

J. A. MILLER.
 APPARATUS FOR BENDING PIPES, RODS, &c.
 APPLICATION FILED SEPT. 3, 1909.

1,105,914.

Patented Aug. 4, 1914.

4 SHEETS—SHEET 1.

Fig. 1

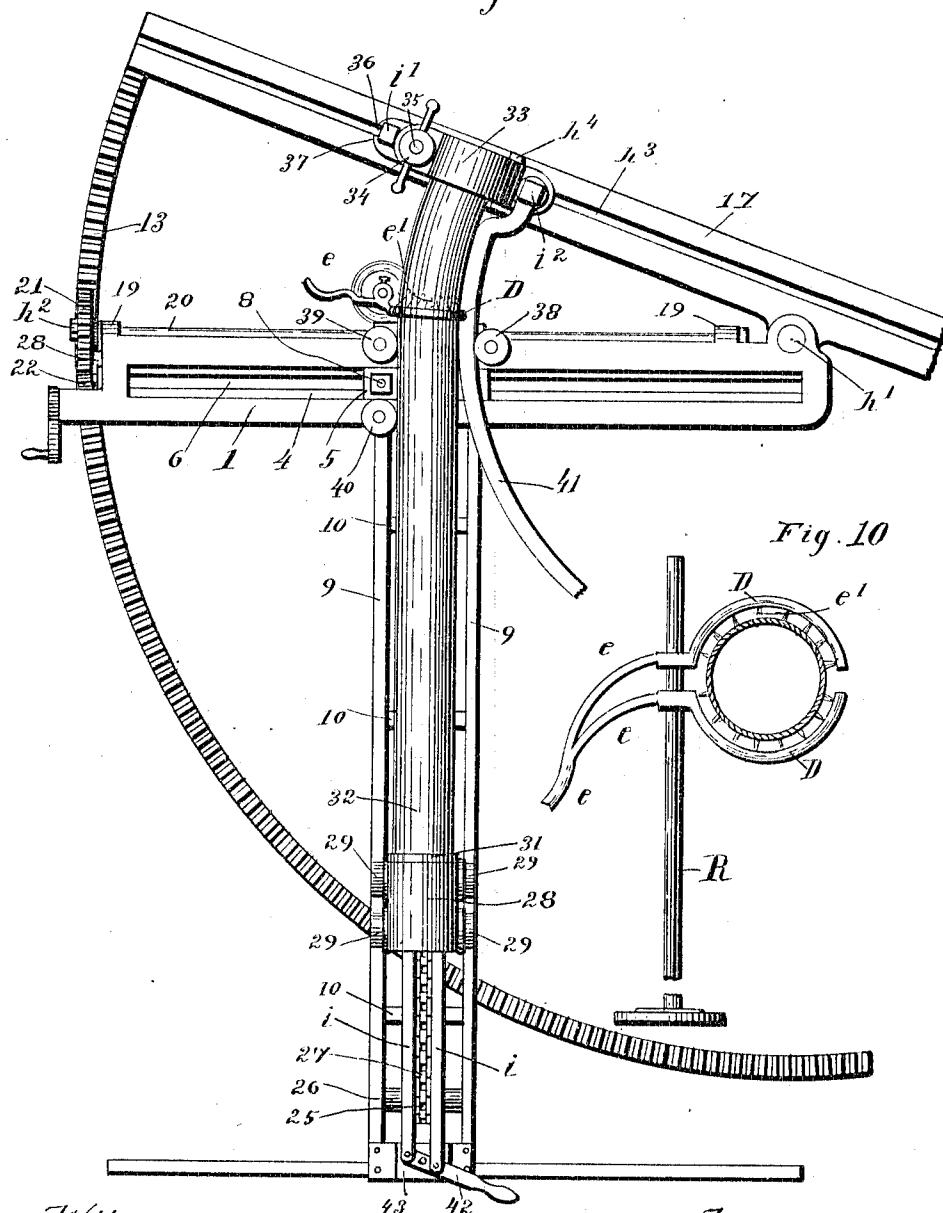


Fig. 10

Witnesses.
 Frank H. Fairweather
 Arthur R. R. R.

