No. 721,209. PATENTED FEB. 24, 1903.

M. MANNESMANN.

ART OF ROLLING TUBES.

APPLICATION FILED OCT. 7, 1901. RENEWED SEPT. 17, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

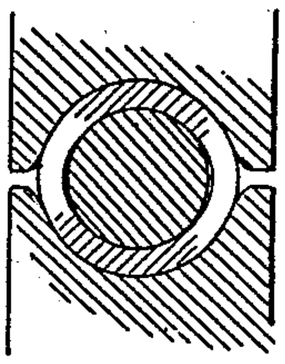


Fig. 3.

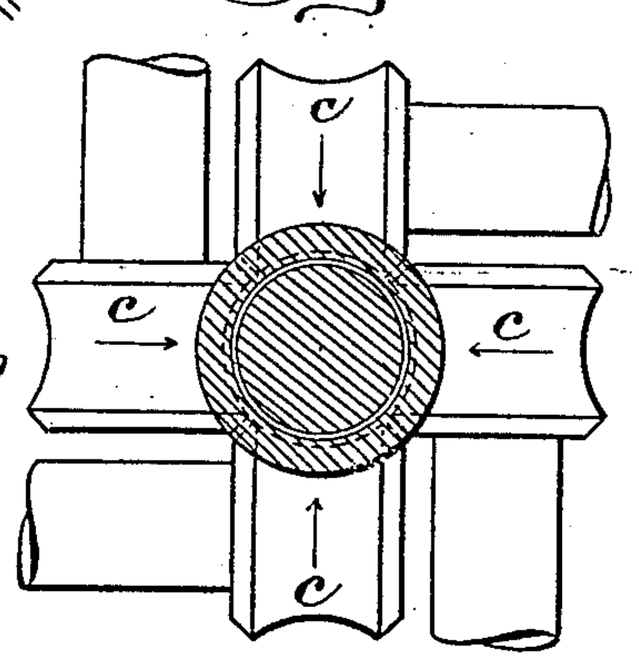


Fig. 2.

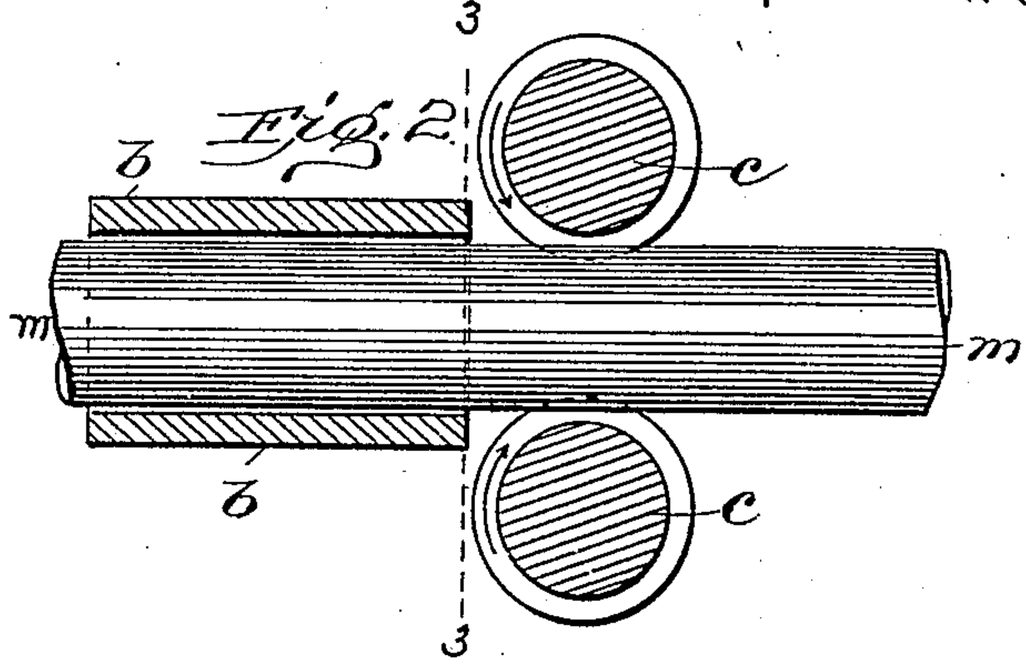


Fig. 4.

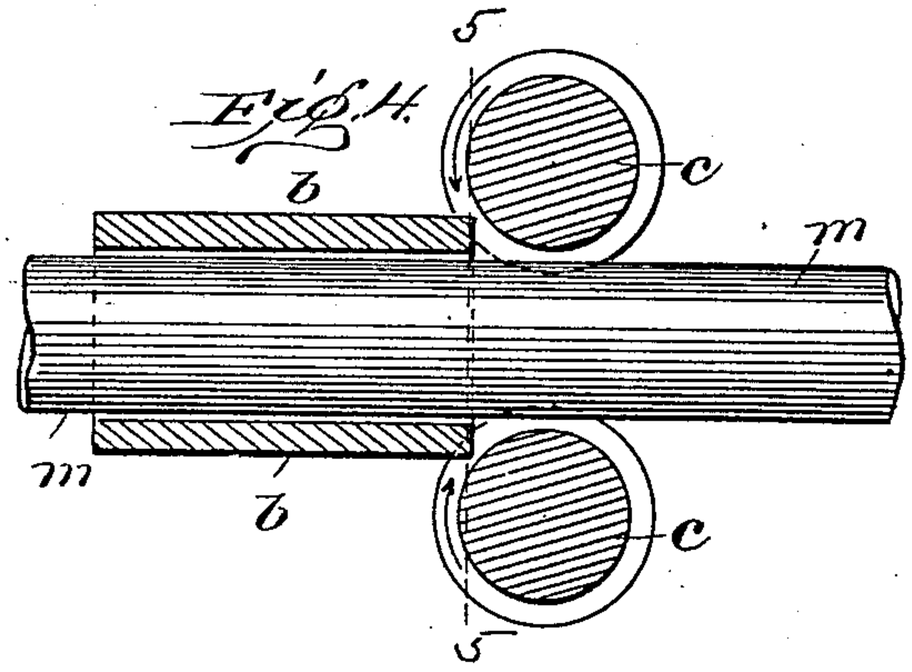


Fig. 5.

