

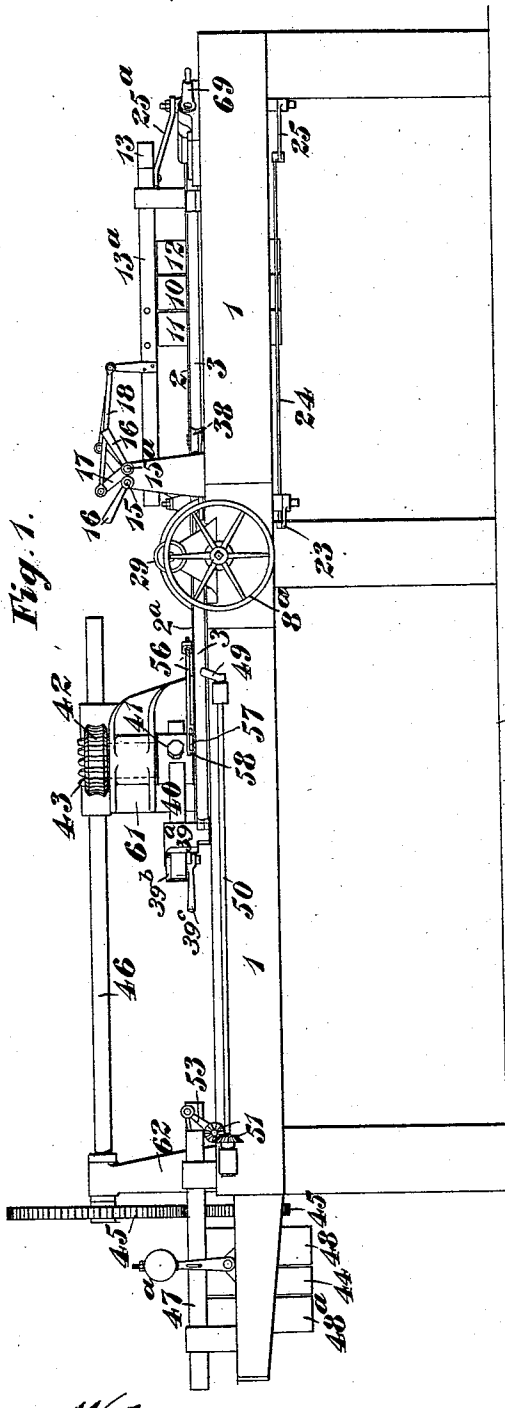
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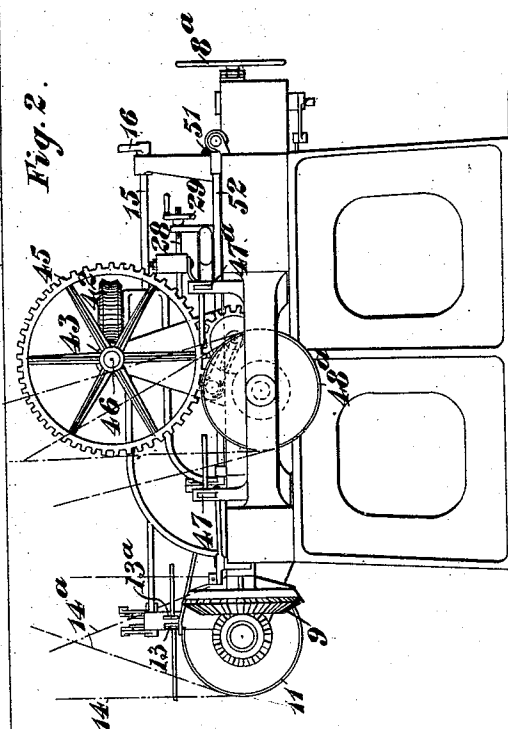
J. DONALDSON.
APPARATUS FOR BENDING TUBES.

No. 472,969.

Patented Apr. 12, 1892.



