L. D. DAVIS.

METHOD OR PROCESS OF FORMING METALLIC TUBES.

APPLICATION FILED SEPT. 24, 1904.

938,646. Patented Nov. 2, 1909.

3 SHEETS—SHEET 1.

Fig. 1

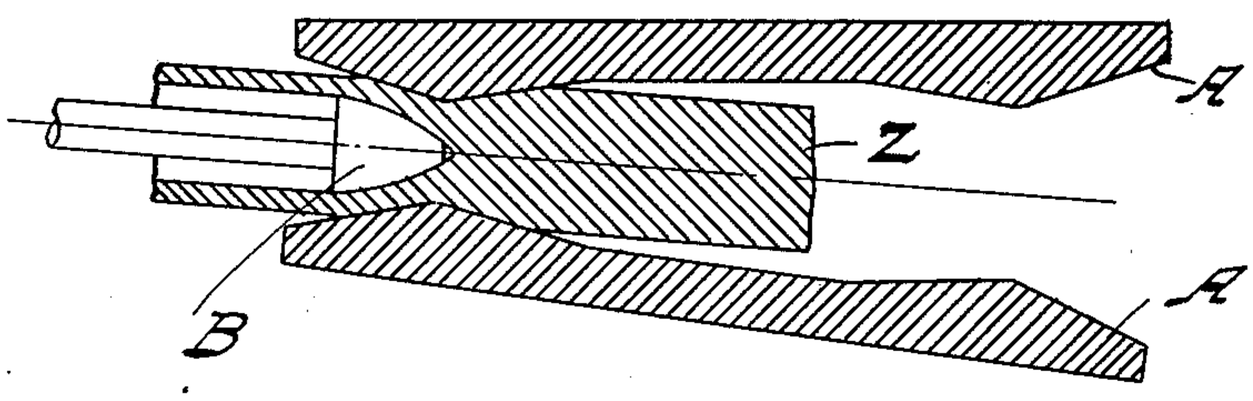

Fig. 2

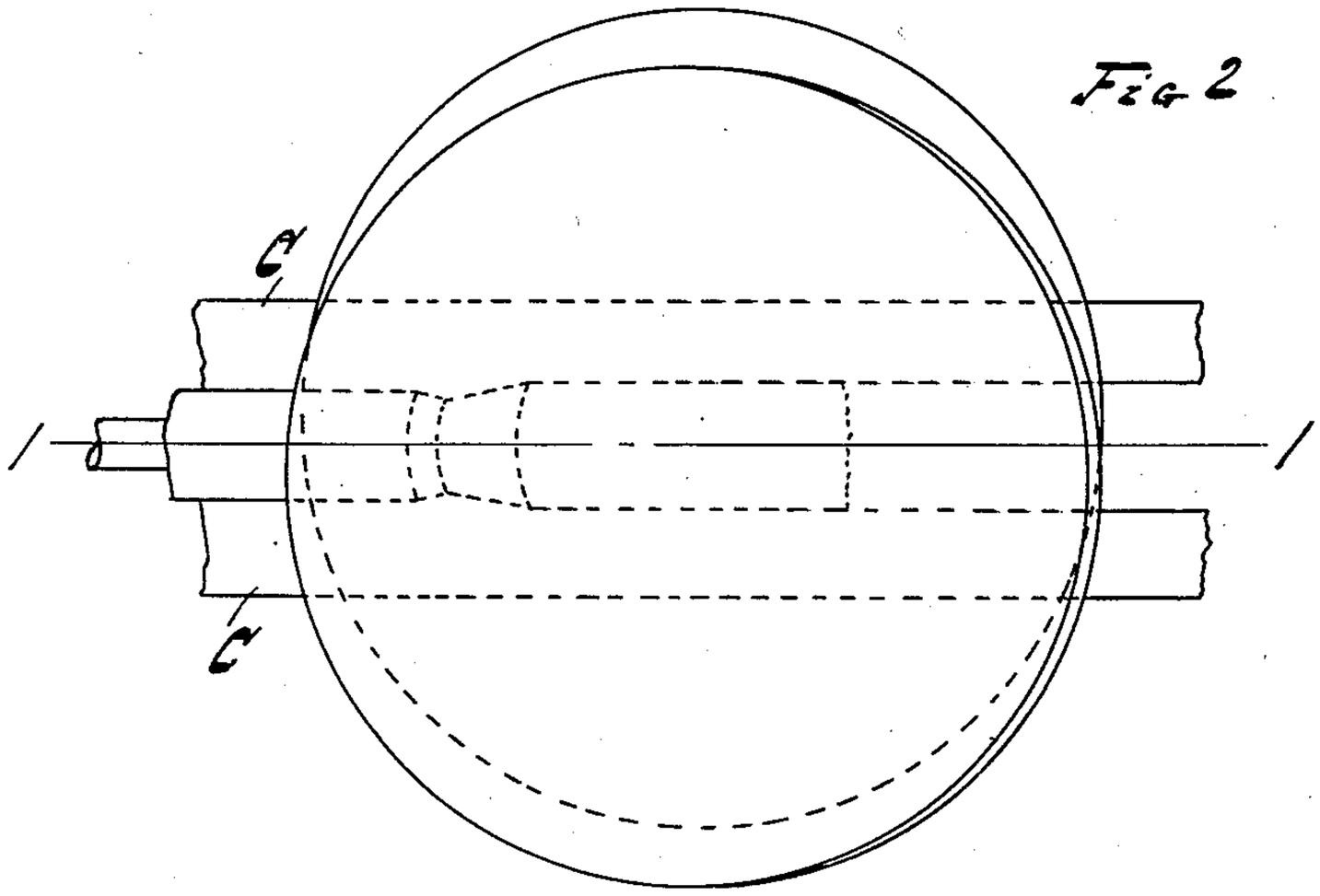

