

# UNITED STATES PATENT OFFICE.

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

## STEEL.

SPECIFICATION forming part of Letters Patent No. 303,151, dated August 5, 1884.

Application filed May 5, 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 Steel; and I do hereby declare the following to be a full, clear, and exact description thereof.

In my British Patent No. 200, of January 12, 1883, and my pending application No. 120,640 for Letters Patent of the United States, I describe an improved process, which 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 always been 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 per cent. nor more than thirty per cent. of manganese the 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 honey-comb 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 great 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 making my improved steel 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 invention renders the presence of silicon unnecessary for producing soundness.

In making my improved steel by the process described in my said application I proceed as follows, viz: The ferro-manganese is, if desired, first carefully melted or treated 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, or the molten iron or steel is added to the melted or highly-heated ferro-manganese. The iron or steel for receiving or being added to the manganese is prepared in any of the known processes 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 vice versa. 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 rolled or forged 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 thirty 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.

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

As a new article of manufacture, steel containing a proportion of from about seven to thirty per cent. of manganese.

In testimony whereof I have hereunto set my hand this 23d day of June, A. D. 1884.

ROBERT HADFIELD.

Witnesses:

HAYR. R. ROBSON,  
BENJ. FREEBOROUGH.