No. 694,618. Patented Mar. 4, 1902.

S. A. COSGRAVE.

COMPOUND INGOT.

(Application filed Jan. 23, 1900.)

(No Model.)

FIG. 1.

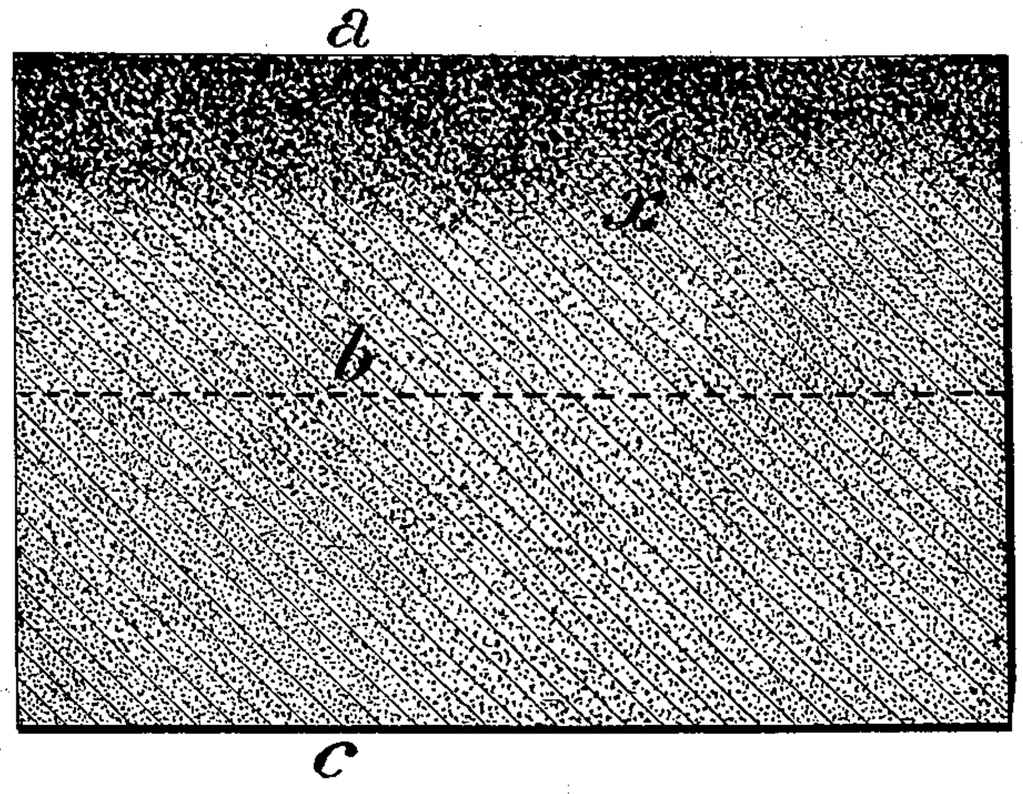
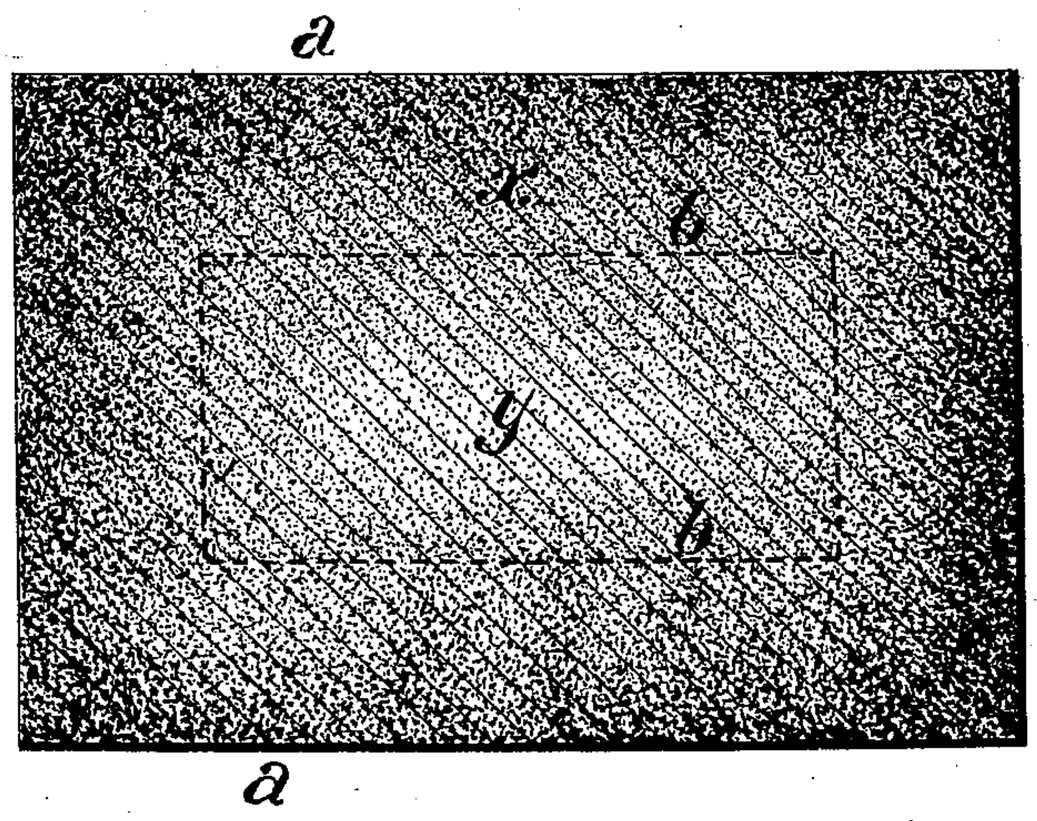