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Fig 3

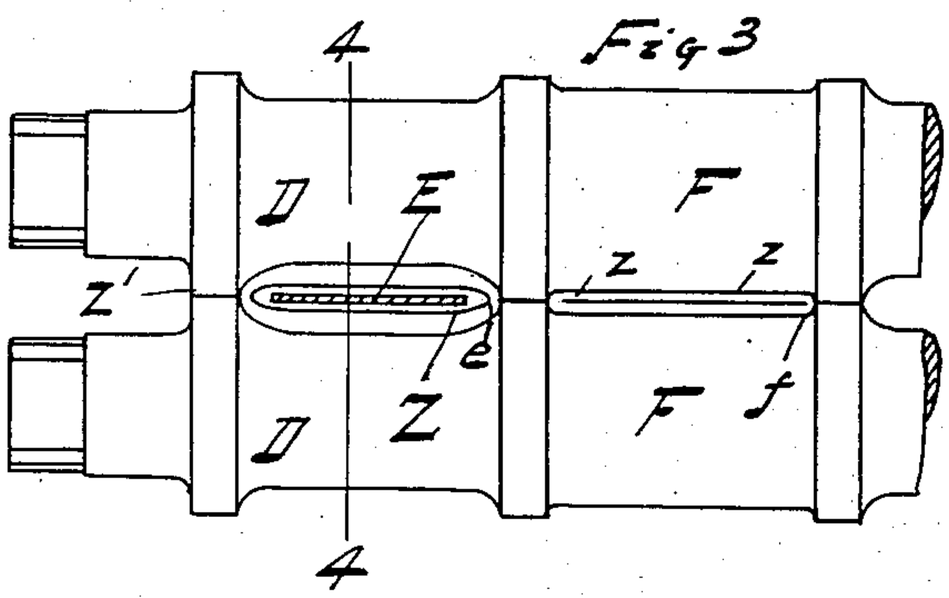


Fig 4

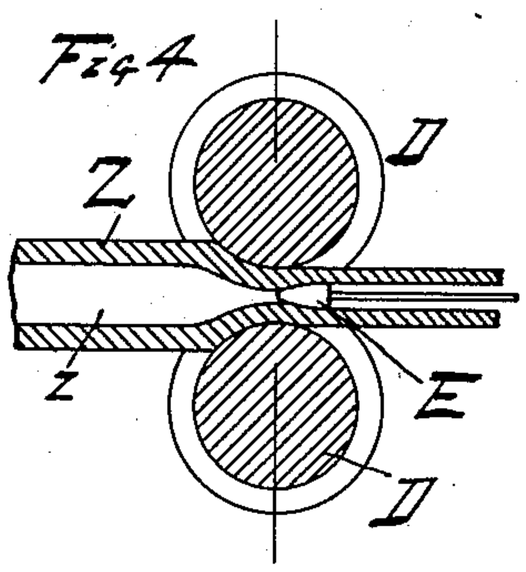


Fig 5

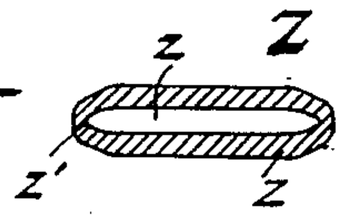


Fig 6.

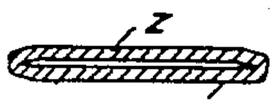
