

UNITED STATES PATENT OFFICE

2,249,336

METHOD FOR PRODUCING ALLOYS

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No Drawing. Application August 3, 1940,
Serial No. 351,127

4 Claims. (Cl. 75-127)

This invention relates to metallurgy and has for an object the provision of certain improvements in processes for mixing metals. More particularly the invention contemplates the provision of an improved method of incorporating alloy metals in molten bodies or baths of base metals. A further object of the invention is to provide an improved method of forming chromium alloys by incorporating chromium in molten bodies or baths of base metals such, for example, as iron and steel.

According to some heretofore customary practices, metallic alloys, or mixtures of metals, are formed by mixing together the various components of the alloys sought to be produced. The various components all may be solid, all may be molten, or one or more may be solid and the remainder molten, when mixed initially. The mixture is heated to a temperature or maintained at a temperature such that all components become or remain molten and sufficiently fluid to permit thorough mixing with the production of a substantially homogeneous product. Thorough mixing with the production of homogeneous products is difficult and expensive to accomplish, particularly when high-melting point components such as chromium are employed.

It has been proposed also to incorporate alloy metals in bodies or baths of molten base metals by placing on the surfaces of the molten bodies or baths of base metals in ladles and furnaces exothermic reaction mixtures capable of reacting upon ignition to produce molten alloy metal of the type sought to be incorporated in the base metal. This procedure can be employed effectively to produce substantially homogeneous products, but recoveries of the alloy metals contained in the exothermic reaction mixtures may be low because of the presence in the ladles or furnaces of slags which interfere with the reactions. Low and unpredictable recoveries complicate the problem of producing alloys according to specification and result in losses in money and efficiency because of spoiled heats and alloy metal waste.

The present invention is based on my discovery that exothermic reaction mixtures may be employed effectively to incorporate alloy metals in base metals by placing the mixtures in suitable receptacles and pouring the molten base metals into contact with the mixtures and through molten slag products formed by reaction of the mixtures.

In a preferred process of my invention, I employ an exothermic reaction mixture comprising

solid components capable of reacting upon ignition (through contact with molten base metal, for example) to produce molten metal of the type sought to be incorporated in a molten body or bath of base metal. A reaction mixture employed may be of a type capable of producing by reaction any metal in the molten state suitable for mixing with a body or bath of base metal. The exothermic reaction mixtures may contain the alloy metals in the elemental or metallic state, in the form of reducible compounds or partly in the elemental or metallic state and partly in the form of reducible compounds. Exothermic reaction mixtures containing alloy metals in the elemental or metallic state also will contain oxidizing material and reducing material capable of reacting to generate sufficient heat to melt the alloy metal. Exothermic reaction mixtures containing reducible compounds of alloy metals will contain oxidizing material and reducing material capable of reacting with the oxidizing material and the reducible metal compounds to reduce the metal compounds to metal and generate sufficient heat to melt the reduced metal and any other metal present in the mixtures. Oxidizing agents include, for example, sodium nitrate, sodium chlorate and chromates and dichromates of sodium and calcium. Reducing agents include, for example, carbon, silicon, aluminum and various silicides such as silicides of aluminum, calcium and magnesium. Reaction mixtures suitable for use in carrying out the method of the invention for the production of chromium alloys are described in my Patent No. 2,176,688 and in my copending application, Serial No. 301,375, filed October 26, 1939 which has matured into Patent No. 2,243,783. Upon ignition, reaction mixtures employed in carrying out the method of the invention react to produce molten slag and molten metal. Reduction or melting or reduction and melting proceeds as long as the components of the reaction mixtures remain in effective contact with one another and with the molten base metal.

The improved method of the invention preferably involves the relatively gentle pouring of molten base metal from a furnace or other container into contact with the exothermic reaction mixture in a suitable ladle or other receptacle and through the molten reaction mixture or slag produced upon ignition of the reaction mixture. Preferably, pouring of the molten base metal is so conducted that a gently boiling mass of metal is produced beneath the molten reaction mixture or slag during the pouring operation

without causing substantial rupturing of the layer of molten reaction mixture or slag. The boiling effect causes effective and repeatedly renewed contact of substantially all portions of the molten metal with the under surface of the molten reaction mixture or slag layer, while avoidance of substantial rupturing of the molten reaction mixture or slag layer effectively prevents exposure of the molten metal to oxidation by the oxygen of the atmosphere. The repeatedly renewed contact of substantially all portions of the molten base metal with the under surface of the molten reaction mixture or slag layer results in a wide and thorough dissemination of the molten alloy metal produced throughout the body of base metal. As pouring proceeds, reactions within the mixture proceed to completion, leaving a molten slag which may serve as a protecting and purifying slag for the molten alloy produced. The boiling effect with the repeatedly renewed contact of base metal with the molten reaction mixture or slag insures effective reacting contact of all reagents including contact of all silicon and similar reagents which may become dissolved and dispersed in the molten base metal with oxidizing material contained in the molten reaction mixture or slag layer.

