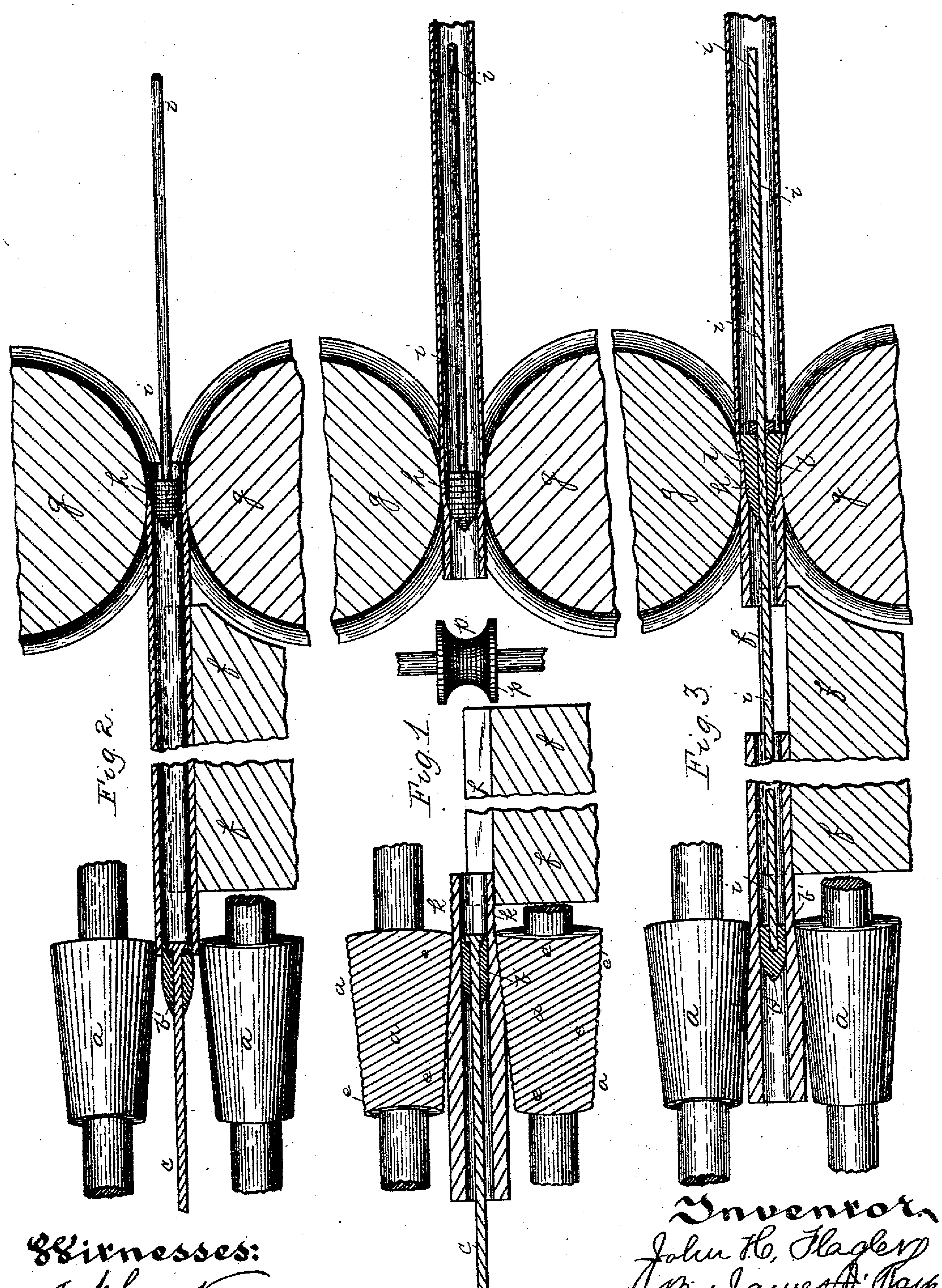
(No Model.)

