

UNITED STATES PATENT OFFICE.

ROBERT HADFIELD, OF SHEFFIELD, COUNTY OF YORK, ENGLAND.

MANUFACTURE OF STEEL.

SPECIFICATION forming part of Letters Patent No. 303,150, dated August 5, 1884.

Application filed February 13, 1884. (No specimens.) Patented in England January 12, 1883, No. 200.

To all whom it may concern:

Be it known that I, ROBERT HADFIELD, of Sheffield, in the county of York, England, have invented a new and useful Improvement in the Manufacture of Steel; and I do hereby declare the following to be a full, clear, and exact description thereof.

My improvement consists in the admixture of a large percentage of manganese with molten iron in a decarburized or nearly decarburized condition, or to molten steel, whereby I produce a new description of steel of great toughness and hardness, and possessing several peculiar and valuable distinguishing characteristics.

The use of manganese in the manufacture of steel has been known and practiced, but only in proportions not generally exceeding one to one and one-half per cent., it having been always supposed, previous to my invention, that the presence of any larger percentage of manganese would be injurious to the steel and result in an utterly worthless product. I have discovered, however, as the result of extensive experiments, that when manganese is added to the metal or to melted steel in the process of manufacture in any proportions not less than about seven nor more than twenty parts of manganese, which said per cent. is obtained by the use of ordinary commercial ferro-manganese, in one hundred parts of molten metal nearly or wholly decarburized, or to melted steel, most beneficial effects are produced, and a new product results, which has the valuable qualities of ordinary steel while differing from it in several important respects, so that my new manufacture of steel is distinguishable from the grades of steel produced by any of the ordinary processes heretofore known in the following particulars: first, in its freedom from honeycomb and other similar defects; second, in its great toughness and extreme hardness, by reason of which the hitherto indispensable processes of rolling, forging, hammering, hardening, and tempering become unnecessary and may be in many cases entirely dispensed with, though of course this material can, if desired, be rolled or forged in the usual manner; third, in its greater thinness and fluidity, whereby fine steel castings can be

made without misrunning, and which will be nearly, if not quite, as smooth as the so-called metal castings; fourth, that when cast it does not settle much, and does not draw like ordinary castings, particularly at the junction of the thin and thick parts of the casting. These characteristics of my improved steel render it specially adapted for the manufacture of steel rolls to be used in place of chilled rolls; also, for casting guns and armor-plates, and for wheels for railroad-cars and street-cars, and for the railway plant generally; also, for the manufacture of various implements and parts of machinery, and for making articles known in the trade as "steel toys," and for the larger edged tools, which, when cast of my improved steel, need only to be ground, as they can be used without forging or tempering.

In carrying my invention into effect the ordinary ferro-manganese of commerce may be used; but I prefer in all cases a rich ferro-manganese as high as possible in manganese, containing about eighty per cent. of manganese, and as low as possible in carbon, silicon, and other foreign bodies. And here I may remark that my improved process for the manufacture of steel renders the presence of silicon unnecessary for producing soundness.

The ferro-manganese to be used in my process is first carefully melted in a reverberating or other suitable furnace before adding it to the molten decarburized iron or steel, into which it is poured in a melted or highly-heated state.

I need not describe the process of preparing the iron or steel for receiving the addition of manganese, as such processes are well known, and my invention is applicable to any method of melting and decarburizing cast-iron or making steel in reverberating or other furnaces, and by the Bessemer process, or that known as the "open-hearth" process. When the metal is decarburized, or nearly so, or the steel melted, as the case may be, in any desired manner, the melted or heated ferro-manganese is poured into it, or the melted decarburized metal or steel may be poured into the melted ferro-manganese. The mixed molten mass is then well stirred by any known means, so as to incorporate the manganese thoroughly with

the molten decarburized iron or the steel. When this has been effected, nothing remains but to pour out my improved steel thus produced into ingot or other suitable molds, when, after cooling, it is ready for use without tempering, rolling, forging, or hardening, though it may be forged or rolled in the usual manner.

It remains only to state the proportions in which the manganese should be mixed with the iron or steel to produce the desired result. This will depend on the purpose for which the steel is desired to be used. To produce a steel suitable for armor-plates, I add such a quantity of rich ferro-manganese (containing about eighty per cent. of manganese) as to obtain in the steel, decarburized iron, &c., under treatment about ten per cent. of manganese. If the steel is to be used for making car-wheels or railway-plant, I add such a quantity of ferro-manganese which yields a steel containing about eleven per cent. of manganese. In edge-tools and steel toys I add such a quantity of ferro-manganese as to obtain a steel containing about twelve per cent. of manganese. More or less ferro-manganese may be used, according to the hardness of steel required. The range of proportions which I have found to produce beneficial results, and which I desire to include in my invention, is from about seven to twenty per cent. of manganese.

The steel thus produced I have found to be harder, stronger, denser, and tougher than steel now made, even when the latter has been forged and rolled.

I am aware that in British Patent No. 1,728 of 1863 it proposed to "combine with crushed iron ores as much oxide or carbonate of manganese as will produce a metal containing five to eight per cent. of metallic manganese;" but this differs from my improvement not only in

the process, but also because it is inapplicable to the manufacture of steel, for the reason that the resultant product would contain too high a percentage of carbon to make steel.

I herein refer in the claims to the use of ferro-manganese containing eighty per cent. of manganese; but I do not limit myself to the percentage of ferro-manganese therein given, because if it is less rich in manganese the amount added to the molten metal must be increased proportionately, in order that the resultant product shall contain the proper amount of manganese.

Having thus described my improvement, what I claim as my invention, and desire to secure by Letters Patent, is—

1. In the process of making steel, adding to and thoroughly mixing with the molten steel from eight to twenty-five per cent. of melted ferro-manganese containing eighty per cent. of manganese, whereby the resultant product shall contain from about seven to twenty per cent. of manganese, substantially as and for the purposes described.

2. The process of making steel, consisting of adding to molten pig metal previously either wholly or partially decarburized by any desired method from eight to twenty-five per cent. of melted ferro-manganese containing eighty per cent. of manganese, whereby the resultant product shall contain from about seven to twenty per cent. of manganese, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 15th day of January, A. D. 1884.

ROBERT HADFIELD.

Witnesses:

C. B. HOBBS,

THOS. RENSHAW,

Clerks to Mess. Burdekin & Co., Solrs., Sheffield, England.