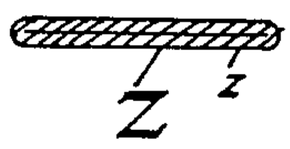


Fig 7



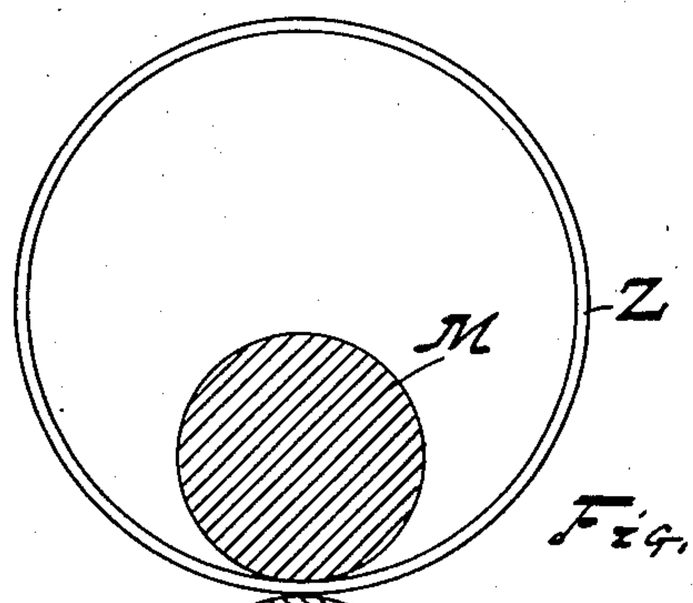


Fig. 11

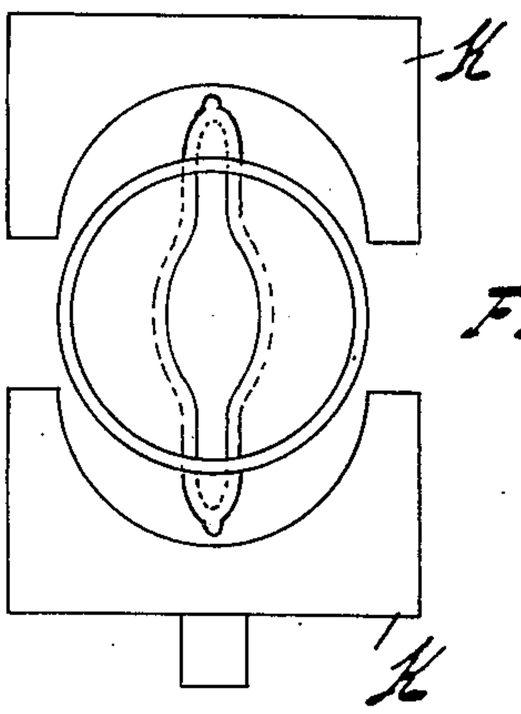


Fig 10

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3 SHEETS—SHEET 3.

