

Oct. 19, 1926.

1,603,518

R. G. COATES

METHOD OF ROLLING INGOTS

Original Filed August 25, 1920

Fig. 1.

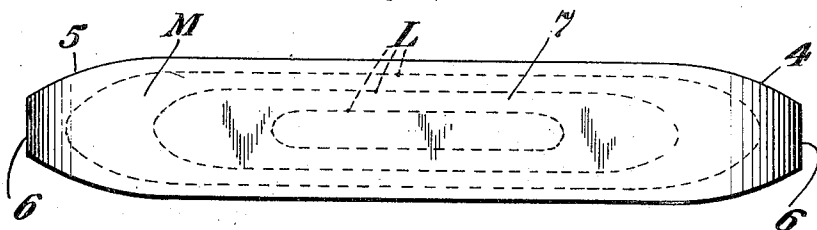


Fig. 2.

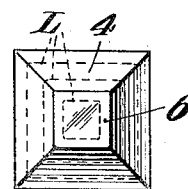


Fig. 3.

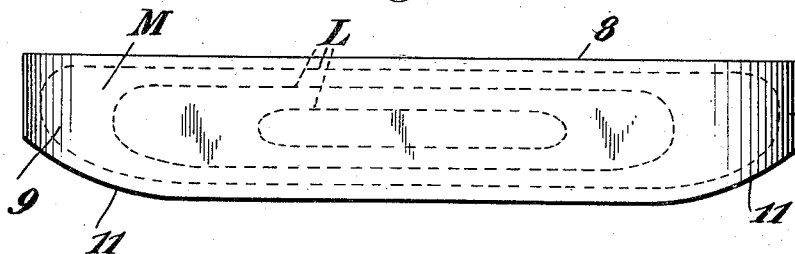


Fig. 4.

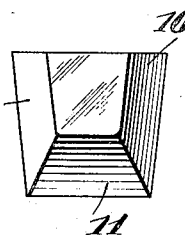
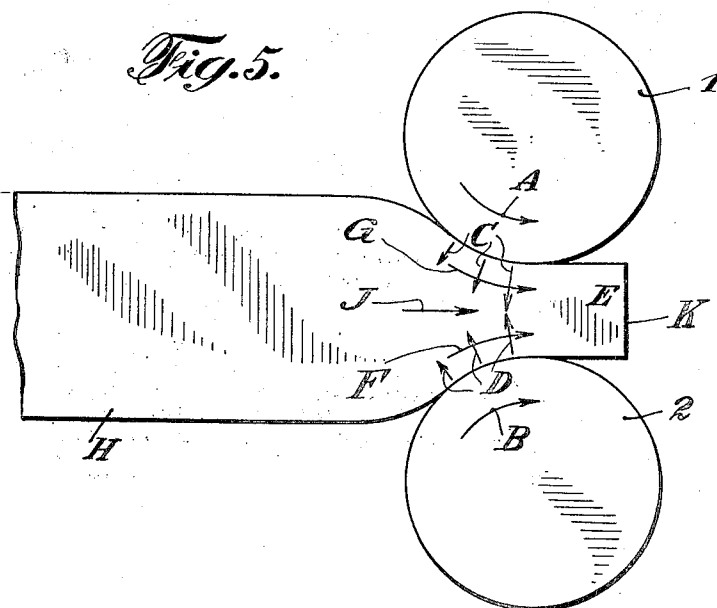


Fig. 5.



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UNITED STATES PATENT OFFICE.

RAY G. COATES, OF PASADENA, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, OF ONE-HALF TO THE ESTATE OF H. G. HAMILTON, DECEASED, LATE OF YOUNGSTOWN, OHIO.

METHOD OF ROLLING INGOTS.

Original application filed August 25, 1920, Serial No. 405,977. Divided and this application filed February 11, 1924. Serial No. 691,891.

This invention relates broadly to metallurgy and more especially to a method of rolling ingots.

The principal object of the invention is the method of rolling an ingot by causing the initial rolling contact to occur back of the forward end of the ingot.

Another object of this invention is the method of rolling which comprises causing the rolls to cease rolling pressures before the rear end of the ingot is reached during the initial rolling.

Another object of the present invention is a steel ingot having tapered end portions adapted to be inserted between blooming rolls in such manner that the initial contact with the rolls is back of the forward end of the ingot.