2 Sheets—Sheet 1.

J. H. FLAGLER.

APPARATUS FOR THE MANUFACTURE OF METAL TUBING.

No. 401,143. Patented Apr. 9, 1889.



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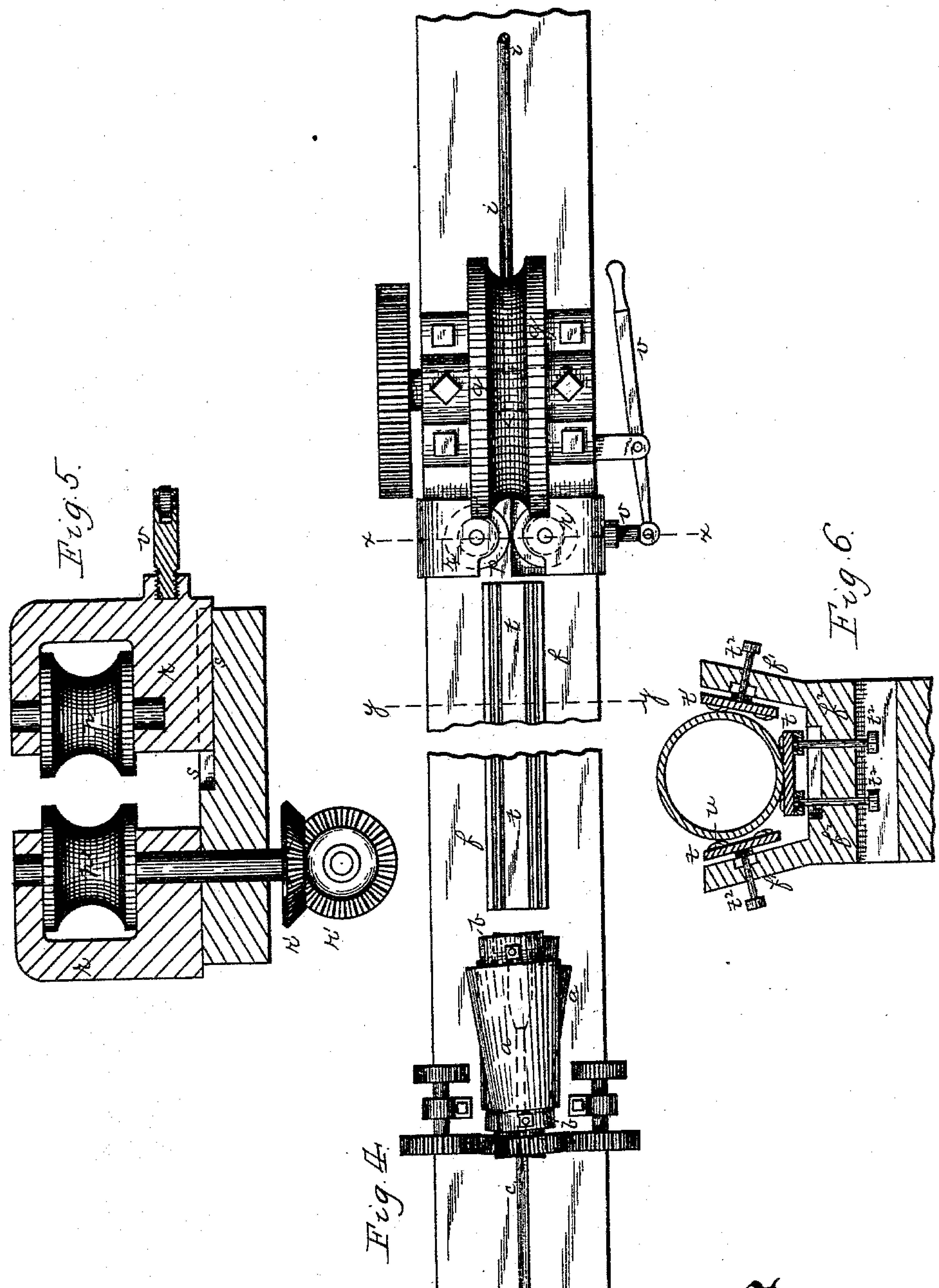