Inventor.
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4 SHEETS—SHEET 2.

Fig. 2

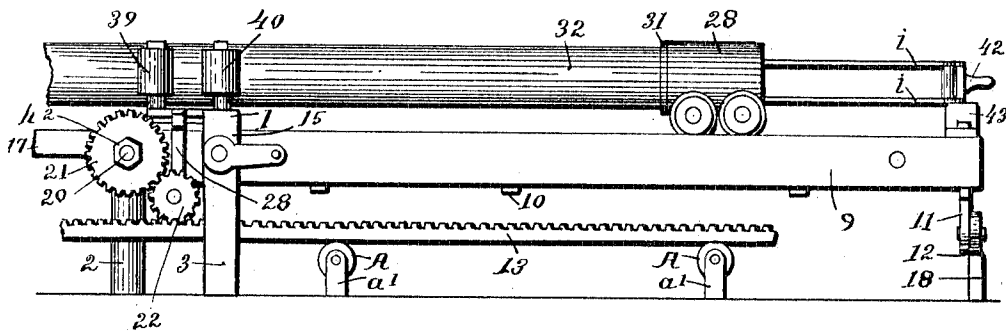


Fig. 3

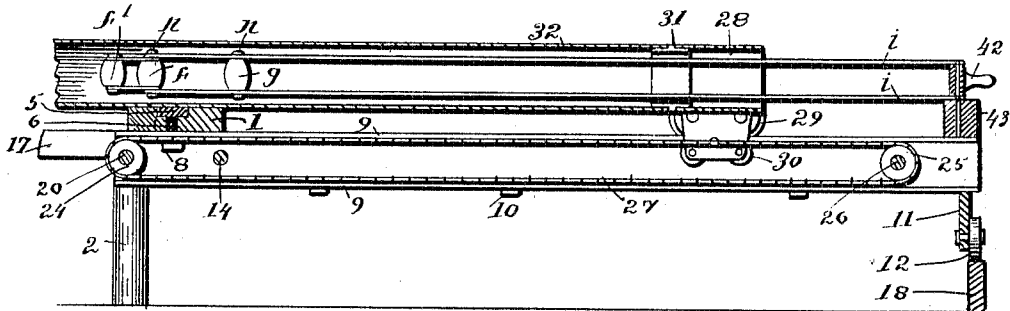
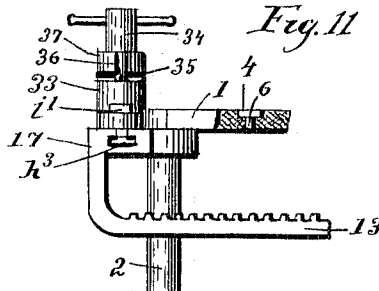


Fig. 11



Witnesses.
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4 SHEETS—SHEET 3.

