C. F. WILLIAMS & W. DICKS.

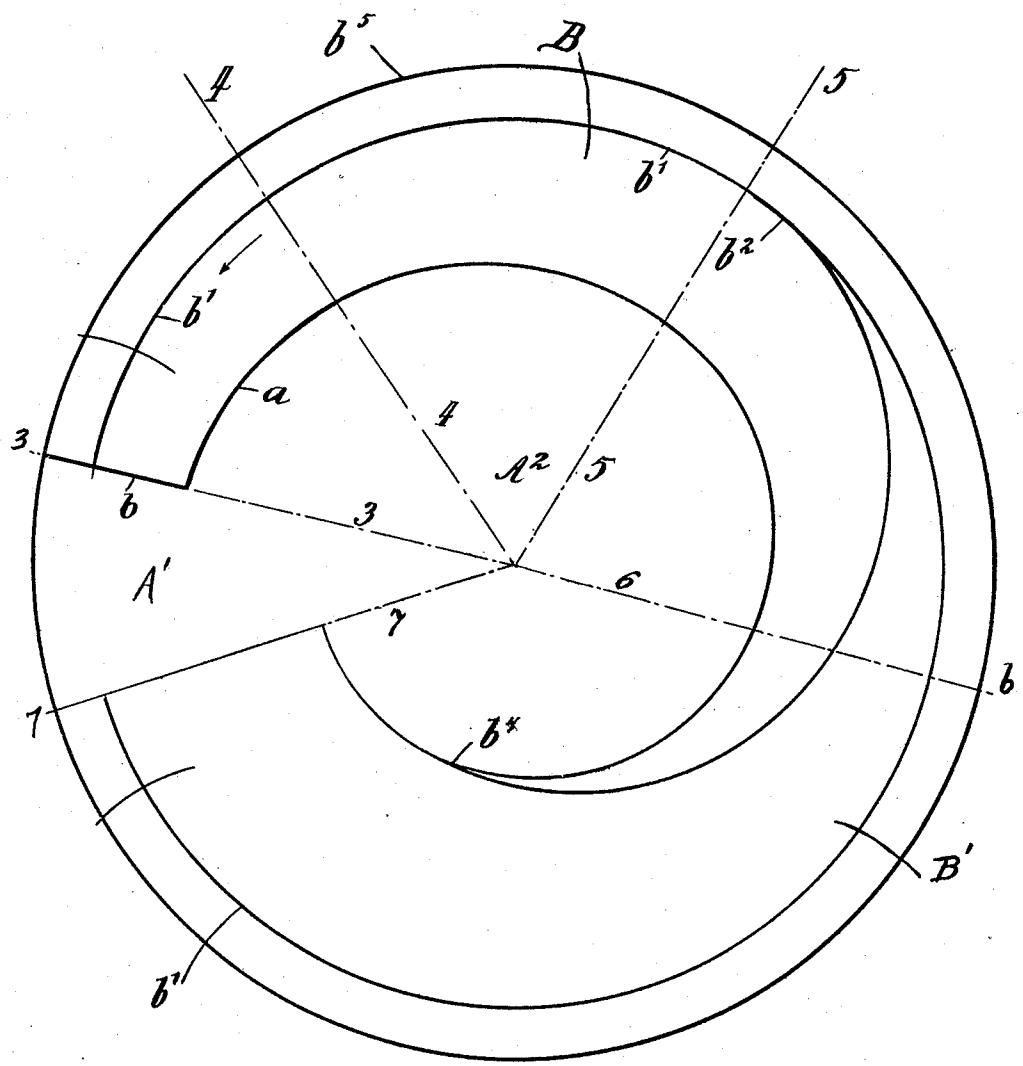
APPARATUS FOR THE MANUFACTURE OR PRODUCTION OF WELDLESS OR SEAMLESS METAL TUBES.

APPLICATION FILED NOV. 19, 1907.