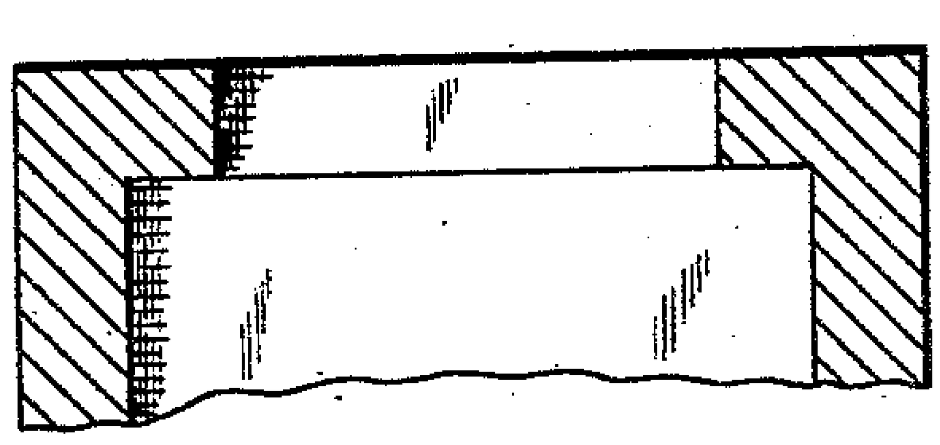

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UNITED STATES PATENT OFFICE.

JOHN H. FLAGLER, OF NEW YORK, N. Y.

APPARATUS FOR THE MANUFACTURE OF METAL TUBING.

SPECIFICATION forming part of Letters Patent No. 401,143, dated April 9, 1889.

Application filed December 17, 1887. Serial No. 258,162. (No model.)

To all whom it may concern:

Be it known that I, JOHN H. FLAGLER, of New York, in the county of New York and State of New York, have invented a new and useful Improvement in the Manufacture of Wrought-Metal Tubing; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the manufacture of tubing, and more especially seamless tubing—that is, tubes produced without welding—its object being to provide apparatus for producing a thin seamless tube in which the interior surface is highly finished, and in which the fibers are arranged spirally around the tube on the interior as well as the exterior thereof, and the strength of the finished tube is therefore relatively increased. To these ends, as described in an application of even date herewith, I form the tube from a hollow ingot or blank by spirally rolling the same to reduce the thickness of the walls and to elongate it by drawing out its external fibers spirally, and I then roll the tube thus produced longitudinally over a rotating mandrel to further reduce the thickness of the walls and to impart a spirality to the fibers of the interior of the tube, while at the same time the tube is reduced to the required thickness and the interior thereof brought to a high finish, the interior, or both the interior and the exterior, of the tube being increased, if desired, at the second rolling thereof, the said process not only laying the fibers both of the interior and exterior in a spiral course, but producing a highly-finished tube of greater diameter.

My present invention relates specially to the apparatus employed for the manufacture of this seamless tubing by the process above described, and the special features of the invention included therein are hereinafter specifically pointed out.

To enable others skilled in the art to make and use my invention, I will describe the same more fully, referring to the accompanying drawings, in which—

Figure 1 shows a view, partly in section, of my improved apparatus for carrying out said process and the manner of operating the same. Fig. 2 is a like view showing the tube leaving the first set or passing of the rolls and entering the second set thereof. Fig. 3 shows the apparatus where the tube formed is increased in diameter. Fig. 4 is a plan view illustrating my improved apparatus. Fig. 5 is an enlarged cross-section on the line *x x*, Fig. 1; and Fig. 6 is a like view on the line *y y*, Fig. 1.

Like letters of reference indicate like parts in each.

