Patented Dec. 20, 1932 1,891,889

UNITED STATES PATENT OFFICE

JOHN M. HUGHES AND JOSEPH H. CARTER, OF YOUNGSTOWN, OHIO, AND LEWIS B. PERKINS, OF SHARON, PENNSYLVANIA, ASSIGNORS TO SHARON STEEL HOOP COMPANY, OF SHARON, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

SUBSTITUTE FOR NATURAL FEED ORE

No Drawing. Application filed June 21, 1930. Serial No. 462,926.

During the working of the bath in the production of steel in open hearth furnaces, electric furnaces or the like, it is usual to reduce the carbon content by feeding thereinto at a suitable time before the heat is tapped, material adapted to act as a decarburizer, the quantity of the material utilized depending on the desired amount of carbon reduction, the individual characteristics of the particular bath being worked, and other well known factors. The material ordinarily employed for this purpose, and commercially known as "feed ore", is a natural iron ore containing a relatively high amount of one of the oxides of iron, generally in the form of Fe_2O_3 or, less frequently, Fe_3O_4 or FeO.

At the time this ore is introduced into the furnace, customarily by merely manually throwing it through the charging doors, the metal of the bath is covered to a depth of several inches with a viscous and difficultly penetrable layer of slag, but in order to bring about the proper reactions and consequent decarburizing effect, it is necessary for the feed ore to penetrate this slag and enter the subjacent metal. When the pieces of ore are of sufficient size and weight, this result is readily accomplished but as the pieces become smaller and lighter they increasingly tend to float on or in the slag with corresponding lessening of the decarburizing effect which should theoretically be attained from a given amount of ore.

It is a well recognized fact in the steel industry that progressively greater difficulty is being experienced by consumers in obtaining feed ore in pieces of sufficient size for satisfactory use, a ton of ore as now furnished being ordinarily made up of some large sized pieces and an excessive amount of relatively finely divided material of such character that it is substantially worthless for the purpose for which it was purchased. Whether this is due to increasing difficulty in mining the relatively few sources from which ore suitable for feeding purposes can be obtained or to other causes not under the control of the consumer, the fact remains that while formerly a relatively large proportion of a ton of feed ore could be efficiently used for decarburizing the bath in an open hearth furnace, at present only a comparatively small part thereof can be similarly employed, with the result that the cost of production of the steel is materially increased.

Because of these and other conditions the provision of a substitute for natural feed ore has become of distinct importance in the steel industry but as far as we are aware no commercially satisfactory one has been evolved prior to the present invention.

A principal object of our invention, therefore, is to provide a satisfactory substitute for the natural feed ore heretofore customarily employed for decarburizing the bath in the operation of open hearth furnaces and which may be used similarly and in place of the natural ore with entirely satisfactory and, generally, improved results.

A further object of the invention is the provision of a substitute for the natural ore which is capable of giving a very quick reaction with the bath and which may be prepared in pieces or masses of any size, shape and weight adapted to rapidly penetrate the slag and also convenient for use and of such form as to enhance the speed of the reaction in the furnace by affording a maximum surface for contact with the bath.

A still further object of the invention is to provide a substitute for the natural ore which may be formed from readily obtainable materials, one of which may desirably be a by-product of certain of the operations incident to the manufacture of steel and thus readily available in most steel plants; which, in its preferred embodiment, may be lifted with a magnet for handling and transportation and which, when introduced into the furnace, has no detrimental but, on the contrary, a beneficial effect upon the bath, in addition to its decarburizing action.

Our invention is further advantageous in that the use of our substitute for natural feed ore results in the production of cleaner steel since, when prepared in accordance with the preferred practice, it contains fewer impurities and more iron than the average of the natural feed ores obtainable, while the fact that all of the pieces or masses may desirably

be formed of the same size, shape and weight facilitates determination of the proper amount of the material to be used to effect a given extent of decarburization. Moreover, the material can be manufactured at a cost not exceeding and frequently materially below the cost to the consumer of the natural feed ore, thus enabling it to compete directly therewith on a tonnage basis, even without taking into consideration the losses due to the inclusion, as hitherto explained, of a high percentage of unsatisfactory or unusable ore in each ton of the natural product.