1,005,091. Patented Oct. 3, 1911.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses
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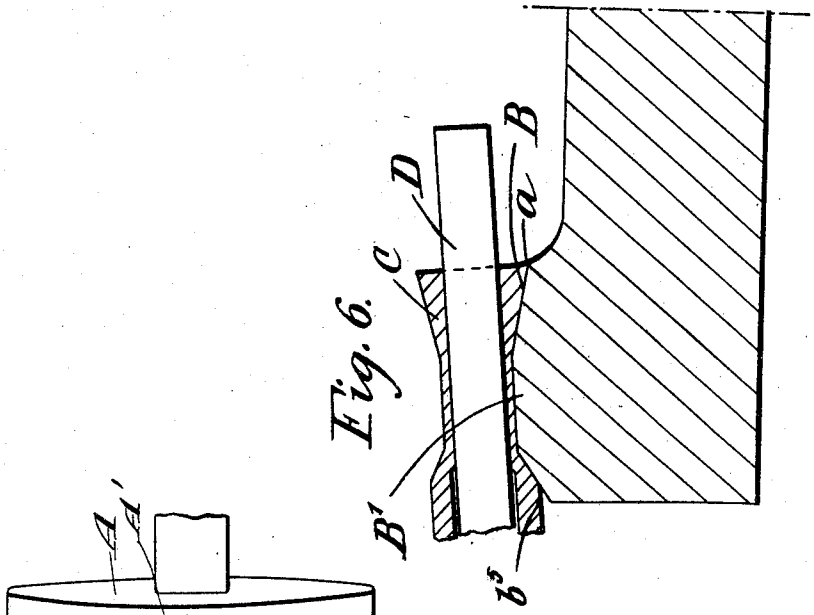

Fig. 6.

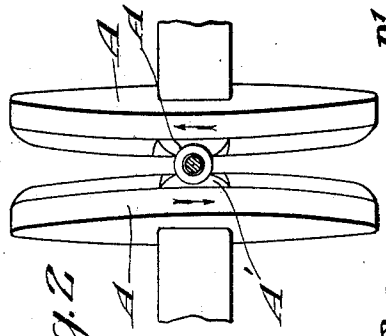

Fig. 2

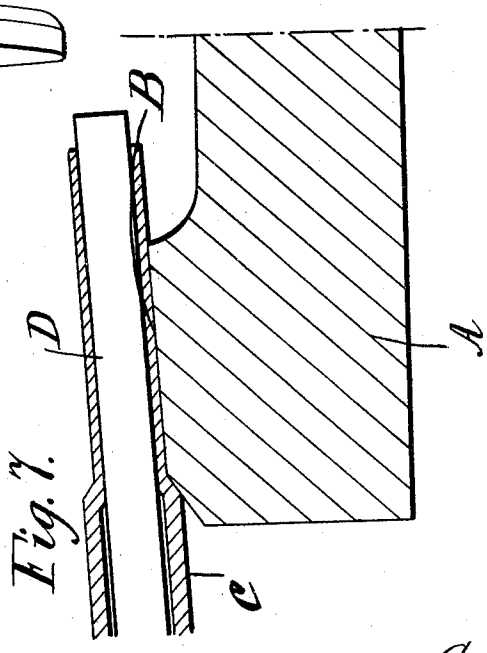

Fig. 7.

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4 SHEETS—SHEET 3.

Fig. 3.

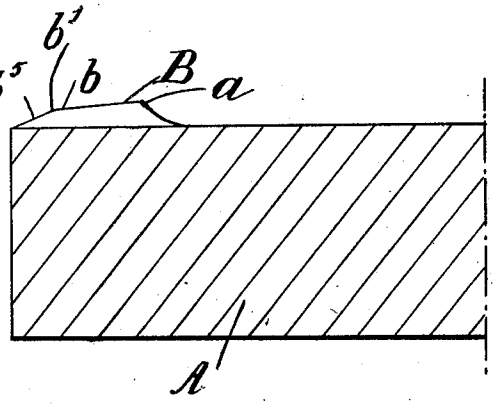


Fig. 4.