Witnesses
Charles W. Keigley
W. Cross



Inventor.
J. Donaldson.
By O. E. Hubbs atty

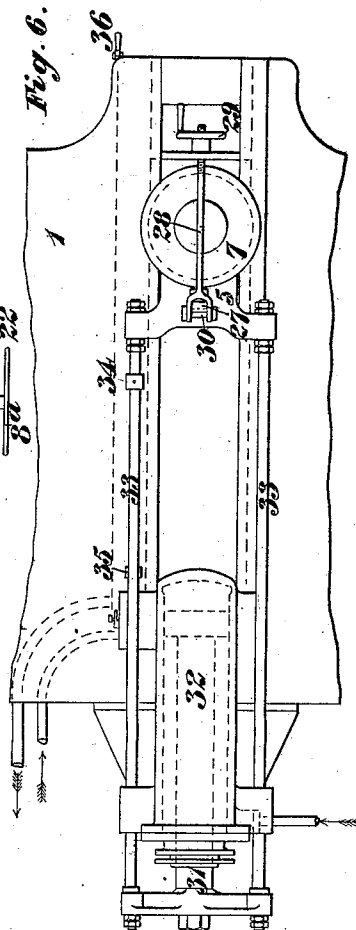
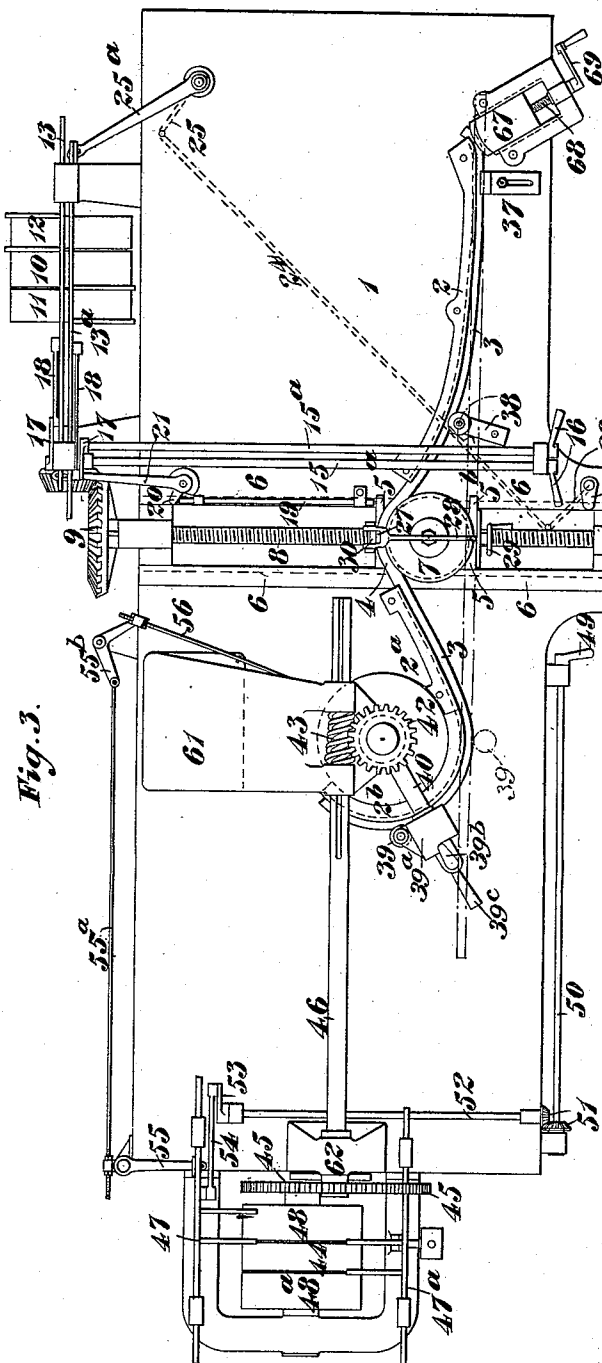
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3 Sheets—Sheet 3.