The following examples illustrate the advantages of the process:

Example I

A reaction mixture comprising reducible chromium and iron compounds and silicon and capable of reacting exothermically upon ignition to produce molten ferrochromium was employed in amounts calculated to produce low-carbon steel containing chromium in the range 0.85% to 1.05% by placing the reaction mixture on the surface of a molten bath of steel in a furnace in one operation and by placing the reaction mixture in a ladle and pouring steel of the same composition into contact with it in accordance with the invention in another operation.

The product formed in the furnace operation contained 0.54 percent chromium, and the product formed in the ladle operation in accordance with the invention contained 0.97 percent chromium.

Example II

A reaction mixture comprising reducible chromium and iron compounds and silicon and capable of reacting exothermically upon ignition to produce molten ferrochromium was employed in amounts calculated to produce high-carbon steel containing chromium in the range 0.90% to 1.10% by placing the reaction mixture on the surface of a molten bath of steel in a furnace in one operation and by placing the reaction mixture in a ladle and pouring steel of the same composition into contact with it in accordance with the invention in another operation.

The product formed in the furnace operation contained 0.67 percent chromium, and the product formed in the ladle operation in accordance with the invention contained 1.05 percent chromium.

Example III

A reaction mixture comprising high-carbon ferro-chromium, silicon and sodium nitrate (of the type described and claimed in my copending application Serial No. 301,375, filed October 26, 1939) and capable of reacting exothermically upon ignition to produce molten ferrochromium was employed in an amount calculated to pro-

duce spring steel containing chromium in the range 1.00% to 1.20% by placing the reaction mixture in a ladle and pouring steel into contact therewith in accordance with the invention. The product formed contained 1.07 percent chromium.

The method of the invention is particularly suitable for use in the production of relatively low-chromium iron and steel alloys such as those containing chromium in the range 1.00% to 1.20% and those containing chromium in the range 4.00% to 6.00%. The method of the invention may be employed advantageously also in the production of chromium and other alloys containing greater and lesser amounts of alloy metal than those indicated because of the high speed of reaction accomplished. The method of the invention may be employed advantageously in the production of alloys of all compositions in the production of which the volume of slag produced by reaction does not interfere with efficient operation.

I claim:

1. In a method of producing alloys in which molten base metal to which an alloy metal is to be added is contacted with a reaction mixture capable upon ignition of reacting exothermically to produce molten alloy metal and molten slag, the improvement which comprises placing the reaction mixture in a suitable receptacle, pouring the base metal into the receptacle into contact with the reaction mixture and producing by igniting the reaction mixture a molten bath comprising molten metal beneath a layer of molten slag, and controlling the pouring to produce a gently boiling mass of metal beneath the layer of molten slag produced upon ignition of the reaction mixture without causing substantial rupturing of the layer of molten slag.

2. In a method of mixing metals in which molten metal is contacted with a reaction mixture capable upon ignition of reacting exothermically to produce molten metal and molten slag, the improvement which comprises placing the reaction mixture in a suitable receptacle, pouring the molten metal into the receptacle into contact with the reaction mixture and producing by igniting the reaction mixture a molten bath comprising molten metal beneath a layer of molten slag, and controlling the pouring to produce a gently boiling mass of metal beneath the layer of molten slag produced upon ignition of the reaction mixture without causing substantial rupturing of the layer of molten slag.

3. In a method of producing a ferrous metal alloy containing chromium in which molten ferrous metal to which the chromium is to be added is contacted with a reaction mixture capable upon ignition of reacting exothermically to produce molten metallic chromium and molten slag, the improvement which comprises placing the reaction mixture in a suitable receptacle, pouring the molten ferrous metal into the receptacle into contact with the reaction mixture and producing by igniting the reaction mixture a molten bath comprising molten metal beneath a layer of molten slag, and controlling the pouring to produce a gently boiling mass of molten metal beneath the layer of molten slag produced upon ignition of the reaction mixture without causing substantial rupturing of the layer of molten slag.

4. In a method of incorporating chromium in steel in which molten steel is contacted with a reaction mixture capable upon ignition of reacting exothermically to produce molten metallic

chromium and molten slag, the improvement which comprises placing the reaction mixture in a suitable receptacle, pouring the molten steel into the receptacle into contact with the reaction mixture and producing by igniting the reaction mixture a molten bath comprising molten steel beneath a layer of molten slag, and con-

trolling the pouring to produce a gently boiling mass of molten steel beneath the layer of molten slag produced upon ignition of the reaction mixture without causing substantial rupturing of the layer of molten slag.

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