No. 817,796. PATENTED APR. 17, 1906.

J. H. NICHOLSON.

APPARATUS FOR CROSS ROLLING TUBULAR BODIES OR BLANKS.

APPLICATION FILED APR. 1, 1904.

3 SHEETS—SHEET 1.

Fig. 1a.

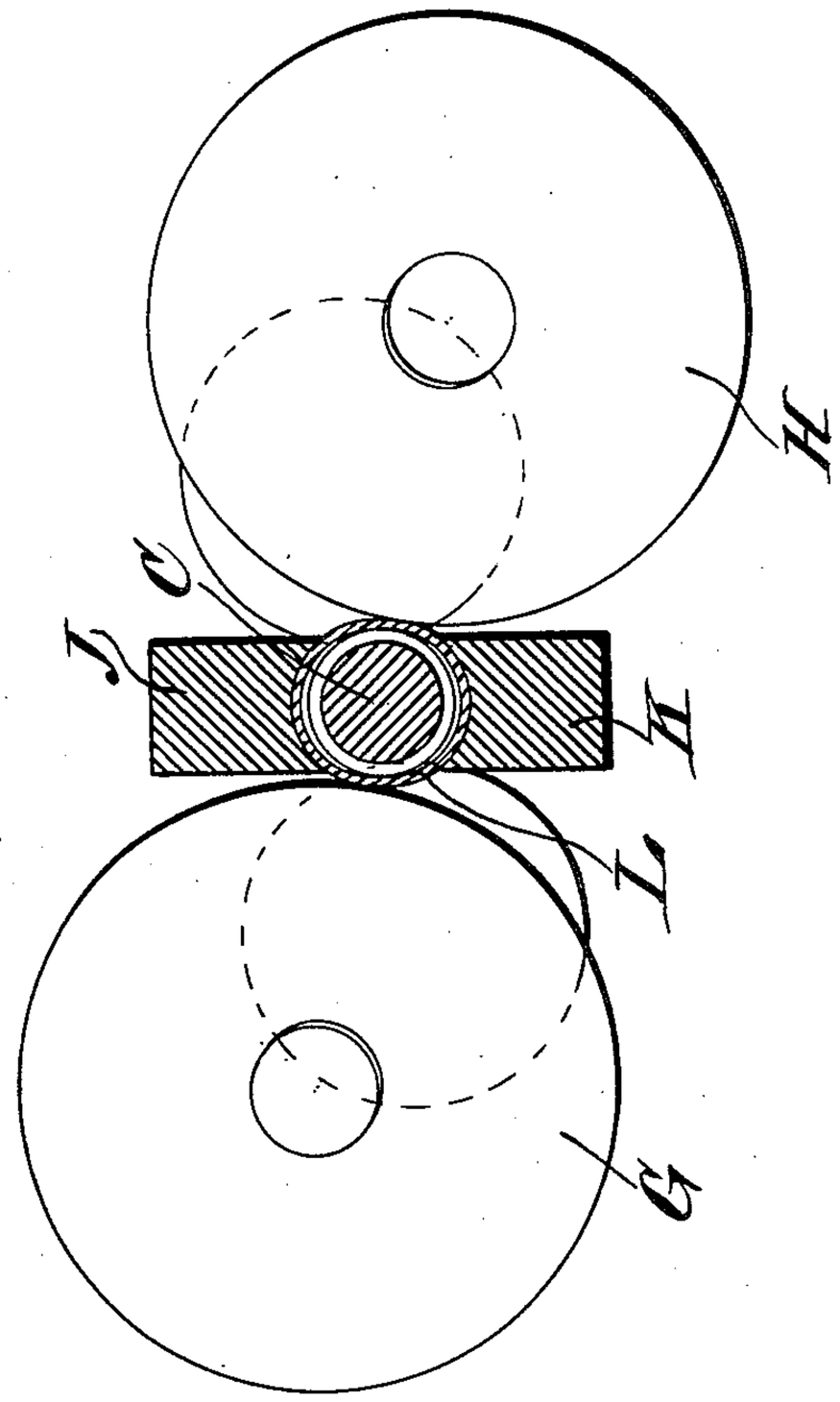
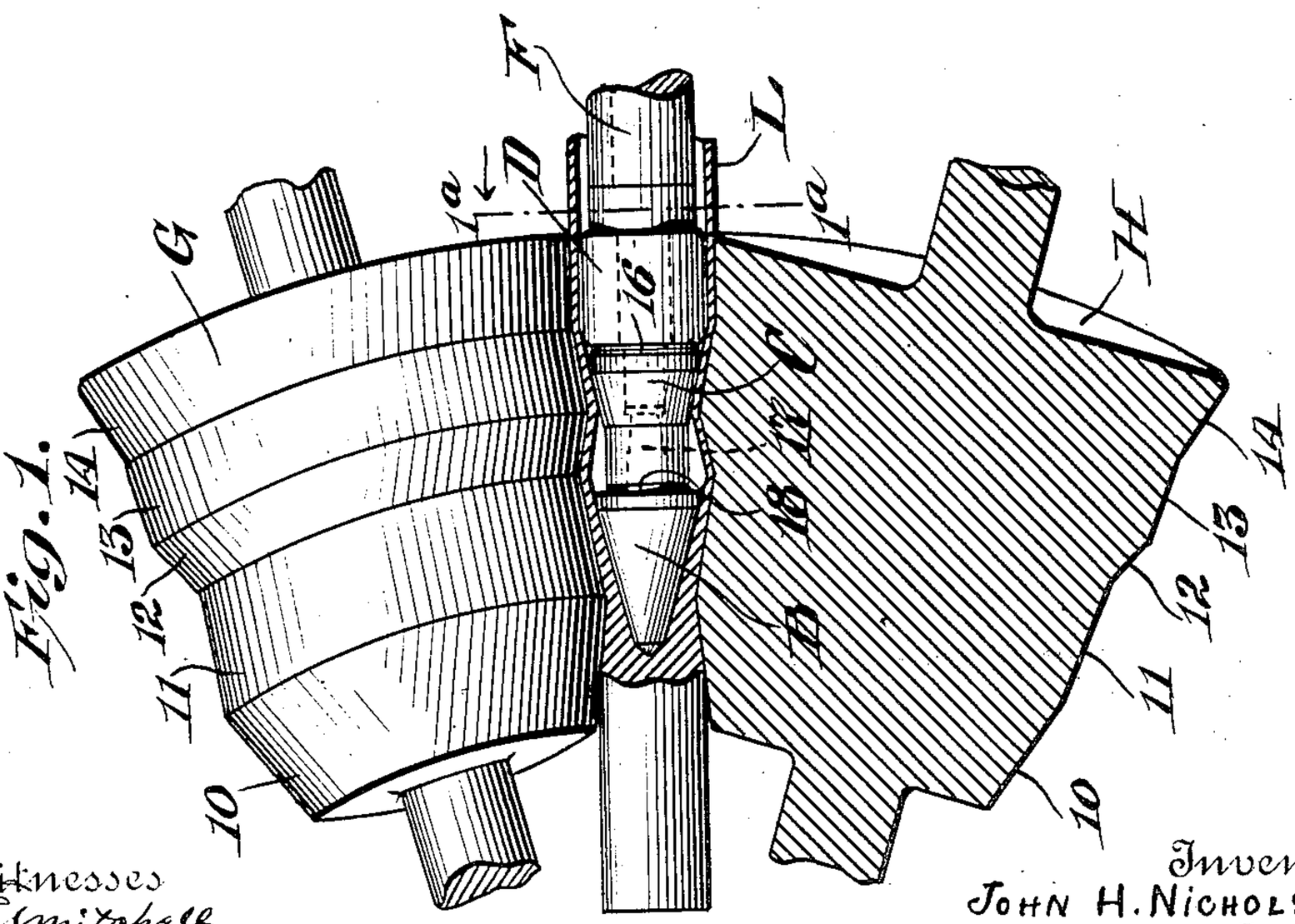