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Fig. 5.

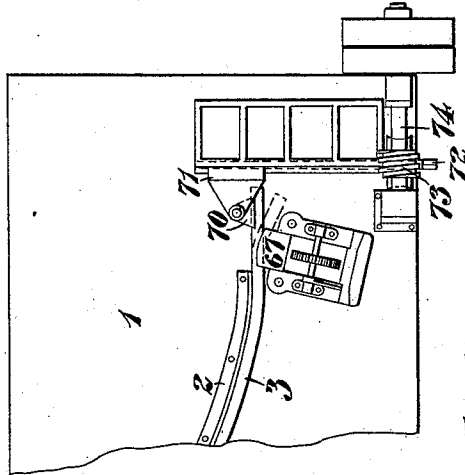


Fig. 8.

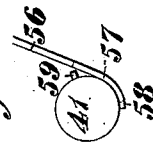


Fig. 4.

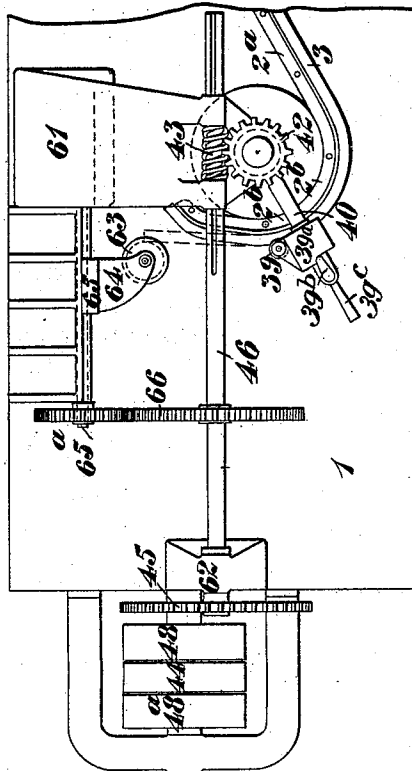
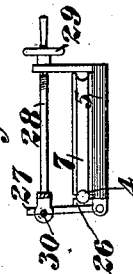


Fig. 7.



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UNITED STATES PATENT OFFICE.

JOHN DONALDSON, OF CHISWICK, ENGLAND.

APPARATUS FOR BENDING TUBES.

SPECIFICATION forming part of Letters Patent No. 472,969, dated April 12, 1892.

Application filed June 30, 1891. Serial No. 398,737. (No model.) Patented in England December 27, 1890, No. 21,095; in Germany June 21, 1891, and in France June 22, 1891, No. 214,361.

To all whom it may concern:

Be it known that I, JOHN DONALDSON, a subject of the Queen of Great Britain and Ireland, residing at Chiswick, in the county of Middlesex, England, have invented Improvements in Machinery or Apparatus for Bending Tubes, (for which I have obtained Letters Patent in Great Britain, No. 21,095, dated December 27, 1890; in France, No. 214,361, dated June 22, 1891, and in Germany, dated June 21, 1891,) of which the following is a specification.

This invention has reference to machinery or apparatus whereby tubes can be readily and economically bent to curved forms, such as those of the tubes for steam-boilers of the kind described in the specification of Letters Patent granted to J. I. Thornycroft, No. 387,547, of 1888, as I will now proceed to explain by the aid of the accompanying drawings, in which—

Figures 1, 2, and 3 are respectively a side elevation, an end elevation, and a plan of a tube-bending machine or apparatus constructed according to this invention. Figs. 4 and 5 are plans showing means whereby the ends of a tube can be bent to certain special forms when desired. Fig. 6 is a plan showing a modified construction of part of the machine or apparatus. Figs. 7 and 8 are detail views.