FIG. 2.



WITNESSES:

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SYLVESTER A. COSGRAVE, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DARWIN S. WOLCOTT, TRUSTEE, OF SEWICKLEY, PENNSYLVANIA.

COMPOUND INGOT.

SPECIFICATION forming part of Letters Patent No. 694,618, dated March 4, 1902.

Application filed January 23, 1900. Serial No. 2,456. (No specimens.)

To all whom it may concern:

Be it known that I, SYLVESTER A. COSGRAVE, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered certain new and useful Improvements in Compound Ingots, of which improvements the following is a specification.

The invention described herein relates to certain improvements in what is known in the art as a "compound" ingot—*i. e.*, an ingot having varying percentages of carbon in different parts thereof.

It has been characteristic of the compound ingots heretofore produced that there is a sharp and well-defined line of division between the two grades or kinds of metal forming the ingot. The line of division is due to the methods employed in the manufacture of ingots. These methods while differing in small details can be generally classified under two heads. One method consists in casting the two grades of metal on opposite sides of a thin metal plate, the integrity of which is destroyed by the molten bodies of metal. The other method consists in casting one body of metal in a mold having a movable wall, which is withdrawn as soon as the first body of metal has hardened sufficiently to preserve its shape and the other body of metal cast against the exposed face of the first body. In the practice of this method the molten metal in contact with the movable wall becomes chilled and solidified, forming a thin metal wall, which is so softened when the second body of metal is cast against it as to permit a welding of the two bodies together. It is characteristic of both of these methods that between the two bodies of metal is interposed a solid metal wall, which although it may be melted and its integrity destroyed will retain its integrity for a sufficient length of time to prevent an interchange of chemical and physical characteristics between the two bodies of metal. It is probable that the thin metal plate or sheet employed in the practice of the first method introduces a foreign element, which although the sheet is destroyed would prevent the interchange of characteristics, and in the second method it is probable that the surface exposed on the withdrawal of the movable wall becomes oxidized or otherwise chemically changed, and thereby prevents the desired interchange of characteristics.

While the sharp definite separation of the two bodies of metal characteristic of compound ingots heretofore produced may be due to causes other than those stated, such demarcation or stratification of the metals always occurs. This stratification of the metals is not especially detrimental when the articles formed therefrom are not subjected to excessive strains, but is fatal when the article, such as armor-plate formed from such a compound ingot, is subjected to excessive strains. Under such conditions the two metals separate along the plane of stratification.

The invention described herein consists, generally stated, in an ingot formed of two bodies of metal so united that there will be a gradual change of characteristics from one body to the other.

In the accompanying drawings, forming a part of this specification, Figure 1 is a sectional plan view of a compound ingot wherein its characteristics gradually or decrementally change from one side to the other, and Fig. 2 is a similar view of an ingot wherein the characteristics change gradually from the outer surfaces to the center.

