M. B. LLOYD.

PROCESS OF REDUCING AND SURFACE FINISHING METAL TUBES, RODS, AND THE LIKE.

APPLICATION FILED AUG. 7, 1912.

1,129,835.

Patented Feb. 23, 1915.

5 SHEETS—SHEET 1.

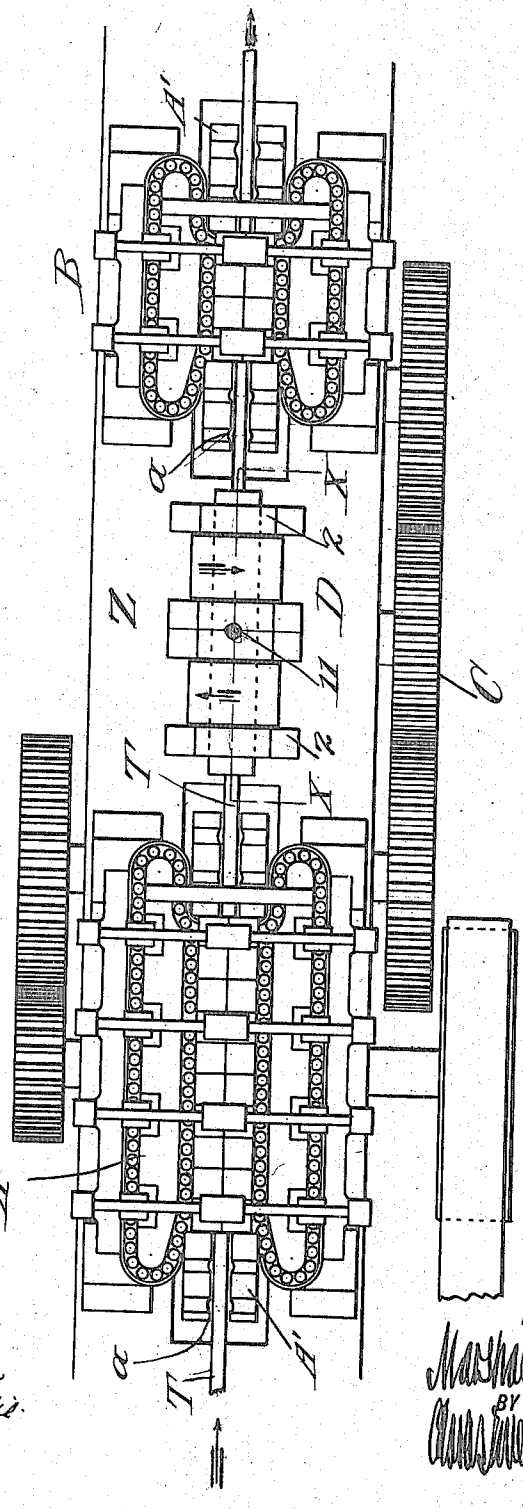


Fig. 1.

