UNITED STATES PATENT OFFICE.

ROBERT B. CARNAHAN, JR., OF MIDDLETOWN, OHIO, ASSIGNOR TO THE INTERNATIONAL METAL PRODUCTS COMPANY, OF NEWARK, NEW JERSEY.

IRON MANUFACTURE.

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To all whom it may concern:

Be it known that I, ROBERT B. CARNAHAN, Jr., a citizen of the United States, residing at Middletown, Butler county, Ohio, have invented certain new and useful Improvements in Iron Manufacture, of which the following is a specification.

The present invention, comprehending the production of an extraordinarily high grade of rolling mill and bloomery iron from comparatively low priced material and by a method characterized by special economy and regular certainty of result, will be readily understood from the following description.

My improved method of manufacture which is a process of elimination from start to finish may be carried out as follows:—

First, employ a high power furnace capable of what might be termed a particularly "fierce" action, by preference a gas fired basic open-hearth furnace.

Second, charge the furnace with pig iron or cast iron or molten iron or other carbon-bearing iron reduced from ore, preferably employing iron whose phosphorus and sulfur and silicon do not aggregate over 3.05 per cent. In practice I have, in cases, substituted iron or steel melting stock or mixed scrap to the extent of 50 per cent. of the charge.

Third, charge lime or limestone to reduce sulfur and phosphorus, the lime or limestone being preferably charged prior to charging the metal.

Fourth, melt the charge and, by the employment of iron ore, refine it as in the operation of the usual process for making mild steel, and, as in that process, the iron ore may be all charged into the molten bath or some of it may be charged prior to or along with the charging of the metal.

Fifth, refine to the stage usual at the point of tapping for high grade mild steel, say .10 to .15 per cent. carbon.

Sixth, thereafter continuously raise the temperature as the carbon becomes reduced, continuing the operation till analysis by bath test shows that the sulfur, phosphorus, manganese, carbon and silicon do not in the aggregate exceed .14 per cent. The time required will be very much lessened if iron ore in excess is continuously added in the presence of the increasing temperatures. In practice I find the period of treatment by the ascending temperatures with continuously added iron ore will consume from one to four hours. My improved process, under its most favorable conditions, consumes from one to four hours more time than is employed in making high grade mild steel.

Seventh, let the tapping temperature reach about 2850 deg. F., and tap the melted hot charge into a ladle or other receptacle.

Eighth, pour into ingot molds while still at high temperature, not below 2775 deg. F.

Ninth, degasify the molten metal, say with aluminum, in the same manner as in ordinary open-hearth practice with mild steel.

Owing to the extremely high temperatures, and to the long continuance of these temperatures my process is particularly destructive to furnaces, very much more so than anything met with in usual operations in the production of mild steel. My experience up to the present time indicates that my process is about three times as destructive to furnace roofs as are the usual processes with similar furnaces.

I have above referred to a temperature of 2850 deg. F. for the bath and this is correct as far as I have been able to ascertain from the most reliable authorities and literature. In practice, correct temperature may be determined by stirring the bath with an iron rod one and one-eighth inches in diameter for one minute and a quarter. If about eighteen inches of the rod has been melted off and if the fluxed rod end has a glassy appearance the temperature is correct. A more rapid or slower cutting away of the rod indicates that the bath is too hot or too cold.

The poured ingots represent a product extraordinary in the art, and the extraordinary characteristics of these ingots can be secured with a degree of regularity and certainty quite unattainable in any previously known commercial method for the production of iron having their characteristics. The bodies of the ingots are free of slag. The heads of the ingots involved at the end of a pouring may show a trifle of slag but this is harmless and drops off in the heating and working of the ingot and never enters the worked product. The

bodies of the ingots will be found free from slag, thus far detected by the microscope in the hands of a professional metallographist which is, of course, the case also with products worked from the ingots. Briefly, the product of my improved method is iron of a purity exceeding that of the very highest grade of Swedish charcoal iron and the manufacture is not subject to the variations and uncertainties incident to other methods of producing these high grade irons, and my improved method is vastly more economical. The method is capable of yielding a product whose percentage of iron is almost identical with "iron by hydrogen."

My improved method provides, for the first time in the history of the art, so far as I am apprised of it, for the commercial production in an open hearth furnace of a product heretofore arrived at only in the laboratory. This may be judged of by the fact that, without considering the more refined capacities of my method, I am in every day practice in an open hearth furnace regularly producing a product analyzing as follows:—

Silicon	Trace.
Manganese	.010
Sulfur	.019
Phosphorus	.003
Carbon	.027
Iron (by diff.)	99.941

Sheets, plates, bars and other forms are readily rolled or forged from these ingots and possess the following characteristics:—

First:—tensile strength somewhat higher than high grade iron.

Second:—ductility somewhat higher than high grade iron.

Third:—density somewhat greater than ordinary iron.

Fourth:—will galvanize more satisfactorily than any commercial iron known to me.

Fifth:—resists all corroding agents to an extraordinary degree, being in this respect vastly superior to any commercial steel known to me, and equal to the very highest grades of Swedish charcoal iron.

Sixth:—forges and rolls with facility at temperatures considerably lower than high grade charcoal iron and very much lower than steel, thereby avoiding the scaling incident to the employment of high temperatures. The material is especially adapted for smooth sheets comparatively free from scale, being, it is believed, superior in this respect to any iron or mild steel known to the art.

Seventh:—substantially proof against internal electrolysis.

Eighth: welds perfectly with a flux, but without a flux it welds less perfectly than charcoal or puddled iron without a flux.

Ninth:—The product well lends itself to use in making crucible steel, being superior to ordinary iron and much more economical than charcoal iron.

Tenth:—the microscope has detected no slag in the body of the ingot or in the finished product.

Eleventh:—the material combines in a most remarkable degree the most valuable qualities of commercial mild steel and the most valuable qualities of the best commercial iron, with apparently none of the many undesirable qualities of either.

I claim:—

The improved method of producing rolling-mill and bloomery ingots of specially high-purity iron consisting of the following steps:—first, in charging a high-powered open hearth furnace with iron: second, in employing therewith eliminating agents for carbon and manganese and sulfur and phosphorus: third, in refining the charge in molten condition till carbon is about .10 per cent.: fourth, in continuing the refinement at continually increasing heat till analysis by bath test shows that the sulfur, phosphorus, manganese, carbon and silicon do not in the aggregate exceed .14 per cent., and with an ultimate bath temperature of at least 2850 deg. F.: fifth, in pouring the hot purified metal into ingot molds, the metal being treated with a degasifying agent while in molten state after tapping from the furnace, substantially as set forth.

ROBERT B. CARNAHAN. JR.

Witnesses:
ELMER R. SHIPLEY,
M. S. BELDEN.