Fig. 4

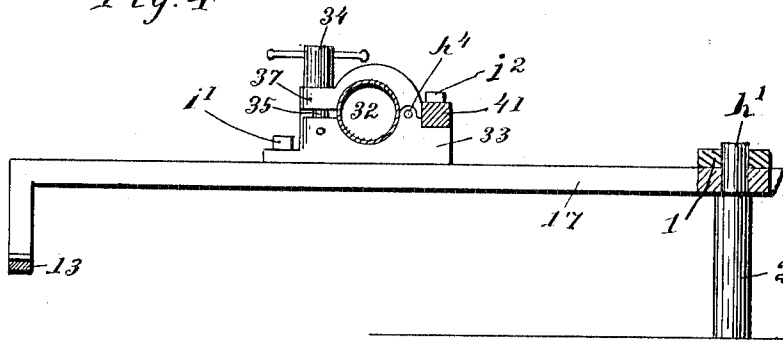


Fig. 5

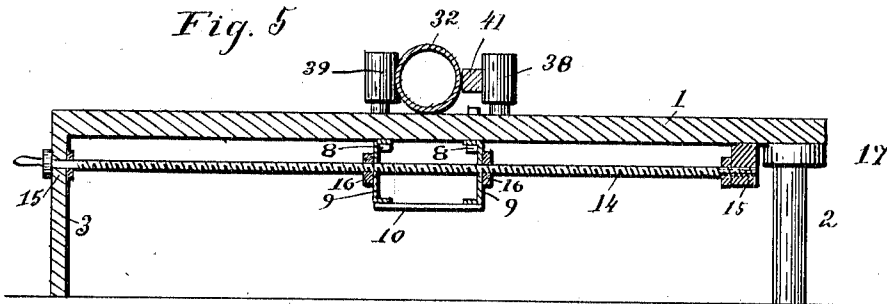
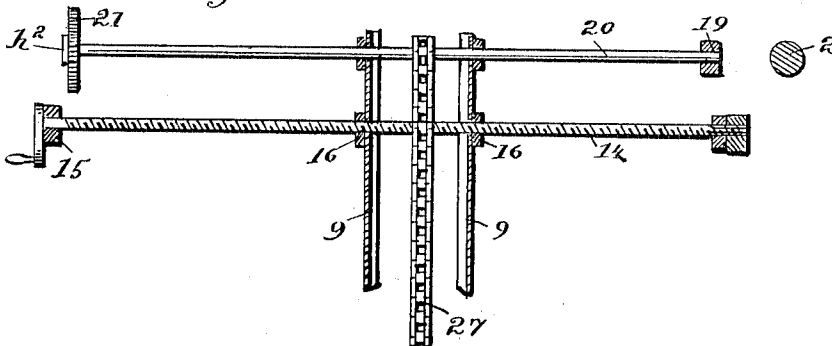


Fig. 6



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UNITED STATES PATENT OFFICE.

JAMES ACTON MILLER, OF JERSEY CITY, NEW JERSEY.

APPARATUS FOR BENDING PIPES, RODS, &c.

1,105,914.

Specification of Letters Patent.

Patented Aug. 4, 1914.

Application filed September 3, 1909. Serial No. 516,147.

To all whom it may concern:

Be it known that I, JAMES ACTON MILLER, of Jersey City, in the county of Hudson and in the State of New Jersey, have invented a certain new and useful Improvement in Apparatus for Bending Pipes, Rods, &c., and do hereby declare that the following is a full, clear, and exact description thereof.

My invention relates to improvements in bending pipes, rods, etc., and it has for its object to provide a method of and machine for bending pipe, etc., to different radii with facility and certainty of result, and particularly for bending large pipes or other articles hot, although adaptable for bending pipes, rods, etc., of all diameters, material or thickness, either hot or cold, as required.

The invention consists in the novel arrangement, combination and construction of parts substantially as hereinafter more fully described and claimed.

In the accompanying drawings forming a part of this specification: Figure 1 is a plan view of a bending machine embodying my invention, shown in the operation of bending a pipe. Fig. 2 is a side elevation, viewed lengthwise and from the outer end of the fixed or stationary frame of the machine. Fig. 3 is a central vertical section through the pipe carriage and carriage track with the pipe shown mounted thereon. Fig. 4 is a vertical section. Fig. 5 is a vertical section. Fig. 6 is a horizontal section through the carriage track. Fig. 7 is a central horizontal section through the pipe and the mandrel rolls. Fig. 8 is a central vertical section through the pipe and mandrel rolls of Fig. 7. Fig. 9 is a cross section. Fig. 10 is a cross section of the pipe on the bending plane, and a view of the pipe cooling mechanism. Fig. 11 is a detail view of the tube supporting chuck or clamp.