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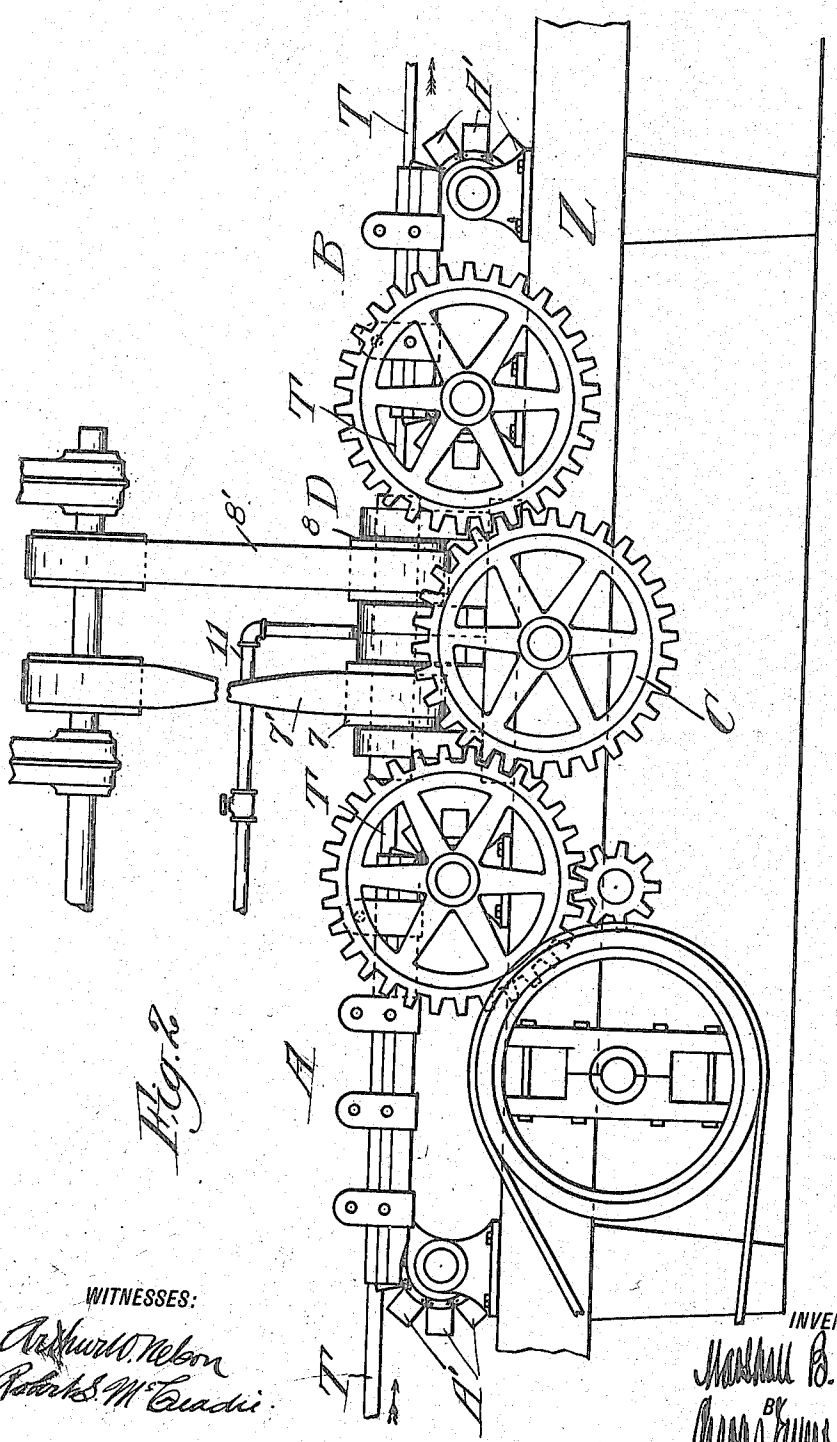


Fig. 2.

WITNESSES:

