(No Model.) 2 Sheets—Sheet 1.

J. H. FLAGLER.

APPARATUS FOR THE MANUFACTURE OF METAL TUBING.

No. 401,144. Patented Apr. 9, 1889.

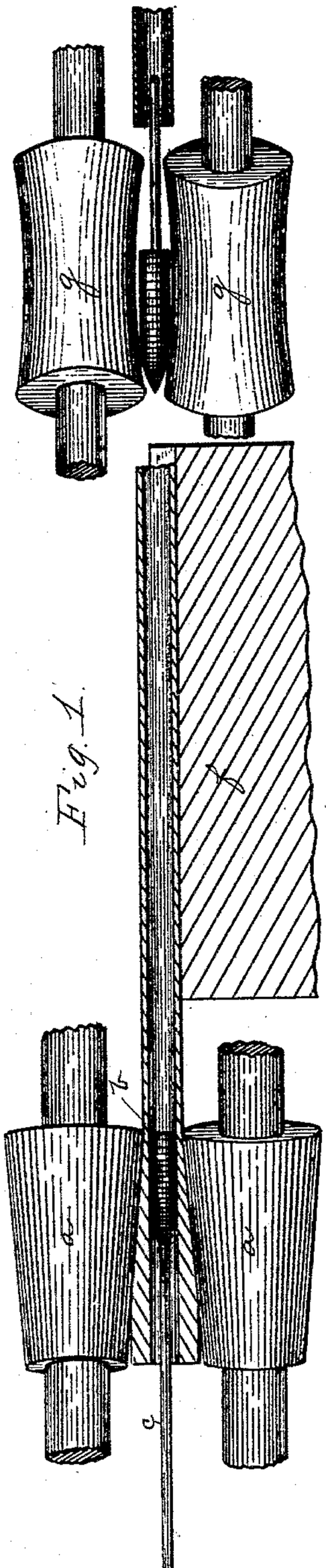

Fig. 1.

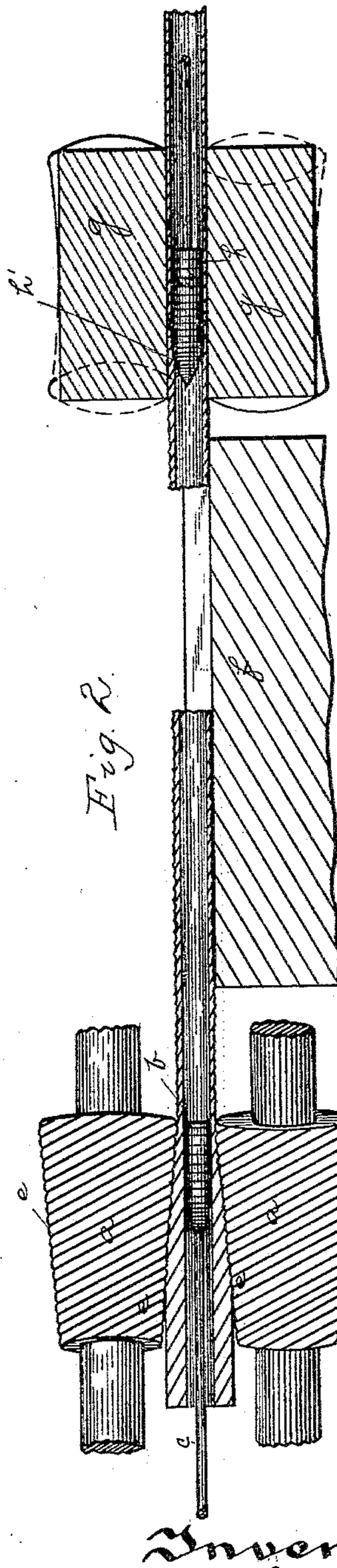

Fig. 2.

