April 20, 1926. 1,581,512

R. G. COATES

METHOD OF MAKING ARTICLES FROM STEEL INGOTS

Filed August 25, 1920 2 Sheets-Sheet 1

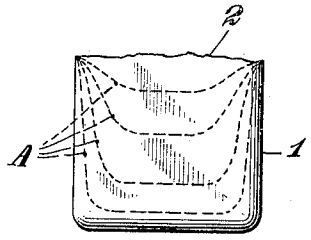


Fig. 1.

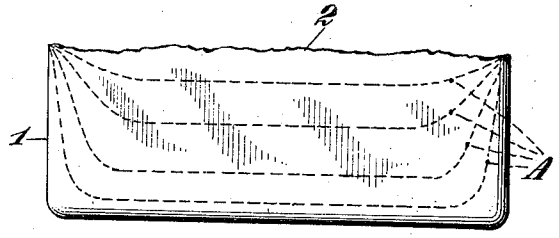


Fig. 2.

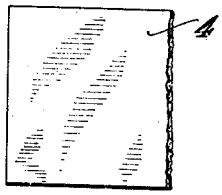


Fig. 3.

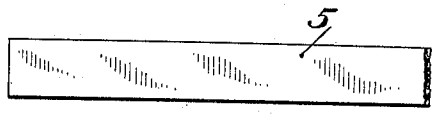


Fig. 4.

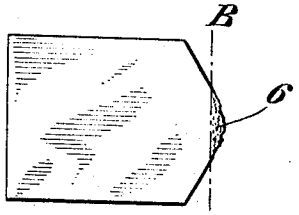


Fig. 5.

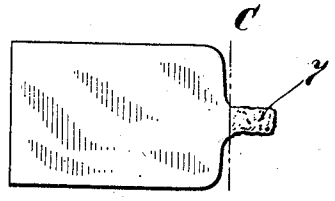


Fig. 6.

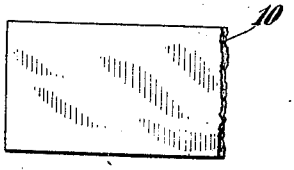


Fig. 7.

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April 20, 1926. 1,581,512

R. G. COATES

METHOD OF MAKING ARTICLES FROM STEEL INGOTS

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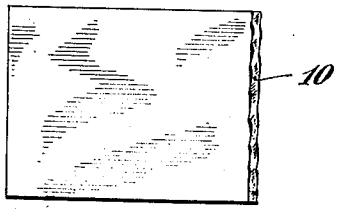


Fig. 8.

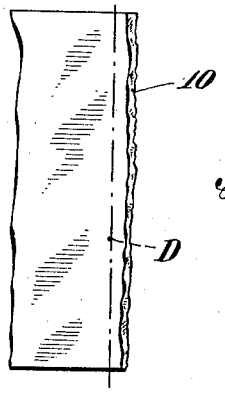


Fig. 9.

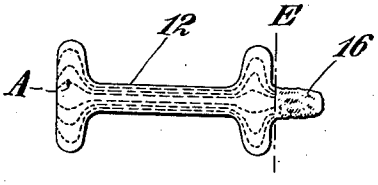


Fig. 10.

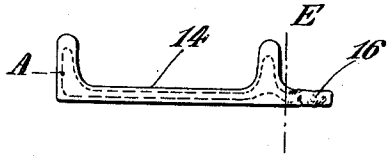


Fig. 11.

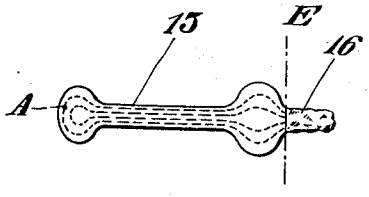


Fig. 12.

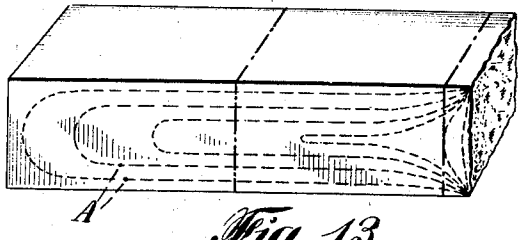


Fig. 13.