Fig. 1.



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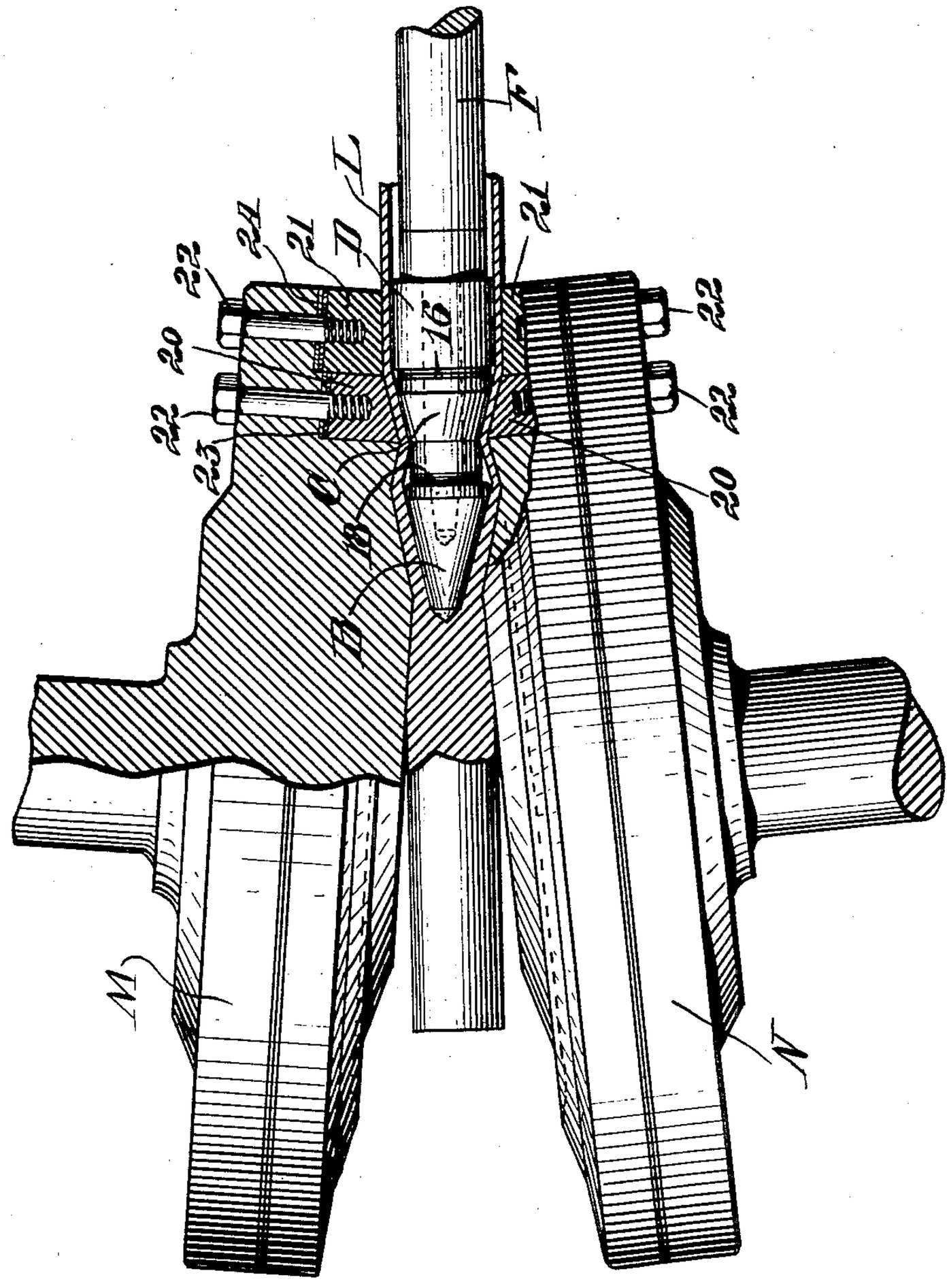
3 SHEETS—SHEET 2.

Fig. 2.



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3 SHEETS—SHEET 3.