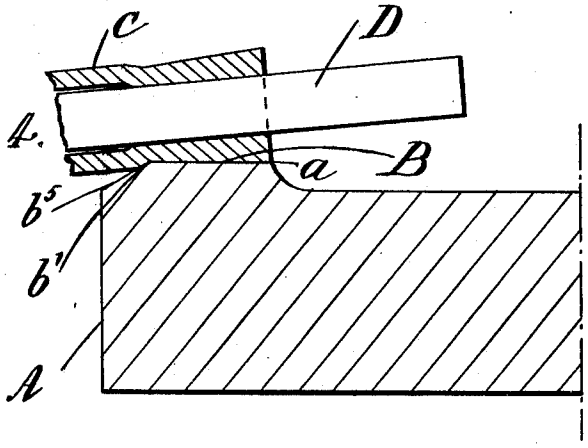
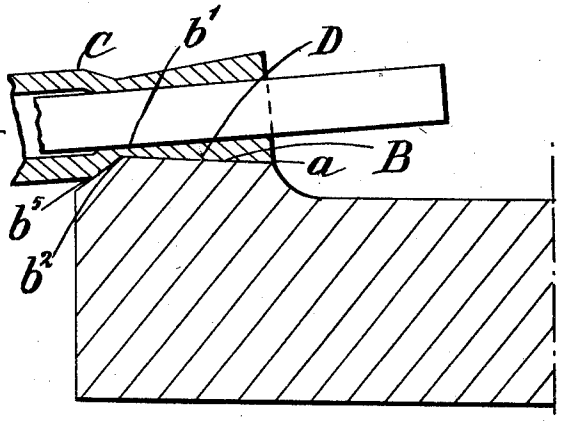


Fig. 5.



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4 SHEETS—SHEET 4.

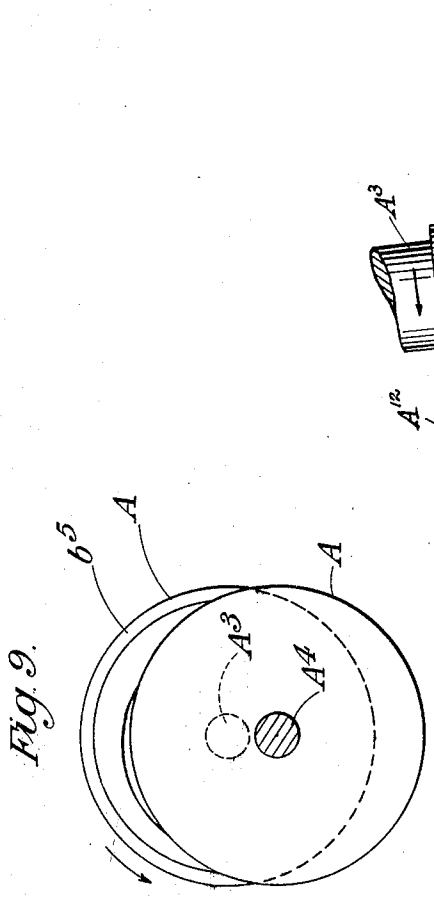

Fig. 9.

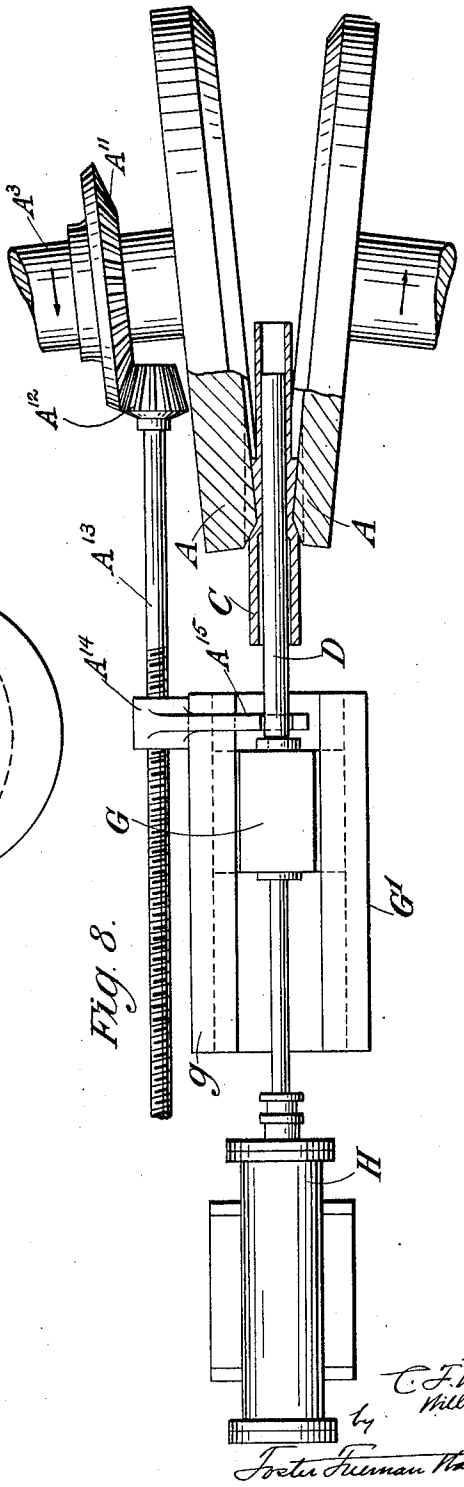

Fig. 8.