1 is a table or bed on which are fixed two curved bars 2 2^a, (hereinafter called "formers,") the curvatures of which correspond, respectively, to the curvature of a finished tube is to have at those parts 3 of it situated at each side of an intermediate and approximately central curved portion 4. Mounted on a slide 5, arranged to work in guides 6 between the formers 2 2^a, and in a direction at right angles to the length of the tube to be bent, there is a third former 7, hereinafter called for distinction the "intermediate" former, and which may advantageously be a grooved wheel, as shown, free to rotate about a pin carried by the slide.

The slide 5 can be reciprocated by any convenient means. In the arrangement shown in Figs. 1, 2, and 3 it is operated by a screw-shaft 8, driven by bevel-gearing 9 from a shaft provided with a fast pulley 10 and loose pulleys 11 and 12.

13 13^a are belt-shifters for the belts 14 14^a, one of which is crossed, that run on these pulleys.

15 15^a are rods, each provided with a handle 16, whereby either belt can be shifted from its loose pulley to the fast pulley 10, or vice versa, as well understood for the purpose of changing the direction of motion of the slide or for bringing the slide to rest. For this purpose each rod 15 15^a is connected to its corresponding belt-shifter by a lever-arm 17 and link 18. In order that the motion of the slide 5 in either direction may be arrested automatically at the desired points of its travel, the slide is provided with two projections 5^a 5^b. When the slide 5 is near the inner end of its stroke, the projection 5^a acts against one end of a sliding rod 19, the other end of which then acts against one arm 20 of a lever, the other arm 21 of which is connected by a pin-and-slot connection to the belt-shifter 13, which is thereby automatically operated to shift the corresponding driving-belt from the fast to the corresponding loose pulley. When the slide is near the outer end of its stroke, the projection 5^b acts against a lever-arm 22 and operates the belt-shifter 13^a through a lever-arm 23, rod 24, and lever-arms 25 and 25^a to automatically stop the machine.

8^a is a wheel whereby the screw-shaft 8 can be rotated by hand. 26 is a block, Fig. 7, that may advantageously be used for firmly holding the tube to be bent in contact with the intermediate former 7. This block is fixed to a lever 27, that can be moved in a direction to hold the tube by a screw-threaded rod 28 and hand-wheel 29. To release the tube quickly, the rod 28 is forked and provided with a pin 30, that can enter a recess in one side of the upper end of the lever 27, so that, when necessary, the rod can be quickly disengaged from the lever.

In Fig. 6 the slide 5 is reciprocated by the ram 31 of a hydraulic motor 32 through rods 33, one of which carries a tappet 34, which, by acting against a tappet 35 on the valve-rod, stops the motor and arrests the slide when the same has moved sufficiently inward.

36 is a lever for operating the valve by hand. 37 and 38 are guides adjustably mounted

on the table 1, so that they can be moved into the positions shown and form passages with the former 2. A guide similar to 37 may also be similarly arranged in relation to the former 2^a. Usually, however, the roller 39, hereinafter referred to, can, when moved into the position shown as a dotted circle in Fig. 3, be used in lieu of a separate guide.

With the arrangement described, when a straight tube (indicated by dotted lines in Fig. 3) has been placed between the said formers and guides, the latter can be moved into positions in which passages will be formed between them and the formers, and then while the intermediate former 7 is moving inward and bending the intermediate or approximately-central portion 4 of the tube the other portions 3 thereof will be partly drawn through the passages referred to, and in this way will be caused to assume curved forms corresponding, respectively, to those portions of the formers 2 2^a located between the guides and the intermediate former. As this bending action takes place, the guide 38 is adjusted toward the former 2, in order that the tube shall closely follow the curvature of the said former.