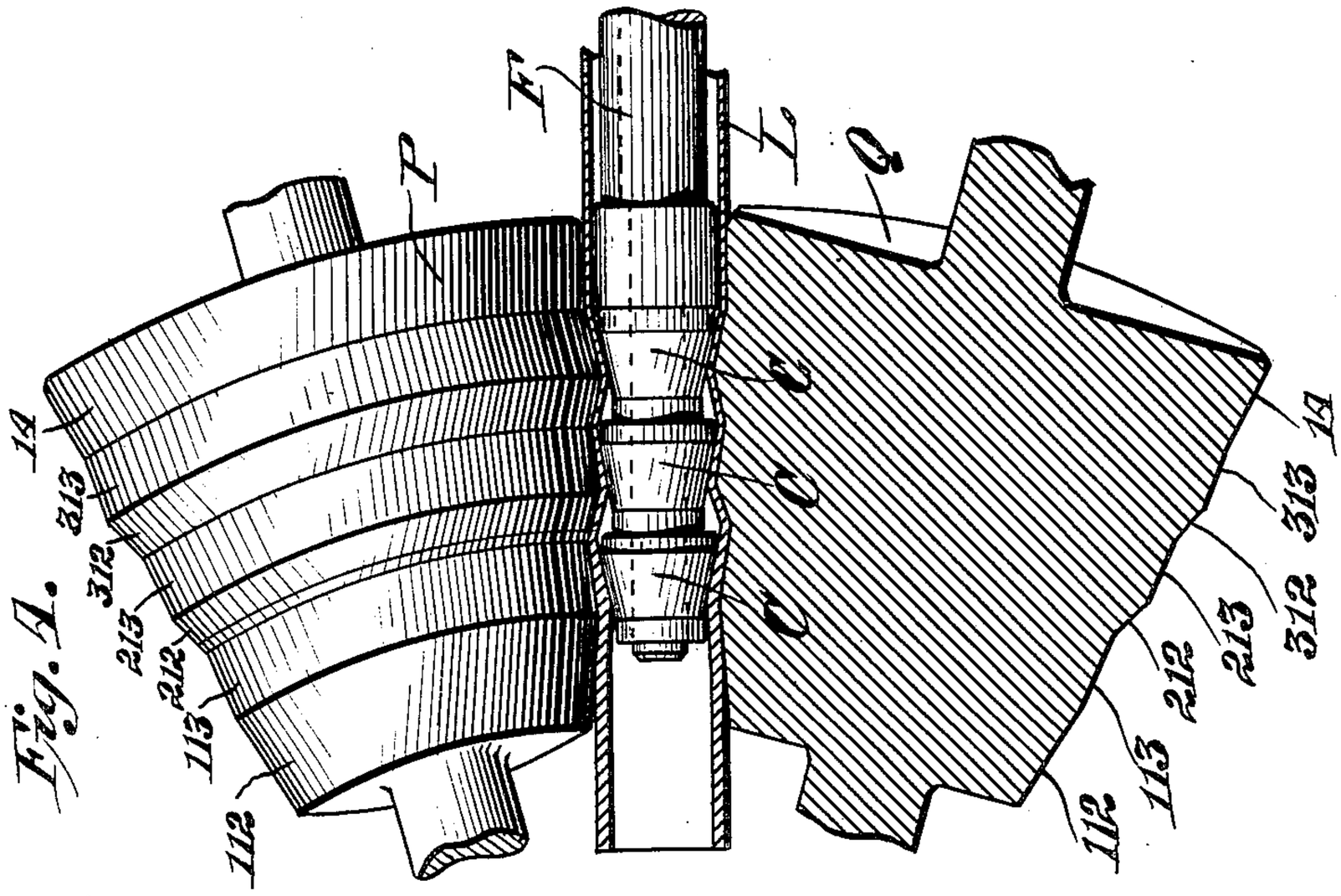

Fig. 4.

