METHOD AND APPARATUS FOR ROLLING BIMETALLIC ARTICLES

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2 Sheets-Sheet 2
This invention relates to the rolling of such bimetallic stock as comprises sheath metal which is relatively more plastic than the core metal, a particular instance being the rolling of bimetallic stock comprising a steel core and a sheath of copper.

One object of the invention is to so control and balance the redistribution of sheath and core metal in the course of the rolling that the finish rolling produces a rod or similar article in which both the core and the sheath are uniform or symmetrical in cross section.

In the accompanying drawings which illustrate my invention,

Figs. 1 to 11 show cross sections of the stock imparted by successive roll passes and indicate the redistribution of the core metal and the sheath metal as the reduction of the stock progresses; and

Figs. 12 to 22 show the corresponding roll passes.

This invention applies generally to bimetallic stock wherein the sheath metal is relatively more plastic than the core metal. The invention can be better described and more readily comprehended, however, by referring to some concrete example; and therefore, for purposes of illustration merely, the material referred to above, namely, stock comprising a steel core C and a sheath S of copper is discussed herein. For the purposes of such illustrative discussion, the core may be taken to be a tough steel such as the steel having a manganese content between 1.75% and 2.25%, and a carbon content between 0.13% and 0.17%.

In the rolling of such stock, it is customary to reduce the stock in successive roll passes, in each of which a substantially oval cross section is imparted to the stock, and to impart as truly round a cross section to the stock as possible in the last or finishing pass.

In each successive pass, the reduction of the bimetallic stock is accompanied by an alteration in the cross section of the core metal. As there is no direct contact with this core metal, the pressure necessary for such reshaping is imparted thereto through the relatively more plastic sheath metal; and obviously this reshaping of the core metal is difficult to control. As rolling proceeds, the ends of the oval cross section imparted to the core metal are "sharper"; that is, adjacent the ends of the oval the radius of curvature diminishes to a relatively short radius before again increasing. When, for the next pass, the stock enters between the rolls with the long axis of the oval transverse to the roll axes, the principal rolling pressure is against these "sharpened" ends of the oval; so that the relatively more plastic sheath metal does not offer sufficient resistance to penetration by the "sharpened" ends of the core metal to bring about a proper reshaping of the core. As above mentioned, it is only through the sheath metal (which is relatively more plastic than the core metal) can the core be changed in shape. If the sheath metal is thinned out excessively in certain portions, more particularly the portions which were subjected to pressure from beneath by the "sharpened" ends of the oval core, an improper distribution of sheath and core metal persists through the succeeding rolling operations.

In accordance with my invention I am able, at an intermediate point in the successive reduction passes, to regulate and balance the redistribution of the sheath metal circumferentially about the core by limiting or restricting the flow of the sheath metal. From another point of view, my procedure for accomplishing the desired end is to carry out the reduction of the stock in such a manner as to compress inwardly and push back bulging portions of the core metal through limitation of the flow (i.e., redistribution) of the sheath metal circumferentially about the core. It will be apparent from the ensuing description that the limiting or restricting of the redistribution of the sheath metal somewhat partakes in its nature of the obstructing of flow, as by a dam or restricted throat which builds up pressure behind the same. As this pressure is exerted on the core metal, it is possible to bring about a reforming of the core metal, even when there are relatively "sharp" projecting portions thereof.

It will furthermore be noted that by my control of the flow circumferentially of the sheath metal, I am able to interchange the axes of the oval of the cross section of the core metal. With the usual practice, the long axis of this oval is shortened in one pass, lengthened in the next pass, and shortened again in the succeeding pass, and so on. In accordance with my invention I so change the contour of the core metal, at an intermediate point in the successive reduction passes, that the oval axis which was formerly the long axis becomes its short axis and vice versa. I prefer to accomplish this by deviating at this point from the routine shift through 90° of the orientation of the stock in the roll pass, and instead causing the stock to be oriented alike as it is rolled in two successive passes.

Referring to Figs. 1 to 11 which show the cross sections of the stock as it is progressively reduced,
Fig. 1 shows stock which has been subjected to a plurality of passes including the pass between the rolls Rs Rs shown in Fig. 12, it being noted that in this pass the axis a—b of the stock has been shortened under the pressure of the rolls Rs, the directions in general of application of the pressure being indicated in Fig. 3 by the arrows d. As indicated by Fig. 2, the cross section resulting from the next pass (see Fig. 13) in which the directions in general of application of the pressure of the rolls Rs Rs are indicated in Fig. 2 by the arrows is such that the axis a—b is somewhat lengthened. Fig. 3 indicates that as a result of the next pass (see rolls Rs Rs in Fig. 14) in the axis a—b has again been shortened, and the stock has become considerably reduced.