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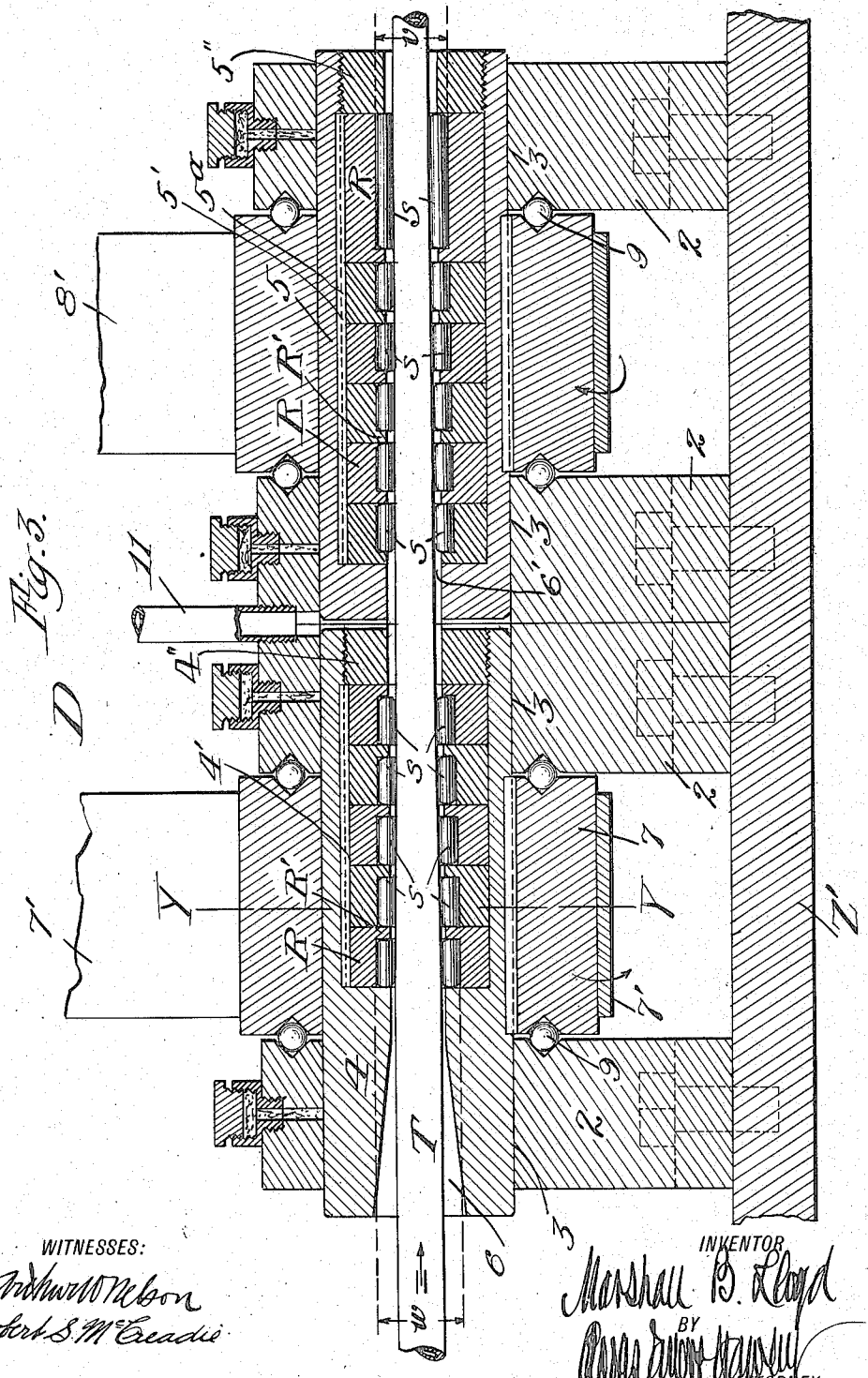


Fig. 3.

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5 SHEETS—SHEET 4.

Fig. 4.

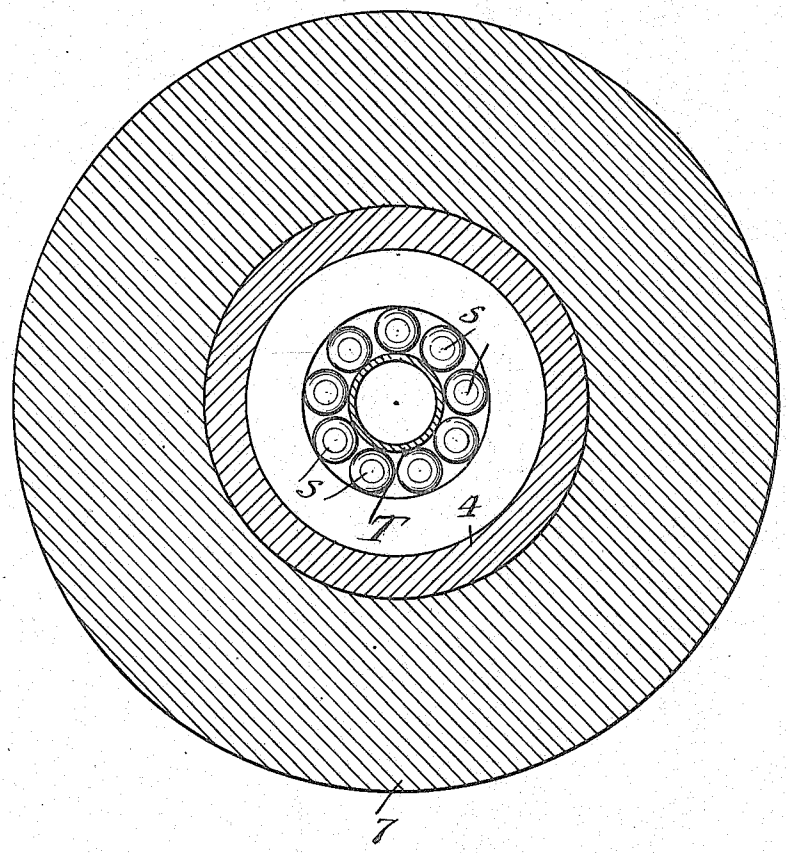
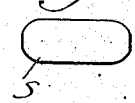