In my improved apparatus a hollow ingot or blank the thickness of the walls, and the length of which is proportioned to the length, diameter, and thickness of the walls of the finished tube to be made, is cast or otherwise formed, it being generally preferable to cast an ingot of homogeneous iron or low-grade steel, and then reheat and roll it to the desired diameter through rolls having a series of reducing passes, whereby the ingot is brought to the proper diameter and the metal compacted, all imperfections or porosity of the metal being thus overcome and a fiber induced therein, after which the hollow bloom so formed is cut to the desired length, proportioned to the length of the finished tube and the desired reduction and elongation thereof. The ingot may, however, be cast to the proper shape for feeding direct to the rolls.

The apparatus employed consists in a set of diagonally-acting converging rolls, together with an interposed mandrel, for spirally rolling and drawing out the tube, and a pair of direct-acting concave rolls mounted in line therewith, and a rotating mandrel employed in connection with the said direct-acting concave rolls. In the drawings two or more of these diagonally-acting rolls, *a a*, having converging faces, are mounted in suitable housings, *b*, the rolls shown in the drawings being what may be termed "conoidal" rolls, and being so mounted that the ingot or blank may be passed between the working-faces of the rolls over a suitable mandrel held between them. I have not shown in detail the housings in which these rolls are mounted or the gearing, as their construction is well known, and the manner of applying power to said rolls is also well known. The axes of the two rolls *a a* are parallel in horizontal planes, while the vertical planes which pass through the same are at an angle to each other. In this way, and by having the working-faces of the rolls converge toward one another—produced in this case by conoidal rolls—a reducing-pass is formed, and the metal as it passes through the space between the rolls is acted upon on opposite sides by the working-faces, which are moving in opposite directions and which gradually converge toward each other. The effect on the metal with a pass of this nature is to gradually reduce the diameter of the blank, and at the same time draw or force the metal forward by a spiral movement, which is greatest on the exterior surface of the blank, and as the blank turns with the rolls it is gradually drawn out by the action thereof into a tube of less external diameter than that of the blank, and with its walls of less thickness and the outer fibers arranged spirally around the tube. This spiral arrangement of the outer fibers is obtained by the increased speed of the roll-surfaces proportionately to the surface speed of the blank as it passes through the rolls, the blank decreasing in diameter and surface speed, while the diameter and surface speed of the rolls at the point of discharge is greater, or at least as great, as at the point where the blank first engages therewith. To support the blank under the pressure of the rolls and prevent the decreasing of the internal diameter, as well as facilitate the reduction of the metal, and in some cases slightly increase its internal diameter, I prefer to employ a mandrel, *b'*, between the working-faces of the rolls. This mandrel may be supported from the forward end of the rolls—that is, the entering end for the ingot—in which case the support *d* for the mandrel-rod *c* must be so constructed that the rod can be removed therefrom, so that it may be thrust through the heated hollow blank and be again secured to its holder when the blank is fed to the rolls. In some cases, however, the mandrel may be supported from the opposite or delivery end of the rolls by the same shaft or rod which supports the mandrel between the second set of rolls, as hereinafter described, as shown in Fig. 3. The mandrel *b'* is arranged to enter the blank before it is reduced to any great extent, and its forward end is generally formed slightly tapering to direct the blank onto the parallel portion thereof and to spread the metal of the blank where it is increased in internal diameter. It is also desirable in some cases that the surfaces of the rolls *a a* have formed thereon a series of ribs or spiral corrugations, *e*, as the rolls obtain therefrom a better grip on the metal of the blank and their drawing action is increased, and at the same time the tube produced by the first rolling operation has a series of spiral ribs formed on it, as indicated at *k*, Fig. 1, which facilitate the operation of the direct-acting rolls, hereinafter described. The blank after being fed into the diagonally-acting rolls is gradually reduced and fed forward, and the tubular blank thus produced passes along a suitable guideway, *f*, to a pair of plain concave rolls, *g g*, the pass of which is directly in line with that of the diagonally-acting rolls, and the distance of the two sets of rolls from each other is so arranged that the direct-acting rolls will catch and begin to act on the tubular blank just as its rear end leaves the pass of the diagonally-acting rolls. The pass of these concave rolls forms a perfect circle, and the roll-faces meet and are held in contact by a heavy pressure, so that there is no liability of the metal "finning" between them. Supported in the pass of these direct-acting rolls is a mandrel, *h*, which is attached to a rod or shaft, *i*, that extends from a suitable support at rear end of the apparatus in line with the pass of the rolls, and which is rotated at a proper speed by any suitable mechanism. This mandrel *h* has a tapering forward end, and is preferably rotated in the same direction as the blank is caused to revolve by the action of the rolls *a a*, so acting to assist the blank in rotating in case the rolls *g g* obtain a heavy hold on it before it leaves the rolls *a a*, as well as to impart the spirally-laid fibers to the interior of the tube, as hereinafter referred to.

