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MANUFACTURE OF STEEL.

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To all whom it may concern:

Be it known that I, Sir ROBERT ABBOTT HADFIELD, F. R. S., a subject of the King of Great Britain and Ireland, residing at Westminster, England, have invented new or Improved Manufacture of Steel, of which the following is a specification.

This invention has for object the manufacture of a manganese steel or iron alloy possessing amongst other qualities, great toughness and resistance to perforation, particularly when in the form of heat treated sheets or plates.

I have found that this object can be attained by adding copper to an alloy of iron high in manganese and relatively low in carbon. The alloy of iron, manganese and carbon may vary in the percentage composition of its constituents. It may for example be of the kind or character of ordinary manganese steel, that is to say, comprising iron with about 10 to 15% or it may be up to 17% of manganese and from about .9 to 1.5% of carbon, but the invention is not limited to these percentages, the main feature of the new steel or alloy being the presence therein of copper. The copper may be added to the manganese steel when in the molten state, or to the mixture of iron and ferro-manganese, or iron and manganese, used to produce the manganese steel, and melted simultaneously therewith the resulting new steel being cast into ingots or other castings. The copper may be added as such or in any other suitable form. The amount of copper to be added to form the new steel or alloy may vary but usually it will be within the limits of about one per cent to about three or four per cent.

The quality of the new manganese steel or iron alloy can be improved, at least for some purposes, by subjecting it to a toughening process consisting in heating it to a high temperature, say for example from about 900° up to it may be 1050° C. or above but below its melting point, and cooling it quickly as by quenching it in water. The new steel when thus heat treated and water quenched, usually called water toughened, has a greater toughness and resistance to perforation than ordinary manganese steel of commerce.

For many purposes, the new steel or alloy may advantageously be rolled into the form of sheets or plates (hereinafter referred to as sheets) or of rods, bars or wire, and be subjected to the toughening process referred to, when in such form, or previously as when in the form of ingots or slabs. If desired, the toughening process may be repeated. The new steel or alloy can also be used for castings of any desired shape and be heat treated or not as may be required.

The amount of silicon present in the new steel or alloy may vary from a small percentage say up to about 2% or it may be above. Also, another element such for example as chromium, nickel, cobalt, vanadium, tungsten, titanium or aluminium, or two or more of such elements, may be added to the steel or alloy for the purpose of improving or varying the quality thereof. The percentage of such element or elements employed is such say for example from one half of one per cent to seven per cent, as to give to the resulting steel or iron alloy the varying desired qualities.

By way of example, it may be stated that good results have been obtained with a manganese steel or iron alloy according to the invention and in the form of water toughened plates or sheets, when containing about .95% of carbon, about 1.25% of silicon, about 1.44% of copper and about 12.72% of manganese and also with a manganese steel or iron alloy containing about 1.24% of carbon, about .11% silicon, about 1.18% of copper and about 12.42% of manganese.

The new steel or iron alloy can be used for various purposes and in either the rolled, forged or cast condition.

What I claim is:—

1. Manganese steel with from about one per cent to four per cent of copper.

2. Steel having great toughness and resistance to perforation and containing iron with from about ten to seventeen per cent of manganese, about nine tenths per cent to two per cent of carbon, and from about one per cent to four per cent of copper.

3. A steel alloy containing iron and carbon with from about ten per cent and upwards of manganese and with from about one to four per cent of copper and treated by heat to above about 900° C. and below its melting point and then cooled quickly.

4. Manganese steel retaining from about one to four per cent of copper and treated by heat to from about 900° C. and below its melting point and then cooled quickly.

5. As a new article of manufacture, steel

having great hardness and toughness and containing at least ten per cent of manganese and up to about four per cent of copper.

6. As a new article of manufacture, manganese steel in wrought form and containing up to about four per cent of copper and treated by heat to from about 900° C. and below its melting point and then cooled quickly.

7. As a new article of manufacture, manganese steel in sheet form alloyed with from about one to four per cent of copper and treated by heat above 900° C. and below its melting point and then cooled quickly.

8. An alloy of iron high in manganese, low in carbon and containing a substantial amount of copper.

9. A steel alloy containing iron and carbon with from about ten per cent and upwards of manganese and from about one per cent to four per cent of copper.

10. A steel alloy containing carbon up to one decimal five per cent, manganese from about ten per cent to about seventeen per cent and copper from about one per cent to four per cent.

11. As a new article of manufacture, a steel alloy having great toughness and resistance to perforation and containing iron and carbon with from about ten per cent to seventeen per cent of manganese and from about one per cent to about four per cent of copper.

12. As a new article of manufacture, manganese steel having great toughness and resistance to penetration and in wrought form and containing from about one per cent to four per cent of copper.

13. As a new article of manufacture, manganese steel having great toughness and resistance to perforation and in sheet form and containing from about seven tenths to two per cent of carbon, from about ten per cent to about seventeen per cent of manganese and from about one per cent to about four per cent of copper.

14. As a new article of manufacture, manganese steel in sheet form, having great toughness and resistance to perforation and containing about one per cent of carbon, about one per cent to about two per cent of copper and about twelve per cent to thirteen per cent of manganese.

15. An alloy having the essential ingredients of commercial manganese steel together with copper, the percentage of copper being less than the percentage of manganese.

16. An alloy composed of steel with 10 to 14% of manganese, and copper in appreciable amount but less than 2%.

17. Manganese steel containing copper in a proportion of between 0.55% and 2%.

Signed at 22 Carlton House Terrace, Westminster, England, this sixteenth day of June 1916.

ROBERT ABBOTT HADFIELD.

Witnesses:

WILLIAM CROSS,

JOHN HAROLD HALLATT.