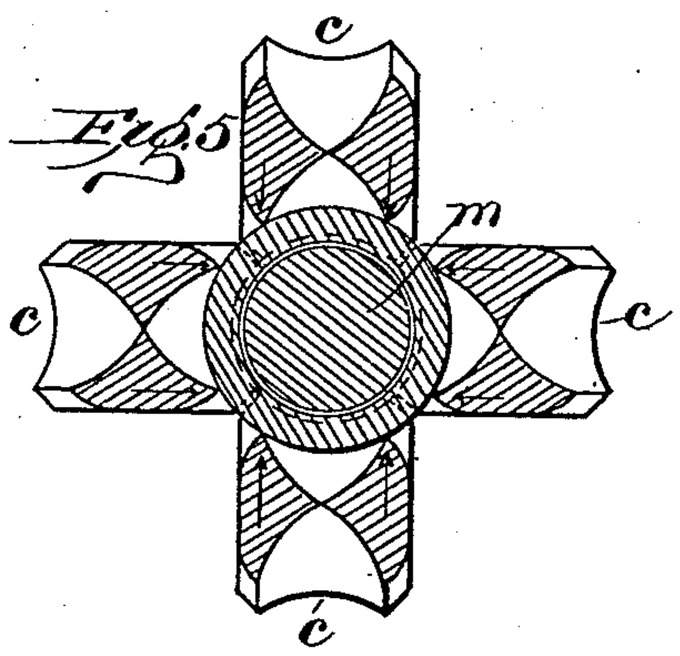


Fig. 6.

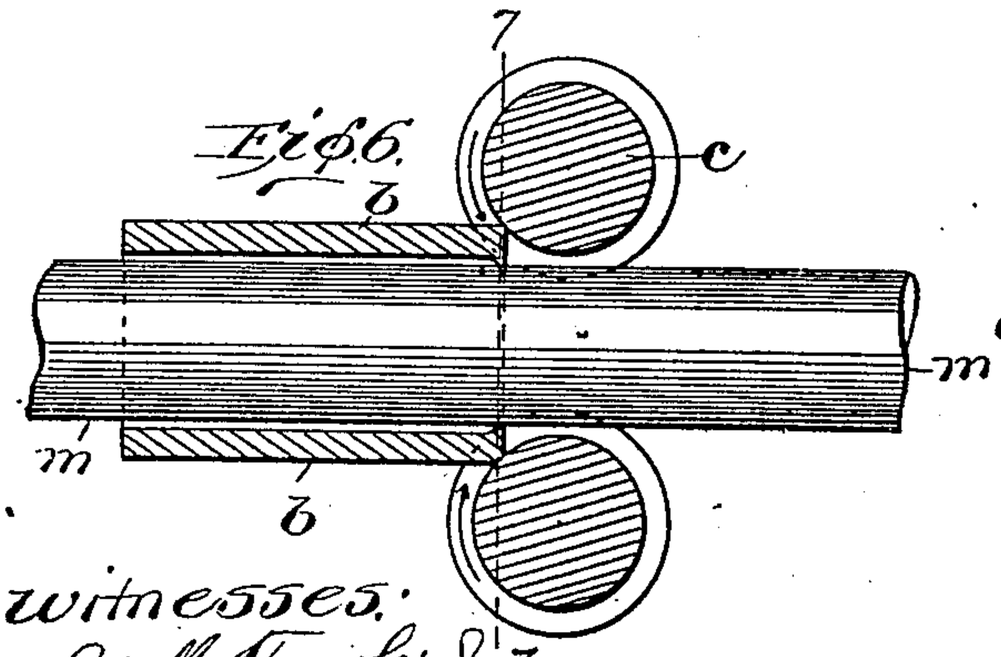
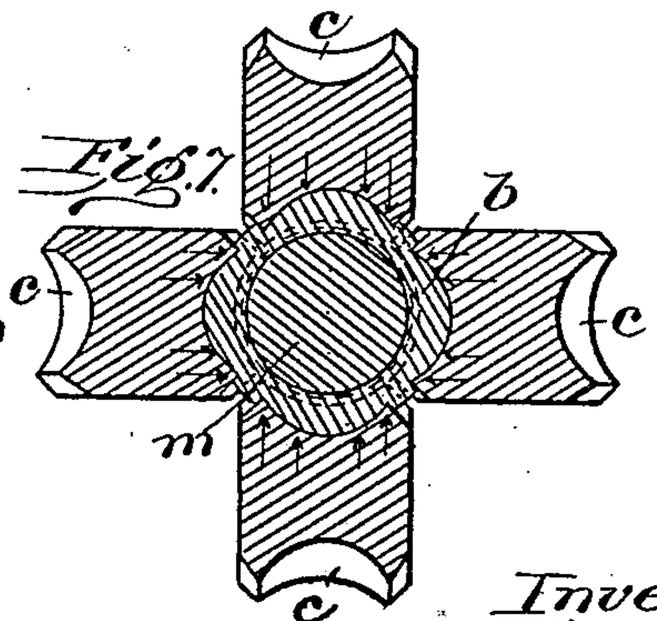


Fig. 7.



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L. C. Wilson

Inventor:
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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 8.