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by
Foster Freeman Watson & Coit Attys.

UNITED STATES PATENT OFFICE.

CHARLES FRANCIS WILLIAMS, OF ERIE, PENNSYLVANIA, AND WILLIAM DICKS, OF DUMBARTON, SCOTLAND.

APPARATUS FOR THE MANUFACTURE OR PRODUCTION OF WELDLESS OR SEAMLESS METAL TUBES.

1,005,091. Specification of Letters Patent. **Patented Oct. 3, 1911.**

Application filed November 19, 1907. Serial No. 402,885.

To all whom it may concern:

Be it known that we, CHARLES FRANCIS WILLIAMS, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, and WILLIAM DICKS, a subject of the King of Great Britain, residing at Dumbarton, Scotland, have invented certain new and useful Improvements in Apparatus for the Manufacture or Production of Weldless or Seamless Metal Tubes, of which the following is a specification.

This invention relates to the treatment, production or manufacture of seamless metal tubes and refers to processes wherein a pierced tube or billet is subjected to pressure by or between rotary rolling devices which act to reduce the thickness of the walls of the tube as it is passed between them.

This invention refers to processes known in the art of tube-making as "stepwise rolling."

According to the present invention, the acting or reducing surface comprises two portions arranged to act successively upon the same portion of the billet or tube. The first portion of the reducing surface is disposed so that it acts on the tube or billet in a direction that is oblique to or inclined to the axis of the tube's rotation, and operates upon the entire length of that part of the tube that has been last fed forward to be reduced or acted upon, and the second portion which acts upon the same portion of the billet or tube rotates or moves in a plane parallel with the longitudinal axis of the tube. In other words, the plane of the first portion of the reducing surface is such, viewed in plan, that if a line is drawn along the face of the reducing surface, it will, if produced, cut the line representing the longitudinal axis of the tube; this portion of the reducing surface engages the tube gradually, as it slopes outwardly and upwardly from the center of the disk to the outer edge thereof, and in the rotation of the rolling device, approaches bodily nearer to the axis of the tube until it merges into the second portion of the reducing surface which, as already stated, is parallel with the tube's axis, and acts upon the same portion of the tube or billet that has just been acted upon by the inclined or oblique portion. When more reducing surfaces than one are formed upon each rotary rolling device, or rotate co-axially with one another and are joined by an offset, the different surfaces are so disposed that each successive reducing surface projects farther into the pass between the rotary rolling devices than the neighbor preceding it. By this means the tube is engaged gradually and the walls therefore thinned down equally and evenly so that the thickness of the walls is the same throughout and no bulges or inequalities exist in the tube and the diameter thereof is prevented from running up due to sudden thinning of the walls. The reducing surfaces are preferably formed upon or carried by rotary disks but it is within the scope of the present invention to apply the surfaces to cylindrical or conical rollers.

Referring to the drawings: Figure 1 is a plan or face view of a disk constructed according to the present invention. Fig. 2 is a side elevation of two disks as shown in Fig. 1, shown in the position they are mounted in the rolling mill to receive the tube. Figs. 3, 4, 5, 6, 7 are sections respectively on the lines 3—3, 4—4, 5—5, 6—6, 7—7, of Fig. 1 and Fig. 8 is a plan of the mill with disks in position. Fig. 9 illustrates an arrangement of the reducing disks to insure "back feeding" of the billet during the reducing operation.

A is the disk, B, B′ the portions of the reducing surface, C is the billet and D the mandrel. The reducing surfaces do not extend entirely around the face of the disk, a gap A′ being left for the entry of the tube or billet C and the center portion A^2 of the disk is hollowed out. The tube is fed forward until its inner end reaches the outer edge of the hollowed out portion at the line *a* which will be referred to as the neutral line, that is the line from which the acting or reducing surface extends. This line *a* moves in a plane that is parallel with the axis of the billet.