The succeeding roll pass (see Fig. 15) results in a further reduction, as indicated by Fig. 4; and here the flattening of the oval cross section of the core metal imparts such "sharpness" to the ends of the oval as to be troublesome. In order to overcome this difficulty, the next reduction is performed by this compression or obstruction of the flow of the sheath metal circumferentially about the core as to overcome these "sharpened" ends. The core metal itself acts as one portion of the constricting throat, and the roll pass of the sheath is shaped with such contour as to provide the other portion of the throat. The roll pass shown in Fig. 16 rolls down the long axis a—b of the oval cross section resulting from the preceding roll pass. In contrast to the conventional oval shapes of the passes of Figs. 12 and 14, however, this pass (Fig. 16) is shaped to damp or obstruct the flow of sheath metal in redistribution of the same about the core; and preferably, the constraining or restricting of the flow of the sheath metal is accomplished on the quarters, as indicated at 2, 2 and 3, 3 in Fig. 16 of the drawings.

It will be noted that in the cross section of Fig. 16 a heavy sheathing of metal overlies the ends of the oval core. The shape of the roll pass of Fig. 16 is such as to bring the contours of the core C and of the rolls Rs Rs relatively close together on the quarters (as indicated at 2, 2 and 3, 3); and this has the effect in rolling of damming up heavy pressure on the sheath metal overlying the two oval ends between these quarters. This pressure is so large as to impede the roll pass and the sheath metal to the metal of the core as to force in or relieve the protruding portions of the core. Under the limitations of the constricitions imposed upon the flow of the sheath metal, it is no longer a matter of more plastic material giving way instead of the less plastic material, as would be the case with the reshaping of bimetallic articles with uniform rolling pressures.

As indicated in Fig. 5, the cross section produced in this roll pass works for greater uniformity of distribution of the sheath metal, more particularly in that the sheath metal has been, to a considerable extent, retained over the portions of the core which were the ends of the oval. The ideal distribution of sheath metal is more nearly accomplished by shaping the roll pass so that (as shown in Fig. 5) as the metal is pushed out laterally in the course of rolling down the long axis of the oval (the oval of Fig. 4), the accumulation of sheath metal at the sides is held in, as indicated by the numerals 8, 8, by a further impingement and balance of distribution of the metals in the core and sheath is obtained if, in the succeeding roll pass (see the rolls Rs Rs of Fig. 17), rolling is effected with the stock oriented approximately the same as in the preceding roll pass. It will be noted that turning of the stock through approximately 90° with respect to the roll axes, or vice versa, has been indicated in Fig. 3, and the pass shown in Fig. 12, and the pass shown in Fig. 13. The same is true as between Figs. 13 and 14 and as between Figs. 14 and 15. This is likewise true as between Figs. 15 and 16. Obviously, this turning through approximately 90° may be effected in either of two ways. The roll axes in succeeding roll passes may be similarly disposed and the stock itself turn through approximately 90° before introducing the same into the succeeding pass. On the other hand, the stock move along without being turned about its axis, the roll axes of each succeeding pass being, in this case, at an angle of 90° with respect to the axes of the preceding pass. With either of these two expedients, the effect is to orient the stock differently in succeeding passes, the angle of change being approximately 90°. When the stock has been rolled to the cross section shown in Fig. 5, it is introduced into the next succeeding pass (see the rolls Rs Rs of Fig. 17) without the change in orientation which has been each time effected up to this point. Rolling then proceeds as indicated in Figs. 7, 8, 9 and 10, the corresponding roll passes of the rolls Rs Rs of Fig. 17 being approximately 90° prior to each pass, this time there is no turning; or, on the other hand, it up to this point succeeding passes have had the roll axes disposed at approximately 90° to the preceding roll axes, this time there is parallelism between the two sets of roll axes, i.e., Figs. 16 and 17. By the expression "the same orientation" is meant no change in the relation of the stock to the roll pass it is entering as compared to the relation which existed between the stock and the preceding roll pass, and such expression is applicable broadly in connection with whatever method is employed in general for varying such orientation from roll pass to roll pass.

As the stock issues from the pass shown in Fig. 17, its contour (see Fig. 6) is again oval; but the axis a—b is no longer the long axis but the short axis instead. In succeeding rolling operations the axis, which in Figs. 1 to 4 inclusive was the long axis, in the succeeding rolls it is the short axis. In other words, the stock has been so rolled in the passes of Figs. 16 and 17 as to decrease the long axis of the oval of the core until it is the short axis of a new oval.