Other objects and advantages comprehended by or incident to our invention are hereinafter more particularly pointed out or will be apparent to those skilled in the art from the following description of one manner of performing it.

In accordance therewith we prepare an aggregate of suitable iron bearing material, which may be in the form of roll or hammer scale, iron ore, or the like, roll scale being preferred, or a mixture of any or all of said materials in any desired proportions, and a binder such as calcium aluminate and calcium silicate cement, Portland cement being ordinarily preferred, although among other suitable binders any natural, slag or hydraulic cement can be utilized or a mixture of any or all of these cements, the proportion of binder to the iron bearing material being preferably from two to twenty-five per cent. by weight, although under certain conditions these limits may sometimes be exceeded. To this mixture we add sufficient water or other liquid to form a mass which may be poured, pressed, rolled or otherwise conveniently formed into shapes or masses which on standing a sufficient length of time will harden or set at least enough to permit convenient handling or transportation. We then mold or otherwise form this plastic or semi-fluid material into the desired shapes or masses which, after being allowed to harden for a suitable length of time, are then ready for employment as a substitute for natural ore in feeding the furnace bath. In order to insure rapid penetration of the slag covering thereof, the shapes or masses into which the plastic or semi-fluid mixture is molded or otherwise formed, and which for convenience we denominate "blocks", are desirably made of sufficient weight and size to readily effect this result, while, additionally, to facilitate the reaction in the furnace they are also preferably so shaped as to afford a large surface area for contact with the bath. These conditions are well fulfilled when the material is molded into cubes measuring approximately one foot on each side, but other shapes of different weights and sizes and either hollow or solid, may be utilized if preferred, it being ordinarily preferable to make the blocks as heavy as can be conveniently handled and thrown into the furnace and with as large a surface area as possible commensurate with suitable adaptability to penetrate the slag.

We have stated that we prefer to utilize roll scale as the iron bearing material and have found that under most conditions the greater the amount of subdivision of the scale, the greater must be the amount of cement combined therewith in order to produce a block or mass of the desired hardness. Therefore, when using very finely divided scale, we prefer to mix the more finely divided scale with the less finely divided as in that way we are enabled to obtain the desired degree of hardness in the block with a proportionately smaller amount of cement. Thus we have found that scale obtained from ordinary blooming mills may be utilized with relatively small amounts of cement, but that obtained from lighter rolling mills requires relatively larger proportions thereof when used alone; it may, however, be mixed in reasonable quantities with the less finely divided scale without necessiating the use of materially greater quantities of cement than would be required if the latter were used alone.

Thus, by way of example, we may prepare a mixture of blooming mill scale in its natural condition, that is, just as it is produced during the rolling operation, and Portland cement in the following proportions: 93% of scale and 7% of cement, by weight. To this we add enough water to enable the mass to be conveniently poured into molds adapted to form cubes measuring approximately 12″ on each side, some tamping or other pressure being preferably employed to assist in consolidatng the material in the molds. The mixture is then allowed to set until it is sufficiently hard to permit removal from the molds without deformation and the molded blocks are then allowed to stand for a further length of time until they attain a degree of hardness adequate to enable them to be transported and handled without breakage. They are then in condition to be fed to the furnace bath either immediately or at any subsequent time, and are of sufficient weight (approximately 220 lbs., the specific gravity of the material being from 3.50 to 3.60) to readily penetrate the slag when they are thrown into the furnace.