Referring to the drawings 1 designates a fixed or stationary frame, comprising a heavy plate or girder mounted horizontally on suitable supporting legs 2, 3 at its ends which may be bolted to the floor or embedded therein for insuring stability, but need not here be shown so secured, or further described. The frame is formed with a lengthwise groove 4 on its upper side which receives a slide 5, adapted to be moved freely therein, and a slot 6 is cut through the plate centrally of the groove to the lower side thereof. Through said slot are passed the bolts 8 which connect the slide with the ends of a

pair of parallel channel beams 9 beneath the frame, which are tied together by suitable cross bars 10 and comprise a double rail track at right angles to the frame. The opposite end of this track is supported by a leg 11 carrying a roll 12, which travels upon a rail 13 fastened to the floor. By means of this construction the track may be moved to any position along the frame and secured rigidly in such position by the clamping bolts 8. For the purpose of moving the carriage track along the frame, a screw shaft 14 is provided, suitably journaled in bearings 15 in the frame and passing through nut collars 16 riveted to the channel beams 9.

The leg 2 of the frame is a cylindrical column having a journal 17 upon its upper end which passes through the frame and through a movable lever 17 which is thus pivoted upon the fixed frame with its end resting thereon. To the outer end of this lever a circular rack 13 is attached, and having the pivotal point of the lever as a center. The lever may extend past the center to an equal length on the opposite side thereof, and attach to the rack at that end as indicated brokenly in Fig. 1, in which case the rack would comprise a semi-circle and with the lever form the half section of a complete wheel; but the lever and rack may, if desired, comprise a greater or less section of a wheel, as for instance, a quarter section or a complete wheel, suitable radial arms being in such case provided in accordance with the requirements of the design, not necessary to be here shown. In pipe bending work bends of various degrees or fractional parts of a circle are required from one eighth or one quarter turn, to coils of a complete circle or of several convolutions, and in the machine herein described a bend of greater degree than the arc of the movable lever and its rack can be produced by returning the lever to its initial position after having operated it to its full scope, and repeating its operation, that is successively gripping and acting upon the pipe, as will be readily understood in connection with the hereinafter described operation of the mechanism. In addition to its attachment upon the lever or arms added thereto, the rack may be further supported by and arranged to travel upon anti-friction rolls A mounted upon standards *a* erected on the floor as shown.

Mounted in the bearings 19 on the frame and extending the entire length thereof and

through the ends of the channel beams 9 is a shaft 20 having its axis radial to the pivotal point of the frame and carrying a gear 21 at its outer end, which is secured thereto by any suitable means which permit it to be readily removed therefrom, as nut h^2 . Said gear intermeshes with an intermediate gear 22 supported upon a bracket 28 removably secured to the frame, and intermeshes with the rack 13 whereby rotation of the shaft will drive the rack and swing the movable lever on its pivotal center.

Slidably mounted on the shaft 20, in the space between the channel beams of the track is a sprocket wheel 24, and a similar sprocket wheel 25 is mounted between the rails on a shaft 26 at the opposite end of the track. A sprocket chain 27 is arranged over the sprocket wheel with its ends fastened to the lower part of a tubular thrust carriage 28 which is mounted upon the track by means of anti-friction rolls 29 pivoted to its sides as shown, and adapted to track upon the upper sides of the upper flange of the channel beams 9. Anti-friction rolls 30 are also arranged to track upon the lower sides of said flanges to hold the carriage upon the track. The rotation of the shaft 20 by revolving the sprocket chain 27 carries the tubular carriage 28 along the track in conjunction with the revolution of the rack 13 and movable lever. The motive power for driving the machine may be applied to the shaft 20, at any point throughout its length and may be arranged in any suitable manner, not requiring here to be shown, or further described. If desired, the thrust carriage in the case of very heavy work may be driven or pushed directly by hydraulic pressure or by hydraulic power or other force applied by any well known method and the movable lever operated by such motive power through the sprocket chain, sprocket wheels, shaft and gearing hereinbefore described. It will be understood that in connection with said gearing whatever method is employed to move either the thrust carriage or the movable lever would also move the other part in unison therewith and I do not restrict my invention to any particular motive power or means for driving the parts or point of application thereto. The objects of the intermediate gear 22 between the gear 21 and the rack, are, to attain the required direction of motion of the rack, that is, to cause it to move in the same direction as the thrust carriage, and to enable the speed of the movable lever relatively to that of the thrust carriage in accordance with the distance of the rail track from the center, to be changed as required, by placing a larger or smaller gear on the shaft 20, and correspondingly proportioning and placing the intermediate gear to intermesh with the driving gear and

