(No Model.) 2 Sheets—Sheet 1.

J. H. FLAGLER.

ART OF FORMING SEAMLESS TUBING.

No. 401,145. Patented Apr. 9, 1889.

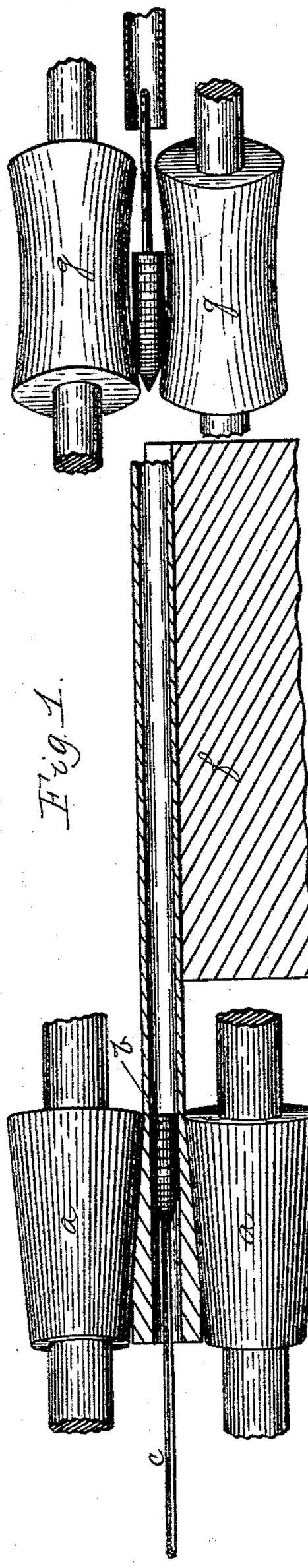

Fig. 1.

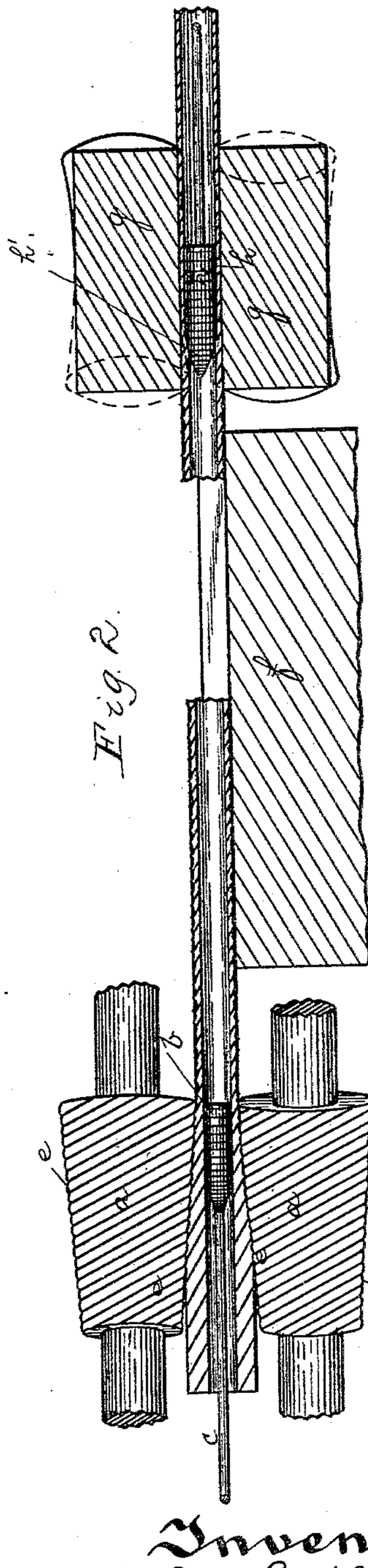

Fig. 2.

Witnesses:
J. A. Cooke
Robt. D. Totten.

Inventor.
John H. Flagler
By James L. Ray
Attorney

(No Model.) 2 Sheets—Sheet 2.

J. H. FLAGLER.

ART OF FORMING SEAMLESS TUBING.

No. 401,145. Patented Apr. 9, 1889.

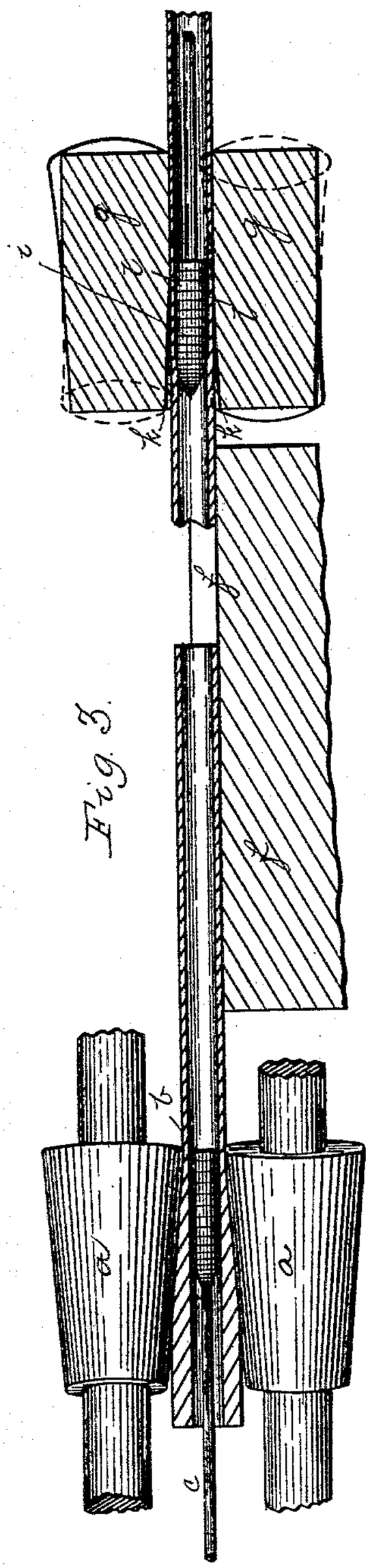

Fig. 3.