Fig. 10



Fig. 9



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5 SHEETS—SHEET 5.

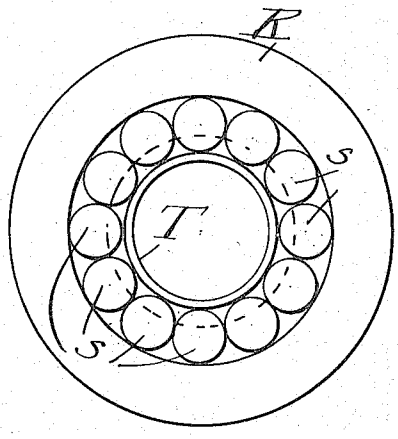


Fig. 5.

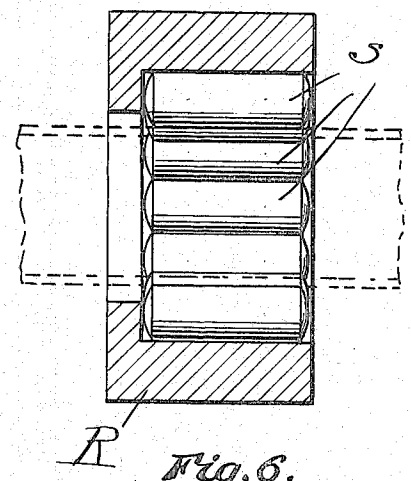


Fig. 6.

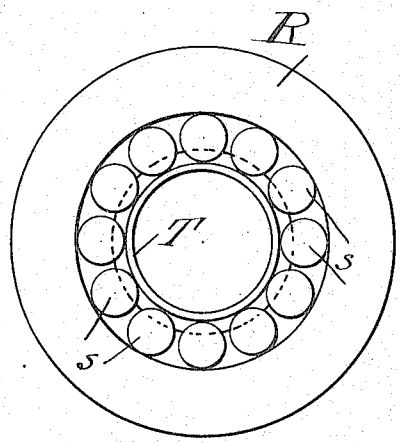


Fig. 7.

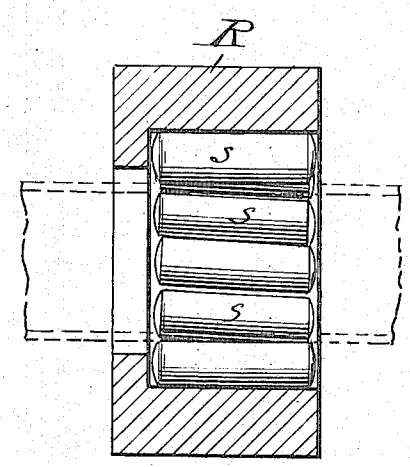


Fig. 8.

WITNESSES:

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UNITED STATES PATENT OFFICE.

MARSHALL BURNS LLOYD, OF MENOMINEE, MICHIGAN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE ELYRIA IRON & STEEL COMPANY, OF ELYRIA, OHIO, A CORPORATION OF OHIO.

PROCESS OF REDUCING AND SURFACE-FINISHING METAL TUBES, RODS, AND THE LIKE.

1,129,835. Specification of Letters Patent. Patented Feb. 23, 1915.

Application filed August 7, 1912. Serial No. 713,851.

To all whom it may concern:

Be it known that I, MARSHALL B. LLOYD, a citizen of the United States, and resident of Menominee, in the county of Menominee and State of Michigan, have invented a certain new, useful, and Improved Process of Reducing and Surface-Finishing Metal Tubes, Rods, and the like, of which the following is a specification.