rack. In such changes of gear the bracket 28 itself may be replaced by other brackets of the required proportion to attain the required result. In the drawings the position of the carriage track with reference to the lever is midway of its length hence the rack is at twice the distance from the pivotal center and the gear at the outer end of the shaft 20 requires to be of twice the diameter of the sprocket gear wheel.

The tubular carriage forms an abutment for a thrust collar 31 which bears against the forward end thereof also fitting within it to centralize and hold the collar in place. The collar is adapted to correspondingly fit within or hold and thrust against the pipe or tube 32 to be bent, which is thus mounted above the track and supported at that end by the carriage. The other end of the tube is supported and carried by a chuck or clamp 33 mounted upon the movable lever 17, which has a T slot h^3 extending throughout its entire length by means of which the chuck may be bolted down at any point thereon, similarly as the carriage track may be adjusted on the frame at any distance from the center, for the purpose of bending the pipe to any desired radius. The chuck, or clamp is of a construction suitable for holding the end of the pipe and is here shown to be composed of two half bearings hinged together by a pin h^4 , the lower part being clamped to the lever bolts i^1 , i^2 on said T slot, and the upper half clamped to the lower by a lever nut 34 and a swing bolt 35 which may be pivoted in the lower half and adapted to be swung out of or into a suitable slot 36 in the flange 37 of the bearing to readily disengage the parts. Rolls 38, 39 are mounted on the frame on the radial line which is at right angles to the carriage track 9, there function being to guide the pipe and hold it in position at the point at which it is to be bent, also, when desired, a roll 40 may be placed in contact with the pipe somewhat back from the roll 39 to resist any tendency of the pipe to buckle back of the point bending, through pressure. When desired, a curved former 41 may be arranged to assist in the operation of bending, although the machine is adapted to bend pipe without the use of a form. In such case the form could be fastened in place by means of the inner bolt i^2 of the chuck 33 and the roll 38 would be set correspondingly away from the pipe, and adjusted to bear upon the form as shown in Fig. 1. It will be understood that the guide roll 38 may be set to contact with the pipe the same as the opposite roll 39 when the former 41 is not used.

Constructed as above described and shown, the operation of my improved bending mechanism as far as described is as follows; tak-