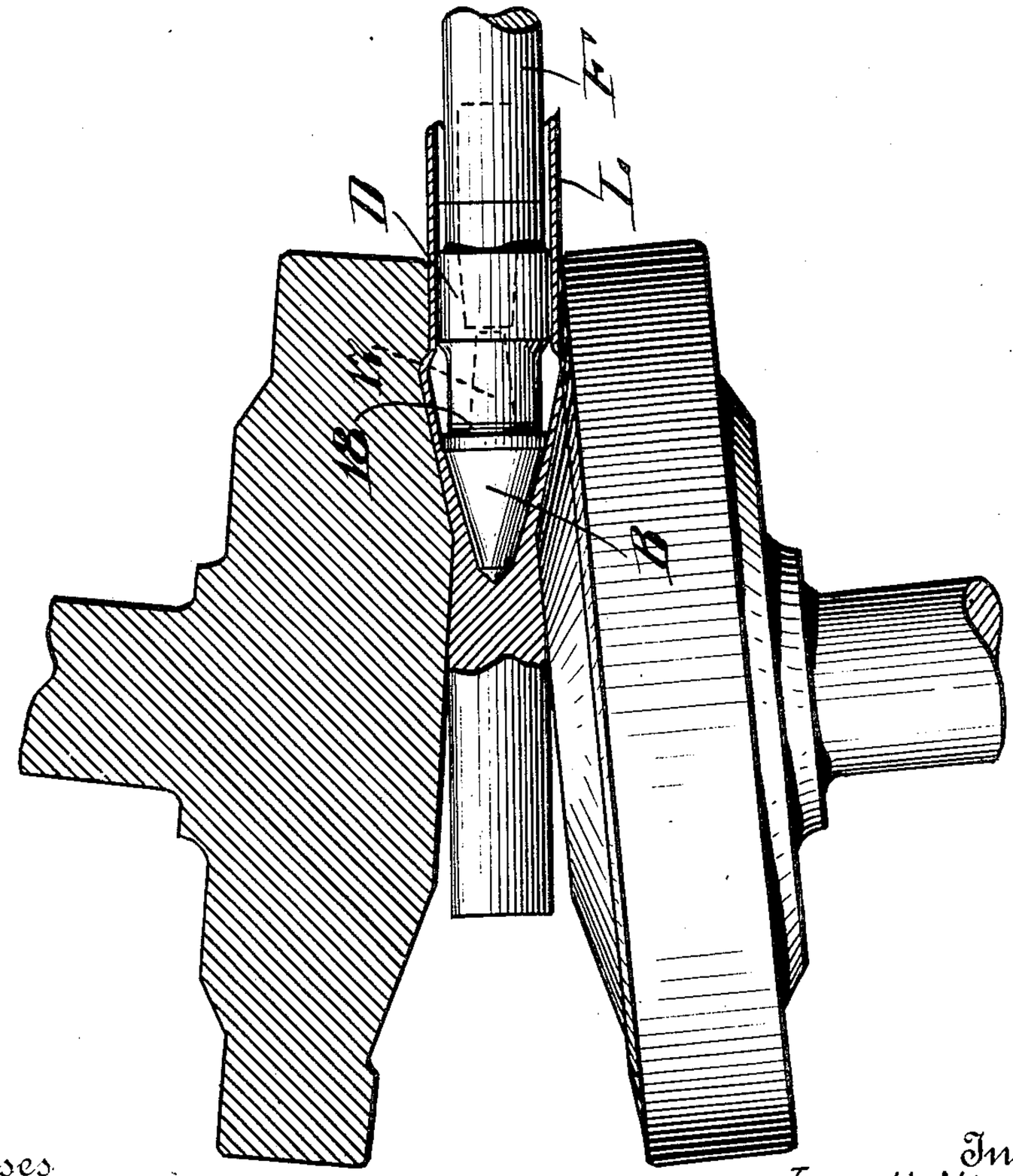

Fig. 3.

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UNITED STATES PATENT OFFICE.

JOHN H. NICHOLSON, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO NATIONAL TUBE COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

APPARATUS FOR CROSS-ROLLING TUBULAR BODIES OR BLANKS.

No. 817,796. Specification of Letters Patent. Patented April 17, 1906.

Application filed April 1, 1904. Serial No. 201,078.

To all whom it may concern:

Be it known that I, JOHN H. NICHOLSON, third vice-president of the Shelby Steel Tube Company, a citizen of the United States, and a resident of Pittsburg, Pennsylvania, have invented certain new and useful Improvements in Apparatus for Cross-Rolling Tubular Bodies or Blanks in a Heated State, of which the following is a specification accompanied by drawings.