Actual analysis of a block formed in this manner showed approximately the following: iron 67.05; phosphorus .021; silica 2.14; manganese .42; alumina .71; lime 4.03; magnesia .27; sulphur .14, while a corresponding analysis on a dry basis of an average of five of the best known commercial natural feed ores showed approximately: iron 59.66; phosphorus .348; silica 7.13; manganese .81; alumina 1.82; lime 2.31; magnesia .90; sulphur .055; loss on ignition 2.63.

It will thus be noted that our substitute

for the natural feed ore is somewhat higher in iron oxide than the natural ore; it also contains some 1% to 2% of metallic iron which was not figured in the foregoing analysis and which enters the bath and adds to the metal thereof, so that the increased efficiency of the substitute based on iron alone is in the neighborhood of 8.3% while the smaller amount of impurities contained therein over the natural ore tends to the production of cleaner steel. Moreover, because of the ability of the large and relatively heavy blocks of the substitute material to penetrate and sink below the slag, a greater decarburizing effect is obtained than with the natural ore even under the best conditions and with less loss ir slag, while the uniformity in the size and weight of the blocks assists materially in determining the proper quantity requisite to attain a desired degree of carbon reduction.

An additional advantage incident to the use of roll scale, or other iron bearing material having its iron oxide in the form of Fe_3O_4, as the predominant ingredient, resides in the fact that the blocks under these conditions are magnetic and can thus be lifted and transported with a magnet, with consequent increase in the convenience and frequently decrease in the cost of handling.

While for the foregoing reasons, among others, we prefer under ordinary conditions to employ roll scale or other like material as an ingredient of our substitute for natural feed ore, we may utilize the natural ore itself if preferred and either cintered or in its natural state, and this will frequently be found advantageous when the natural ore can only be obtained in such finely divided condition as to make it more or less unsuitable for feeding purposes. Moreover, through our invention, a field of use is created for large quantities of finely divided natural ore necessarily produced as an incident to the mining operations, for such ore may profitably be used as the iron bearing ingredient in the production of our substitute for natural feed ore. Of course, as the iron in most natural ores suitable for feeding purposes is in the form of Fe_2O_3, the blocks of which it is the predominant ingredient are non-magnetic and thus incapable of being lifted with a magnet, an advantage possessed by those in which the predominant iron bearing material, such as roll scale, is magnetic as has been pointed out.

Practical use of our substitute for feed ore has demonstrated its entire adaptability for its intended purpose; has materially facilitated the operation of decarburizing the bath and has shown that by its employment in place of the natural feed ore a more rapid reaction may be obtained, the quality of the steel improved, and the other advantages attained to which we hereinbefore referred.

Although we have herein described with considerable particularity, and by way of example only, one manner of performing our invention, we do not thereby desire or intend to in any way restrict or confine ourselves thereto, nor to the use of any specific proportions of the iron bearing and/or cement or other binding material employed as the same are capable of a wide range of variation, while, additionally, any suitable manner or means for forming the plastic or semi-liquid mixture into blocks or other shapes may be utilized as preferred, without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described our invention, we claim and desire to protect by Letters Patent of the United States:

1. A substitute for natural feed ore consisting of a block formed from over 93% by weight of Fe_3O_4 and the balance a binder consisting substantially of Portland cement.

2. A substitute for natural feed ore consisting of a block formed from over 93% by weight of roll scale and the balance a binder consisting substantially of calcium-alumino-silicate cement.

3. A substitute for natural feed ore consisting of a block formed from over 93% by weight of Fe_3O_4 and the balance a binder consisting substantially of calcium-alumino-silicate cement.

4. A substitute for natural feed ore consisting of a block formed from over 93% by weight of roll scale and the balance a binder consisting substantially of Portland cement.

5. A decarburizing medium for molten steel consisting of a block including an aggregate of from 75% to 98% of iron oxide and the balance a binder composed substantially of calcium-alumino-silicate cement.

In witness whereof, we have hereunto set our hands this 19th day of June, 1930.

JOHN M. HUGHES.
JOSEPH H. CARTER.
LEWIS B. PERKINS.