

UNITED STATES PATENT OFFICE.

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ALLOY OF IRON.

SPECIFICATION forming part of Letters Patent No. 577,851, dated March 2, 1897.

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To all whom it may concern:

Be it known that I, ROBERT A. HADFIELD, a subject of the Queen of Great Britain, and a resident of Sheffield, in the county of York, England, but temporarily residing in New York, county of New York, and State of New York, have invented an Improvement in Alloys of Iron, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention relates to a new alloy of iron.

The constituents of the alloy are iron, manganese, nickel, and carbon, the quaternary alloy formed being very different in its characteristics from the ternary alloy of iron, carbon, and manganese.

The iron which forms the principal constituent of the alloy or steel may be used in any desired form, as, for instance, steel-making pig-iron, cast or wrought iron, steel or iron scrap, or a mixture of any or all of these, and the process by which the same is subsequently treated is not essential.

In using the Bessemer or open-hearth process for manufacturing my alloy I carry on said process in the usual manner until the iron has been substantially decarburized and desiliconized, and the other constituents of the alloy are then added, preferably in a molten condition. I may also produce decarburized and desiliconized iron or steel in the ordinary manner by any of the usual processes, and then add to it the other constituents of the alloy. If the alloy is to contain a great deal of carbon, the decarburizing may be incomplete or even omitted in certain cases. When the crucible process of steel-making is employed, the special constituents of the alloy may be introduced at any stage of the operation. The manganese and nickel are introduced by the metals, or by alloys of the metals themselves, or of mixtures containing such elements, in such proportions as will give the proper percentages of manganese and nickel. The manganese addition, for example, may consist of ferromanganese, preferably that containing a high percentage of manganese, as, for instance, the eighty-per-cent. material used in the manufacture of ordinary steel. The nickel addition may be in the form of ferronickel or what is known as "nickel

cubes." These additions may also be made by a compound alloy containing all these elements, but I prefer to add each constituent separately, as I thereby have greater control over the result. I prefer to introduce to the iron the additions in a heated or molten state, and after their incorporation with the iron the material is ready to be run into ingots or other desired forms. The subsequent treatment of the alloy, whether in castings or forgings, is determined by the particular intended application of the product.

In practicing my invention I have found the following proportions to be productive of good results when malleableness is desired: To seventy-nine pounds of decarburized and desiliconized iron I add six pounds of eighty-per-cent. ferromanganese and fifteen pounds of nickel, the resulting steel or malleable alloy of iron containing about 0.65 per cent. carbon, five per cent. manganese, and fourteen per cent. nickel.

Obviously the foregoing proportions may be somewhat varied, according to the exigencies of the case.

I consider that the range of relative proportions of the constituents which my new steel or alloy should contain in order to attain the best results is as follows: carbon, up to about 1.5 per cent.; manganese, from about three to fifteen per cent.; nickel, from about four to twenty-five per cent.

When malleableness is not needed, the percentage of carbon may be greatly increased.

The steel or malleable variety of the alloy of iron made in accordance with my invention is very tough and possesses great tensile strength, it can be forged and rolled, and it is suitable for castings or for steel that has to be forged, variation being made in its constituents according to the purpose for which it is to be used. It may be annealed in the usual manner or it may be annealed by heating and suddenly cooling, as, for instance, by quenching in water, increasing the ductility greatly.

A ternary alloy of iron, carbon up to 1.5 per cent. and from three to eight per cent. of manganese, is slightly magnetic, hard, has high thermal and electrical resistance, but it cannot be machined, and its field of usefulness is thereby exceedingly limited.

The quaternary alloy embodying my invention possesses wholly new properties, as the addition of the nickel actually increases the thermal and electrical resistance and renders it capable of being machined, while making it practically non-magnetic. It possesses a high elastic limit, much higher than mild steel. Its hardness varies according to the percentages of the constituents, but the alloy containing about five per cent. manganese and fourteen per cent. nickel can be readily machined.

The applications of my novel alloy are numerous, such, for instance, as dynamo-castings, resistance-wire, and many other articles allied to or connected with the practical application of electrical engineering, and because of its thermal resistance it is of very great value for steam-engine pistons and cylinders.

While I have hereinbefore described the best proportions for the constituents of the alloy forming my invention, so far as I have

attained good results therewith and for the special purposes to which I have chiefly put it, I do not restrict myself to the exact proportions given, for obviously the proportions may be varied to suit the exigencies of different cases without departing from the spirit and scope of my invention.

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

A quaternary alloy or steel containing iron, carbon up to 1.5 per cent.; from three to fifteen per cent. of manganese, and from four to twenty-five per cent. of nickel, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ROBERT A. HADFIELD.

Witnesses:

GEO. W. WICKERSHAM,
A. W. ANDREWS.