The cross-rolling process as invented by the Mannesmanns and improved by Ralph Charles Stiefel and others, while satisfactory under certain conditions, has given considerable trouble where it is desired to make small tubes with thin smooth walls in a single piece without undue strains upon the metal. In these processes the piercing-point is a conical-shaped mandrel which has an uninterrupted continuous conical surface that acts as an anvil over which the billet is advanced, the revolving rolls rotating the billet, impinging the metal, and reducing the thickness of the wall of the forming-tube. This operation produces a hollow blank or tube, the thickness of the wall being dependent upon the size of the piercing-mandrel and the opening or pass between the rolls, and it is a general law in piercing with these types of machines that the thinner the wall the larger the diameter of the tube and the more severe the stress or strains put upon the physical conditions of the metal.

It is the prime object of the present improvement to divide or split up the rolling operation into a number of different steps or suboperations (but all being performed simultaneously on the same machine) for the purpose of improving and bettering the conditions under which the walls are decreased in thickness and whereby the lineal length of the tube can be increased and at the same time hold any desired diameter independent of the thickness of the wall.

Tubes can be produced by this process of such smooth finish and thinness that they can be taken direct to the cold-draw bench for finishing without any subsequent rolling operation as is customarily used and can be cold-drawn to a finish with as few passes as is now required for the swaged or rolled blank. No difficulty is encountered in securing a pierced blank sufficiently long to make any of the standard lengths required for pipe or boiler tubes.

These and certain other aims and advantages will readily be apparent to those skilled in the art; and the invention consists of apparatus for carrying out the above objects embodying the features of construction, combinations of elements, and arrangement of parts having the general mode of operation, substantially as hereinafter fully described and claimed in this specification and shown in the accompanying drawings, in which—

Figure 1 is a diagrammatic illustration, partly in longitudinal section through a pass, showing the rolls and plugs or mandrels in full and the metal in section. Fig. 1ª is a cross-section on the plane 1ª of Fig. 1. Fig. 2 is a similar view of a modification, part of one roll being shown in section. Fig. 3 is a view similar to Fig. 2, showing another form of the invention. Fig. 4 shows a special application of the invention to reducing the wall thickness without enlarging the diameter of the tube.

In Fig. 1, B, C, and D are three plugs or mandrels independently rotatable and coaxially mounted one in front of the other upon a mandrel-bar F. G and H are rolls, preferably equal rolls, having a plurality of conical or conoidal surfaces that coöperate with the plugs B, C, and D. J and K are guides which, as shown, snugly surround and guide the blank or tube L at substantially all points except where the rolls G and H act upon it. It will be noticed in Fig. 1ª that the tubular body L, as well understood, will be slightly elliptical in form, while under the action of the rolls G and H of course the guides J and K must conform and allow for this ellipticity and longitudinally should be profiled in the same way as the rolls are profiled to form the pass. The rolls, as well understood, are preferably skewed to produce a feeding effect, though some parts of the process and some advantages may be derived without skewing the rolls, the metal being forced through by a ram; but the feeding and elongating effect of the rolls will be sacrificed if a ram-feed only is provided. The rolls G and H have rolling-surfaces 10, 11, 12, 13, and 14. Surfaces 10 form a converging portion of the pass, which in coöperation with the diverging portions 11 and the piercing or ex-

panding mandrel B first give the rolling, compressing, and feeding of the metal onto the point of the plug B and then the expansion and reduction of the wall thickness upon the larger base portions of the plug B.