My invention relates to improvements in the art of reducing tubes, rods, shafting and the like to specified circular cross sections, and further relates to the art of finishing the surfaces of such articles.

The object of my invention is to accurately reduce such articles to specified sizes, and also surface finish the same more rapidly and at less cost than can be done with known processes.

Wherever the terms "tube" and "tubing" are used in this specification and the appended claims, they are to be read as meaning and including various elongated cylindrical or substantially cylindrical articles, such as pipes, tubes, wires, rods, and shafting.

My invention consists in holding the elongated cylindrical article against rotation, and simultaneously feeding it forward at a substantially constant speed, and progressively subjecting its surface to circumferential rolling at relatively high speed. As a further step of my process I wash and lubricate the rolls with either clear or soapy water while acting upon the surface, to prevent high temperatures, to cleanse the rolls and the articles, and to yield a highly finished surface. These and other features and steps of my novel process are more fully described hereinafter and are particularly pointed out in the appended claims.

My invention will be more readily understood by reference to the accompanying drawings, forming part of this specification, and in which I have depicted a machine or apparatus that I find best suited to the carrying out of the several steps of the process.

In said drawings: Figure 1, is a plan view of such machine; Fig. 2, is a side elevation thereof; Fig. 3, is a longitudinal vertical section on the line X—X of Fig. 1, enlarged; Fig. 4, is a further enlarged cross section on the line Y—Y of Fig. 3; Fig. 5, is an end view of one of the roller rings and a number of rolls which completely fill the same; Fig. 6, is a longitudinal section thereof; Fig. 7, is similar to Fig. 5, but showing rolls which do not completely fill the ring; Fig. 8, is a longitudinal section showing the action of such rolls when in operation; Fig. 9, is a side view of one of the rolls; and Fig. 10, is a similar view of a roll of modified form.

It will be understood that my invention is not limited to the machine herein shown; nevertheless it admirably serves the ends of my process and is the best means that I have thus far devised for the purpose.

The mechanism shown herein may be used in the continuous tube mill that is described and claimed in Letters Patent No. 1,027,865, granted May 28th, 1912, in which case the continuous or traveling vise herein marked A will replace the mechanism marked E in that patent. On the other hand the herein shown mechanism may be used for reducing and finishing successive and relatively short pieces of tubing.

As before stated one important step of my process consists in holding the tube to be reduced, against rotation while it is advancing. I do not attempt to treat the whole length and surface of the tube at one time but restrict the reducing and finishing forces to one locality and by feeding the tube forward to and through such locality reduce its diameter and progressively finish its surface. To thus hold the tubing against rotation and at the same time positively advance or feed it at a constant rate of speed, I employ the traveling or continuous vise A, and preferably also employ a second traveling vise B, which may be of less length and relatively of less strength. These traveling vises are fixed upon a bench or table Z, and are driven by a train of gearing C, means being interposed to compensate for the elongation of the tubing between the two vises, due to the reduction of the tubing by the reducing mechanism. Primarily each vise comprises an endless conveyer equipped with a plurality of pairs of laterally opening and closing jaws A. In the working stretches of the vises the jaws, A, are closed together

upon the tube. As the jaws grasp the tube in this manner and as the jaw carrying conveyers are in constant rotation, it is obvious that the tube will be propelled forward at a substantially constant rate of speed. The detail construction vises is not of material moment in this case, but is clearly described in aforesaid patent. Any series of devices which will accomplish the simultaneous holding and propulsion of the tubing may be utilized in lieu of the traveling vises shown. It may be explained that the jaws of the vises are provided with grooves, *a*; which fit the tube and when opposing pairs of jaws are closed in the working stretch of the device they substantially inclose the portion of tubing which they engage and an effective gripping of the tubing by the vise is thus insured. It may also be explained that the working stretches, and the jaw grooves thereof, belonging to the two vises A and B are arranged in alinement so that the traveling vises have no tendency to bend or twist the tubing.

Throughout the drawings the tubing is indicated by the letter T.