The ingot forming the subject-matter of this case may be produced in several ways—as, for example, in the manner described in Letters Patent Nos. 638,908 and 638,961, dated December 12, 1899, or in the manner forming the subject-matter of application, Serial No. 2,455, filed January 23, 1900.

The method described in the Letters Patent referred to consists, generally stated, in casting one body of metal—*e. g.*, high-carbon steel—in a mold having a movable wall, removing said wall and causing another body of metal, as low-carbon steel, to flow up along the exposed surface of the first body, and thereby melting the thin skin formed on the first body, and allowing the two molten bodi[es] to come together without agitation or [dis]turbance. In order to protect the sur[face]

the first body as against any elemental change which would tend to prevent the amalgamation of the adjacent portions of the two metals, the surface of the movable mold-wall against which the first body is cast is covered or coated with a material which will prevent any elemental change of the metal of the first body or will reconvert the portions of the first body elementally changed.

In the method described in the application referred to both bodies of metal are cast on opposite sides of a movable partition, which is gradually withdrawn as the casting proceeds. In the practice of this method it is preferred that the exposed surfaces of the partition should be formed of a material which will prevent elemental change in the metals cast or will reconvert any elementally-changed metal. By either of these methods two qualities or grades of metal, as high and low carbon steel, are brought together under such conditions that while certain portions of each grade will be unchanged, or practically so, there will be an interchange of qualities from one to the other such as to result in a gradual merging from the high carbon of one to the low carbon of the other and without any definable or ascertainable line of cleavage or demarcation between the strata or layers. The gradual or decremental change from one body or quality to the other is clearly shown in the cross-sections of ingots as actually made. The lines *a b* represent approximately the thickness of the stratum or layer forming the high-carbon body, and the lines *b c* in Fig. 1 or *b b* in Fig. 2 represent approximately the thickness of the stratum or layer forming the soft-metal body as these bodies or strata were proportioned in that casting. As the exterior walls of the ingot became rapidly solidified and as it is desirable that the surfaces should be unchanged, I found that in the particular case here illustrated the interchange or interdiffusion of the properties of the two qualities of steel thus employed existed substantially between the points *x* and *y*—that is to say, in consequence of the interdiffusion referred to the steel gradually changes or becomes reduced in carbonization from the points *x* to the points of lowest carbon, which in Fig. 2 would be the center of the ingot, as at *y*, but in Fig. 1 would be at one side of the ingot—and this I have found to be the case generally throughout the compound ingot—that is, through other planes or sections; but in thus illustrating the peculiar features of the present invention I do not wish to limit myself to any specific depth or extent of interdiffusive action, provided only a hard outer surface or wall is preserved of the desired thickness and from the inside of such wall there shall be a gradual and progressive change in the carbonization such as to exclude the presence of any well-defined line or plane of demarcation or cleavage, and such an ingot, for the purposes of the present invention, I would term a "decrementally-carbonized ingot."

I claim herein as my invention—

1. A homogeneous cast ingot, having at the end of the casting operation a substantial portion or layer of one kind or grade of metal, another substantial portion or layer of a different kind or grade of metal, and a substantial portion or layer intermediate of the others wherein the characteristics of the two metals merge gradually and equally into each other, said portions or layers being parallel or approximately parallel to each other, substantially as set forth.

2. A homogeneous cast ingot, having at the end of the casting operation, a substantial portion formed of a steel of a certain carbonization, another substantial portion or layer formed of a steel having a different degree of carbonization and a portion intermediate of the other portions wherein the carbonization changes gradually or decrementally and with substantial regularity from one layer to the other, said portions or layers being parallel or approximately parallel to each other, substantially as set forth.

3. A homogeneous casting ingot having at the end of the casting operation a substantial stratum or layer approximately uniform in thickness formed of steel of a certain carbonization, and another substantial stratum or layer approximately uniform in thickness formed of steel having a different degree of carbonization, and a stratum or layer intermediate of the other two, decrementally carbonized from one stratum or layer to the other, substantially as set forth.

In testimony whereof I have hereunto set my hand.

SYLVESTER A. COSGRAVE.

Witnesses:

DARWIN S. WOLCOTT,

F. E. GAITHER.