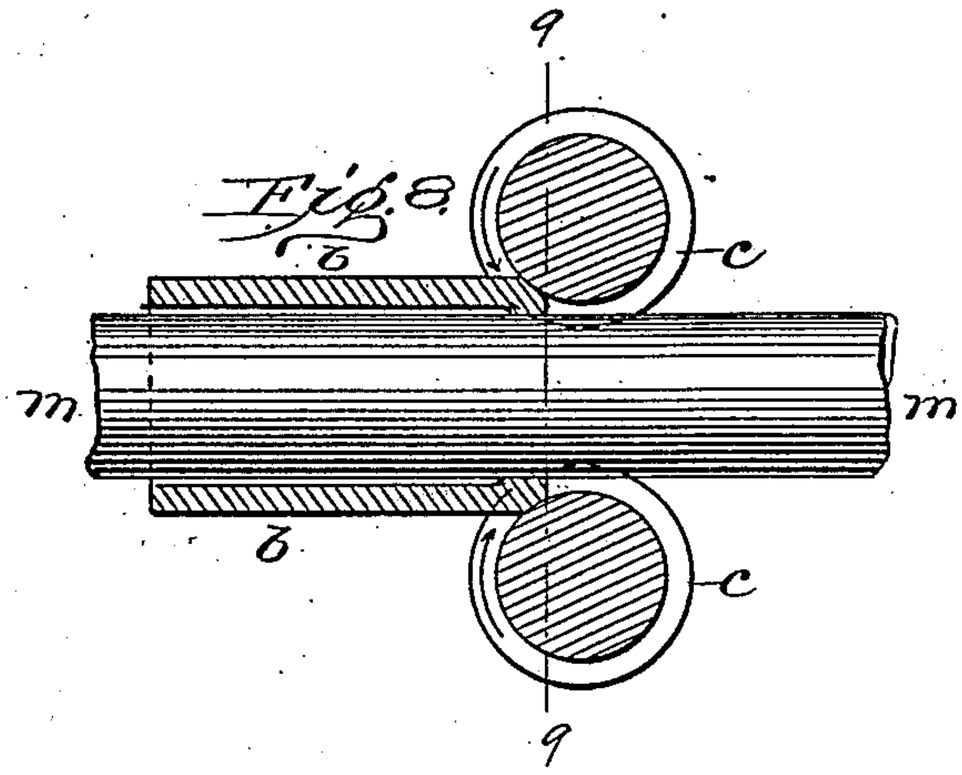


Fig. 9.

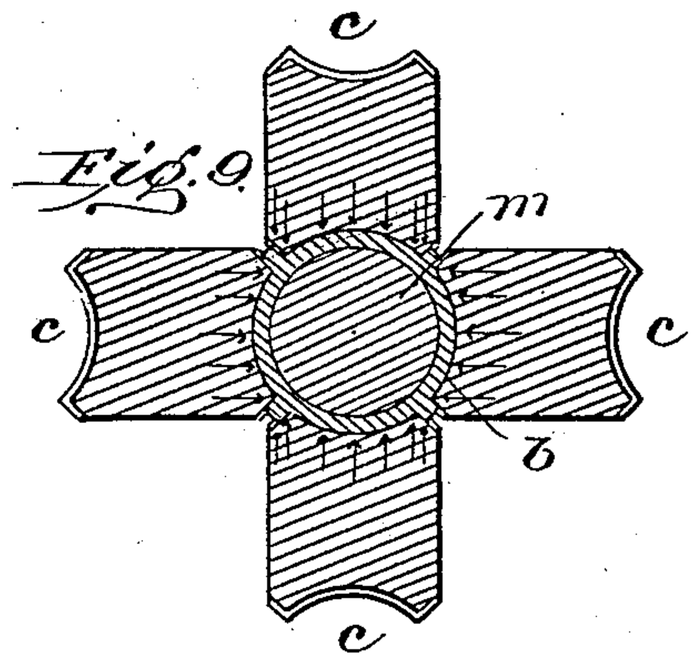


Fig. 10.

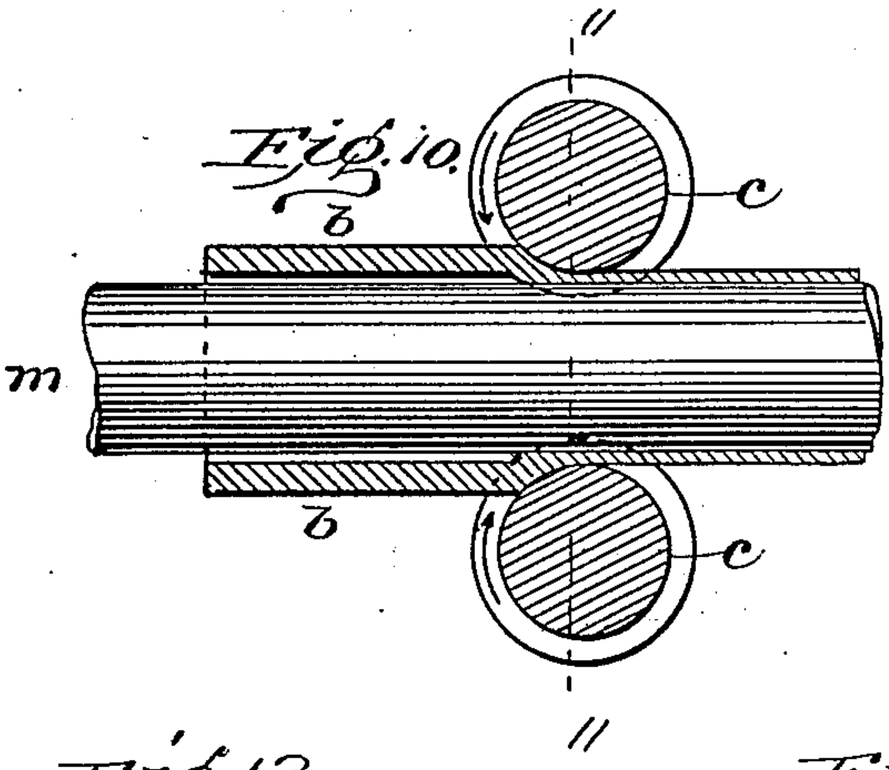


Fig. 11.

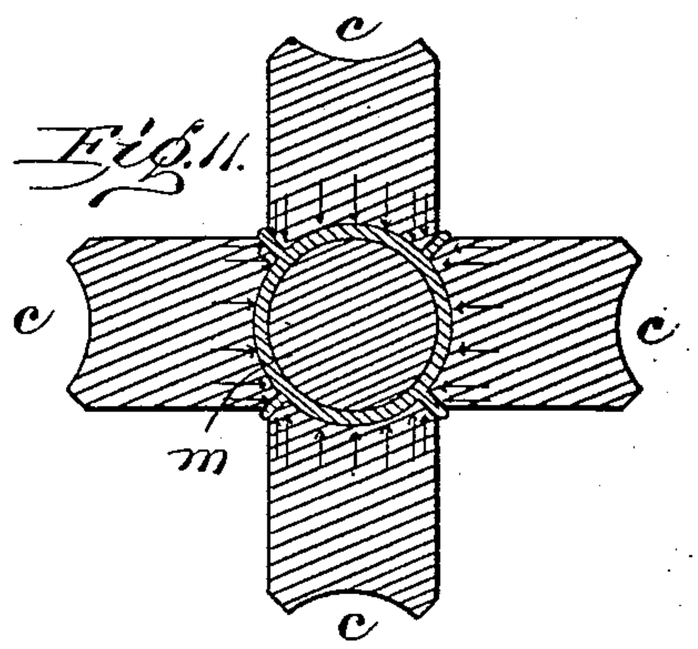


Fig. 13.