Another and important object of the present invention is the method of blooming steel ingots which comprises providing tapered end portions on the ingots with the end of the ingot extending past the plane of initial contact with the blooming rolls and then operating the rolls to elongate the ingot.

A further object of the present invention is the method of rolling which comprises providing a steel ingot with end portions thereof tapered to a size substantially equal to the end of the bloom desired when finished and with the rolls engaging and leaving the ingot during initial rolling at a point back of the ends of the ingot whereby ears or cups are avoided at the ends of the ingot.

A still further object of the present invention is the method of rolling which comprises providing a hot ingot with a tapered end having an end cross-section of a depth which is not greater than the depth of effective extruding rolling forces, then rolling said ingot through suitable rolls by causing the initial engagement of the rolls with the ingot to occur back of the end of the ingot until the ingot is reduced to a size equivalent to a size of the cross-section of the original end thereof.

A still further object of the present invention is the method of rolling which comprises providing a hot ingot with a tapered end having an end cross-section of a depth which is not greater than the depth of effective extruding forces, then rolling said ingot through suitable rolls.

Realizing that the present invention may be carried out by methods other than those herein specifically disclosed, it is desired that the present disclosure shall be considered as illustrative and not in the limiting sense.

The ingot which may be used in this method is not claimed in this application, but is claimed in my original application Serial Number 405,977, filed August 25, 1920, of which the present application is a division.

Throughout the drawings like parts are indicated by like characters.

Figure 1 is the side view of an ingot which may be used in carrying out this method.

Figure 2 is an end view of the ingot shown in Figure 1.

Figure 3 is a side view of a flat top ingot adapted also to be utilized in carrying out the present invention.

Figure 4 is an end view of the ingot shown in Figure 3.

Figure 5 is a diagrammatic view illustrating the rolling forces effective during the carrying out of the present method.

Heretofore in the art it has been customary to roll ingots by engaging substantially the end of the ingot so that the rolls tend to have a displacing effect on the metal at the end of the ingot to form ears due to stretching the metal at or adjacent the rolls beyond that in the center of the ingot, and if an ingot is rolled on all sides, the ends tend to become cupped.

This cupping action may be due to several conditions, one of which is that it is customary to permit the initial engagement of the blooming rolls to occur at the end of the ingot thereby pulling or drawing the metal adjacent the roller engagement and this drawing or pulling takes place to a depth of the metal which is equal to the effective penetration into the hot metal of the pressure and drawing forces exerted by the rolls. The pressure forces may be resolved into forces acting substantially radially of the rolls and becoming maximum at the plane adjoining the axis of the ingot and just prior to the tangent where the reduced portion of the ingot leaves the rolls. The drawing forces may be considered as acting in directions substantially circumferential of the rolls and in the direction of their rotation. The resultant of these combined

forces is an extrusion force which elongates the metal. While the extrusion force is sustained throughout the complete cross-section of the metal between the rolls it is effective only for a predetermined depth dependent upon the plasticity of the ingot due to the degree to which it has been heated and the amount of reduction of the ingot in cross-section by the rolls. Where these ears occur, as has been common in the art, it is necessary that the ends of the blooms be cropped. This cropping is not due to any fault of the metal so therefore perfectly good metal is cut away as scrap and an additional and troublesome step is introduced in the manufacture of the steel articles.

The present method of rolling or treating ingots obviates the difficulties of the known prior art by causing the initial engagement of the rolls to occur at a point back of the end of the ingot so that the resultant extrusion forces are absorbed in the surrounding metal during the initial rolling in such manner to elongate the end of the ingot without producing the undesired ears. The end of the ingot may be either of a size which is substantially the final size to which the ingot is to be rolled, or the end may be of such size that the resultant extrusion forces from the upper and from the lower roll meet so that the complete area of the end of the ingot is active under forces which move forward the metal in the entire end without producing the ears or cupped effect.

In carrying out this method the ingot or billet is heated to a predetermined temperature to render the metal sufficiently plastic so that in rolling the metal the amount, or depth, of reduction relative to the end dimensions of the ingot will be such as to cause the extrusion forces to be active over the total end area to move the end surface substantially uniformly relatively to the body of the ingot.

