July 18, 1939. W. C. McBAIN 2,166,418

METHOD OF ROLLING

Filed April 21, 1934

Fig. 1.

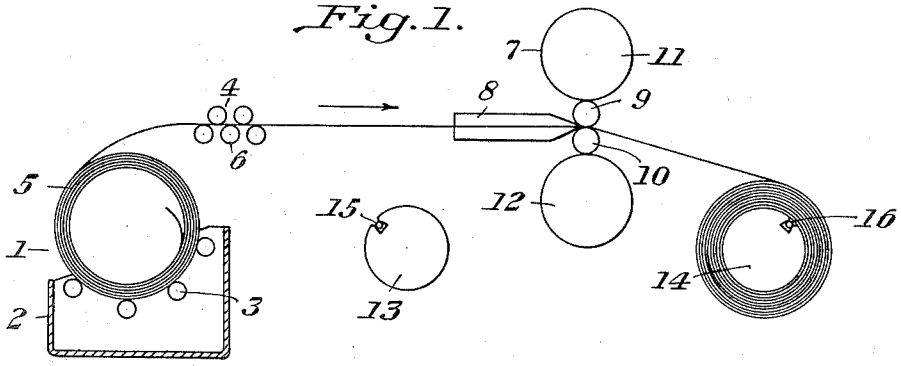


Fig. 2.

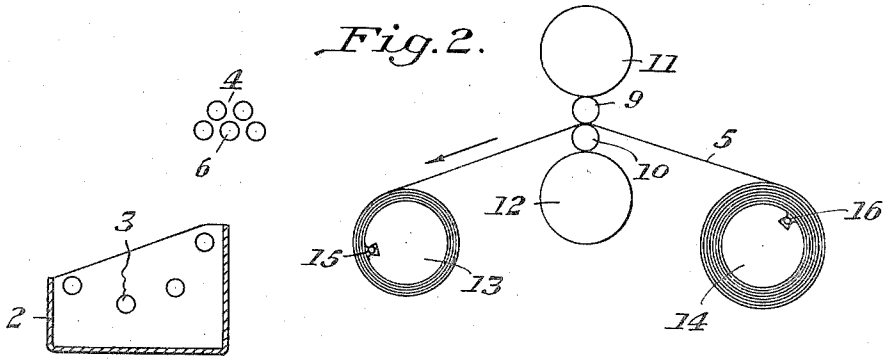
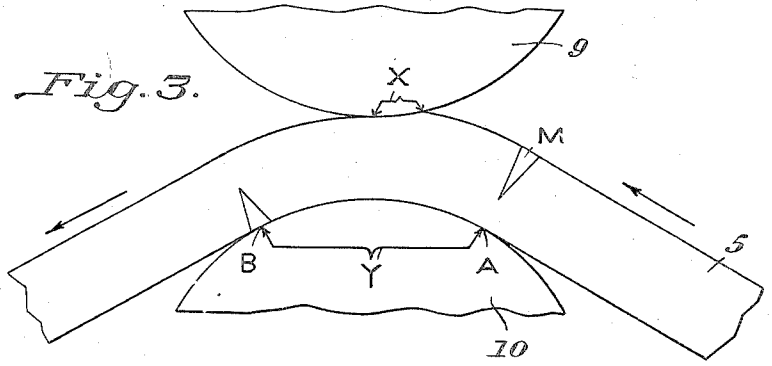


Fig. 3.



INVENTOR

William C. McBain

by his attorneys

Byrnes, Stebbins & Blenko

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METHOD OF ROLLING

William C. McBain, Youngstown, Ohio, assignor to The Cold Metal Process Company, Youngstown, Ohio, a corporation of Ohio

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12 Claims. (Cl. 80—60)

My invention relates to a method of rolling strip metal and is especially concerned with the cold rolling of strip in a reversing mill equipped with either power-driven or idle work rolls, i. e., rolls driven by the forward tension applied to the strip.

It is now well known that it is advantageous to subject strip to tension while rolling. My method is an improvement over the present practice and has the added advantage of making it possible to subject only very small portions of the strip entering and leaving the rolls to a tensile stress exceeding the elastic limit, whereas the strip as a whole is subjected to a tension not exceeding the elastice limit during the actual rolling. Another advantage of this method of tensioning is that it produces flatter strip. The reason is that there is a permanent deformation of a portion of the metal in the strip, at a point opposite the first point of contact of the strip with the work roll. There is another slight permanent deformation of a portion of the metal in the strip at the point where the metal in the strip straightens out and departs from contact with the work roll. Since this bending action progresses uniformly over the entire length of strip, I exert the same effect on all portions thereof. At the same time, the strip is not subject to the hazard of breaking which would inevitably accompany the stretching thereof throughout its entire cross-sectional area, beyond its elastic limit.