ing the case of pipe, for illustration: The pipe being placed over the carriage track with one end clamped in the chuck of the movable lever and the other received and held upon the carriage, the movement of the carriage in conjunction with that of the lever by rotation of the shaft 20, or any other means of applying power, will carry the pipe along over the fixed frame, and carry it between the rolls 38, 39 and 40. At the point where the pipe leaves the frame and the said perpendicular rolls as the movable lever swings on its pivot the pipe will be bent on the radius of the arc described by the clamp or radius between said clamp and the pivotal center of the lever without the use of a form for determining the curvature. The curvature of the pipe will be alone insured by the combined action of the movable lever and the carriage. This effect will readily be understood when it is considered that if the pipe were merely drawn ahead by the means of the movable lever such action would tend to pull the pipe into a straight line between the holding clamp and the guide rolls while if the pipe were to be pushed at its rear end and resisted at its forward end it would tend to buckle between the clamp and the roll, therefore if these two forces are proportioned substantially equal one will counteract the other and curvature will be produced in the pipe corresponding to the arc having the pivotal center of the lever and the center of the pipe for a radius. After the pipe is bent to the extent the scope of the machine permits, if a greater bend is required, the lever may be returned to its original or initial position and a new grip taken upon the pipe by the clamp, and the operation successively repeated, to the production of a complete circle, or coil of a number of convolutions, as hereinbefore described. The aforesaid operation relates to bending pipe in its cold state, but does not differ from that of bending it hot, except that in the latter instance, mechanism is provided for automatically cooling the pipe as fast as bent, which is described as follows, reference being had to Figs. 1 and 10 of the drawings. Just beyond the guiding rolls, 38, 39, 40 two sections of pipe D, D are arranged in the plane of the diametrical cross section thereof, each extending nearly half way around the pipe to be bent and together comprising a girdle encircling the pipe as shown. These pipes are adapted to be connected with a flow of water through a pipe or hose *e* and are perforated to direct small streams *e*¹ inwardly and forwardly, or away from the plane of bending upon the pipe, effectually cooling it with a sharp line of demarcation between the heated and cooled portions under or in the plane of the water girdle, which line may be adjusted as near to the point of bending as desired by proper adjustment

of the sections D, D. The sections of the girdle may be attached to the machine or to a standard R rising from the floor. They may also be hung from over head, preferably convenient to the operator, who has generally to occupy a position on a platform directly over the work at a sufficient distance above it to escape the heat. It will be seen that by cooling the heated pipe immediately ahead of the point or cross plane of flexure, all that portion of the pipe between the holding clamp becomes a rigid part or arm of the lever, and serves to transmit the strain to the point of bending, whereas, if it were not so cooled, its ductility would permit it to straighten out under the pull of the lever necessitating much more frequent fleeting back for a renewed grip upon the pipe or the use of a bending form. By the use of the cooling mechanism it will be possible to construct quarter turn bends and in some cases bends of still greater extent at a single operation, or without fleeting the lever back for another grip. The action of returning the lever to the initial point without corresponding backward movement of the thrust carriage may be accomplished by the temporary removal of the intermediate gear 22 or other part of the connecting gearing, but suitable clutching mechanism may be substituted for such less elaborate method when the work is such as to warrant it. And in such event the clamp for holding the pipe may be armed with jaws corresponding to the curvature of the pipe suitable for gripping upon it after the first or initial setting, before which the pipe is entirely straight and not adapted for being gripped by curved clamping jaws.

In pipe bending mechanism it is advantageous and in some cases highly important and absolutely necessary to provide means for counteracting the tendency of the pipe to collapse or flatten the bending sides together. In my machine with the forces distributed as described for simultaneously pushing and drawing the pipe through the guide rolls this tendency is lessened but I have provided additional means for preventing such result which are described as follows: Upon the end of the carriage track a horizontal lever 42 is pivoted to the tie plate 43 which is bolted to the channel beams 9 on the upper side thereon and to this lever a pair of parallel bars *i* are pivoted on each side of its pivotal center equi-distant therefrom, one of the bars of each pair being placed above and the other below the lever. Said bars extend forward to the plane of the guide rolls 38, 39 or point of bending and each pair supports two anti-friction rolls *f* and *g* placed at a short distance apart on the bars. Said rolls are of the shape described by the revolution of an arc of the internal circumference of the pipe into which they are to enter. The rolls of each

