the presser bar are returned to the position shown in Fig. 1. He then lowers the segmental form and the block and cam clamping devices carried by the standard 58, thus releasing the bent tube. This
 40 tube is removed; a new tube is inserted in the machine, and the bending operation is repeated, and so on.

From the foregoing described construction and operation it will be seen that boiler tubes of relatively thin and ductile material can be rapidly and economically bent to a given
 45 radius and with any length of arc on the bend that may be desired, such arc varying over a considerable range according to the position the tube is to occupy in the boiler. It will also be seen that the progressive
 50 pressure which is applied to and longitudinally of the tube by the tangentially-disposed rolling bar ensures an absolutely smooth and uniform bend without any crippling or distortion of the interior or the exterior surface of the tube, and without any
 55 scratching or shearing of the exterior surface. Further, owing to the absence of sliding friction of the presser bar on the opposing surface of the tube, the use of grease or graphite on the tube is obviated, and at the same time the wearing action on the bearing
 60 surface of the bar is reduced to a minimum.

The standard 58 preferably supports a spring-pressed bumper 72 in the path of the thrust and head blocks on the sector gear, which bumper receives and cushions the impact of such blocks when the bar is returned
 70 to its horizontal position.

73 is simply a weighted lever which is connected to a friction band brake 74 on the drive shaft.

It is to be understood that I do not limit
 75 my invention to the particular construction herein disclosed, as the mechanism may be considerably modified within the principle of the invention and the scope of the appended claims.

I claim:—

1. In a tube-bending machine, a supporting structure, a form member thereon having a curved tube-supporting surface, a
 80 presser bar approximately tangential to said surface and having a longitudinal tube-engaging surface means for clamping at a point beyond the form member the body of a tube which is interposed between said
 85 surfaces in a plane longitudinally of the presser bar, means for supporting said bar and bodily rolling it in close relation to the curved surface of the form member, whereby the bar exerts a progressive non-sliding pressure upon the tube, and means
 90 for bodily moving said form member into and out of clamping relation to the tube.

2. In a tube-bending machine, a supporting structure, a form member thereon having a curved tube-supporting surface, a
 100 presser bar approximately tangential to said surface and having a longitudinal tube-engaging surface, means for supporting said bar and bodily rolling it in close relation to the curved surface of the form member, whereby the bar exerts a progressive non-sliding pressure upon a tube interposed between said surfaces in a plane longitudinally of the bar, and means for bodily lowering
 105 and raising said form member in relation to the presser bar.

3. In a tube-bending machine, a supporting structure, a form member thereon having a curved tube-supporting surface, a presser
 110 bar approximately tangential to said surface and having a longitudinal tube-engaging portion, an oscillatory element movable through an arc concentric to the said supporting surface, a sliding connection between said element and the presser bar, means for clamping at a point beyond the form member the body of a tube which is interposed between the form member and the bar, means for actuating said element, whereby the bar is operated to exert a progressive non-sliding pressure upon the tube, and means for bodily moving said form member into and out of clamping relation to the tube.

4. In a tube-bending machine, a support- 130

ing structure, a form member thereon having a curved tube-supporting surface, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging portion, an oscillatory element movable through an arc concentric to the said supporting surface, a sliding connection between said element and the presser bar, means for actuating said element, whereby the bar is operated to exert a progressive non-sliding pressure upon a tube interposed between said surfaces in a plane longitudinally of the bar, and means for bodily lowering and raising said form member in relation to the presser bar.

5. In a tube-bending machine, a supporting structure, tube-clamping and releasing mechanism thereon, a form member arranged in proximity to said clamping mechanism and having a curved tube-supporting surface, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging surface, means for supporting said bar and bodily rolling it in close relation to the curved surface of the form member, whereby the bar exerts a progressive non-sliding pressure upon a tube clamped by said mechanism and interposed between said surfaces in a plane longitudinally of the bar, and means for bodily moving said form member into and out of clamping relation to the tube.