It will be noted that the space between the two vises is occupied by another mechanism or tool D, which is also attached to the table or bench Z. This tool is the rolling appliance which I employ for reducing and finishing the tubing, in the interval of its passage from the vise A to the vise B. The direction of travel of the tubing is indicated by arrows in Figs. 1 and 2. I perform the rolling operation, preferably, at very high speed, accomplishing same by a plurality of annular series of small rolls which are confined circumferentially and with relation to the tubing. These series, I rotate rapidly, as stated, and each small roll thereof rolls upon the surface of the tubing at high speed and turns bodily around the tubing many times per minute. The first rolls, or series of rolls force the tubing fed thereto to a round shape and may somewhat reduce its size. The next series of rolls is confined within a smaller circumference than the first and the tube in its passage reduced in diameter to the extent of the difference between the internal circumference of the first annular series and the internal circumference of the second annular series of rolls. I employ still other series of rolls of gradually diminishing internal or working circumference, and by means thereof gradually roll down or reduce the tubing to specified diameter and circumference. While thus reducing the size of the tubing to the extent determined by the pre-arrangement of the reducing rolls, I at the same time gradually smooth the surface of the tubing and form thereon a surface skin, the grain of which extends circumferentially, as opposed to the longitudinal grain of the body of the tubing. To perfect the surface I prefer to add to the number of reducing rolls, one or more series of rolls distinguished by internal working circumferences substantially identical with that of the last series of reducing and surfacing rolls.

While I have mentioned the tubing as being held against rotation and such holding as being an important step of my process, I nevertheless wish that it be understood that the term "holding the tubing against rotation," or the like, is relative or comparative; meaning that it must not be permitted to rotate at the speed at which the reducing rolls rotate. Rotation of the tube in a contrary direction or at a less speed in the same direction, would not exceed the scope of my invention; though the process, so practised, would certainly involve the employment of machinery of far greater complexity and cost. At this point I will also say that I have had measurable success in the practice of my process by using hardened steel balls in lieu of the rollers herein shown. An annular series of balls, if held in close contact with the tubing and rotated rapidly while the tubing moves forward, successfully rounds the tubing and reduces the diameter and circumference thereof, but tends to mark the tube with visible spirals, and thus yields a surface that is not as fine as that produced by the elongated rolls.

The high speed rolling mechanism D, appearing in Figs. 1 and 2, will be best understood upon reference to Figs. 3 to 10. The parts 2 are bearing blocks containing bearings 3, and secured upon a bed plate Z' on the table Z. The bearings 3, are in exact alinement and contain two sleeves 4 and 5. Each sleeve contains a central hole 6, 6' to receive the tubing. In addition to this central opening, each sleeve contains a larger chamber 4', 5', closed at the discharge end by a screw plug 4'', 5'', respectively. The plugs contain central openings for the tubing. The chambers 4' and 5' are concentric with the axis of the tubing. The sleeves 4 and 5 are likewise concentric with the axis of the tubing. Within each chamber 4 and 5, I provide a plurality of hardened steel rings R. The rings are made to fit snugly within respective sleeves, and keys, 4^a, and, 5^a, hold them against rotation in respective sleeves. The parts marked, S, are the small rolls before referred to. For clearness of illustration, all of these rolls in Fig. 3 are shown as of the same diameter. It will be noted that the rolls are held against longitudinal movement by internal flanges R', provided on the rings R, for the purpose. The direction of travel of the tube T is shown by the arrows in Fig. 3. The diameter of the tubing as it approaches the mechanism D is considerably greater than the diameter of the tubing as it is discharged

from that mechanism. This difference has been considerably exaggerated in Fig. 3, though such a reduction by my process is not actually impractical. The internal diameter of the ring R, at the receiving end of the mechanism D, is greater than that of any other ring in the mechanism. The internal or working circumference of the series of rolls held in this first ring may be no greater than the circumference of the tube T, at that point or may be slightly less if desired. The next ring R, is slightly smaller in diameter; and such reduction of diameter proceeds from ring to ring, preferably until the last rings including the wide ring R, are reached in the sleeve 5. The diminishing diameters of the rings are indicated by the dotted lines of Fig. 3, distinguished by the dimension marks *w* and *v*.