The billet on being fed forward passes into the gap between the rollers to an extent which is equal to the line *b* of the reducing surface. In the rotation of the

disks the billet is first engaged by the portion B of the reducing surface which is inclined at an angle to the billet's axis of rotation. This inclined surface gradually reduces the portion of the billet which engages as shown at Figs. 4 and 5 of the drawings, and when the position as indicated by line 5—5 in Fig. 1 has been reached this inclined surface has broadened out and the second portion of the reducing surface which is flat and parallel to the axis of the billet's rotation as shown at Figs. 6 and 7, engages the same portion of the billet's surface as has been engaged by the first reducing portion. This second reducing portion starts at a point b^2 and gradually widens out until when the gap is again reached it has increased to its widest extent stretching the billet to a corresponding extent. By the action of this reducing surface the metal of that part of the walls of the tube under treatment is rolled down obliquely and stretched or fed forward relatively to the body or untreated part of the billet. From the point b^2 the tapering or sloping surface B is continued until it disappears at the point b^4 where the flat portion B′ covers the entire surface of the disk. The second portion B′ of the reducing surface forms a continuation of or adjoins the portion B and commences conveniently at a point b^2 at the outer edge of the reducing surface B. From this point it widens out until it extends over the entire available surface of the disk and terminates at the edge of the inlet opening or gap A′. This surface B′ is flat or parallel with the longitudinal axis of the tube or billet under treatment. In the revolution of the disk the portion of the billet which has first been acted upon by the surface B is next subjected to the further reducing action by the reducing surface B′.

As shown in Fig. 1 the widths of the reducing surface B along the line b represents the length of the feed of the billet. From this line b the surface along the line b' sinks deeper and deeper into the walls of the tube until at the point b^2 the thickness of metal in the tube walls represents the finished thickness whereas so far no reduction in the tube's walls has taken place along the neutral line a and the inner end of the billet at the end of its treatment does not extend beyond the line a. The flat reducing surface B′ starting at the point b^2 gradually widens out until at its farther end at the gap A′ it is wider than the widest part of the surface B, being sufficiently wider relatively to the widest part of the surface B to enable the entire portion of the tube's walls treated by the surface B to be reduced to the finished size.

By the action of the reducing surface B B′ the walls of that portion of the tube acted upon are reduced in thickness by the pressure between the disk and the supporting mandrel D within the tube. Thus throughout the action the tube which is fed forward step by step is engaged gradually the walls being first thinned down by a reducing surface moving obliquely to the longitudinal axis of the tube and then the walls receive a further treatment by the second portion of the reducing surfaces which moves parallel with the axis of the tube thus the same thickness of wall is maintained throughout and the tube is only fed forward when a fresh portion is to be acted upon. The outer edges b^5 of the disks are preferably beveled.

Two sets of reducing surfaces B B′ may be employed, the second set adjoining the first and when so used the second set are conveniently longer and occupy a greater amount of the disk's surface than the first set, and are similarly arranged to those already described. The two sets are connected by a sloping shoulder or offset. The second set of reducing surfaces engages the same portion of the tube as the first set and engages that portion when it has been acted upon by the first reducing surfaces before the tube has been again fed forward. This second set of reducing surfaces B B′ projects farther into the pass or nearer to the axis of the tube than the first set so that the tube walls which by pressure between the first reducing surface and the mandrel have been reduced in the thickness receive a further thinning down or reduction. The tube is thus acted upon by reducing surfaces so arranged that each successive surface acts upon and further reduces the thickness of the tube walls and the tube is fed forward step by step at the end of each cycle of reducing operations. The reductions are the same throughout being in all parts even and gradual so that no inequalities exist in the walls of the finished tube or in the diameter thereof. The tube is also prevented from "running up" due to sudden thinning of the walls.

In the machine shown two disks constructed in accordance with this invention are provided each having a reducing surface B B′ as already described. The two disks A are mounted on spindles F which are inclined to each other, as shown.