6. In a tube-bending machine, a supporting structure, tube-clamping and releasing mechanism thereon, a form member arranged in proximity to said clamping mechanism and having a curved tube-supporting surface, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging surface, means for supporting said bar and bodily rolling it in close relation to the curved surface of the form member, whereby the bar exerts a progressive non-sliding pressure upon a tube interposed between said surfaces in a plane longitudinally of the bar, and means for bodily lowering and raising said form member in relation to the presser bar.

7. In a tube-bending machine, a supporting structure, tube-clamping and releasing mechanism thereon, a form member arranged in proximity to said clamping mechanism and having a curved tube-supporting surface, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging portion, an oscillatory element movable through an arc concentric to the said supporting surface, a sliding connection between said element and the presser bar, means for actuating said element, whereby the bar is operated to exert a progressive non-sliding pressure upon a tube clamped by said mechanism and interposed between said surfaces in a plane longitudinally of the bar, and means for bodily

moving said form member into and out of clamping relation to the tube.

8. In a tube-bending machine, a supporting structure, a tube-clamping and releasing mechanism thereon, a form member arranged in proximity to said clamping mechanism and having a curved tube-supporting surface, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging portion, an oscillatory element movable through an arc concentric to the said supporting surface, a sliding connection between said element and the presser bar, means for actuating said element, whereby the bar is operated to exert a progressive non-sliding pressure upon a tube interposed between said surfaces in a plane longitudinally of the bar, and means for bodily lowering and raising said form member in relation to the presser bar.

9. In a tube-bending machine, a supporting structure, a segmental form member pivoted at its lower end to said structure, a toggle-connection between the upper end of said member and the structure, whereby said form member can be raised and lowered, a presser bar approximately tangential to the periphery of the form member and having a longitudinal tube-engaging surface, and means for supporting said bar and bodily rolling it in close relation to the periphery of the form member when said member is in raised position.

10. In a tube-bending machine, a supporting structure, a form member thereon having a curved tube-supporting surface, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging surface and a longitudinal gear rack, a stationary gear with which the rack is in mesh, said gear being concentric with the tube-supporting surface of the form member, an oscillatory element movable through an arc concentric to the said supporting surface, a sliding connection between said element and the presser bar, means for actuating said element, and means for bodily moving the form member into and out of clamping relation to a tube interposed between the said surfaces in a plane longitudinally of the bar.

11. In a tube-bending machine, a supporting structure, a form member thereon having a curved tube-supporting surface, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging surface and a longitudinal gear rack, a stationary gear with which the rack is in mesh, said gear being concentric with the tube-supporting surface of the form member, a sector gear rotatable in a path concentric to the said supporting surface, a guide block fast on said sector gear and slidably supporting the presser bar, gearing for actuating said sector gear, and means

for bodily moving the form member into and out of clamping relation to a tube interposed between the said surfaces in a plane longitudinally of the bar.

5 12. In a tube-bending machine, a supporting structure, a form member thereon having a curved tube-supporting surface, a presser element arranged in close relation to said surface and operable to bear upon
10 and bend a tube imposed on the form member, means for supporting and operating said presser element, and means for bodily lowering and raising said form member in relation to the presser element.

15 13. In a tube-bending machine, a supporting structure, and tube clamping and releasing mechanism thereon comprising stationary and movable blocks having complementary clamping surfaces, means for

shifting the movable block toward and from 20 the stationary block, cam means operable to engage the movable block and lock it in clamping position, a form member arranged in proximity to said clamping mechanism and having a curved tube-supporting sur- 25 face, a presser bar approximately tangential to said surface and having a longitudinal tube-engaging surface, means for supporting said bar and bodily rolling it in close relation to the curved surface of the 30 form member, and means for bodily lowering and raising said form member in relation to the presser bar.

Signed at Milwaukee, in the county of Milwaukee and State of Wisconsin, this 35 15th day of February A. D. 1921.

JOHN F. JACKSON.