In front of the rolls *g g* are the concave feeding-rolls *p p*, which are preferably mounted on vertical axes, these rolls being employed to feed the tubular blank into the rolls *g g* in case it is not fed into said rolls by the rolls *a a*. These feeding-rolls are mounted in suitable bearings, *r*, and one or both of the rolls driven by suitable gearing, as at *r'*. In their normal position the pass between these rolls is greater than the diameter of the tubular blank fed from the rolls *a a*, so that they do not engage therewith; but the journals of one or both rolls are supported in a suitable slide, as at *s*, mounted in the bed-frame, and operated by lever mechanism *v*, so that in case the tubular blank does not feed properly to the rolls *g g* the rolls *p p* may be drawn together and caused to engage with the tubular blank and feed it to the said rolls, thus insuring the continuous feeding of the blank through the apparatus.

As it is desirable to hold the tubular blank in proper line when it leaves either pass of the apparatus and prevent its sagging, and that different diameters of tubing may be formed therein, I find it desirable to employ guideways or troughs, which can be adjusted according to the diameter of blank passing through. The manner of adjusting the guideway is fully shown in Fig. 6, the guideway being provided with adjustable base-plate *t* and side plates, *t'*, and screws t^2, extending through the side walls, *f'*, and base f^2 of the guideway, these adjustable plates carrying, if desired, idle-rollers, as at *u*, to overcome friction of the blank in passing through.

By the second set of rolls the internal diameter of the tube is generally increased, while the external diameter is held the same or slightly decreased, the tube being thus drawn out between the direct-acting rolls and rotating mandrel and its walls reduced in thickness, while it is correspondingly elongated, such steps being shown in Figs. 1 and 2. During its pass through these rolls the rotating mandrel rolls or laves aside the metal on the interior of the blank, while the rolls force the blank forward slowly, and therefore the combined action causes a spiral rolling over the interior surface of the tube, such action imparting a spiral fiber to the interior of the metal tube, and so increasing greatly the strength of the tube, and with the spiral fiber imparted to the exterior of the blank by the rolls *a a* forming as strong a tube as can be obtained. Though the longitudinal rolling of the tubular blank through these rolls stretches the outer fiber somewhat, yet, as the principal action is on the interior of the blank, the exterior fiber is preserved. The fiber of the metal is thus laid in spiral lines on the exterior of the blank by the first set of rolls and on the interior by the second set thereof, while by the rapidly-rotating mandrel in the second set of rolls a high finish or polish is imparted to the interior of the tube. In some cases the tube may not only have its walls reduced in thickness by the second set of rolls, but the tube may also be expanded, as shown in Fig. 3, in which case the rotating mandrel *h* is made of such size as to expand the tube to the desired internal diameter, while the rolls *g g* force the metal up the enlarged mandrel, and in this way reduce it to the desired thickness of wall, the rolls being set slightly forward of the largest diameter of the mandrel, and the tapering forward end of the mandrel being so curved as to coact with the rolls in thinning the blank, in such case the tapering forward end of the mandrel being formed slightly concave in longitudinal section to act with the rolls in enlarging and reducing the tube, as shown at *l*, Fig. 3. Where the diagonally-acting rolls *a a* have the corrugated surfaces *e e*, and the spiral ribs or corrugations are formed on the exterior surface of the blank passing from said rolls, as at *k*, as heretofore referred to, these ribs are drawn out by the direct-acting rolls *g g* and the surface of the tube made smooth, these ribs causing a considerable elongation of the tube and also assisting the second set of rolls to grasp the blank, and, especially where the tube is enlarged, giving the rolls a firm hold and providing metal for such enlargement. Where the finished tube is to be of an internal diameter about that of the tube produced from the blank by the rolls *a a*, the mandrel *h* is about the same diameter as that of the interior of the tube coming from said rolls *a a*. In this case the pass formed by the direct-acting rolls *g* is smaller than the external diameter of the tube coming from the rolls *a a*, and the metal of the tube is pressed down against the rotating mandrel *h*, which, as it is rotating, tends to impart to the fibers of the metal a circular movement, and, in connection with the slow longitudinal movement imparted thereto by the rolls, acts to lay the fibers in a spiral course, as before referred to. As before stated, the same mandrel-rod which supports the mandrel *h* between the rolls *g g* may support the mandrel *b'* between the rolls *a a*, in which case the latter mandrel is generally loosely mounted in the rod, so that it can turn with the ingot while being rotated through the rolls.