In Fig. 1 provision is found for thinning the wall of the tube without at the same time enlarging it too much. Thus the rolling-surfaces 12 compress and reduce the tube exteriorly without any interior support from the tube, and they force the tube onto the plug C at a somewhat smaller diameter than the largest part of plug B. The rolling-surfaces 13 diverge, and consequently compress, expand, and reduce the thickness of the tube upon the plug C. Plug C therefore repeats an effect similar to that of the base portion of plug B. Finally plug D is a cylindrical smoothing-plug, which coöperates with the rolling-surfaces 14 of the rolls, which form between them a parallel and not a diverging portion of the pass. The interval between the plug D and the rolling-surfaces 14 should converge slightly, too slightly to be noticed in the drawings, so as to merely smooth out the irregularities on the interior and exterior of the tubular wall without materially expanding or materially confining the wall. Plugs B, C, and D coöperate with progressively-increasing diameters of the exterior rolling-surfaces, the mean diameter of the surfaces 13 being greater than of surfaces 11 and the mean diameter of surfaces 14 being greater than that of surfaces 13. The exterior rolling-surfaces therefore have a progressively-increasing peripheral speed from front to rear of the pass, and the plugs B C D in order to have proper speed relations with the external bodies must be free to rotate relatively to each other. This is accomplished by mounting the plug D so that it is free to turn upon the projecting end of the mandrel-bar F, (seen in dotted lines within it.) The plug C is likewise mounted so as to turn freely upon the end of the mandrel-bar, and one or more washers 16 are preferably interposed between C and D to take the end thrust. Plug B has a rear-extending center or trunnion 17, which fits a recess in the plug C and permits the point of plug B to turn relatively to the plug C. A washer 18 is interposed between them. By increasing or decreasing the thickness of washers 16 the plug C may be adjusted longitudinally, and thereby the space between the plug C and the rolling-surfaces 13 may be adjusted with great nicety. Similarly, the washers 18 may be of different thicknesses to nicely adjust the position of plug B longitudinally; but in addition to permitting adjustment these washers are of great importance as compensating for the wear, which is very much greater upon the plugs B and C than upon the plug D. Owing to the increased peripheral speed of the larger diameters of the rollers G and H and a consequent increased speed effect due to the skew of the roll, there is a tendency for the heated metal which is being rolled to travel more rapidly between the plug D and the surfaces 14 than between the plug B and the surfaces 11 and 10. This seems to produce an elongated or tensile effect upon the metal in the pass, and it seems to go through the pass with less expenditure of mechanical energy than would otherwise be the case, while, furthermore, the independent freedom to rotate of the successive plugs B C D contribute to this advantageous effect and not only reduces the power required, but also greatly lessens stresses and strains to which the metal is subjected. It is possible by this process and by means of this apparatus to roll a tube with a thin smooth wall without any undue strains in the metal and to accomplish this at a single pass, so that the tube is ready for finishing on a cold-bench without the subsequent usual rolling operation. From a given size of billet or blank it seems possible to make thinner walls with smaller sizes of tubes than has heretofore been thought possible of attainment by the known processes and apparatus.

In Fig. 2 the rolling-tubes are in the form of disks M and N. The plugs B, C, and D are substantially the same as in Fig. 1. Several adjustment-washers 16 and 18 are shown, and the exterior rolling-surfaces of the rolls or disks M and N are also shown adjustable by means of the removable rings 20 and 21, secured by adjustable bolts 22 and backed by washers 23 and 24. This construction is valuable not only as permitting adjustment, if necessary, of the width of the pass, but more particularly as permitting the compensation for the wearing away of the rolling-surfaces. As the surfaces wear away additional annular washers 23 and 24 may be inserted or thicker ones substituted for those already in place.

Fig. 3 differs in principle from Figs. 1 and 2 only in the omission of the intermediate plug C. This figure therefore provides only for the initial action upon the plug B and the smoothing and finishing action upon the plug D.

Fig. 4, on the other hand, shows three successive plugs C for thinning the wall of the tube, and the rolls P Q have successive sets of coöperating, converging, and diverging surfaces 112 113 212 213 312 313. The plug D coöperates with the rolling-surfaces 14, that correspond with surfaces 14 in the other figures. In this figure it will be seen that the metal is compressed against the expanding plug-surfaces and reduced in thickness, while being enlarged in diameter, and then it is again compressed, so as to reduce the external diameter and again rolled thinner upon an expanding-surface, and so on to the final finishing-plug D. The process disclosed

in this application to be carried out by the apparatus described and illustrated forms the subject-matter of a separate patent application, Serial No. 201,077, filed April 1, 1904; but obviously some features of this apparatus may be used without others and the invention may be embodied in widely-varying forms.

Therefore, without limiting the invention to the constructions shown and described nor enumerating equivalents, I claim and desire to secure by Letters Patent the following:

1. In apparatus for cross-rolling tubes or blanks, rolling mechanism comprising a piercing plug or mandrel, means for forcing the blank on said piercing-plug, diverging roll-walls for expanding, elongating and simultaneously reducing the thickness of the blank on said plug, converging roll-walls for externally compressing the blank, a second plug or mandrel rotatable independently of said first-named plug, roll-walls for again expanding, elongating and reducing the thickness of the blank upon said second-named plug, an independently-rotatable smoothing-mandrel, and roll-walls for compressing and smoothing the tube on said smoothing-mandrel.