The rolls in each ring may bear that relation to the ring and tube which is depicted in Figs. 5 and 6, or their relation may be as depicted in Figs. 7 and 8. In the case of Figs. 5 and 6, the rolls S, bear one against the other and snugly fill the ring R. Such rolls maintain positions parallel with the axis of the tubing, when the containing ring R is rotated about the same. In the case of Figs. 7 and 8, the rolls are relatively smaller and the series thereof does not completely fill the containing ring. In consequence, spaces are left between the rollers, as shown in Fig. 7. In both cases, the tubing obviously completely fills the opening within the series of rolls, and the external circumference of the tube T, depicted in Figs. 5 and 7, is identical with the before mentioned internal or working circumference of the rolls. The difference in action between the arrangement of Fig. 5 and the arrangement of Fig. 7 is occasioned by the looseness of the rolls S, in the ring of the Fig. 7; for as indicated in Fig. 8, the rotation of the containing ring R, causes one end of each roll to lag behind its other end so that the rolls assume oblique positions in the containing ring. In other words each roll that is allowed such latitude of movement within the ring, will bear upon the containing ring at its ends and will lie in a plane which intersects the axis of the tubing. The parallel rolls of Figs. 5 and 6 serve to condense the metal of the tube and thereby reduce its diameter, and also serve to roll down and polish the tube's surface. The rolls of Figs. 7 and 8, perform the same functions but in addition, they operate as cross rolls and tend to propel the tube longitudinally.

The sleeves 4 and 5 are equipped with respective pulleys or drivers 7 and 8. Thrust bearings 9 arranged between the ends of the pulleys and the adjacent bearing blocks 2, prevent endwise movement of the sleeves 4 and 5 in their bearings. These pulleys 7 and 8 may be driven by belts 7′ and 8′. The rotation of the closely contacting rolls S has a tendency to twist the tubing T, and to counteract this tendency, I prefer to drive the roll containing sleeves 4 and 5 in opposite directions, as indicated by the crossed belts shown in Fig. 2. Except for this possible twisting of the tube, and in cases where the strength of the article to be reduced and polished is more than sufficient to overcome the twisting effort of the rolls, all of the rolls required to do the work may be arranged in a single direction rotary member or sleeve. In either case, I admit water under pressure to the roll containing sleeve or sleeves, as by a supply pipe 11. The water flows in both directions within the sleeves and among the rolls, finding escape at the ends of the sleeve or sleeves. In passing between the tube and the rolls, the water sufficiently lubricates the latter and cleanses both the rolls and the surface of the tubing while keeping the temperature of the tubing at such a low point as to insure a smooth bright finish. When a very high finish is desired I sometimes use soapy water as a lubricant.

It will be understood that the cylindrical rolling surface of each roll S is a hardened and preferably ground surface. It will also be understood that the inner cylindrical surfaces of the several rings are likewise hardened and ground. The smoothness of these parts is transmitted or communicated to the surface of the tubes in the cold rolling process described. The rolling action is so rapid that the tubing may be fed through the mechanism at the rate of many feet per minute.

I prefer that the rolls in the receiving end of the mechanism shall be of the form and arrangement shown in Figs. 7 and 8. When so arranged the rapidly rotating rolls exert a very considerable pulling force upon the non-rotating tubing T. This force may be utilized as the only force for feeding the tubing, in cases where adequate means are provided for preventing the rotation of the tubing. However, the special advantage of the Figs. 7 and 8 arrangement, lies in the cross rolling effect of rolls arranged at slightly oblique angles to the tubing, which facilitates the reduction of the tubing.

Whatever the relative size and arrangement of the rolls in the sleeve 5, I prefer that the terminal series of rolls or the last several series of rolls shall have an internal working circumference which is not appreciably less than the working circumference of the last series of rolls which is relied upon to reduce the size of the tubing. The multiplication of rolls of the same working circumference insures a high finish or polish upon the surface of the tubing.

Where I rely upon the first used series of rolls to markedly reduce the diameter of the

tubing, I prefer that the oppositely running rolls in the sleeve 5 shall be mostly of the form and arrangement shown in Figs. 5 and 6 to the end that they may counteract the twisting effect of the reducing rolls and still avoid setting up a powerful re-action against the propelling effort of the rolls in the sleeve 4.