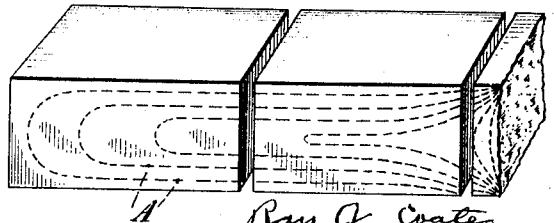


Fig. 14.

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Inventor

By George Ramsey
Attorney

Patented Apr. 20, 1926. 1,581,512

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 MAKING ARTICLES FROM STEEL INGOTS.

Application filed August 25, 1920. Serial No. 405,976.

To all whom it may concern:

Be it known that I, RAY G. COATES, a citizen of the United States, and a resident of the city of Pasadena, in the county of Los Angeles, State of California, have invented new and useful Improvements in Methods of Making Articles from Steel Ingots, of which the following is a specification.

This invention relates broadly to metallurgy and more particularly to the method of treating steel ingots in making articles of manufacture, and the article resulting from the treatment.

The principal object of the present invention is the method of treating a steel ingot to elongate the same while maintaining the upper portion of the ingot in a definite part of the elongated mass and then severing such upper portion as scrap.

A still further and important object of the present invention is the method of fabricating articles from a steel ingot which comprises rolling or forging the article to a shape approximating the final form and maintaining the metal from the top portion of the ingot in an extended protuberance or fin which may be cut away as scrap.

A still further and important object of the present invention is the method of fabricating steel articles which comprises producing an elongated ingot having cupped zones of iso-crystallization extending toward one side of the ingot, forging or rolling the ingot to maintain such cupped zones crosswise of the shape so that zones of iso-crystallization extend lengthwise of the metal mass as longitudinal transverse laminations or zones.

Another and important object of the present invention is an article of manufacture comprising a fabricated shape of steel with iso-crystallization zones extending lengthwise of the shape as blended laminations.

Other and further objects of the present invention will in part be obvious and will in part be pointed out hereinafter by reference to the accompanying drawings wherein like parts are represented by like characters throughout the several figures thereof.

It is realized that the present invention may be carried out by departing from the specific description herein but without departing from the spirit of the invention so therefore it is to be understood that the descriptive matter herewith is to be considered as illustrative and not in the limiting sense.

Figure 1 is a diagrammatic view illustrating an elongated ingot which has been cast in an elongated mold and showing an end view thereof with crystallization zones diagrammatically indicated by dotted lines.

Figure 2 is a view illustrating the side of the ingot shown in Figure 1;

Figure 3 is an end view of the ingot shown in Figure 1 after it has been rolled on four sides, and illustrating the rough top as being one side;

Figure 4 illustrates further rolling of the ingot to form a slab and showing the rough top maintained at the edge;

Figure 5 illustrates the shaping of the ingot to form a bloom with the rough top in a marginal part of one side;

Figure 6 is a view similar to Figure 5 showing the bloom further developed with the marginal top isolated at one side.

Figure 7 is a plan view of a slab with the rough top on one edge;

Figure 8 illustrates a further rolling of the slab;

Figure 9 illustrates cutting the rough edge from a sheet;

Figure 10 is a view illustrating an intermediate step in rolling an I-beam shape and illustrating the zone of crystallization by dotted lines and showing the rough top rolled into a protuberance or fin;

Figure 11 is a view similar to Fig. 10 showing an intermediate shape for channel bar;

Figure 12 is a view similar to Figure 11 and showing a different shape; for example, a continental rail;

Figure 13 illustrates the method of cutting a bloom to take advantage of segregation;

Figure 14 illustrates a bloom or slab cut in accordance with the lines indicated in Figure 13.

Heretofore in the art it has been customary to cast ingots in vertical molds and cut off the top portion thereof and then treat the remaining portion by rolling or hammering without respect to the relation of any part of the ingot bears to the part of the fabricated article. In view of the fact that an ingot cast in a vertical mold separates or segregates on zones which are concentrically

symmetric relative to the axis of the mold it follows that the upper end of the ingot contains more metalloid content than the lower end and the fabricated articles made from such an ingot are not uniform in metal content at the cross sections taken at opposite ends of a long piece, like a railroad rail.