Fig. 4.

Witnesses:
J. H. Cooke.
Robt. D. Totten

Inventor:
John H. Flagler
By James D. Tray
Attorney

UNITED STATES PATENT OFFICE.

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

ART OF FORMING SEAMLESS TUBING.

SPECIFICATION forming part of Letters Patent No. 401,145, dated April 9, 1889.

Application filed December 17, 1887. Serial No. 258,164. (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.

The object of my invention is to provide a method of manufacturing seamless tubes in which the interior surface is highly finished and the fibers of metal are arranged spirally, both on the interior and exterior surfaces, as well as the strength of the finished tube increased, and the tube itself straightened and given a true cylindrical form in one continuous operation.

To these ends my invention generally consists in, first, spirally rolling and reducing a hollow ingot or blank to draw out the metal into a tube and arrange the exterior fibers thereof spirally, and then cross-rolling and internally rolling said tube to further draw out the metal, preserve the spiral arrangement of the exterior fibers of the tube and arrange the interior fibers spirally, and also straighten and impart a true cylindrical form to the finished tube, as 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 the apparatus employed in carrying out my improved method of making tubes. Fig. 2 shows a view of the same apparatus, with the second set of rolls partly in section, for the purpose of indicating the nature of the pass to which the tube is subjected. Fig. 3 is a similar view showing a modified form of cross-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, or a horizontal 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 subjected directly to the method hereinafter described without the preliminary treatment set forth above.

In carrying out the method which forms the subject-matter of this application, I take the hollow ingot or blank prepared, as heretofore described, and first subject it to a spiral rolling operation to draw out the ingot into a tube, decrease the thickness of its wall, and arrange the exterior fibers of the tube spirally. In the form of apparatus considered to be preferable for this operation two or more diagonally-acting rolls, *a a*, having converging faces are mounted in suitable housings, the rolls shown 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 the details of the housings or the manner of driving the rolls, as they are well known to those skilled in the art and need no explanation herein. 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. This arrangement of the axes of the rolls and by having the working-faces of the latter converge toward each other a reducing pass is formed in which the metal of the ingot or blank 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 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 or ingot 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 roll the ingot or blank is gradually drawn out into a tube of less external diameter and thinner wall 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 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 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 spread the metal of the blank when 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 are produced on the tube made, which facilitates the second rolling operation, hereinafter described. The tube or tubular blank thus produced is next subjected to the rolling action of concave cross-rolls over a mandrel to further reduce the thickness of the tube and produce a spiral arrangement of internal fiber as well as to straighten said tube and impart a true cylindrical form thereto.

In carrying out this second step the tube coming from the first set of rolls 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 diagonally-acting rolls *a a*, and the distance between the two sets of rolls being so arranged that the concave cross-rolls *g* 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 lines 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 rolling operation 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 the area of the pass formed by the working-faces of the rolls remains substantially the same throughout, and a mandrel, *h*, having a tapering face, *h'*, is supported in the pass 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 imparting a spiral fiber to its interior surfaces, and preserving that imparted to the exterior surfaces by the first rolling operation, also 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, and the rear portion of the latter serving to smooth the surface of the tube, straighten it, and impart a true cylindrical form thereto. The mandrel *h* may be positively rotated in a direction opposite that of the rolls, or it may be simply loose on the mandrel-rod, so that it can turn with the tube during its movement through the rolls, or it may be held stationary. When, however, the thickness of the tube to be reduced by the second rolling operation is considerable and the internal diameter is not to be increased and perhaps decreased, I prefer to employ the form of concave cross-rolls shown in Fig. 3. In these 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 the same 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 rolls 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 preferably not extending rearwardly much beyond the middle of pass, as there is no reduction of the metal produced by the latter part of the rolls, their action being more that of straightening and bringing the tube coming from the first half to a true cylindrical form. 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 of the tube drawn forward and the thickness of the wall decreased by the pressure of the converging working-faces of the roll, and forcing the metal of the interior of the tube against the surface of the mandrel, so that it will be rolled by the same and impart a spiral arrangement to the fibers of the tube in addition to what may have been given by the first set of rolls. This operation materially strengthens the tube, and it not only preserves the spirality imparted to the exterior fibers of the tube by the first set of rolls but rolls the tube on its interior and imparts the spiral arrangement to the fibers thereof. The latter half of the pass formed by the concave rolls being uniform throughout serves to smooth the surface of the tube, straighten it, and bring it to a true cylindrical form, so that it leaves the rolls in such condition that no further manipulation is required. 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. Where 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 cross-rolls and assist these rolls in obtaining a firm grip on the metal to force it through the pass and over the mandrel supported between them.

By my improved method I am enabled to produce a thin seamless tube having its fibers both externally and internally arranged spirally and the interior of the tube given a high degree of finish, as well as straighten the tube and give it a true cylindrical form by one continuous operation.

Having now described my invention, what I claim is—

The herein-described improvement in the art of forming seamless metal tubing, consisting in first spirally rolling and reducing a hollow ingot or blank to draw out the metal into a tube and arrange the fibers thereof spirally, and then cross-rolling said tube over a mandrel to further draw out the metal of the same, preserve the exterior spiral fibers, and arrange the interior fibers spirally, and also imparting a true cylindrical form to the tube, and straighten the same, 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.