pair of bars are placed at equal distances
 from the pivotal points of the bars on the
 lever 42 and each pair of rolls is connected
 together by a pair of links n placed upon
 5 the pivotal centers or pins of the rolls at
 the ends thereof and outside the bars in the
 present instance; although they may be
 otherwise arranged when required. Said
 links are the same length between centers
 10 as the distance between the pivotal points
 of attachment of the bars upon the lever.
 The rolls of each pair of bars are in contact
 and when placed in a plane nearly trans-
 verse with a cross section of the pipe as de-
 15 termined by and corresponding with the
 angle of the lever 42 in relation to the axis
 of the pipe, will fill the pipe, forced out-
 wardly thereon with any degree of pressure
 required as regulated by the position of the
 20 said lever, when the rolls are swung by
 means of the lever to occupy planes more
 diagonal to the transverse section of the
 pipe they will be relieved from contact with
 the sides of the pipe and free thereof.
 25 When the rolls are so adjusted in such re-
 lieved position the pipe may readily be
 slipped over them when being placed in po-
 sition in the machine, then after the pipe is
 in position the rolls may be set out against
 30 the walls thereof by slight movement of the
 lever 42, and the corresponding action of the
 parallel bars connecting the rods with it.
 In order to guard against collapse of the
 pipe ahead of the bending point an auxil-
 35 iary pair of rolls f^1 are linked to the ends
 of the parallel bars and rolls f by the links
 M , and connected together by the links E
 and they are thus arranged to swing from
 the centers of the pair of rolls f at the ends
 40 of the bars, and freely adapt themselves to
 the curvature of the pipe while at the same
 time filling the same similarly to the rolls
 f, g . As the axes of all these rolls are ver-
 tical their equatorial planes impinge against
 45 the pipe, which is the area upon which the
 bending strain and displacement of the
 metal takes place. The conical shape of the
 ends of the rolls renders it impossible for
 50 them to be proportioned so as to fill the
 semi-circumference of the pipe and a space
 or clearance thus results on the upper and
 lower sides of the pipe which serves to re-
 ceive the bars i and links n . In said space
 55 which is at right angles to the bending area
 of the pipe the walls of the pipe have no
 tendency to collapse and no internal brace
 or support is necessary to be employed to
 prevent distortion at the point. This sys-
 60 tem of rolls provides a frictionless collapsi-
 ble internal form or support which may
 readily be introduced into or withdrawn
 from the pipes and adjusted with ease. In
 addition to being free from friction against
 65 the pipe in bending this internal supporting

device readily provides for the passing of
 obstructions and irregularities in the pipe,
 which sometimes are very considerable and
 render the use of an inflexible support im-
 possible, either in placing the pipe in posi-
 70 tion or in bending.

In the process of bending pipe and also
 solid rods or bars, the bending force is re-
 solved into compression and tensile strains
 respectively upon the inner and outer
 75 sides of the curve which strains upset
 or close the metal on the inside and
 draw or stretch it upon the outside. The
 closing together of the metal by crushing
 strain and its attenuation by the tensile
 80 strain, are invariably found to be unequal
 in extent, for the attenuation of the metal
 exceeds its compression and results in thin-
 ning the pipe on the outer side of the curva-
 ture, and material damage to the work re-
 85 sults, especially in the case of bending pipe
 in the heated state. It is extremely desira-
 ble to prevent this result and the mech-
 anism hereinbefore described will accomplish
 such purpose, if the gearing for transmit-
 90 ting the motion of the pipe thrusting car-
 riage to the lever or conversely transmitting
 the motion of the lever to the thrust car-
 riage be so proportioned that the speed of
 the carriage shall slightly exceed that of the
 95 lever, whereby there is a certain amount of
 holding back on the lever end of the pipe,
 relatively to the speed of the opposite end.
 Such differential motion of the lever and
 carriage can easily be effected by suitably
 100 porportioning the gear 21 with relation to
 the sprocket wheel 24. The effect of lessen-
 ing the stretching of the metal on the outer
 side of the pipe will be accomplished to
 some extent by simply pushing the pipe
 105 ahead and allowing the lever to move around
 at the same time without being actuated by
 the motive force, the resistance thereof
 alone being sufficient to produce the re-
 quired result. I, therefore, do not limit the
 110 invention to the precise mechanism shown
 for insuring differential motion of the lever
 and carriage.