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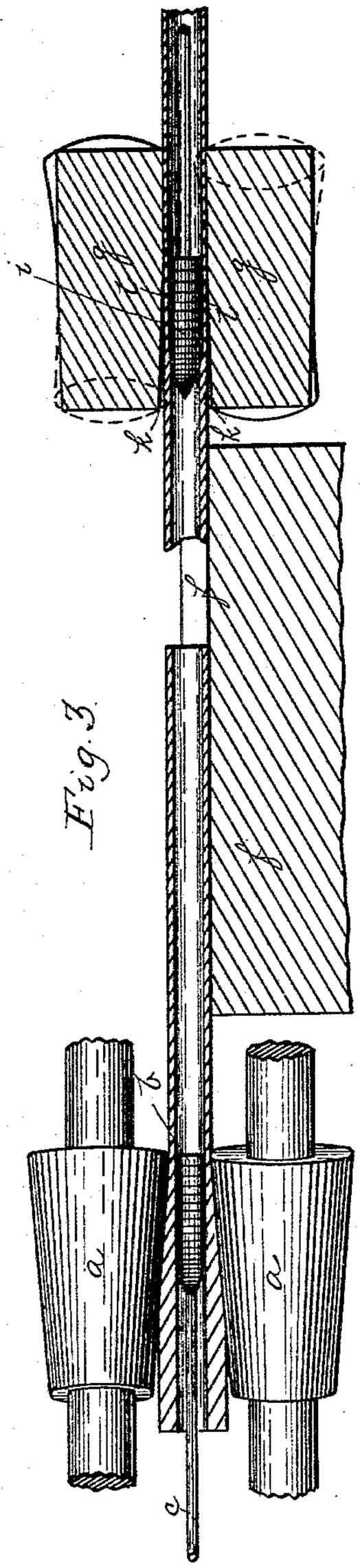

Fig. 3.

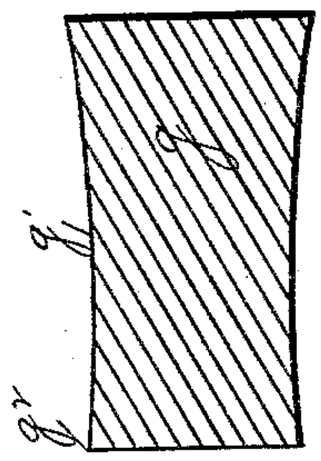

Fig. 4.

Witnesses:
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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. 401,144, dated April 9, 1889.

Application filed December 17, 1887. Serial No. 258,163. (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 thin seamless tubes in which the interior surface is highly finished and the fibers of the metal arranged spirally both on the interior and exterior surfaces, as well as the strength of the finished tube increased, and the tube itself straightened.

To these ends my invention consists generally of the combination of a set of diagonally-acting converging-rolls, and a set of concave cross-rolls having a mandrel interposed between them, the latter set of rolls being in line with and adapted to receive the blank or tube coming from the first set; and the invention also consists in so arranging these concave cross-rolls that the space between the surface of the mandrel and the working-faces of the rolls gradually decreases, so as to effect a reduction in thickness of the walls of the tube and elongate the same; and the invention further consists of certain other improvements, all of which will be more fully hereinafter set forth.

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. Fig. 2 is a view of my improved apparatus, showing the second set of rolls in section and their operation on the tube produced by the first pair of rolls. Fig. 3 is a similar view showing a modified form of rolls, and Fig. 4 is an axial section of the form of rolls shown in Fig. 3.

The sections shown in Figs. 2 and 3 are not such as would be obtained by a vertical longitudinal plane passed through the central portion of the pass formed by the rolls, but are so shown for the purpose of bringing out more clearly the nature of the pass formed by these rolls.

Like letters refer to like parts in each of the figures of the drawings.

In practicing my invention, a hollow ingot or blank is cast or otherwise formed of a length, diameter, and thickness of wall in proportion to the finished tube to be made. It is 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, the metal is compacted, and a fiber produced, as well as all imperfections or porosity of the metal removed. After this rolling operation the hollow bloom is cut into proper lengths for the manufacture of the finished tube. The ingot may, however, be fed directly to the apparatus hereinafter described without the preliminary treatment set forth above.