Fig. 8

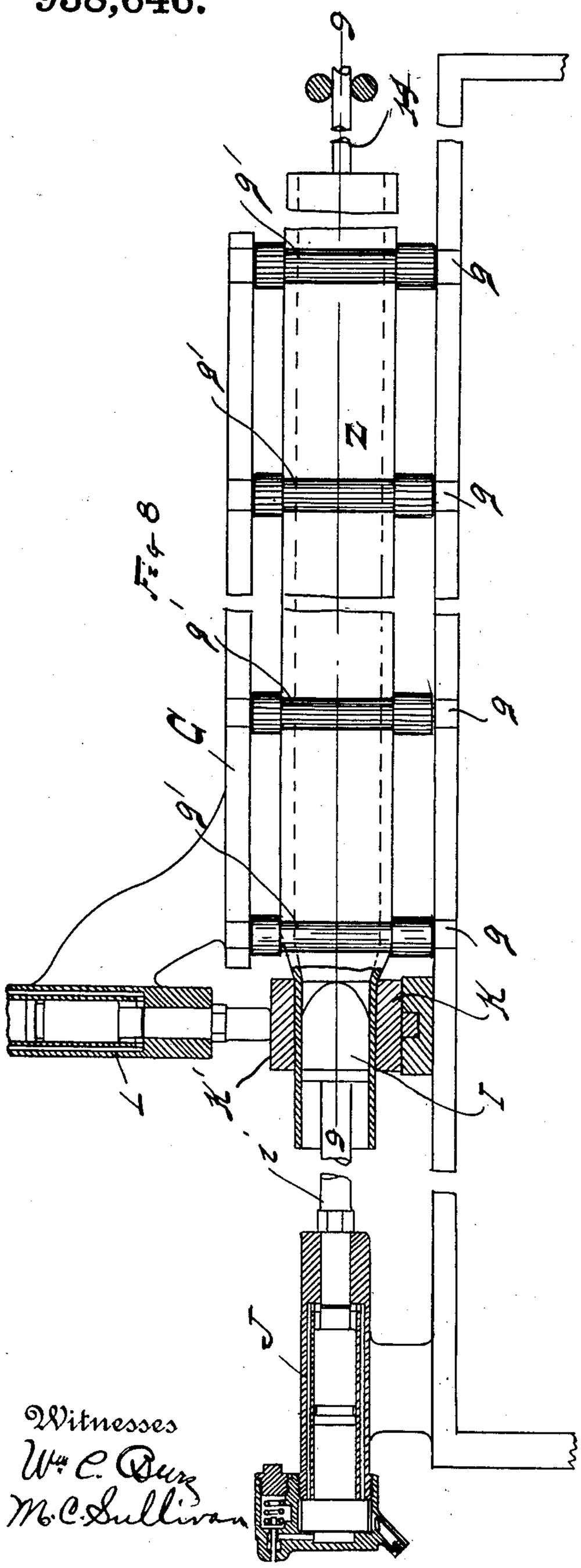
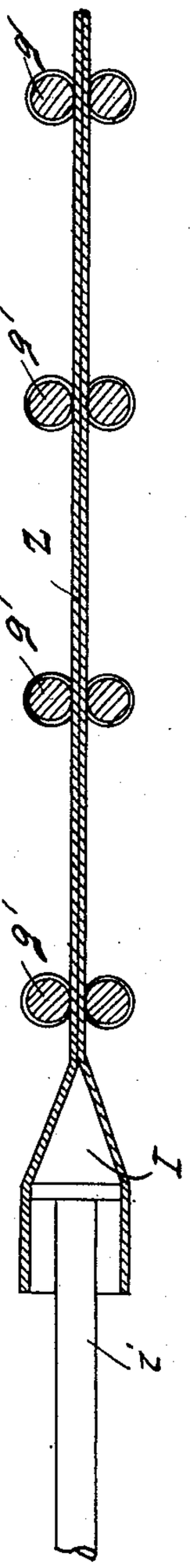


Fig. 9



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UNITED STATES PATENT OFFICE.

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METHOD OR PROCESS OF FORMING METALLIC TUBES.

938,646. Specification of Letters Patent. Patented Nov. 2, 1909.

Application filed September 24, 1904. Serial No. 225,848.

