

UNITED STATES PATENT OFFICE.

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MANGANESE-STEEL CASTING AND PROCESS OF PRODUCING THE SAME.

1,066,258.

Specification of Letters Patent.

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No Drawing.

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To all whom it may concern:

Be it known that I, EDGAR A. CUSTER, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Manganese-Steel Castings and the Process of Producing the Same, of which the following is a specification.

The primary object of this invention is to produce castings from manganese steel without reheating or subsequent treatment of any kind, which will have a uniformly fine, even and closely knit crystalline structure and, besides possessing the usual hardness of manganese steel castings, will also possess, though in a non-annealed and non-quenched condition, the toughness and ductility which are usually characteristic only of manganese steel castings which have been reheated and quenched in the usual manner.

The invention consists in the novel product itself and in the process by which that product is produced.

It is well known that manganese steel, when cast in the ordinary manner, tends to develop shrink holes and that it is necessary to employ large sink heads to compensate for this tendency. It is also well known that manganese steel castings, when allowed to cool in the ordinary manner, are not only very hard but very brittle and possess little or no toughness or ductility, the crystalline structure or molecular arrangement, disclosed by the microscope, being relatively large and loosely knit before the castings are reheated and quenched or annealed. To increase the toughness and ductility of the castings it has been customary heretofore to reheat the castings to a relatively high temperature and then to quench the same by plunging them in water or by other suitable means. This reheating of the castings, which is continued until the metal is in a somewhat soft and plastic condition, permits a molecular readjustment of the metal and removes the internal stresses, which result from slow cooling, and the effect produced by the quenching is to retain the desirable condition developed by the reheating, so that the castings, after being quenched are hard, tough, and somewhat ductile instead of being hard and brittle. Microscopical examination of such castings, after reheating and quenching, shows some improvement in the crystalline structure, although it is not

marked. The production of manganese steel castings which possess a desirable degree of toughness and ductility therefore requires three main operations, namely, the casting of the metal, the reheating of the casting and the quenching of the casting after reheating.

It has been discovered that by the present invention it is possible to produce in one operation a manganese steel casting, non-annealed and non-quenched, which is characterized by great toughness, great ductility and a uniformly fine and closely knit crystalline structure, these desirable characteristics being possessed in an even greater degree than they are possessed by manganese steel castings produced by the processes heretofore employed.

In accordance with this invention the casting is made in a permanent mold with a matrix which yields the desired form, so that only a minimum of grinding or finishing is required. The matrix of the mold is first filled with molten metal of such temperature that substantially all of the metal in the matrix will be at or above the melting point of the metal when the pouring is finished. Then the metal is cooled swiftly and uniformly so that the temperatures of at least the outer portions of the casting, that is, of all portions of the casting in contact with the mold, will be practically the same at any given instant. The swift cooling is continued past the various critical points until the temperatures of all portions of the surface of the casting in contact with the mold pass simultaneously below the crystallizing point of the metal, that is, about 700° C. After the temperature has passed the crystallizing point of the metal, as described, the casting can be removed from the mold and allowed to cool normally, but it is preferable to allow the casting to remain in the mold until the temperature of all portions of the surface thereof is well below the crystallizing point, in order that the creation of internal strains or stresses may be prevented absolutely and that the crystalline structure obtained when the cooling passed through the upper critical point may be permanently fixed. The molten metal is cooled swiftly to a point below the crystallizing point in order to prevent segregation of the various constituents of the metal and the formation of secondary or weakening structures and is cooled uniformly with re-

spect to the entire surface of the casting in order to avoid the unequal hardness in different portions which would result from different rates of cooling in different portions. It is well known that manganese steel gives up its heat with great rapidity while it is molten, but that after it sets it gives up its heat reluctantly. Consequently it is necessary, after the setting has taken place, to accelerate the radiation of heat from the casting beyond the normal rate so as to accomplish the desired cooling as swiftly as possible. This result is secured by employing a mold which possesses not only heat conductivity but a heat storage capacity greater than that usually possessed by a mold as heretofore employed.

In the practice of the process it is preferable to employ a mold of cast iron which has a considerable body or mass, so that the heat of the casting will be absorbed quickly, but it is obvious that a mold of any other material or combination of materials which possesses the required conductivity and heat storage capacity and will resist the wear and tear of practical use may be employed.

By the term "manganese steel," as employed herein, reference is had particularly to a steel which contains from 11 per cent. to 15 per cent. of manganese, but these limits may be varied if desired within the ranges which are permissible for the production of a commercial product and the invention therefore is not limited to manganese steel of any particular analysis.

The product of the improved process not only possesses the characteristics above referred to but is free from the various detrimental structures and strains which often exist in castings produced in the usual manner because of the difficulty or impossibility of removing or curing the same by reheating to a temperature which is permissible without permanently injuring the casting, when such defects have once been developed. Furthermore, the product of the process is of homogeneous metal throughout free from segregations of any kind, and is produced without shrink holes and without the employment of sink heads or other means to prevent the same.

I claim as my invention:—

1. A process of producing castings from manganese steel, which consists in cooling the metal of the outer portions of the casting swiftly from a temperature at or above

the melting point of the metal to a temperature below the crystallizing point of the metal, and then allowing the casting to cool to normal atmospheric temperature.

2. A process of producing castings from manganese steel, which consists in pouring the metal into a mold which has relatively large heat conducting capacity, whereby the metal of the outer portions of the casting is brought swiftly from a temperature at or above the melting point to a temperature below the crystallizing point without permitting segregation to occur, and then allowing the casting to cool to normal atmospheric temperature.

3. A process of producing castings from manganese steel, which consists in crystallizing the metal of the casting without the formation of secondary and weakening structures by swiftly drawing the heat from the outer portions of the casting until the temperature thereof is at or below the crystallizing point, and then allowing the casting to cool to atmospheric temperature.

4. A process of producing castings from manganese steel without quenching, such castings having a uniformly fine crystalline structure throughout, which consists in cooling the metal of the outer portions of the casting swiftly from a temperature at or above the melting point of the metal by pouring the metal into a mold which has a high conducting and heat-storing capacity, causing the casting to remain in the mold until the temperature of the outer portion thereof is at or below the crystallizing point of the metal, and then removing the casting from the mold and allowing the same to cool to normal atmospheric temperature.

5. A non-annealed and non-quenched manganese steel casting which possesses toughness and ductility and has a uniformly fine and closely knit crystalline structure.

6. A non-annealed and non-quenched manganese steel casting which possesses toughness and ductility, has a uniformly fine and closely knit crystalline structure and is free from secondary structures and from internal strains.

This specification signed and witnessed this 18th day of February, A. D. 1911.

EDGAR A. CUSTER.

Signed in the presence of—

JOSEPH M. HUGHES,
JOHN T. PUSEY.