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METHOD OF PRODUCING SEAMLESS TUBES

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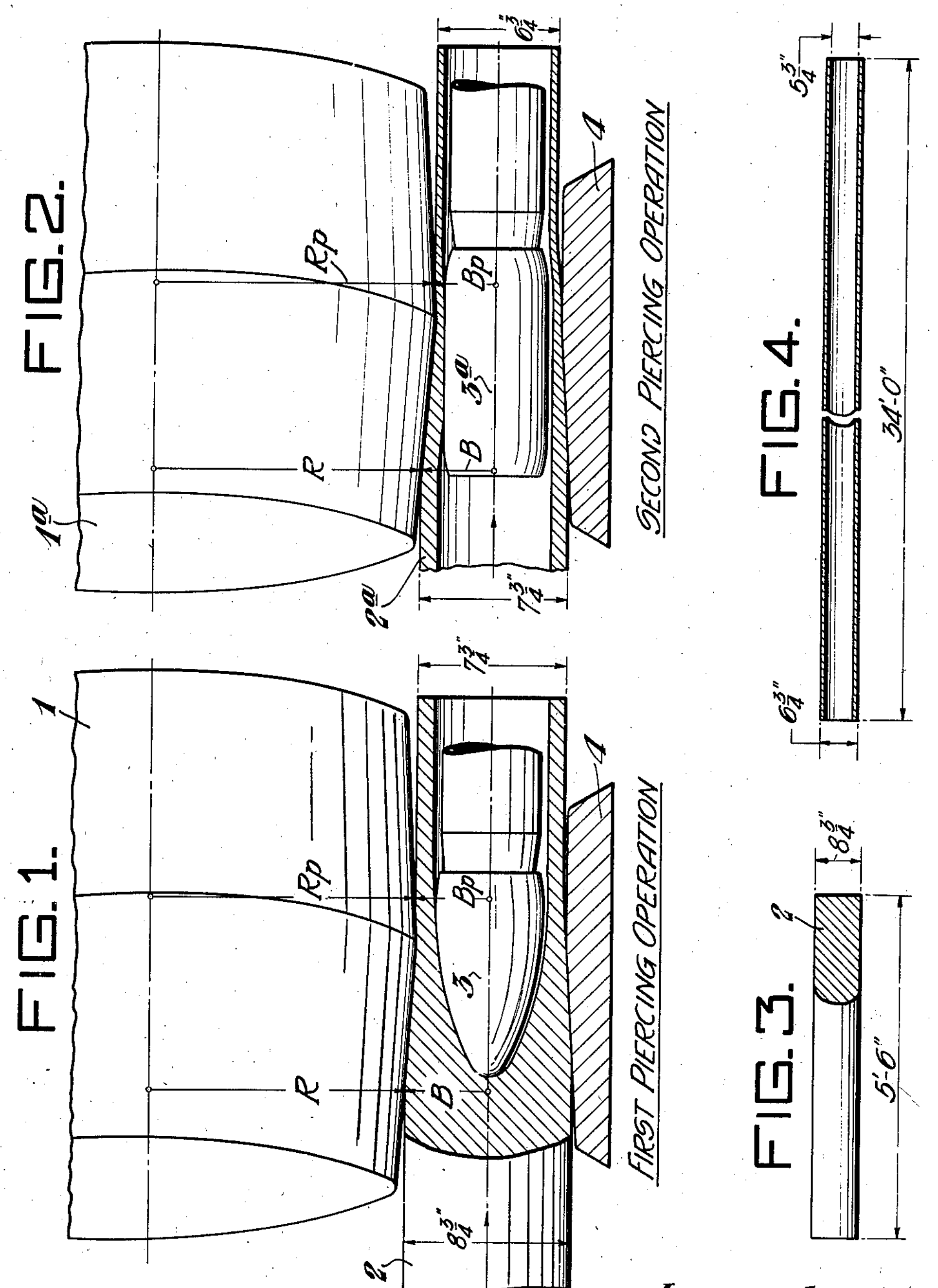

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METHOD OF PRODUCING SEAMLESS TUBES

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2 Claims. (Cl. 80—62)

This invention relates to a method of making seamless tubes and more particularly to the so called "double piercing" method of making seamless tubes.