The present method provides for fabricating articles of manufacture with reference to the zones of crystallization in the steel so that cross-sections through the fabricated articles will be substantially uniform as to metal content, throughout the length of the article. While the invention may be practised with various types of ingots, it is particularly adaptable to ingots cast horizontally with one long side forming the top of the ingot. In casting this type of ingot it is frequently difficult to prevent "wild" metal from raising the top of the ingot, which produces a rough surface which is hard to reduce to a satisfactorily finished surface under the rolls. In accordance with the present invention the ingot is rolled or hammered in such manner that the part containing the "rough top" will become some prearranged marginal part of the intermediate or finished product so that this prearranged marginal part may be sheared off or cut off from the shape so as to leave the finished shape as desired and of good clear metal. In rolling ingots in accordance with this method it is necessary to keep track of the top surface or deleterious metal of the ingot until the bloom, slab, or other shape has been so formed as to make the position of the "rough top" part thereof easily identified and isolated so that it may be cut off by longitudinal shearing rollers or by special shears, by trimming the intermediate shape, or by trimming the plates after the slabs have been rolled into plates or otherwise. The longitudinal shearing preferably is done while the metal is hot and before the final passes through the rollers so that the final passes or run may smooth up the cut and leave the sides of the shape with good surfaces.

Ingots which are cast longitudinally permit the metal to slightly segregate in cupped zones while the metal is cooling. There appears to be a tendency for the metalloids such as sulphur, phosphorus, carbon etc., to be expelled in certain proportions from the steel as it cools. In view of the fact that the steel cools from the bottom and sides of the chill mold in the form of cupped zones, which cups contain the molten steel that has not as yet chilled, the freed metalloids accumulate in the metal last to freeze. Therefore the upper portion of such elongated ingot contains an increasing percentage of these elements as the top surface is approached. In view of the fact these elements are lighter than the metal, gravity also has a tendency to cause these elements to rise in the metal. Furthermore, pure iron chills or freezes at a higher temperature than iron containing carbon so consequently the portion containing the least amount of carbon tends to chill first and the effect of the chill is to push a little more carbon into the liquid part left. This action reduces the fusion point and lowers the crystallization point since the action is traveling away from the solidifying metal, and as the metal continues to freeze the action progresses so that segregation gradually takes place from the bottom side of the ingot to the top side thereof. It appears to happen that the segregation of the carbon, sulphur and phosphorous go along together probably because they act in accordance with similar laws rather than the effect of one upon the other. This action tends to reduce piping in the elongated type of the ingots and produces zones of different saturation as to these materials as zones of segregation in the ingot whereby by cutting the ingot with reference to these zones different characters of steel may be obtained.

Referring to the drawings, Figures 1 and 2 illustrate end and side views respectively of an alongated ingot 1 which is formed with five chilled sides and with the top side non-chilled. Since the top side is the side through which gases have escaped from the ingot while it is cooling it sometimes happens that the top side is rough as at 2. In this type of ingot blended cupped zones A of iso-crystallization are formed. These zones are ordinarily not definitely defined but if the crystallization or freezing of the ingot where stopped at intervals and the molten metal poured out the remaining frozen portion would be of the form indicated by the dotted lines. It will be noted that the shape of the cups gradually flattens toward the top of the surface and therefore it follows that the major selective portions of the zones are defined by the bottoms of the cups so that mechanical separation may be resorted to, to divide out any desired portion of the metal.

Figures 3 and 4 illustrate end views of blooms or slabs 4 and 5 in which the rough surface is worked to one side;

In Figures 5 and 6 which represent end views of the blooms, the rough tops 6 and 7 are worked into marginal portions adapted to be cut away as on lines B and C.

Figures 7, 8 and 9 indicate plan views of slabs being rolled into plates and illustrating the rough tops 10 on one edge of the plates and being adapted to be cut away as scrap on the line D of Figure 9.