The billet C mounted upon the mandrel D is fed in between the disks when these are in the position shown in Fig. 2, that is to say, when the cut-away portions A′ come opposite each other to allow the tube to enter the pass. The mandrel extends for a convenient distance into the pass between the rotary disks, and has its outer end inserted in or secured to a thrust block G that is carried in guides g on a table or bed G′ and this thrust block is operated from an air cylinder H. The piston rod

of the air cylinder is connected to the rear end of the thrust block. To commence, the thrust block is drawn back to allow of the insertion of the tube, and in action the pressure within the air cylinder pushes the thrust block and mandrel forward so that when the relief or cut-away portions A′ of the disks A come around to the pass shown in Fig. 2 the tube is thrust or fed forward to bring a fresh portion between or into the path of the reducing surfaces. The distance to which the billet is pressed forward is determined by a stop. This stop is arranged so that during the time the billet is engaged between the reducing surfaces it moves forward so that when the open parts on the disks are adjacent to the billet the air cylinder automatically feeds the billet forward, the stop being in a position to determine the length to the next fed forward.

Various forms of stop mechanism may be employed, the particular one illustrated in Fig. 8 being as follows: On the shaft A^3 of one disk A is mounted a bevel wheel A^{11} which gears with a bevel pinion A^{12} on a shaft A^{13}. The other end of shaft A^{13} is threaded and on it is mounted an internally threaded boss A^{14} having a projecting part or arm A^{15} which passes through a slot in the guide G′ of the block G and extends into the path of said block. The gearing A^{12} A^{11} is so proportioned that during a revolution of disks A the top A^{15} is fed forward by screw on A^{13} a distance equal to the amount of feed to be given to the billet for the succeeding operation. The stop A^{15} acts long enough for the disks to rotate and initially grip the billet.

The rotary rolling devices are set so as to feed or move the billet backward or in the direction of the thrust block during the reducing process. To insure this, the disks, which rotate in opposite directions, may be arranged in the relation shown in Fig. 9, that is, with their axes A^3 A^4 in different planes, one being higher than the other. This overcomes the tendency which will otherwise exist for the metal of the tube to run up or form a shoulder at the first point of contact of the tube with the rolling device, such tendency arising from the pull exerted upon the tube. It also enables a rigid connection between the mandrel and the thrust block to be done away with and retains the mandrel in proper position during the treatment.

When the reducing operation is complete the tube can be withdrawn readily at the opposite end of the pass from which it entered. Another advantage of the arrangement herein described is that the length of the air cylinder and thrust block guides need only be a little greater than the length of the mandrel, and the mandrel can be withdrawn easily and another billet fed in whenever the previous one is removed from between the disks.

What we claim as our invention and desire to secure by Letters Patent, is:—

1. In an apparatus for use in making seamless metal tubes, the combination with a mandrel, of a device having a reducing surface including two reducing portions, the first extending at an oblique angle to the axis of the mandrel and the second portion, which acts successively upon the same portion of a billet as the first said portion, extending parallel with such axis.

2. In an apparatus for use in making seamless metal tubes, the combination with a mandrel, of means for reducing by rolling pressure a billet supported by the mandrel, said means including two reducing surfaces adapted to act successively on the same portion of the billet, the first of said surfaces extending at an oblique angle to the axis of the mandrel and the other extending more nearly parallel with such axis.

3. In an apparatus for use in making seamless metal tubes, the combination with a mandrel, of a rotary device having a reducing surface including two reducing portions, the first extending at an oblique angle to the axis of the mandrel and the second portion, which acts successively upon the same portion of a billet as the first said portion, extending parallel with such axis.

4. In an apparatus for use in making seamless metal tubes, the combination with a mandrel, of a reducing surface adapted to act upon a section or length of billet supported by the mandrel in a direction oblique to the walls of the billet at the line of contact and to longitudinally extend the billet by reduction, and a second reducing surface arranged to subsequently act upon the same section of the billet in a direction parallel to the walls of the billet at the line of contact to further reduce said walls.

5. In an apparatus for use in making seamless metal tubes, the combination with a mandrel, of a rotary rolling device having a reducing surface adapted to act upon a section or length of billet supported by the mandrel in a direction oblique to the walls of the billet at the line of contact and to longitudinally extend the billet by reduction, and a second reducing surface arranged to subsequently act upon the same section of the billet, in a direction more nearly parallel to the walls of the billet at the line of contact to further reduce said walls.

6. In an apparatus for use in making seamless metal tubes, the combination with a mandrel, of a rotary device having a reducing surface including two reducing portions, the first extending at an oblique angle to the axis of a billet supported by the mandrel and the second portion, which acts

successively upon the same portion of the billet as the first said portion, extending parallel with such axis, the two reducing portions being so related that a gap or opening is provided between the initial end of the inclined portion and the rear end of the parallel portion for the passage of the untreated billet.