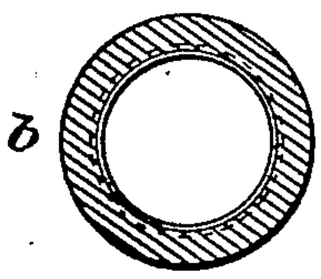


Fig. 12.

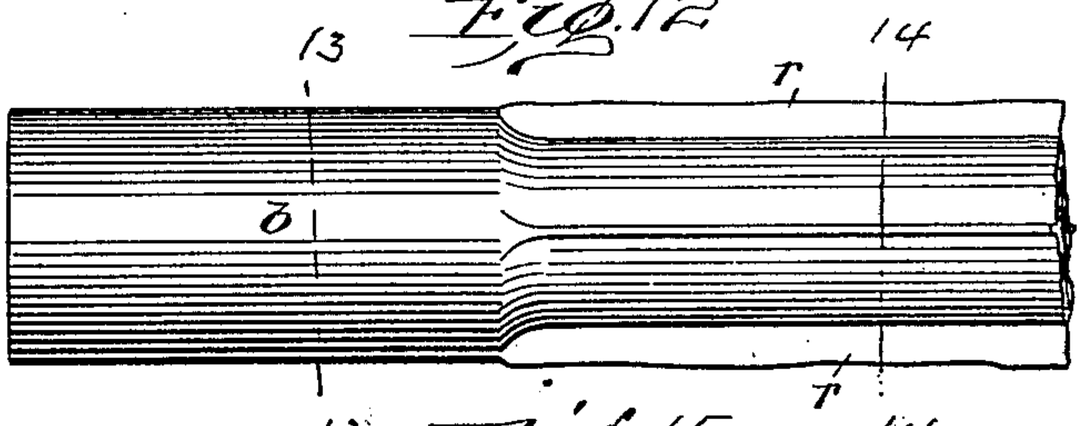


Fig. 14.

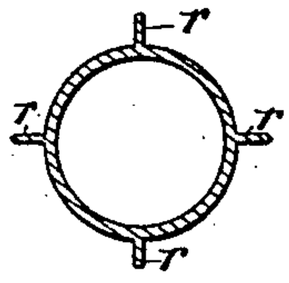


Fig. 16.

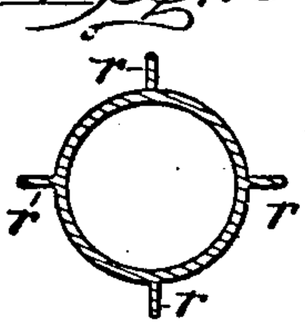


Fig. 15.

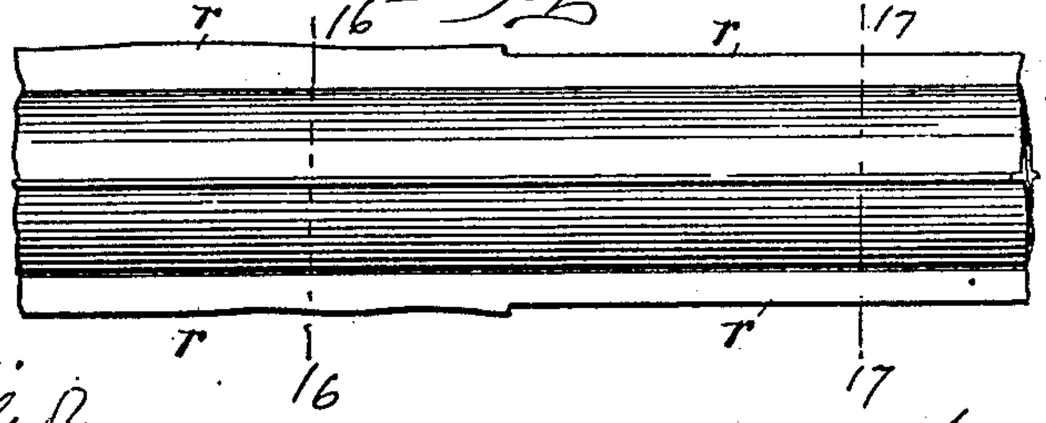
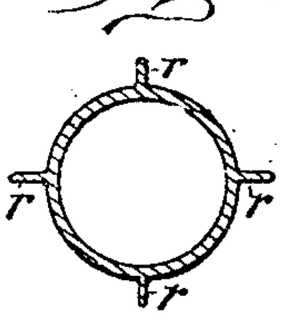


Fig. 17.



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APPLICATION FILED OCT. 7, 1901. RENEWED SEPT. 17, 1902.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 18.