It, of course, will be understood that by
 illustrating and describing in detail the
 115 structure in which I embody my invention I
 do not thereby limit the scope of my inven-
 tion only to an apparatus having such con-
 struction because changes can be made that
 would involve no departure from the prin-
 120 ciple of my invention.

Having thus described my invention, what
 I claim is:

1. In bending machinery, the combina-
 tion of a lever movable on a pivotal center, 125
 a clamp or holder carried by the lever, a
 track or guide way movable with respect to
 the pivotal center of the lever for adjust-
 ment at different distances therefrom at
 right angles to the initial position of the 130

lever, a thrusting and holding carriage guided on the track, means for guiding the article to be bent in its movement along the track, means for conjointly operating the lever and thrust carriage with differential movement and means for cooling a heated article to be bent at the cross plane between the track and initial position of the lever.

2. In pipe bending mechanism, the combination of a system of rolls supported within the pipe linked in pairs in rolling contact and adapted to bear upon the walls of the pipe on the sides of the bending pressure, the corresponding rolls of the pairs being respectively coupled upon and controlled by parallel tail rods projecting from the unbent ends of the pipe and by the reciprocal movement of which the rolls may be swung into contact with the pipe or freed therefrom on the sides of the bending pressure.

3. In pipe bending mechanism, the combination of two pairs of parallel tail rods, a series of rolls pivoted to each pair of rods arranged in opposite pairs, links or bars connecting the pivotal centers of each pair, and comprising a parallel motion, and mechanism connecting the tail rods at one end adapted for reciprocating the pairs of rods relatively to each other to swing the pairs of rolls around the common centers of their connecting links.

4. In pipe bending mechanism, the combination of two series of rolls, the rolls of each series connected together by parallel rods joining their axes arranged in pairs with the rolls of the opposite series, and the rolls of each pair being coupled together by connecting links joining their axes and mechanism connecting the systems of rods at one end adapted for reciprocating the rods relatively to each other and swinging the pairs of rolls around the common centers of their connecting links.

5. In pipe bending mechanism, the combination of two series of rolls, the rolls of each series connected together by parallel rods joining their axes and arranged in pairs with the rolls of the opposite series,

and the rolls of each pair being coupled together by connecting links joining their axes, and a lever corresponding to the transverse links, pivoted to the external ends of the tail rods and adapted through relative movement of the respective rods to move the transverse links at various angles to the walls of the tube to expand or contract the rolls with reference thereto by such inclination of the connecting line of the roll axes.

6. In pipe bending mechanism, the combination of a pair of roll supporting frames adapted to be entered within the pipe to be bent, a plurality of rolls mounted upon each of the roll frames, arranged to conform to and bear upon the inside circumferential outline of the pipe, tail rods or connections from the roll frames projecting from the pipe, and mechanism for setting the rolls into contact with the walls of the pipe or relieving them therefrom by relative movement of the roll supporting frames through movement of the tail rods.

7. The combination of a fixed girder or frame, a pipe guiding track connected to the girder transversely thereof, a lever pivoted to the girder, a pipe gripping chuck carried by the lever, pipe bending and guiding rolls mounted on the girder corresponding in position to the chuck on the lever, a rack projecting from the swinging end of the lever concentric therewith, a driving pinion journaled in the girder and intermeshing with its rack, a pipe thrusting carriage movably mounted upon the guiding track, and motive means positively acting to conjointly move the carriage and to turn the driving pinion whereby the pipe will be pulled through the pipe bending and guiding roll by the lever and conjointly pushed along by the carriage, substantially as specified.

In testimony that I claim the foregoing I have hereunto set my hand.

JAMES ACTON MILLER.

Witnesses:

FREDK. HAMBERT FAIRWEATHER,
PHILIP ORIN MILLER.