One of the objects of the present invention is to provide a method of producing a large variety of pierced billet or shell sizes from a minimum number of billet sizes at a cost materially less than was heretofore possible. Another object of the present invention is to provide a method of producing pierced billets or shells of better quality than can be obtained by methods heretofore used.

In making seamless tubes having a diameter of about 4½" or greater, it is customary to follow the piercing operation with a "second piercing" operation wherein the wall thickness of the pierced billet or shell is reduced by helically advancing it over a tapered plug. In the past it has been customary to increase the diameter of the workpiece in both of the first and second piercing operations. In our copending application filed December 20, 1939, and bearing Serial No. 310,252, we have disclosed a speed relationship between the rolls and billets in the first piercer which permits large diameter reductions during piercing and improved results in both quality and practice.

We have now found that this speed relationship can be used quite effectively in the second piercer and by so doing the total number of billet sizes can be further reduced or all sizes of pipe can be made from a relatively small number of billets and at the same time take advantage of the attendant economies of using billets of larger diameter than that of the product desired.

Existing second piercers are, so far as we are aware, designed to slightly expand previously pierced shells while reducing their wall thickness. Some diameter reduction can be accomplished on these mills but at the expense of quality in the product. By using the present invention on a second piercer, reductions up to 25% are readily obtainable without detriment to the workpiece. Thus, a full range of pipe sizes can be produced from a very limited number of billet sizes. This results in a great saving in billet cost due to the fact that frequent resettings of the bar mill are eliminated, rolling of small lots is rendered unnecessary and it is no longer necessary to stock a large variety of billets, bar mill and piercing mill tools. Moreover, this invention, in addition to the foregoing advantages of a limited number of billet sizes, permits diameter reduction in the second piercer so that billets of relatively large diameter can in all cases be used. Obviously, a blooming and bar mill producing billets for seamless tube mill operations can turn out greater tonnage in a given period of time and at a lower cost where the cross sectional area is high. Likewise, conditioning (removal of entire surface or defects) costs decrease as the diameter increases since the surface to be conditioned varies directly with the diameter, whereas the weight varies as the square of the diameter.

In illustration of the difference in billet sizes used where diameter is reduced in the first and second piercers as contrasted to present day operations wherein diameter is increased, it is pointed out that in order to obtain 6¾" outside diameter workpiece 34' in length out of the second piercer, a conventional mill arrangement requires a solid billet 5½" in diameter by 14' in length, whereas a workpiece of the same dimensions can readily be obtained from a solid billet 8¾" in diameter by 5½' in length with a double piercer arrangement embodying our invention. Also, since greater wall reductions are possible in a second piercer of this design, pierced shells of thinner walls than were heretofore possible can be obtained out of the second piercer. In addition, it may be observed that as a result of diameter reduction in the first and second piercer, a larger percentage of the metal displacement is in a helical direction and thus ruptures due to abrupt longitudinal displacement of helically disposed fibers are largely eliminated. Also, there is a power saving as the bloom and billet are not rolled into a section of small diameter and subsequently expanded into a section of larger diameter.

Moreover, not only is initial billet cost reduced but also, due to the fact that materially shorter billets can be used, billet heating cost is reduced since in many instances multiple rows of billets can be heated in existing furnaces.

The early Mannesman patents and others indicate large diameter reductions in second piercers but such reductions are impossible of commercial attainment with the apparatus shown therein because the improper speed relationship between the rolls and the billet causes severe twisting of the workpiece. Subsequently, skilled workers in the art recognized this difficulty and attempted to correct it by providing theoretically true rolling relationship between the roll surfaces and the billet surfaces as the latter were reduced in the first piercing operation. It was believed that the roll and billet should approximate a bevel gear and pinion in speed relationship, i. e., the roll should have the same diameter ratio to the billet at all transverse sections of the pass. However, we have found that first or second piercers providing this true rolling relationship subject the workpiece to severe twisting and are, therefore, not suitable for the present purposes.

Careful experimentation has developed that this relationship is far from the correct one to obtain no twist or to control twisting within operable limits. It has been found that the speed of the rolls relative to the surface speed of the billet should increase as the cross sectional area of the billet is decreased. This is true largely because as the workpiece section is reduced, the wall thickness is decreased and the metal of the workpiece exerts greater and greater pressure against the guide shoes. Naturally, the tendency for slippage between the roll and workpiece increases as rotational resistance increases, and to compensate for this increased roll surface speed is necessary.