Figures 10, 11 and 12 illustrate shapes 12, 14, 15 rolled with protuberances or fins 16, in which protuberances the rough top sur-

face has been rolled so that by cutting away these protuberances on lines E the scrap material contains the undesirable portion of deleterious metal.

Figures 13 and 14 illustrate the cutting of a bloom or slab with reference to the cup shaped zones so that the pieces of material segregated by the cuts contain the desired percentages of steel and metalloids, etc., which are wanted for the fabrication of particular articles.

By referring to Figures 10, 11 and 12 it will be noted that the zones A are rolled into the shapes in such manner as to extend transversely of the shapes with the open sides of the zones being toward one side of the shape. In shapes which are rolled from billets cut from sections of an ingot the zones may extend entirely across the shape in such manner that the zones are inseparable areas of blended laminations in the fabricated shape as is illustrated in Figure 10. By treatment of the steel in the manner and in accordance with the method herein disclosed only a relatively small portion need be cut away as scrap and thus a great saving is effected, and the product is improved in that the cross-sections are uniform through the length of a shape. Furthermore, the zones of iso-crystallization are uniformly distributed, thereby greatly increasing the homogeneity and strength of the finished product.

The foregoing method primarily is intended to be practiced in conjunction with the ingot and metnod of making same disclosed in my U. S. Patent 1,327,987, Jan. 13, 1920, although it will be clear that the present method may be used to reduce the loss by scrap of such ingots as are cast in vertical molds. This is particularly true of ingots which are cast in vertical molds, and which ingots have one long side imperfect due to a defective mold, lamination, cold shuts, etc., caused by metal overflowing into the space left between the mold and the ingot due to mold expansion or other side flaws in the ingot. In rolling ordinary vertically cast ingots in accordance with the present invention surface improvement is more particularly the object to be attained.

Having thus described my invention, what I claim is:—

1. The method of fabricating an article of manufacture from a steel ingot, which comprises producing an intermediate shape directly from the steel ingot without cropping the ingot and maintaining the metal of the portion of the ingot which was last to solidify in a predetermined extended part constituting an irregular portion of the elongated mass, separating the irregular portion from said intermediate shape as scrap and then fabricating the article from the remaining portion of the mass from which the scrap has been separated.

2. The method of preparing steel in an ingot for fabrication into articles of manufacture which comprises, maintaining the defective part of the ingot which formed the top thereof in a narrow side portion of the steel mass during the formation of an intermediate shape, and cutting away such portion as scrap from the intermediate shape before the final shaping of the metal into the article of manufacture.

3. The method of fabricating an article of manufacture from a steel ingot which comprises rolling the steel ingot into an intermediate shape with the deleterious portion of the ingot in a marginal flange not intended to be a part of the final shape, separating said flange containing said deleterious portion from said mass as scrap, and fabricating said article from the remaining portion of the mass.

4. The method of fabricating an article from a horizontally cast steel ingot having a longitudinally extending defective surface portion, which comprises rolling the ingot in a direction substantially parallel to the direction in which said defect extends compressing said defective portion into a narrow longitudinal extension, and subsequently removing the said defective portion by severing said extension.

5. The method of fabricating an article from a horizontally cast steel ingot having a longitudinally extending defective surface portion, which comprises rolling the ingot and maintaining the defective portion in a longitudinally extending marginal part of the ingot during such rolling operation, and subsequently removing the said defective portion by severing said marginal part.

6. The method of making articles of steel from an ingot having deleterious material on one side thereof, which method comprises working the metal into an intermediate shape and maintaining the deleterious material in an extended marginal portion of the intermediate shape; cutting away the deleterious mass; and finishing the remaining mass into a finished shape.

7. The method of making steel articles which comprises rolling a horizontally cast steel ingot into an intermediate shape with the metal comprising the top portion of the ingot being rolled into a marginal zone and with the remaining portion of the intermediate shape comprising zones of substantially homogeneous crystallization; and cutting away the marginal portion of the intermediate shape comprising the metal from the top of the ingot.

RAY G. COATES.