In the apparatus which forms the subject-matter of the present application two or more diagonally-acting rolls, *a a*, having converging faces, are mounted in suitable housings, the rolls shown in the drawings being what are 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 or the manner of driving the rolls, as they are well known to those skilled in the art, and form no part of my invention.

The axes of the rolls *a a* are mounted in parallel horizontal planes, while the vertical planes passing through the same are at an angle to each other, which varies more or less according to the effect desired. By thus arranging the axes of the rolls and having the working-faces of the latter converging toward each other a reducing pass is formed in which the metal of the ingot or blank as it passes through is subjected to the action of working-faces that are moving in opposite directions and at an angle to the line of movement of the blank, and which gradually converge toward each other and move at an increased rate of speed. 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 the ingot or blank is gradually drawn out into a tube of less external diameter and thinner walls than that of the blank and with the fibers of the tube arranged spirally around the same. This spiral arrangement of the fibers which is greatest on the exterior of the tube 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 engages therewith. To support the blank under the pressure of the rolls and prevent the decreasing of the internal diameter, as well as to facilitate the reduction of 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 roll—that is, the entering end for the ingot—in which case the support for the mandrel-rod *c* must be so constructed that the rod can be removed therefrom and be thrust through the heated blank and 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 that carries the mandrel for the second set of rolls, hereinafter described. 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 corrugations, *e*, as the rolls obtain therefrom a better grip on the metal and their drawing action is increased, and at the same time a series of ribs is produced on the tube formed, which facilitates the action of the second set of rolls, hereinafter described. The tube or tubular blank thus produced passes along a suitable guideway, *f*, to a set of concave cross-rolls, *g g*, the pass of which is directly in line with the diogonally-acting rolls *a a*, and the distance between these two sets of rolls being so arranged that the concave cross-rolls catch and begin to act on the tubular blank just as its rear end leaves the pass of the diagonally-acting rolls. These concave cross-rolls are rolls which have their working-faces concave and their axes in parallel horizontal planes, and in vertical planes which are at an angle to each other, or they may be in parallel vertical planes and in different horizontal planes. By this disposition of the axes of the rolls the working-faces of the rolls are in contact with the tube from the time it enters the rolls until it leaves them, and at points on each roll, which are diagonally opposite those on the other roll, giving a pass of considerable length, as indicated in Figs. 2 and 3. The sectional portion of the cross-rolls shown in these figures is intended to indicate the nature of the pass to which the metal is subjected in passing through the rolls, but as a matter of fact the line of contact of the working-faces of each roll is a spiral one and not straight, as shown in the figures. In some cases where the amount of reduction of the thickness of the tube coming from the first set of rolls is not great, and the interior diameter of the tube is to be slightly increased, the form of cross-rolls shown in Fig. 2 is employed. In this case the area of the pass formed by the working-faces of the rolls remains substantially the same throughout, and a mandrel, *h*, is supported in this pass, which mandrel has a tapering face, *h'*, to form a gradually-decreasing space between the surface of the mandrel and that of the rolls, so that as the tube passes into the bite of the rolls it will be gradually forced along over the tapering surface of the mandrel by the spiral rolling action of the rolls, and compressed against said mandrel by the pressure of the rolls, reducing the thickness of the metal of the tube, and still further increasing the spiral arrangement of the fiber obtained from the first rolling operation or set of rolls, and slightly increasing the internal diameter of the tube. This reducing is effected almost entirely by the first half of the rolls, as the mandrel preferably does not extend rearwardly much beyond the middle of the rolls, the last half of the latter being intended more to bring to true cylindrical form and straighten the tube produced and draw it along than to effect any reduction thereof.