The effect of working the bimetallic stock in two succeeding roll passes without change in the orientation of the stock with relation to the pass is to bring the stock closer to a proper balance as to distribution of sheath metal and core metal about the axis of the stock. It will be noted that the core metal of the cross section shown in Fig. 6 has an oval contour which does not present the above referred to difficulty, namely, the tendency to punch through the more plastic sheath metal. Rolling then proceeds as indicated in Figs. 7, 8, 9 and 10, the corresponding roll passes of the rolls Rs Rs Rs Rs respectively indicated in Figs. 18, 19, 20 and 21. As is customary, a change of 90° is effected each time in the orientation of the stock with relation to the roll pass.

If necessary in a long succession of reducing passes, correction of the distribution of core and sheath metal may be again effected, the turn above being made in the roll axes respectively indicated in Figs. 5 and 6. Generally, however, the remaining reductions may be effected without resorting to such corrections.
tive measures for the contours of the core and sheath metals.

The stock is then subjected to one or more finishing passes, as typified by the roll pass shown in Fig. 25; and the stock appears in cross section as indicated in Fig. 11.

As has been brought out in the course of the above description, my invention provides an advantageous procedure for redistributing the core and sheath metal in the stock. Moreover, it makes available a corrective measure where trouble is encountered due to a core which is relatively less plastic than the sheath metal so that there is a tendency either for the core metal to get out of shape and/or eccentric, or for the sheath metal to become so poorly distributed circumferentially about the core that one or more thinned out portions of the sheath carry through into the finished product. It will be apparent from the above discussion that by constraining the redistribution of sheath metal through the shape or contour of a roll pass, the requisite pressure can be brought to bear upon the core metal to effect proper reshaping of the same.

While I have illustrated and described a preferred embodiment of my invention, it will be understood that the same may be otherwise embodied and practiced within the scope of the following claims.

I claim:

1. In the method of rolling bimetallic stock having a steel core surrounded by a sheath of more plastic metal, the steps consisting in rolling the stock in successive oval passes to reduce the cross section of the core and changing the orientation of the stock relative to the pass between successive rollings while maintaining the core generally oval in cross section, thereby successively increasing and decreasing the long axis of the oval, and then changing the long axis of the oval to the short axis thereof by successive rollings without substantial turning therebetween.

2. In the method of rolling bimetallic articles having a core and a sheath which is relatively more plastic than the core, the steps consisting in subjecting a bimetallic body to successive reducing passes, feeding the body to successive passes in such manner as to compress it alternately along cross-sectional axes generally at right angles to one another, and then effecting redistribution of the sheath metal around the core by subjecting it to successive passes in which the body is compressed along substantially the same cross-sectional axis, and then further reducing the body by feeding it to successive passes in such manner as to compress it alternately along cross-sectional axes generally at right angles to one another.

3. In the method of rolling bimetallic articles having a core and a sheath which is relatively more plastic than the core, the steps consisting in subjecting a bimetallic body to successive reducing passes, feeding the body to successive passes in such manner as to compress it alternately along cross-sectional axes generally at right angles to one another, and then effecting redistribution of the sheath metal around the core by subjecting it to successive passes in which the body is compressed along substantially the same cross-sectional axis, and then further reducing the body by feeding it to successive passes in such manner as to compress it alternately along cross-sectional axes generally at right angles to one another.

4. In the method of rolling bimetallic articles having a core and a sheath which is relatively more plastic than the core, the steps consisting in subjecting a bimetallic body to successive reducing passes wherein it is reduced to oval shape, the core also being oval, then subjecting it to a reducing pass in which it is compressed along the long axis of said oval, reducing the body in such pass in an amount sufficient to render the core generally circular, then rolling the body in a pass in which it is compressed along the same axis and the distribution of the sheath metal around the core is altered, and thereafter subjecting the body to successive passes in which it is compressed alternately along cross-sectional axes generally at right angles to one another and thereby reduced.

5. In the method of rolling bimetallic articles having a core and a sheath which is relatively more plastic than the core, the steps consisting in subjecting a bimetallic body to successive reducing passes generally oval in cross-section, feeding the body therethrough in such manner as to compress it alternately along cross-sectional axes generally at right angles to one another, but during such reducing operation subjecting the body to passes in which it is compressed successively along substantially the same cross-sectional axis, thereby effecting a redistribution of the sheath metal around the core.

6. Apparatus for rolling bimetallic articles comprising rolls having grooves which provide a series of reducing passes generally oval in cross section, there being two successive intermediate passes effective for receiving the body and reducing it along substantially the same cross-sectional axis and effecting a redistribution of the sheath metal around the core, the other passes being adapted to receive the body and compress it alternately along cross-sectional axes generally at right angles to one another.

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