By my improved apparatus I am enabled to take the hollow ingot or blank and first, by its passage through the diagonally-acting rolls, reduce the same and induce a spiral formation of the fibers in the interior thereof, and while passing through the same apparatus feed the tube so formed to a second set of rolls, where the blank is still further reduced and its interior and exterior surfaces brought to a smooth finish, while the interior fibers of the tube are arranged in spiral course, a tube of great strength being thus obtained and the operation being continuous, so that the cost of manufacture is considerably reduced.

I do not claim in this application the process hereinbefore described, as that forms the subject-matter of a separate application filed by me of even date herewith.

Having thus described my invention, what I claim is—

1. In apparatus for the manufacture of metal tubing, a set of diagonally-acting converging rolls with an interposed mandrel, in combination with a set of direct-acting concave rolls and an interposed rotating mandrel, said second set being in line with said first set and adapted to receive the blank therefrom, substantially as and for the purposes set forth.

2. In apparatus for the manufacture of metal tubing, the combination, with a set of diagonally-acting spirally-grooved converging rolls having an interposed mandrel, of a set of direct-acting concave rolls having an interposed rotating mandrel, said second set being in line with said first set and adapted to receive the blank therefrom, substantially as and for the purposes set forth.

3. In apparatus for the manufacture of metal tubing, the combination of a set of diagonally-acting converging rolls provided with an interposed mandrel, a set of direct-acting concave rolls in line therewith, and a rotating mandrel interposed between said second set and of larger cross-section than the internal diameter of the tube fed thereto and having a tapering forward end slightly concave in longitudinal section, substantially as and for the purposes set forth.

4. In apparatus for the manufacture of metal tubing, the combination, with a set of diagonally-acting converging rolls and a set of direct-acting concave rolls having an interposed mandrel, of a pair of concave feed-rolls in the line of feed between said sets of

rolls and adapted to feed the blank to said concave rolls, substantially as and for the purposes set forth.

5. In apparatus for the manufacture of metal tubing, the combination, with a set of diagonally-acting feed-rolls and a set of concave rolls having an interposed mandrel, of a pair of feed-rolls, said feed-rolls being transversely adjustable, so as to engage with the blank and feed it into the concave rolls, substantially as and for the purposes set forth.

6. In continuous rolling-mills for the manufacture of tubing, the combination, with a pair of concave drawing-rolls, of a pair of feeding-rolls mounted in line therewith, a transversely-moving slide or slides carrying one or both said feed-rolls, and lever mechanism to draw said rolls together, substantially as and for the purposes set forth.

In testimony whereof I, the said JOHN H. FLAGLER, have hereunto set my hand.

JOHN H. FLAGLER.

Witnesses:
SAMUEL P. BELL,
WALTER B. TUFTS.