My invention also provides a very simple and effective method of guiding the strip into the rolls. I preferably use top and bottom guides on the first or loading pass after which the guides may be removed and the strip held by tension against one of the rolls for accurate guiding into the pass or place where both surfaces of the strip are in contact with work rolls. The principal advantages of this kind of guiding are first, the high degree of uniformity of the precisely ground roll surface in contact with the strip before it enters its pass, and second, the fact that the strip by this method is guided clear into the pass area, whereas, with the usual guides, it is impossible to guide the strip all the way into the pass area. Another valuable feature of my method of rolling strip is the compactness and simplicity of the equipment required to do the rolling and tensioning. The tension is preferably reduced with each succeeding pass to suit the thinner section. Also the tension is varied as necessary to regulate the roll pressure and, consequently, the spring of the rolls and the shape of the pass and, therefore, the shape of the finished strip.

In the drawing—

Figure 1 is a diagram of the apparatus which I prefer to use in performing my method of rolling strip, particularly in the first or loading pass;

Figure 2 is a similar view showing the operations on the second pass and subsequent passes; and

Figure 3 is an enlarged diagrammatic view of the strip passing through the rolls on the second pass and is typical of the subsequent passes.

Referring again to Figure 1 which shows the first or loading pass, the coil of strip to be rolled is first placed on an uncoiler 1. In the form shown, the uncoiler consists of a coil box 2 and a roller leveler 4. The coil box consists of a housing carrying a multiplicity of rollers 3, either power-driven or idling, said rollers being suitably located to receive a coil 5. These rollers have rolling contact with the coil of strip as it is fed into the roller leveler 4 and a mill 7. The roller leveler consists of a series of staggered rollers 6 that have rolling contact with the strip 5 and straighten the strip for the passage through guides 8 into the mill 7. The mill 7 is represented diagrammatically by the two work rolls 9 and 10 and the two backing-up rolls 11 and 12. It also has winding and unwinding reels 13 and 14. The reels 13 and 14 are equipped with grippers 15 and 16. The guides 8 are removable.

In the loading pass, as show in Figure 1, the right-hand reel 14 only is in use for coiling up the strip after it leaves the mill. The left-hand reel 13 is not used until the second pass. Figure 2 represents the second pass, the mill 7 having been reversed and one strip end now being attached to each of the two reels 13 and 14 by grippers 15 and 16. In this pass the motion of the strip is from right to left as shown by the arrow. This pass is typical of the subsequent passes back and forth until the rolling is completed and the finished coil is removed from the mill. In some cases, I drive the winding reel and retard the unwinding reel, as shown in my U. S. Patent No. 1,881,056, to tension the strip as it is being rolled.

Figure 3 is an enlarged diagrammatic view of the second pass of the strip through the mill. This view shows the top and bottom work rolls 9 and 10 and the strip 5. The upper work roll 9 is in contact with the strip 5 through the arc of contact X and the lower roll is in contact with the strip through the arc of contact Y. The strip 5 is deflected as it comes in contact with the roll 10 at the point of contact A. Sufficient tension is applied to the strip 5 so that there is an actual stretching of the surface of the strip at point M opposite point of contact A. The strip is thus given a permanent set or deformation and therefore conforms to the curvature of the roll 10. As the strip leaves the arc of contact Y with the work roll 10 a similar stretching takes place at the point B removing the curved set previously imparted, again deforming the strip into flat condition. This result might also be obtained by

permitting the outgoing strip to curve partially around the upper roll 9. The tension in the strip is preferably kept low enough so that this stretching effect does not extend clear through the thickness of the strip. If it did, the bending action of the strip, as it comes in contact with and leaves the roll, would no longer be of aid in causing the proper distribution of the stretching. In other words, if the tension were great enough to cause the areas of permanent elongation M and B to extend clear across the strip, then immediately the entire straight portion of the strip would be subject to the same excessive tension and liability of rupture would become so great that the method would become of doubtful value. As shown in the drawing, the axes of the reels, backing-up rolls and work rolls are parallel. Tracking of the strip through the pass is assisted by the proper operation of the screwdown. This, in combination with the use of the high tension in the strip, as previously mentioned, reduces materially the amount of work required to be done by the side guides and in some cases makes it possible to eliminate them altogether.