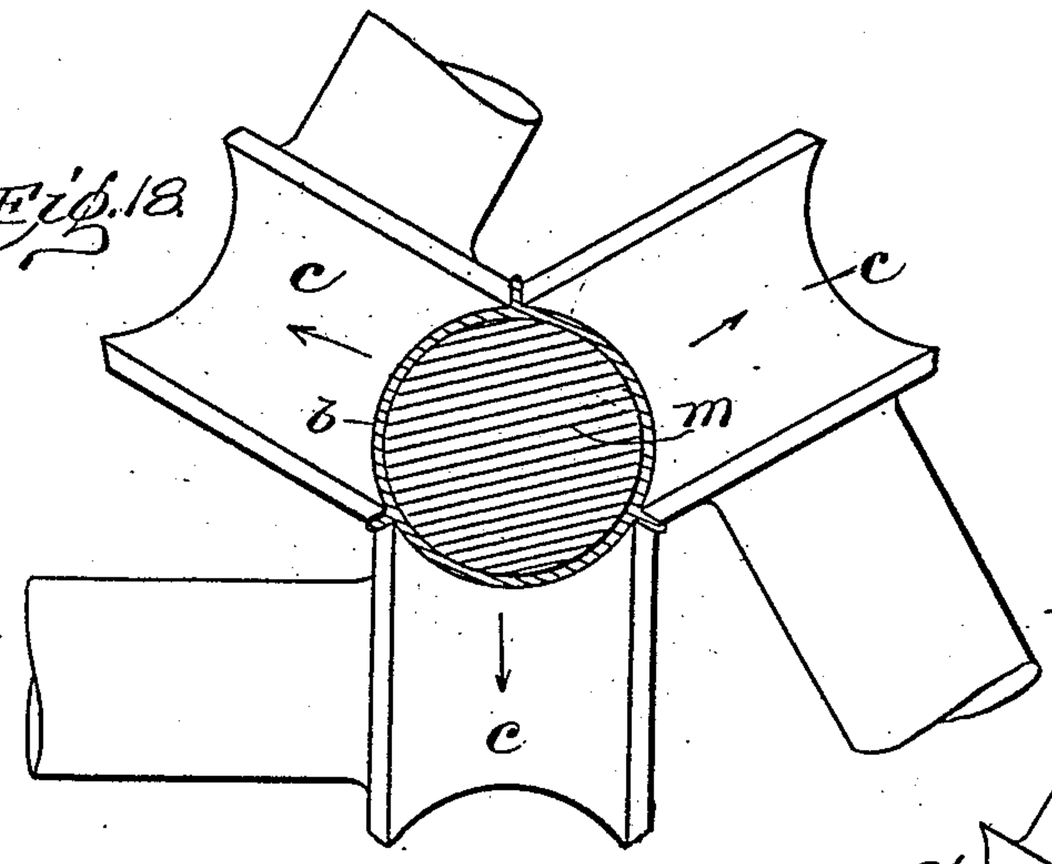


Fig. 20.

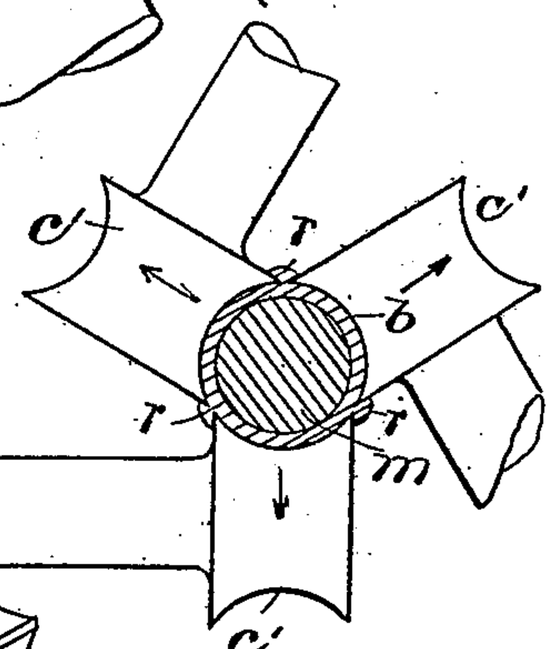


Fig. 19.

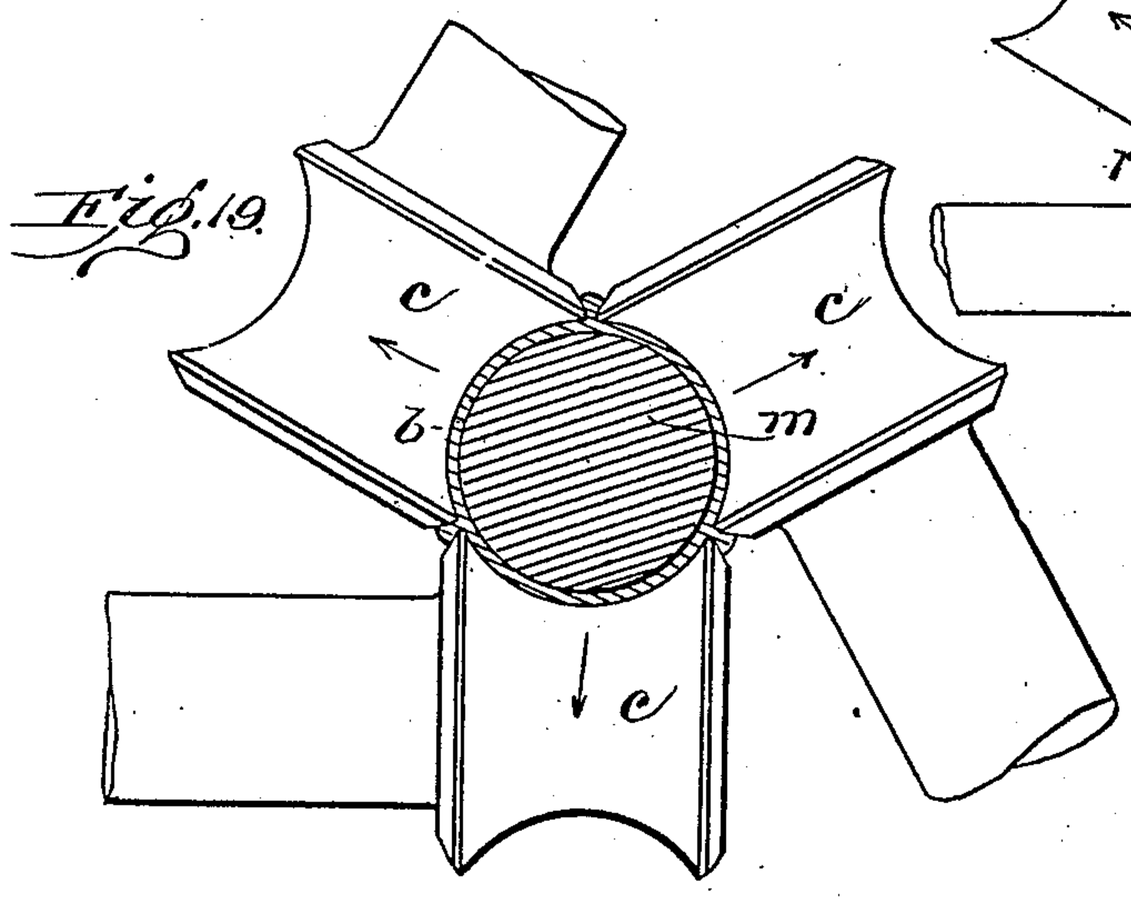


Fig. 22.