To produce a boiler-tube of the kind referred to, that part 2^b of the former 2^a corresponding to the portion of tube between the intermediate or approximately central part and one end of the former has the shape of an arc of a circle. The two parts 2^a and 2^b may be in one piece or in separate pieces, as shown. To bend the one end of the tube around this circular portion of the former 2^b, there is provided a roller 39, carried by a radial arm 40, adjustable radially in a holder 41, that can be partly rotated. For this purpose the holder carries a worm-wheel 42, that gears with a worm 43, rotated in one direction or the other from a fast pulley 44 through change-wheels 45 and shaft 46.

47 is a belt-shifter for moving a driving-belt from the fast pulley 44 to the loose pulley 48, or vice versa.

47^a is another belt-shifter operated by hand for moving another belt from the loose pulley 48^a to the fast pulley, or vice versa.

49 is a handle for operating the belt-shifter 47 by hand through a shaft 50, bevel-wheels 51, shaft 52, arm 53, and link 54.

55 is a lever for automatically actuating the belt-shifter 47 to stop the motion of the arm 40 when the roller 39 nears the end of the tube being bent. For this purpose the lever 55 is connected by a rod 55^a and bell-crank 55^b to one end of a rod 56, (see Figs. 1 and 8,) the other end of which is formed with a long slot 57, against the end wall 58 of which a pin 59 on the holder 41 acts so as to pull the rod and operate the belt-shifter at the required time. In order that the portion of the tube left projecting beyond the former 2^a after the tube has been acted upon by the intermediate former 7 may be bent by the roller 39 in the direction of the former 2^b preparatory to its

being bent closely around this former, the roller is pivoted to a carrier 39^a, that can be forced along the rod 40 by an arm 39^b, actuated by a hand-lever 39^c.

The shaft 46, carrying the worm 43, is carried by brackets 61 and 62, that may be adjustably fixed upon the bed 1 to adapt the machine to bend tubes of different lengths and to different curvatures.

In Fig. 3 the left-hand end of the tube is of circular form to the end. To bend this end of the tube to an irregular form, as is sometimes necessary, the arrangement shown in Fig. 4 is adopted. In this arrangement the end of the former 2^b is made of the desired irregular shape, as shown, and for the purpose of bending the end of the tube to correspond thereto a roller 63 is used, journaled in a bracket 64, carried by a slide 65, arranged to move in a direction at right angles, or approximately so, to the slide 5. The slide 65 is operated by a screw 65^a, driven by any convenient means. It may be by gearing 66 from the shaft 46.

To bend the other end of the tube to the form shown in Fig. 3, another roller or a slide-block 67 is provided, operated by a screw 68 and crank-handle 69. To enable this end of the tube to be partly bent back upon itself, as is necessary for some of the tubes for a steam-boiler of the kind referred to, the arrangement shown in Fig. 5 can be adopted. In this arrangement an adjustable block 67 is provided for holding the tube against the extreme end of the corresponding former 2, while the unsupported end of the tube is bent to the desired extent by a pivoted block 70, having a straight acting surface and carried by slide 71. This slide is operated in any convenient manner—as, for example, by a screw 72, driven by worm-gearing 73 from a shaft 74, provided with fast and loose pulleys, as shown.

To adapt the machine to bend tubes of different curvatures, the formers 2, 2^a, 2^b, and 7 are made removable and a number of different formers are provided to suit the several forms of tubes to be produced.

I consider it advantageous that the surfaces of those parts of my apparatus that bear against the tube while it is being bent should be grooved to a form corresponding with the external form of the tube in cross-section. Where the bend in the tube is acute, it is advantageous that the sides of the grooves should extend up to or past the semi-diameter of the tube to prevent bulging of the tube. As will be obvious, machinery or apparatus, according to this invention, may be modified to adapt it to bend tubes to various shapes.

What I claim is—

1. In a machine for bending tubes, the combination of two rigid formers 2 2^a, fixed to the bed of the machine, an intermediate former 7, arranged to work between said fixed formers in a direction at right angles to the tube to be bent, a reciprocating slide whereon said

intermediate former is mounted, and means for operating said slide and intermediate former, substantially as herein described.