It will be apparent from the foregoing description that the invention described herein is characterized by important advantages over the previously practiced methods of rolling strip. According to my method, the strip is subjected progressively to a tensile stress exceeding the elastic limit but confined to points in the strip adjacent the mill on opposite sides thereof. The tension does not exceed the elastic limit throughout the thickness of the strip at any one point or at any one instant, and, therefore, lower total tensions can be employed than heretofore to accomplish the desired results. This results in a simplification of the problem of strip breakage. This problem is very vexing when it is attempted to roll strip under tension in the neighborhood of the elastic limit throughout the entire cross-sectional area of the strip.

Although I have illustrated and described herein but one preferred practice of my invention, it will be apparent that changes in the described practice may be made without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. In a method of rolling strip, the steps including entering strip while cold between reducing rolls and pulling it therefrom at an angle to the common tangent to said rolls, and subjecting the strip during rolling to a tension such that the tensile stress in the strip exceeds the elastic limit of the material only adjacent the points at which the strip is bent around one of said rolls.

2. In a method of rolling strip, the steps including pulling the strip while cold between reducing rolls, subjecting the material to a retarding tension, and bending the strip about at least one of said rolls to increase the stress in the strip at the points of bending beyond the elastic limit of the strip.

3. In a method of making strip, the steps including subjecting a length of strip while cold to combined tensile and compressive forces insufficient together to elongate the strip, and simultaneously bending the strip sufficiently to effect elongation in combination with said tensile and compressive forces.

4. In a method of rolling strip, the steps including passing the strip while cold between reducing rolls, bending the strip between the rolls partially about one of them, and subjecting the strip to tension and roll pressure sufficient to cause elongation only when combined with the effect of the bending of the strip.

5. In a method of making thin sheet metal, the steps including passing a strip while cold between reducing rolls, applying forward tension to the strip emerging from the rolls, simultaneously bending the strip around one of said rolls, and so regulating the roll pressure and tension that the tension in the strip exceeds the elastic limit only adjacent the points of bending, whereby to reduce the tendency to strip breakage during rolling.

6. In a method of making strip, the steps including passing the strip between reducing rolls, exerting a compressive force on the strip while passing between said rolls, subjecting the strip to a tensile force, bending the strip around one of said rolls, and so regulating said tensile and compressive force that the tensile force is sufficient to elongate the strip only when combined with the effect of said bending.

7. A method of rolling metal strip, including the steps of passing it between rolls, applying tension to the metal and bending it partly around one of said rolls, applying sufficient pressure to the rolls to reduce the metal and thereby elongate said strip only when combined with the bending and tension in the strip at the points of tangency where the strip comes in contact with and leaves said rolls.

8. In a method of cold rolling strip, the steps including subjecting a length of strip to combined tensile and compressive forces and simultaneously bending the strip, said tension and said bending being sufficient by themselves to cause a measurable elongation apart from that produced by the compressive force.

9. In a method of rolling strip, the steps including passing the strip while cold between reducing rolls, bending the strip partially about one of them and subjecting the strip to tension sufficient, in combination with said bending, to cause elongation in addition to that produced by the roll pressure.

10. A method of cold working strip metal, including passing the strip between reducing rolls under tension, bending said strip around an appreciable arc of one roll both before and after it contacts the second roll and producing permanent elongations in said strip at points where the strip meets said first roll and where it leaves said first roll, in addition to the elongation produced in the strip in the area where it is in contact with both rolls.

11. In a method of cold rolling strip, the steps including passing the strip between reducing rolls, exerting a compressive force on the strip while passing between said rolls, subjecting the strip to a tensile force, bending the strip around one of said rolls, and so regulating said tensile force that the tensile force and the bending of the strip around the roll combine to produce an elongation in said strip in addition to that produced in the pressure area where the strip is in contact with both rolls.

12. In a method of rolling strip while cold, the steps including pulling the strip between reducing rolls, subjecting it to a retarding tension, bending it about at least one of the said rolls to increase the stress in the strip at the points of bending, beyond the elastic limit of the strip, and controlling the roll pressure to assist in holding the strip centrally of the mill.

WILLIAM C. McBAIN.