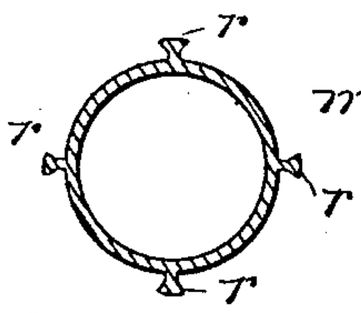


Fig. 21.

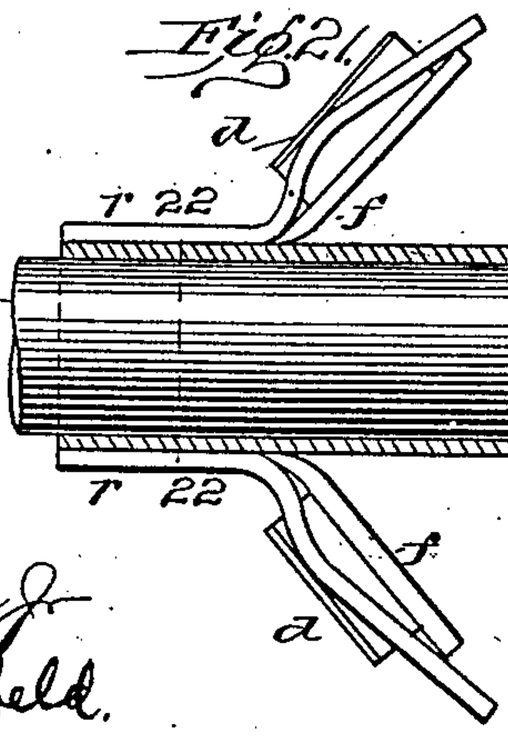
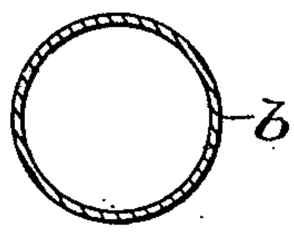


Fig. 23.



Witnesses:
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Inventor
M. Mannesmann

UNITED STATES PATENT OFFICE.

MAX MANNESMANN, OF REMSCHEID-BLIEDINGHAUSEN, GERMANY.

ART OF ROLLING TUBES.

SPECIFICATION forming part of Letters Patent No. 721,209, dated February 24, 1903.

Application filed October 7, 1901. Renewed September 17, 1902. Serial No. 124,805. (No model.)

To all whom it may concern:

Be it known that I, MAX MANNESMANN, a citizen of the Empire of Germany, residing at Remscheid-Bliedinghausen, Germany, have invented new and useful Improvements in the Art of Rolling Tubes, of which the following is a specification.

My invention relates to the rolling out of hollow billets or blanks between grooved rolls on a mandrel into a tube.

In rolling out tubes from a hollow blank or billet the blank was heretofore subjected on a mandrel to the pressure of two rolls, which first contacted with or compressed the material at diametrically opposite points near the middle of the groove, so as to stretch the blank in longitudinal direction. At the same time those parts of the circumference of the tube near the edges of the groove and which were not under compression by the rolls were stretched by the cohesion with the compressed and elongated parts. The tube was then turned around its axis through an angle of ninety degrees and subjected a second time to the rolling operation, so that those portions which were elongated without being compressed were compressed and rolled out and the previously-compressed portions were elongated without being compressed. This process subjected the tube to tearing strains alternating with compression, and several passes were required for producing the finished tube. In rolling out hollow blanks on a mandrel between three or four grooved rolls the same operation was performed. The caliber of the rolls was cut away tangentially to the grooves, so that the center portion of the grooves first touched the blank, and room was left at the sides of the grooves to prevent the formation of fins of the blank. The blank passed many times through the rolls, turned around its axis between each two passes for sixty degrees with three rolls and forty-five degrees with four rolls, and so rolled out to the desired degree, whereby the circumference of the blank at three or four points was alternately subjected to a strong pressure by the center portions of the grooves and to tearing strains or a crowding up between the cut-away sides of the grooves.

The object of the present invention is to overcome the defects of this process, avoiding the alternating compression and tearing strains, and furnish a process in which the stretching of the blank into a tube is produced under pressure throughout its cross-section, so that the stretching operation is produced under pressure exerted on the entire circumference of the tube, and a blank can be rolled out into a tube in one pass through the rolls; and the invention consists of the improvement in the art of rolling tubes by subjecting a hollow blank or billet of a size larger than the pass on a mandrel through its entire cross-section to the pressure of positively-driven rolls, which first contact with or compress the metal near the edges of the groove, so as to squeeze down some of the material of the blank and intentionally to produce ridges, fins, or ribs and a stretching of the whole body of the blank, as well as of the ridges, fins, or ribs, in longitudinal direction.

The invention consists, further, of additional steps in the art of rolling tubes, which will be fully described hereinafter and then pointed out more specifically in the claims.

In the accompanying drawings, Figure 1 represents a vertical transverse section of a tube and mandrel subjected to the pressure of rolls by the process heretofore used. Figs. 2, 4, 6, 8, and 10 are vertical longitudinal sections illustrating the successive steps of my improved process of rolling tubes by circumferential pressure on the hollow blank or billet. Figs. 3, 5, 7, 9, and 11 are vertical transverse sections respectively on lines 3 3, Fig. 2, 5 5, Fig. 4, 7 7, Fig. 6, 9 9, Fig. 8, and 11 11, Fig. 10. Fig. 12 is a side view of a tube shown partly rolled out by my improved process. Figs. 13 and 14 are vertical transverse sections respectively on lines 13 13 and 14 14, Fig. 12. Fig. 15 is a side elevation of a finished tube, on which the ribs or feathers formed on the exterior of the tube are partly trimmed off at their edges. Figs. 16 and 17 are vertical transverse sections respectively on lines 16 16 and 17 17, Fig. 15. Figs. 18, 19, and 20 are end views of a three-roll rolling-mill for carrying out my improved process. Fig. 21 is a side elevation, partly in section, showing the cutters for cutting off the

exterior ribs or feathers, and Figs. 22 and 23 are vertical transverse sections respectively on lines 22 and 23 in Fig. 21.