The mandrel *h* may be positively rotated in a direction opposite to that of the rolls or at a slower rate of speed, or it may be loosely mounted on the mandrel-rod, so that it may simply turn with the tube as the latter is rotated by the spiral action of the rolls themselves. When, however, the amount of reduction of the thickness of the tube coming from the first set of rolls is considerable, and the internal diameter of the tube is not to be increased, or, perhaps, is to be slightly decreased, I prefer to employ the form of concave cross-rolls shown in Fig. 3. In this the concave rolls are mounted similarly to those heretofore described, but the pass produced by them decreases in area from the entering end to about the middle, from which point it remains of substantially constant area to the exit end of the rolls, as shown in Fig. 3. To produce a pass of this nature by the rolls, the first half of the roll from about the middle *g'* is turned off an amount gradually increasing toward the end g^2 of the roll, giving one of the longitudinal sections shown in Fig. 4. A cylindrical mandrel, *i*, having a tapering or

conical end, is supported in the pass formed by the first half of the rolls, the mandrel *i* preferably not extending rearwardly much beyond the middle of the pass, as there is no reduction of the metal produced by the latter part of the rolls, their action being more that of bringing to true cylindrical form and straightening of the tube coming from the first half. This gives from the entering end *k* of this set of rolls to about its middle *l* a space for the passage of the tube, which gradually decreases, in consequence of which, when the end of the tube coming from the first set is seized by the concave rolls, it is gradually forced along over the surface of the mandrel by the spiral action of the rolls and the metal drawn forward and the thickness of the tube decreased by the pressure of the converging working-faces of the rolls, imparting an additional spirality to the fibers of the tube from that obtained by the first set of rolls. The latter half of the pass formed by the concave rolls being uniform throughout serves to smooth the surface of the tube and straighten it and bring it to true cylindrical form, so that it leaves the rolls perfectly straight and does not require any further manipulation. As in the form of cross-rolls previously described, the mandrel in this case can be positively rotated, or it may be simply loose on its rod, so that it turns with the tube in the latter's passage through the rolls.

When the diagonally-acting rolls *a a* have the corrugated surfaces *e e*, and spiral ribs or corrugations are formed by them on the exterior surface of the tube produced, these ribs are drawn out by the concave cross-rolls and the surface of the tube made smooth. The ribs also afford metal for a considerable elongation of the tube by the second set of rolls, and assist these rolls in obtaining a firm grip on the metal to force it through the rolls and over the mandrel supported between them.

By my improved apparatus I am enabled to take a hollow ingot or blank, and by a continuous operation reduce the thickness of the walls of the same and produce a tube of the desired length, in which the fibers of the metal of the tube are arranged spirally around the same and the tube smoothed and straightened, so that no further manipulation of the tube is necessary.

Having now described my invention, what I claim is—

1. In an apparatus for the manufacture of tubing, the combination of a set of diagonally-acting converging rolls, with a set of concave cross-rolls having an interposed mandrel between them, said latter set of rolls being in line with and adapted to receive the blank from the first set, substantially as and for the purpose set forth.

2. In an apparatus for the manufacture of tubing, the combination of a set of diagonally-acting converging rolls, with a set of concave cross-rolls having a rotating mandrel interposed between them, said latter set being in line with and adapted to receive the blank from the first set, substantially as and for the purpose set forth.

3. In an apparatus for the manufacture of tubing, the combination of a set of diagonally-acting converging rolls, with a set of concave cross-rolls having a portion of its pass gradually reducing in area, the latter set of rolls being in line with and adapted to receive the blank or tube coming from the first set, substantially as and for the purposes set forth.

4. In an apparatus for the manufacture of tubing, the combination of a set of diagonally-acting rolls, with a set of concave cross-rolls having a mandrel interposed between them and having the space between the surface of the mandrel and the working-faces of the rolls gradually decreasing in size, the second set of rolls being in line with and adapted to receive the blank coming from the first set, substantially as and for the purpose set forth.

5. In an apparatus for the manufacture of tubing, the combination of two or more concave cross-rolls, the pass formed by which gradually decreases in area throughout a portion thereof and remains constant during the remaining portion, substantially as and for the purpose 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.