The rolls may be either smooth surfaced, as shown in Fig. 9, or may contain spiral clearance grooves, as shown in Fig. 10. I find the smooth rolls to be better under most circumstances.

Before leaving the description of the mechanism, I desire to explain that in rolling mechanisms for the larger sizes of tubing I inclose the rolls of each annular series with an individual cage which prevents possible disarrangement of the rolls in their containing ring.

Having described the several steps of the process in the early part of this specification I deem it unnecessary to repeat that description for the purpose of further identifying the several steps of the process with those parts of the mechanism which are utilized in performing them.

Thus far in my experience with the process herein described I have secured the best results by feeding, or allowing the tubing to feed, forward at a speed of from three to five feet per minute and by rotating the roll containing sleeve or sleeves at a speed approximating five thousand revolutions per minute. On the other hand I have secured admirable results by feeding the tubing at a different rate of speed and by cold rolling the same at a much lower roller speed. All results show that my process is capable of modification through a great range of speeds, roller pressures, roller arrangements, etc., and I do not confine or limit my invention to the precise limits herein specifically set forth, except as required by the claims hereunto appended.

This application is restricted to the process. The novel product or article of manufacture herein described is claimed in my co-pending divisional application Serial No. 790,775, filed September 19, 1913. The novel mechanisms herein disclosed are described and claimed in my divisional application Serial No. 790,776, filed September 19, 1913, and in my application Serial No. 4,625, filed January 27, 1915.

Having thus described my invention I claim as new and desire to secure by Letters Patent:—

1. The herein described process of reducing and finishing tubing, that consists in simultaneously holding the tubing against rotation moving it longitudinally forward at a substantially constant speed and cross rolling the tubing in progressive stages.

2. The herein described process of reducing and finishing tubing at two points, that consists in simultaneously holding the tubing against rotation and simultaneously feeding the same forward and circumferentially rolling the same at relatively high speed between said holding points.

3. The herein described process of reducing and finishing tubing, that consists in simultaneously holding the tubing against rotation and simultaneously feeding the same forward and cold rolling the same at a number of points at relatively high speed.

4. The herein described process of reducing and finishing tubing, that consists in cross rolling and circumferentially cold rolling the tubing in progressive stages, during constant forward movement of the tubing and meantime restraining the tubing against rotation.

5. The cold rolling process of reducing, polishing, and finishing tubing that consists in positively holding the tubing against rotation, moving the tubing longitudinally and acting upon the same by successive series of circumferentially arranged water-lubricated cross rolls.

6. The herein described cold rolling process of reducing, polishing, and finishing tubing that consists in holding the tubing against rotation, moving it longitudinally and acting upon the surface thereof by a plurality of circumferential series of rolls of slightly diminishing working circumferences.

7. The herein described cold rolling process of reducing, polishing, and finishing tubing that consists in firmly holding the tubing against rotation, moving it longitudinally and acting upon the surface thereof by a plurality of circumferential series of rolls formed with diminishing working circumferences and rotated in different directions to avoid twisting the tubing.

8. The herein described cold rolling process of polishing and finishing tubing which consists in holding the tubing firmly against rotation, acting upon the surface thereof by circumferentially arranged and rotating series of rolls the axes of which are slightly oblique to the axis of the tubing whereby the tubing is simultaneously rolled and forwarded.

9. The process of surface finishing and polishing metal tubes and similar articles which consists in feeding the tubing forward at a substantially constant rate of speed, fixedly holding the tubing against rotation and at the same time subjecting the tubing to the reluctant rotative action of a plurality of encompassing series of slightly compressive rolls.

10. The cold rolling process of polishing metal tubing that consists in feeding the tubing forward at a substantially constant rate of speed while fixedly holding the same

against rotation and at the same time subjecting the tubing to the high speed reluctant rotative action of an encompassing series of slightly compressive rolls which are of smaller diameter than the tubing; whereby a fine circumferentially grained surface is produced upon the tubing.

In testimony whereof, I have hereunto set my hand, this 26th day of July, 1912, in the presence of two subscribing witnesses.

MARSHALL BURNS LLOYD.

Witnesses:

F. E. LLOYD,

HILDA C. PETERSON.