2. In apparatus for cross-rolling tubes or blanks, rolling mechanism comprising a piercing plug or mandrel, means for forcing the blank on said piercing-plug, diverging roll-walls for expanding, elongating and simultaneously reducing the thickness of the blank on said plug, converging roll-walls for externally compressing the blank, an independently-rotatable smoothing-mandrel, and roll-walls for compressing and smoothing the tube on said smoothing-mandrel.

3. In apparatus for cross-rolling tubes or blanks, rolling mechanism comprising a piercing plug or mandrel, means for forcing the blank on said piercing-plug, diverging roll-walls for expanding, elongating and simultaneously reducing the thickness of the blank on said plug, a second plug or mandrel rotatable independently of said first-named plug, and roll-walls for again expanding, elongating and reducing the thickness of the plug upon said second-named plug.

4. In apparatus for cross-rolling tubes or blanks in a heated state, the combination of a plurality of interior plugs or mandrels, each rotatable at a different rate of speed, a plurality of externally rolling-bodies different portions of each of which rotate at different rates of speed forming a single pass and provided with rolling-surfaces between which the metal is first pressed against and expanded and reduced upon one of said interior plugs and thereafter rolled upon another of said interior plugs between rolling portions of the external rolls that are rotating with a higher peripheral speed than those pressing against said first-named plug, for substantially the purposes set forth.

5. In apparatus for cross-rolling tubes or blanks in a heated state, the combination of a plurality of interior plugs or mandrels, each rotatable at a different rate of speed, and a plurality of externally rolling-bodies forming a single pass, said rolling-bodies being constructed and fitted to rotate at a greater peripheral speed at the rear end than at the forward end of the pass, thereby causing an elongating effect upon the tubular wall in the pass, for substantially the purposes set forth.

6. In apparatus for cross-rolling tubes or blanks, rolling mechanism comprising a piercing plug or mandrel, means for forcing the blank on said piercing-plug, diverging roll-walls for expanding, elongating and simultaneously reducing the thickness of the blank on said plug, converging roll-walls for externally compressing the blank, a second plug or mandrel rotatable independently of said first-named plug, and roll-walls for again expanding, elongating and reducing the thickness of the blank upon said second-named plug.

7. In apparatus for cross-rolling tubular bodies or blanks in a heated state, the combination of a plurality of exterior rolling bodies, a plurality of independently-rotatable interior bodies, said exterior and interior bodies constituting means for rolling and reducing the heated metal in a single pass upon the interior bodies in succession, and between said bodies and the exterior bodies, for substantially the purposes set forth.

8. In apparatus for cross-rolling tubular bodies or blanks in a heated state, the combination of means for simultaneously expanding and reducing the thickness of the heated metal between interior and exterior expanding-surfaces, a cylindrical interior supporting-body, rotatable independently of said interior expanding-surface, and means for subsequetly compressing and smoothing the metal inside and out upon said substantially cylindrical interior supporting-body in the same pass, for substantially the purposes set forth.

9. A rolling-mill, having a plurality of rolls forming a pass, a plurality of mandrels supported in succession in the said pass, and means for adjusting one portion of the active rolling-surface of one of the rolls relatively to the other portions, for substantially the purposes set forth.

10. In apparatus for cross-rolling tubes or blanks, rolling mechanism comprising a piercing plug or mandrel, converging roll-walls for forcing the blank on said piercing-plug, diverging roll-walls for expanding, elongating and simultaneously reducing the thickness of the blank on said plug, converging roll-walls for externally compressing the blank, an independently-rotatable smoothing mandrel, and roll-walls for compressing and smoothing the tube on said smoothing-mandrel.

11. In apparatus for cross-rolling tubes or blanks, rolling mechanism comprising a piercing plug or mandrel, converging roll-walls for forcing the blank on said piercing-plug, diverging roll-walls for expanding, elongating and simultaneously reducing the thickness of the blank on said plug, a second plug or mandrel rotatable independently of said first-named plug, roll-walls for again expanding, elongating and reducing the thickness of the blank upon said second-named plug.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

JOHN H. NICHOLSON.

Witnesses:
HELEN WOLFE,
H. W. PHELPS.