Similar letters of reference indicate corresponding parts.

In the drawings, *m* represents the mandrel over which the hollow blank or billet is rolled out.

b is the blank, and *c* and *c'* the rolls employed for rolling out the blank on the mandrel. Positive rotary motion is imparted to the shafts of the rolls in any suitable manner. The rolls are so disposed around the mandrel that pressure nearly around its entire circumference is exerted on the hollow blank or billet during the rolling operation, four rolls being preferably used for this purpose, the edges of which are arranged closely together, as shown in Fig. 11, so that the tube is formed in close contact with the mandrel around the entire circumference of the same, while in the small spaces between the rolls small ribs or feathers *r* are formed on the outside of the tube. As the rolling operation progresses and the blank is forced through the rolls the spaces not under pressure at the entry of the pass diminish as the working faces of the rolls approach each other, whereby some of the material of the blank which is located between and acted upon by the beveled parts outside of the edges of the rolls is compressed and elongated with the body of the tube, so as to form longitudinal ribs on the outside of the same. The entire circumference of the tube, as well as the ribs or feathers formed thereon, is in such way under compression while being rolled. The rolling operation is best performed by means of four rolls, as they surround the entire circumference of the blank in a greater or more perfect degree than three or only two rolls, as will readily appear from an inspection of Figs. 4 to 11, in which four rolls, and of Figs. 18 and 19, in which three rolls, are used. The longitudinal ribs or feathers *r*, formed at the exterior circumference of the tube, after the same is rolled out can either be removed by a separate cutting operation or immediately as the tube leaves the rolls by a cutting-tool *f*, which is arranged in proximity to the outgoing end of the rolls, as shown in Fig. 20, or the edges of the ribs or feathers may be trimmed off and the remaining portions of the ribs or ridges retained on the tube, as shown in Fig. 15. In case, however, tubes with exterior ribs are to be rolled, such as are used for the masts of electric lights or the poles of overhead electric railways, then the circumference of the rolls may be so shaped that rounded-off ribs are formed, which act then in the nature of reinforcing-ribs that are not required to be removed from the tube. In this case the ribs should be made of uniform thickness throughout. The ribs or feathers *r* may also be formed by the correspondingly-beveled or at any desired angle cut-away parts of the rolls outside of their edges in dovetail shape or undercut, as shown in Fig. 19, or the rims outside of the edges of the grooves may entirely be dispensed with, as shown in Fig. 20. In this case the shaped edges of the rolls squeeze off or cut off a portion of the material of the blank. Even without the circumferential rims the whole cross-section of the blank is compressed to some extent, as the edges of the rolls crowd up the material cut off by them from the blank. This crowding up becomes larger when instead of sharp edges rounded-off edges are employed; but circumferential rims to compress the ribs, feathers, or fins formed by the edges of the rolls are preferred.

When a cutting-tool is used for cutting off the ribs during the rolling of the tube, a guide-box *d* is used for conducting off each cut-off rib, so that the same does not interfere with the rolls and the roller-bearings. This cutting off of the ribs can be accomplished in a more or less perfect manner and the slight unevenness remaining on the tube be evened up by grinding or polishing or by rolling them down, so that a perfectly smooth exterior surface is obtained.

I am aware that heretofore the attempt was made to form longitudinal ribs on tubes by a drawing process. Such tubes, however, have after the drawing process a considerably inferior rate of elongation or contraction than tubes produced by my rolling process between positively-driven rolls. Besides that, only very ductile material can be strongly stretched out by a drawing process, while many materials can be rolled out by means of positively-driven rolls, which are unfit to the drawing process, as in rolling the stretching out takes place under compression.

The edges of the rolls in my rolling process first impinge upon the hollow blank, compress the same, squeeze down a certain portion of the material of the same, and form ribs, ridges, fins, or feathers between them while holding the rolled-out tube under compression around the whole circumference of the mandrel. Hitherto in rolling out metals fins were sought to be avoided, as the blanks had to pass many times through the rolls, and fins produced by one pass would spoil the tube when being turned for ninety degrees and passed again through the rolls. In my new rolling process I produce fins, ribs, ridges, or feathers intentionally. I compress the hollow blank strongly between the rolls and the mandrel, stretch out the blank into a tube in one pass, and form fins, ribs, or feathers, so that the tube cannot be turned for ninety degrees and again passed through the rolls; but I stretch out the blank into a tube in one pass, so that a turning of the tube for ninety degrees and a second pass through the rolls is unnecessary. Such ribs, fins, or feathers may remain on the finished tube or be cut off.

I am aware that in welding tubes between two rolls fins are sometimes produced at the

edges of the rolls; but in welding tubes no stretching-out takes place, and the fins are exclusively stretched in lateral direction. Should a thick-shelled blank with an open seam be subjected to a strong reduction between the well-known welding-rolls simultaneously with the welding operation, the seam would be opened and the welding of the seam prevented. By said first impingement of the rolls at their edges on the blank the same is first compressed near those points of the circumference which at the entry of the roll-pass are not embraced by the rolls. By the use of three or four rolls forming the caliber these three parts of the circumference of the blank between the edges of the rolls at the entry to the roll-pass are smaller than with two rolls, and therefore embrace the hollow in a more perfect manner. Such rolls the edges of which first impinge on the blank will in most cases move the material of the blank near the edges inwardly close to the mandrel before the grooved center portions of the rolls compress the other parts of the circumference of the blank. During rolling the adjacent edges of the rolls approach each other and finally come close together, compressing between them fins, ribs, or feathers formed on the tube, so that the whole cross-section of the tube is under enormous compression by the rolls. This enormous compression of the whole cross-section of the blank produces a flow of its material in longitudinal direction and the stretching out of the same. When the thickness of the fins is made very small and smaller than the thickness of the wall in the rolled-out tube, then in many cases the pressure between the rims of the rolls being in contact with said fins may be greater than the pressure between the grooved parts of the rolls and the mandrel. As the material of the blank cannot flow out of a room with smaller pressure into a room being under higher pressure, the escape of material of the tube between the grooved parts of the rolls and the mandrel under such condition is effectively prevented. The fins hereby filling out the free spaces between the edges of the caliber act in a similar way as hard pieces of metal would do—*i. e.*, they complete the caliber formed between the rolls and produce an opening or caliber between the rolls closed at its entire circumference. The feathers or fins, therefore, being intentionally produced and compressed between the rims of the rolls, are means to aid the action of the rolls and the mandrel in rolling out a hollow blank into a tube in one pass.