2. In a machine for bending tubes, the combination of two formers 2 2^a, fixed to the bed of the machine, an intermediate former arranged to work between said fixed formers in a direction at right angles to the tube to be bent, means for operating said intermediate former, and adjustable guides so arranged in relation to said fixed formers as with them to constitute passages through which the tubes will be partly drawn by the action of said intermediate former, substantially as herein described, for the purpose specified.

3. In a machine for bending tubes, the combination of two formers 2 2^a, fixed to the bed of the machine, an intermediate former 7, arranged to work between said fixed formers in a direction at right angles to the tube to be bent, a roller carried by a rotary arm and adapted to bend a portion of a tube to correspond to a part of one of said fixed formers, and means for operating said intermediate former and said rotary arm, substantially as herein described.

4. In a machine for bending tubes, the combination of two formers 2 2^a, fixed to the bed of the machine, an intermediate former arranged to work between said fixed formers in a direction at right angles to the tube to be bent, means for operating said intermediate former, and a slide-block or former 67, arranged to work in guides removably fixed to said bed and adapted to bend one end of a tube partly around the end of one of said fixed formers, substantially as herein described.

5. In a machine for bending tubes, the combination of two fixed formers, one of which is partly of circular shape and partly of irregular shape near one end, an intermediate former arranged to work between said fixed formers, a roller carried by a rotary arm and adapted to bend one end of a tube around the circular portion of said fixed former, an auxiliary former adapted to bend the remaining portion of the end of said tube to correspond to the irregular-shaped portion of said fixed former, and means for operating said intermediate and auxiliary formers and said rotary arm, substantially as herein described.

6. In a machine for bending tubes, the combination of two fixed formers, the curvatures of which correspond, respectively, to the curvature a finished tube is to have at those parts of it situated at each side of an intermediate curved portion, an intermediate former arranged to work between said fixed formers, means for operating said intermediate former, a block adapted to hold a tube against one end of one of said fixed formers and leave

one end of the tube unsupported, an additional former arranged to act against said unsupported end of the tube, and means for operating said additional former, substantially as herein described, for the purposes specified.

7. In a machine for bending tubes, the combination of two fixed formers, an intermediate former arranged to work between said fixed formers, a slide whereon said intermediate former is mounted, and a clamping device, substantially as hereinbefore described, carried by said tube and capable of holding a tube to said intermediate former.

8. In a machine for bending tubes, the combination of two fixed formers, an intermediate former arranged to work between them and carried by a slide, mechanism for reciprocating said slide, and a stopping device for putting said mechanism out of action, said stopping device being arranged to be operated by said slide, substantially as herein described, for the purpose specified.

9. In a machine for bending tubes, the combination of two fixed formers, an intermediate former arranged to work between said fixed formers and carried by a slide, mechanism adapted to reciprocate said slide and comprising fast and loose pulleys with open and crossed belts controlled by belt-shifters, and lever mechanism arranged to be operated by said slide when near the ends of its stroke in each direction and to actuate said belt-shifters, substantially as herein described, for the purposes specified.

10. In a machine for bending tubes, the combination of two fixed formers, one of which has a part bent to the shape of an arc of a circle, an intermediate former arranged to work between said fixed formers in a direction at right angles to the tube to be bent, means for operating said intermediate former, a roller carried by a rotary arm and adapted to bend a portion of a tube around the circular portion of said former, driving mechanism for rotating said rotary arm, lever mechanism capable when actuated of throwing said driving mechanism out of action, and a tappet operated by said driving mechanism and arranged to automatically actuate said lever mechanism when said tube has been sufficiently bent by said roller, substantially as herein described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN DONALDSON.

Witnesses:

PERCY E. MATTOCKS,

WM. THOS. MARSHALL,

Both of 2 Pope's Head Alley, Cornhill, London, Gentl.