To all whom it may concern:

Be it known that I, LEONARD D. DAVIS, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, have invented new and useful Improvements in the Method or Process of Forming Metallic Tubes, of which the following is a specification.

This invention relates to the method or process of forming metallic tubes, and consists in certain improvements therein as will be hereinafter fully described and pointed out in the claim.

Various methods have been employed to thin the walls of a pierced ingot. The common methods in use are as follows:

The round billet initially solid has been pierced by any of the existing methods of piercing. At present there are two methods in general use for reducing the walls of the pierced billet, namely swaging and rolling in a plug mill. Each method possesses limitations and difficulties that will be briefly pointed out. First in the swaging method the pierced billet is placed upon a hard steel mandrel and is fed between a pair of gap rolls, usually arranged with a groove of varying diameter. The larger diameter first acting upon the larger diameter of the billet, the groove tapers down to a practically round groove of the finished diameter desired. This method imparts a reciprocating motion to the billet and mandrel and requires a considerable period of time to finish a billet of any considerable length. It is also very expensive for the reason that the blows delivered by the rolls effect the expensive steel mandrels which being somewhat softened by the heat of the red hot billet are more susceptible to this destructive action, the result being that they are very soon distorted in shape. This action of course becomes more pronounced as the walls of the billet are thinned. For this reason this method has been found very expensive for general use when it is attempted to swage boiler or other tubes down to a very thin gage.

In the plug mill, as it is technically termed, an ordinary two high mill with grooved rolls is used similar to that in ordinary use for bar rolling. A mandrel supported at one end at the back of the rolls and carrying at the other end, a plug, which is inserted in the pass of the rolls. The billet being fed forward and over this plug by the grip of the rolls is gradually reduced, in diameter and has its walls thinned as rapidly as the grip of the rolls and the plasticity of the metal will permit, and carry the billet over the plug without sticking in the rolls. It is obvious that in using this method there must be a relation between the diameter of the billet and its length. Considerable force is required to hold the plug rigidly in place. In tubes of small diameter and considerable length requiring a small diameter of mandrel sufficient rigidity cannot be obtained to prevent buckling of the bar or mandrel. For this reason this method has only been found practicable in finishing tubes of considerable diameter to gage, the smaller sizes usually requiring cold drawing to reduce them to the smaller diameters and greater lengths.

Attempts have been made to reduce the walls of pierced billets or billets that have been pierced and whose walls have been subsequently thinned to some extent by the rolls, by drawing through a die and over a mandrel similar to the method practiced in cold drawing. It has been found impracticable however to reduce the walls to any great extent in this manner, because the metal being softened by the heat will stretch at the thinnest point and does not possess sufficient tenacity to permit pulling through the dies with any great reduction of the walls. Its use is confined largely to rounding up and sizing the tube by sinking the diameter slightly and without the use of a mandrel inside.

In my improved method of forming metallic tubes I reduce the walls of the pierced billet by passing the pierced billet through a pair of rolls having flat grooves while hot, the action of which tends to stretch or elongate the billet an amount which is governed by the width and height of the pass in the rolls. In this manner the work can be done very quickly as it is possible to make very much greater reductions than is possible when rolling over a plug in the ordinary plug mill, and the walls can be reduced to a much thinner gage in the initial heat. The billet retains its heat longer because the radiating surface being only that due to a flat surface equal to the circumference of the finished tube, while in the plug mill the radiating surface is increased by the circumference of the inside diameter of the

tube, it is also chilled to some extent by the colder plug over which it is drawn. The billet when finished to the desired thickness is then carried to a bench, and the ends slightly opened by hand, where it is supported in any suitable manner, preferably by rolls, and is fed over a mandrel and plug. The mandrel is subjected to a series of rapid light blows in character like those delivered by the pneumatic riveting and chipping hammers, delivering a series of very rapid but comparatively light blows per minute. The wedge shaped faces of the point upon the end of the mandrel tend to separate the flat tube and round it up. It has been found that very little force is required until the tube begins to assume a round shape of such a diameter that the straight flattened edge must be pulled down. In this manner the inertia itself is utilized for opposing the blows so that the upsetting action which would be incident to thrusting the mandrel through the plank by a single action of force is avoided. To aid the work at this point a hammer and die may be employed to aid in rounding up as well as taking out the slight projection or flute in the circumference that it has been found difficult to take out to complete the perfect round.