In order to understand why an increase in roll speed will compensate for slippage, it might be well to consider that portion of the workpiece being acted upon by the roll as a series of thin disks such as would be made if the workpieces were cut by transverse planes, closely spaced. In this case, if the roll diameter contacting each of the disks bore a constant diameter relationship or, stated in another way, if the diameter of the roll at each section contacting the disks divided by the diameter of the disk in question was the same for all sections, true rolling relationship would exist and, if the disks were free to rotate without resistance, each would rotate the same number of revolutions per revolution of the roll. However, as the outlet end of the pass is approached, the resistance to rotation increases and, as a consequence, under the conditions above described the rotation of the disk would progressively decrease towards the outlet of the pass. In order to compensate for this, the roll diameter should progressively increase from the inlet to the outlet of the rolling surface by an amount which will overcome the tendency for the billet to lag. In this connection it should be understood that there is some slip between the roll and the workpiece at all points in the pass, but this slip is greatest at the outlet end.

In order to obtain the speed relationship required in a diameter reducing operation, we have found that the ratio of roll diameter to billet diameter where wall reduction ceases, divided by the ratio of roll diameter to billet diameter where rolling commences must be greater than unity but should not exceed unity by more than 25% for the best results. Expressed graphically this becomes:

$$\frac{\frac{Rp}{Bp}}{\frac{R}{B}}=\frac{Rp\times B}{R\times Bp}$$

should be between a value greater than 1 and 1.25, wherein

R=radius of roll at point where rolling commences
B=radius of billet at point where rolling commences
Rp=radius of roll at point where wall reduction ceases
Bp=radius of billet at point where wall reduction ceases.

The accompanying drawing schematically shows an application of the above, Figures 1 and 2 respectively showing the first and second piercing operations when the diameter of the work is reduced during both operations, and Figures 3 and 4 being small-scaled representations of the solid billet and of the billet after it leaves the second piercing operation, these representations illustrating the effects of the operation of Figures 1 and 2 respectively.

In this drawing, 1 is a first piercer roll and 1a is a second piercer roll, 2 is the solid billet and 2a the pierced billet or shell, 3 is the tapered piercing plug and 3a a cylindrical second piercer plug, and the guide shoes are designated 4. It is to be understood that the guide shoe is projected into the plane of the roll for illustrative purposes.

Thus, it is seen that by combining a first and second piercing operation, each of which permits a wide range of diameters from a given size of workpiece, a maximum in flexibility results. Moreover, by reducing the diameter of the workpiece in both passes, the advantages set forth above are realized in the highest degree and at the same time a product having improved concentricity or uniformity of wall thickness is obtained.

This design permits the use of a cylindrical plug or mandrel in the second piercer. This obviates the necessity for extensive care in positioning the plug as the plug is made slightly longer than necessary and variations in its longitudinal position do not offset the results. A cylindrical plug is cheaper to cast than a tapered plug and also is obviously cheaper to grind and polish. Moreover, after it is worn somewhat it can be turned down and reused, whereas tapered plugs must be scrapped.

We claim:

1. A method of reducing the cross sectional area of previously pierced billets by helically advancing a pierced billet over a mandrel intermediately disposed between at least two metal working rolls, characterized by applying a progressively varying roll surface speed to said billet as its cross sectional area is reduced so that the numerical value of the formula

$$\frac{Rp\times B}{R\times Bp}$$

lies between a value that is greater than unity but does not exceed 1.25 wherein

R=radius of roll at point where rolling commences
B=radius of billet at point where rolling commences
Rp=radius of roll at point where wall reduction ceases
Bp=radius of billet at point where wall reduction ceases.

2. A method of reducing the cross sectional area and diameter of previously pierced billets by helically advancing a pierced billet over a mandrel intermediately disposed between at least two metal working rolls, characterized by applying a progressively varying roll surface speed to said billet as its cross sectional area and diameter are reduced so that the numerical value of the formula

$$\frac{Rp\times B}{R\times Bp}$$

lies between a value that is greater than unity but does not exceed 1.25 wherein

R=radius of roll at point where rolling commences
B=radius of billet at point where rolling commences
Rp=radius of roll at point where wall reduction ceases
Bp=radius of billet at point where wall reduction ceases.

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