Figure 5 is a diagrammatic view which illustrates the action of certain of the forces during the blooming or rolling operation and shows the ingot in slightly exaggerated form wherein a greater degree of reduction in thickness is illustrated than takes place in practice. This is done in order to more clearly illustrate the forces. The rolls 1 and 2 rotate in the direction of the arrows A and B and direct pressure forces are radial as illustrated by the groups of arrows C and D. The length of these arrows is intended to illustrate the depth of effective displacement or extrusion pressure which is greatest between the rolls and just prior to the tangent point where the reduced portion E of the ingot leaves the rolls. The curved arrows F and G indicate the drawing forces set up in the ingot H because of the rotation of the rolls 1 and 2. The resultant of the several forces is an extrusion in the di-

rection of the arrow J which tends to elongate the ingot H in the manner desired. Where the effective forces between the rolls meet as illustrated by the arrows C and D Figure 5, then the reduction takes place without seriously distorting the end surface K.

Figures 1 and 2 illustrate forms of the ingot adapted for use in carrying out this method. The end portions 4 and 5 substantially taper in all directions toward the end areas 6. These end areas are so proportioned to the cross-section of the body 7 of the ingot that the initial contact, and also the initial departure of the blooming rolls occurs back of the ends and as the ingot is reduced in size this initial point of contact moves toward the end until finally the rolls contact adjacent the end portions. The area of the ends however, is of such size that the resultant forces which produce the extrusion force J penetrate the full depth of the metal so that the full cross-section of the metal is substantially uniformly affected by these forces, and the rolling may then continue without serious distortion of the end areas thereby obviating cropping. Figures 3 and 4 illustrate a form of the ingot wherein the top portion 8 is flat, the sides are curved inward as at 9 and 10 and the bottom is curved as at 11. The upward curve 11 is equal to the summation of the curves 8 and 10 on the sides so that the total amount of reduction is such that the planes parallel to the end and intersecting the ingot will maintain a cross-sectional area of the same shape as the end section.

Where the ingot used is cast in a chill mold the chilling is uniform around the ingot and the zones L of chill or iso-crystallization will in a general way follow the shape of the ingot with the last zone to freeze being the middle of the ingot. However, since the ends of the ingot are of less cross-sectional metal mass than the body portion, the chill will be deeper at the ends as at M than in the middle of the ingot. When rolling, these hardened end portions are less yielding than the body portion and this also is a factor tending to prevent ears or cupped ends when rolling.

It is to be understood that the shapes shown are merely illustrative and that the present invention may be practiced by using shapes other than those specifically shown. Having thus described my invention, what I claim is:

1. The method of rolling ingots to avoid ears or cupped ends on the same which comprises providing an ingot having predetermined end dimensions, and predetermining the heat of the ingot and the depth of reduction relatively to the said end dimensions to cause the effective extrusion forces to be active over the total end area to move

the end surface substantially uniformly relatively to the body of the ingot.

2. The method of rolling ingots to avoid ears or cupped ends on the same which comprises providing a ingot having a body portion and relatively smaller predetermined end dimensions, and predetermining the heat of the ingot and the depth of reduction relatively to the said end dimensions to cause the effective extrusion forces to be active over the total end area to move the end surface substantially uniformly relatively to the body of the ingot.

3. The method of rolling ingots to avoid ears or cupped ends on the same which comprises providing an ingot having chilled end portions, and predetermining the heat of the ingot and the depth of reduction relatively to the area of said end portions to cause the effective extrusion forces to be active over the total end area to move the end surface substantially uniformly relatively to the body of the ingot.

4. The method of rolling ingots to avoid ears or cupped ends on the same which comprises providing an ingot having predetermined end dimensions, and predetermining the heat of the ingot and the depth of reduction relatively to the said end dimensions to cause the effective extrusion forces when the same are delivered to any part of the end area to be active over the total end area to move the end surface substantially uniformly relatively to the body of the ingot.

5. The method of rolling ingots to avoid ears or cupped ends on the same which comprises providing an ingot having tapered truncated ends, predetermining the heat of the ingot and the depth of reduction relatively to the area of the truncated ends, initially engaging the ingot remote from the end, and moving the place of engagement toward the end during subsequent passes, whereby when the truncation is reached the effective extrusion forces will be active over the total end area to move the end surface substantially uniformly relatively to the body of the ingot.

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