I am aware that attempts have been made to cast a hollow ingot and roll it down in this manner, after which it was opened up and rounded by drawing through a die in a bench, resembling the ordinary draw bench and over a plug, or by pulling it over a plug by the use of one or more pairs of rolls. The first method is subject to the difficulties referred to in hot drawing, and in the second method a large proportion of stickers are obtained.

The mechanism for carrying out my process is illustrated in the accompanying drawings as follows:—

Figure 1 shows a section on the line 1—1 in Fig. 2 of a piercing mill. Fig. 2, a side elevation of said mill. Fig. 3, a side elevation of the thinning or extending rolls. Fig. 4, a section on the line 4—4 in Fig. 3. Figs. 5, 6, and 7, sections of the tubular blank in the different stages of manufacture. Fig. 8, a side elevation of the machine partly in section for opening the flattened blank. Fig. 9, a section on the line 9—9 in Fig. 8. Fig. 10, an end elevation of the auxiliary opening mechanism. Fig. 11, a transverse rolling mill, preferably used for giving the tube its final shape when the tube is of very large diameter.

The piercing mill comprises the disks A—A, piercing mandrel B and guide C. These disks are arranged eccentrically and operate in the ordinary manner of piercing mills of this kind. After the billet has been pierced it is passed through the rolls D—D having the working groove *e*. An elongated mandrel E is arranged in this pass, the purpose of the mandrel being to thin the edges *z'* of the blank Z to substantially the desired thickness of the walls of the finished tube. The blank is then passed through the rolls F having the working groove *f*. As many rolls similar to the rolls F—F may be used as is necessary to accomplish the desired reduction. A cross section of the blank coming from the rolls D—D is shown in Fig. 5.

After the blank has been thinned in this manner so that the walls are of the desired thickness, it is then passed through the mill shown in Fig. 8. In this mill a frame G is provided with a series of feeding rolls *g* having feeding grooves *g'*. The flattened blank Q is placed in these rolls and thrust forward by the rolls themselves or by a thrust device H. A forming mandrel I is arranged in the path of the blank as it comes from the rolls *g*. The shank *i* of this mandrel is acted upon by a pneumatic hammer J so that the mandrel delivers a series of light blows to the interior of the blank, and in this manner opens the blank to give it form. By proportioning the force of these blows to the thickness of the walls of the blank, the inertia of the blank may be utilized to prevent upsetting.

It is desirable to assist the opening process by exerting pressure at the outside of the blank and at the edges thereof. I therefore provide the anvil *k* over which the lower edge of the blank passes as it is acted upon by the mandrel I, and immediately above this I provide the swage K' which is operated upon by the pneumatic hammer L, an end view being shown in Fig. 10, the tube there shown being a part of it finished and part just coming from the feeding rolls. After forming the tube in this manner it may be further finished if desired by passing it through the transverse rolls M—M as shown in Fig. 11, when of large diameter.

By thinning the edges of the blank as by the mandrel E in the rolls D—D, the finished tube may be made with walls of uniform thickness. If these edges were not thinned in the ordinary process of manufacture here employed, they would be extended during the thinning process so that when the tube was expanded there would be a rib along this edge. This is avoided in the manner suggested. It will be noted that the mandrel I has a comparatively fixed position, the tube being fed onto it. It is of course vibrated to some extent by the pneumatic chamber.

What I claim as new is:—

The method or process of forming metallic tubes, which consists in expanding a heated hollow flattened blank by a series of blows applied to the interior of the blank in an axial direction, the blows being of sufficient rapidity to expand the blank while the metal

is in a heated condition, the blows being so proportioned to the body of the metal forming the walls of the tube, that the greater portion of the force of the blow is absorbed by the inertia of the walls of said tube immediately adjacent to the surfaces upon which the blows are delivered.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

LEONARD D. DAVIS.

Witnesses:
M. C. SULLIVAN,
F. S. STEWART.