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METHOD OF PRODUCING ARTICLES OF
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Pa., a corporation of PennsylvaniaNo Drawing. Application March 31, 1937,
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3 Claims. (Cl. 75—22)

This invention relates to the production of shaped articles of Hadfield manganese steel, and consists of a method of procedure whereby articles of this material may be prepared most economically.

Hadfield manganese steel is a steel having a manganese content that ranges from 7 to 20 per cent. and a carbon content of 0.47–2%, and typically has a non-ferrous composition of combined carbon, 1.15%; silicon, 0.551%; manganese, 13.733%; sulphur, 0.043%; phosphorus, 0.091%. (See Harbord & Hall, Metallurgy of Steel, 4 ed. London, 1911, pp. 392–394.) This, as the authors cited say, was, when Hadfield first produced it “for all practical purposes, a new metal.” It “possesses very peculiar hardness both in the cast and forged state, and it is scarcely possible to machine” it. Because of its relatively great hardness, fabrication of particular articles is difficult, and on that account its use for certain articles, for which otherwise it is well suited, has been practically inhibited. An instance is found in the case of a bit for the drilling of wells. Hadfield manganese steel has properties such that a bit formed of it must manifestly be peculiarly serviceable; but the cost of fabrication has been such as to diminish, if not completely to destroy, its availability here. In the practice of this invention shaped articles (of which a bit for drilling wells may be taken as typical) of Hadfield manganese steel may be cheaply produced.

According to preferred procedure, a quantity of iron powder is prepared, and a quantity of manganese powder or of ferro-manganese powder, and these two powders are combined in such ratio as to afford the desired ratio of iron to manganese in the finished product (typically 87:13). Care is taken that the carbon content of the combined powder shall be within the typical range (and this, for the iron-manganese ratio just given, will not greatly exceed 1%). To such end, the iron that is reduced to powder will preferably be, relatively speaking, carbon free, and the carbon content of the manganese or ferro-manganese will be properly limited. While preferably the iron powder will be substantially free of carbon it is permissible to employ a powder having an appreciable carbon content; but in such case the carbon content of the manganese (or ferro-manganese) powder will be such as to afford in the ultimate product no more than the desired carbon content.

When the two quantities of powder have been brought together they are intimately and thoroughly mixed. The body of mixed powder is

then charged into a suitable mold or die and subjected to a pressure of the order of 2000 pounds to the square inch and upward. Under such pressure the body becomes coherent. The shaped and coherent body is then removed from the mold; it is then packed in finely divided alundum or equivalent refractory material, within a suitable tube or boat of carbon or other refractory; and, so packed, it is brought within a furnace whose atmosphere is an atmosphere of hydrogen or other reducing gas to a temperature of 1500°–2000° F. Under such conditions a coalescence or sintering of the compacted material occurs. Alloying, however, does not occur.

When by such procedure the substance of the shaped and coherent but granular article has been caused to coalesce, the article is taken from the furnace, allowed to cool, and is then removed from its packing.

The article is now in the form of a block or brick, and has acquired the condition of integrity, as distinguished from granular condition. An alloying of the component metals has not, however, yet occurred. In such condition of integrity the article may readily be machined, and it is then by appropriate tools brought to the desired ultimate shape. It may at this time and in such condition be otherwise shaped, as by forging, rolling, or die-pressing. In whatever way the shaping be done, the shaped article is packed again as before in a tube or boat, placed again in a reducing furnace, and heated, this time to the higher temperature of 2250°–2650° F., short of the melting-point of iron. At such higher temperature the component metals combine to form the intended alloy. The shape, however, continues. When thereafter the article is removed from the furnace, cooled, and taken from its packing, it will be found to be the desired article—the shaped article of Hadfield manganese steel.

The detailed procedure that has been described is that which I have found to be practical in the production of such an article as a bit for drilling wells, for example.

Instead of beginning with the iron and the manganese in metallic state, I contemplate also the preparation of a pulverized mixture of the oxides of these metals, together with carbon in properly measured quantity; heating the prepared mixture to substantially 1800° F., whereupon the oxides will be reduced; and then proceeding by heat and pressure in such manner as has already been described, with the result that a shaped article of Hadfield manganese steel is produced.

It is permissible to enjoy the invention and to produce a manganese steel, modified by additions up to 20% of one or more of the metals molybdenum, tungsten, chromium, and vanadium; and in such case the appropriate modifying metal, or its carbide, may, in pulverized condition, be included in the initial mixture.

In the ensuing claims I mean to include within the meaning of the terms iron-containing powder and manganese-containing powder powders of substantially pure iron and of substantially pure manganese, as well as powders of iron oxide, of manganese oxide, and of ferro-manganese; and I mean to include within the meaning of the term manganese powder powders both of substantially pure manganese and of ferro-manganese.

I claim as my invention:

1. The method herein described of producing a shaped article of Hadfield manganese steel which consists in effecting intimate mixture of iron-containing and manganese-containing powders, the manganese constituent being 7-20% of the combined metals, effecting under pressure coherence of particles, subjecting the pressed and coherent body while in reducing atmosphere to a temperature of 1500°-2000° F. and in so doing effecting coalescence while the particles continue in unalloyed state, shaping the cold body, and subjecting the shaped body while in reducing atmosphere to a temperature of 2250°-2650° F. and in so doing effecting alloying of the particles within the article of unchanged shape.

2. The method herein described of producing

a shaped article of Hadfield manganese steel which consists in effecting intimate mixture of pulverized iron and a manganese powder, the manganese constituent being 7-20% of the iron constituent, together with carbon present in a quantity not exceeding 2%, effecting under pressure coherence of particles, subjecting the pressed and coherent body while in reducing atmosphere to a temperature of 1500°-2000° F. and in so doing effecting coalescence while the particles continue in unalloyed state, shaping the body, and subjecting the shaped body while in reducing atmosphere to a temperature of 2250°-2650° F. and in so doing effecting alloying of the particles within the article of unchanged shape.

3. The method herein described of producing a shaped article of Hadfield manganese steel which consists in effecting intimate mixture of iron-containing and manganese-containing powders, the manganese constituent being 7-20% of the combined metals, effecting under pressure coherence of particles, subjecting the pressed and coherent body while in reducing atmosphere to a temperature of 1500°-2000° F. and in so doing effecting coalescence while the particles continue in unalloyed state, cooling the body, machining the cold body, subjecting the machined body while in reducing atmosphere to a temperature of 2250°-2650° F. and in so doing effecting alloying of the particles within the article of unchanged shape.

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