7. In an apparatus for use in the manufacture of seamless metal tubes, the combination with a mandrel, of a rotary device having a reducing portion extending at an angle to the longitudinal axis of a billet supported by the mandrel to act on and reduce the walls of a section or length of the billet, said reducing portion having a narrow initial end to engage the billet first, and a wider rear end equal in width to the extent to which the billet is stretched by such reducing surface, a second reducing portion on said device adjoining said inclined portion and arranged to act in a direction parallel with the axis of the billet's rotation and reduce the walls of the same section of the billet as that acted upon by the first said reducing portion, said second reducing portion having a narrow initial end and a rear section wider than the rear end of the first said portion and adapted to extend over the entire surface of the portion of the billet acted upon.

8. In an apparatus for use in manufacturing seamless metal tubes, a rotary rolling disk, having a central hollowed out portion on one face, a gap at one edge for the insertion of the portion of the billet to be treated, and a beveled outer edge on the working face of the disk, said working face including an initial reducing portion which slopes radially from the hollowed out center to the beveled edge and has its initial end adjoining one side of the gap and widens out from its initial to its rear end, and a second reducing portion having a plain surface throughout its length with a narrow initial end adjoining the rear end of the sloping reducing portion, and a rear end wider than the rear end of the sloping. reducing surface and adjoining the aforesaid gap, substantially as and for the purpose described.

9. In a mill for the production or manufacture of a seamless or weldless metal tube, the combination of two opposed rotary rolling devices, each having a reducing portion located to act upon a section or length of the billet in a direction that is oblique or inclined to the axis of the billet's rotation, and a second reducing portion, adjoining the first mentioned reducing portion, and located to act in a direction parallel with the axis of the billet's rotation and further reduce the walls of the section of the billet last acted upon by the inclined reducing portion, the said rolling devices having each a gap which together form a passage for the entry of the billet.

10. In a mill or apparatus for the production or manufacture of a seamless or weldless metal tube, the combination of two opposed rotary rolling devices each having two different shaped and arranged reducing portions which act successively to each other on the same length or section of the billet, and shafts supporting said rolling devices and located at such an angle to one another and to the length of the billet that the billet while being acted upon by the reducing portions is moved bodily backward or in a direction opposite to the feed.

11. In a mill or apparatus for the production or manufacture of a seamless or weldless metal tube, the combination with two opposed rotary rolling devices and two reducing portions located one at an angle to and the other parallel with the axis of rotation of the billet to act successively upon the same portion of the billet and each extending over the entire surface under treatment, and each having a gap between the adjoining ends of the two reducing portions, of a mandrel for supporting the billet while under treatment.

12. In a mill or apparatus for the production or manufacture of a seamless or weldless metal tube, the combination with two opposed rotary disks, a reducing portion on each disk being located to act upon a section or length of the billet in a direction that is oblique to or inclined to the axis of the billet's rotation and a second reducing portion on each disk, adjoining the inclined portion and located to act upon the same section or length of the billet as the first reducing portion but parallel with the axis of the billet's rotation, the said disks having a gap between adjoining ends of the reducing portions, of a mandrel supporting the billet, while being acted upon, and means for feeding forward to the reducing portions a fresh section of the billet at the end of each reducing operation or cycle of reducing operations.

13. In a mill or apparatus for the production or manufacture of a seamless or weldless metal tube, the combination of two opposed rotary rolling disks having beveled outer edges on their working faces and hollowed out centers, each disk having a reducing portion arranged obliquely or inclined to the axis of the tube's rotation and having a rear end wider than the end which first engages the billet, a second reducing portion on each disk arranged to act upon the same length or section of the billet as the inclined reducing portion and located parallel with the axis of the billet's rotation and having a rear end wider than its initial end and also wider than the widest portion of the inclined reducing portion,

shafts carrying the disks and arranged at an angle to one another and to the axis of the billet's rotation, a supporting mandrel for the billet, an air cylinder, a thrust block by which the billet is fed forward after each reducing operation, and a stop which determines the distance through which the billet is to be fed forward, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

CHARLES FRANCIS WILLIAMS.
WILLIAM DICKS.

Witnesses as to Williams:
JAMES REED CRAIG,
E. G. JOHNSON.

Witnesses as to Dicks:
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WM. J. DOW.