Instead of rolling out a hollow billet or blank in one pass through the rolling-mill, as described, I may pass the blank several times through the mill; but in this case the blank, with its fins or feathers, must be fed in such way to the mill that each fin or feather is in a plane laid through the axis of the blank and the space between two adjacent edges of the rolls. In such way by the second pass the height of the fin or feather will be increased; or in producing tubes from hollow billets or blanks by several passes the fins or feathers produced between the rolls may be cut off and then the tube again be passed through the rolls. A tube so stretched out by several passes is similar to and the equivalent of a tube stretched out to the same extent by one pass, the difference being only in the height or form of the fins or feathers.

The above-described process is especially useful for producing or rolling out seamless tubes; but all other kinds of tubes or hollow blanks may be rolled out by said rolling process.

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. The improvement in the art of rolling tubes, which consists in subjecting the hollow blank or billet of a size larger than the pass on a mandrel to the pressure of positively-driven rolls, which first contact with, or compress the metal near the edges of the groove, so as to stretch it in longitudinal direction into a tube, and to compress the same around the entire circumference of the mandrel, substantially as set forth.

2. The improvement in the art of rolling tubes, which consists in subjecting the entire cross-section of a hollow blank or billet of a size larger than the pass, on a mandrel to the action of positively-driven rolls, which first contact with, or compress, the metal near the edges of the groove, so as to stretch it in longitudinal direction into a tube, and to compress the same around its entire circumference, substantially as set forth.

3. The improvement in the art of rolling tubes, which consists in subjecting the blank to the reducing action of positively-driven rolls on a mandrel, simultaneously with the squeezing action of the edges of the rolls, whereby a relatively large reduction of the blank and a stretching of the same in a longitudinal direction into a tube with longitudinal ribs, ridges, fins or feathers is produced, substantially as described.

4. The improvement in the art of rolling tubes, which consists in subjecting the entire cross-section of a hollow blank or billet of a size larger than the pass on a mandrel to the action of positively-driven rolls, which first contact with or compress, the metal near the edges of the groove, so as to stretch the same in longitudinal direction, and forming simultaneously exterior longitudinal ribs, fins or ridges, at the circumference of the tube at the points between the edges of the rolls, substantially as set forth.

5. The improvement in the art of rolling tubes, which consists in subjecting a hollow billet or blank of a size larger than the roll-pass on a mandrel to the pressure of three or more positively-driven rolls, which first contact with or compress the metal near the edges

of the groove so as to stretch the same in longitudinal direction, and forming simultaneously exterior longitudinal ribs, fins or ridges at the circumference of the tube at the points between the edges of the rolls, substantially as set forth.

6. The improvement in the art of rolling tubes, which consists in subjecting a hollow blank or billet of a size larger than the roll-pass, on a mandrel, to the pressure of three or more positively-driven rolls, which first contact with, or compress, the metal near the edges of the groove, and forming simultaneously exterior longitudinal ribs, fins, feathers or ridges at the circumference of the blank, and stretching out the ribs, fins, feathers or ridges simultaneously with the other part of the blank in longitudinal direction, substantially as set forth.

7. The improvement in the art of rolling tubes, which consists in subjecting a hollow blank or billet of a size larger than the pass on a mandrel to the pressure of three or more positively-driven rolls which first contact with, or compress, the metal near the edges of the groove, forming simultaneously exterior longitudinal ribs, fins, feathers or ridges at the circumference of the tube, and at points between the edges of the rolls, stretching out in longitudinal direction said fins, ribs, feathers or ridges simultaneously with the other parts of the blank, and then trimming off the outer edges of the fins, ribs, feathers or ridges, substantially as set forth.

8. The improvement in the art of rolling tubes, which consists in subjecting a hollow billet or blank of a size larger than the pass, on a mandrel, to the pressure of three or more positively-driven rolls which first contact with, or compress, the metal near the edges of the groove, stretching out the blank into a tube, forming, and stretching out simultaneously in longitudinal direction ribs, fins, feathers or ridges at the circumference of the tube at points between the edges of the rolls, and then cutting off the exterior ribs, fins, feathers or ridges formed, substantially as set forth.

9. The improvement in the art of rolling tubes, which consists in subjecting the entire cross-section of a hollow billet or blank of a size larger than the pass, on a mandel, to the action of three or more positively-driven rolls which first contact with, or compress, the metal near the edges of the groove so as to stretch the same in longitudinal direction, forming, and stretching out simultaneously in longitudinal direction, exterior longitudinal ribs, fins or ridges at the circumference of the tube and at points between the edges of the rolls, and then cutting off the exterior ribs, fins or ridges formed, substantially as set forth.

10. The improvement in the art of rolling tubes, which consists in subjecting the entire cross-section of a seamless hollow billet or blank of a size larger than the roll-pass, on a mandrel, to the action of three or more positively-driven rolls, which first contact with or compress, the metal near the edges of the groove, forming ribs, fins, ridges or feathers on the circumference of the blank, at points between the edges of the rolls, and stretching out the hollow part of the blank, and the ribs, fins, ridges or feathers in longitudinal direction, and cutting off said ribs, fins, ridges or feathers, substantially as set forth.

11. The improvement in the art of rolling seamless tubes, which consists in subjecting the entire circumference of the tube of a size larger than the pass, on a mandrel, to the pressure of three or more positively-driven rolls which first contact with, or compress, the metal near the edges of the groove, so as to stretch the blank longitudinally, forming simultaneously, and stretching out in longitudinal direction, exterior longitudinal ribs, fins or ridges at the circumference of the tube at the points between the edges of the rolls, and then cutting off the exterior ribs or ridges thus formed, and finally smoothing and finishing off the exterior surface of the tube thus obtained, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

MAX MANNESMANN.

Witnesses:

ARCHER PETER,

EMORY H. BOGLEY.