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UNITED STATES PATENT OFFICE.

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PROCESS OF PRODUCING CARBON-STEEL CASTINGS.

SPECIFICATION forming part of Letters Patent No. 746,039, dated December 8, 1903.

Application filed November 5, 1898. Serial No. 695,605. (No specimens.)

To all whom it may concern:

Be it known that I, JAMES C. DAVIS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Processes of Producing Carbon-Steel Castings, of which the following is a full, clear, and exact description.

This invention relates to improvements in that class of processes for producing steel in which hardening elements—such as ferro-manganese, chromium, tungsten, &c.—are introduced into the molten metal to produce the desired chemical action that results in the formation of cast-steel of great toughness and possessing the capability of being given extreme hardness by the usual cooling method generally employed in the hardening of such metals. In processes of this kind heretofore used quite a large percentage of the hardening element employed, varying from about two to fifteen per cent., is necessary to produce the best results attainable by such processes, and this involves considerable expense. Another difficulty sometimes experienced in connection with the older processes which it is my purpose by this invention to overcome arises from the fact that in some cases when the metal is cast and cooled it is sometimes too hard to be readily worked and finished and must be reheated and softened or reheated and worked in a heated condition in order to permit it to be properly formed, which adds greatly to the cost of the finished product.

By my invention the hardening element is intimately combined with the steel and the casting thereby produced is rendered capable of being given extreme and uniform hardness by the usual processes employed for hardening such metals, while at the same time it is of a soft and easily-workable character before such hardening process.

In the practice of my invention I accomplish the object set forth, as well as such others as may hereinafter appear, by the introduction of the hardening element at such a time and in such a form that the full hardening and toughening effect or chemical action of such element does not take place until the casting is subjected to the usual process of heating and submerging in a suitable cooling-bath.

The steel to be hardened may be of any suitable composition and may be produced by any of the methods known or commonly practiced, it being simply necessary as a preliminary step in my invention that the metal shall be reduced to a molten or liquid form, for so far as relates to the broad idea of my invention it is wholly immaterial in what manner or with what method or apparatus the metal is reduced to a molten state. The next step of my process is to introduce into the molten metal at the time of pouring the metal into the mold after it leaves the crucible or ladle a small percentage of ferro-manganese, chromium, tungsten, or any other suitable hardening element or elements in a cold state or granular form, the idea that the hardening element instead of being introduced into the molten metal and incorporated therewith while in the crucible, furnace, converter, or other containing vessel is to be introduced into the molten metal at the time and during the act of pouring the same from the crucible or other containing vessel into the mold, so as to be carried into the mold by the flow of the molten metal.

I have found in practice that the best results are obtained by reducing the hardening element to a small granular form that will pass through a screen of a sixteenth of an inch mesh, although in some metals and for some uses the hardening metal may be comminuted to even a finer granular form. The proportion of the hardening element which I have found in practice to produce the best hardening and toughening effect is about one-half of one per cent., which produces a steel of superior toughness immediately after casting, while still not possessing the maximum hardness that can be produced by subjecting the metal to the usual hardening process. In fact, a metal thus produced is susceptible of being worked, machined, and finished in a cold state, the toughness of the metal preventing chipping or fracture thereof while being worked. The proportion of the hardening element may, however, vary from one-quarter of one per cent. to two and one-half per cent., according to the compo-

sition of the molten metal and the intended uses of the finished product.

Of course the castings may be made with sufficient accuracy and smoothness for some uses to avoid the necessity for being worked or finished after the casting operation; but the greatest advantage in the use of my process occurs where the castings are of such a nature as to require working and finishing, and it is therefore of the utmost importance that the castings shall not be too hard when first made or require their being subjected to heat to soften it during the working and finishing operation or before the same, because the expense thereof is considerable.

It appears that by introducing the hardening element into the molten metal at the particular time and in the manner stated the minimum quantity of such element may be employed to produce a maximum effect of hardening the metal. Furthermore, by reason of the introduction of the hardening element into the molten metal at the particular time stated the full effect of the hardening element does not seem to take place before the metal cools, which therefore leaves the casting in a condition to be worked, machined, and finished. The full effect of the hardening element is brought about by the subsequent act of hardening and the raising of the temperature of the castings to the point stated, which does not affect the form or shape thereof, and then quenching the same in a liquid-bath, which is substantially the usual process of hardening metals of this kind.

Where I have employed the term "hardening element" in this specification I desire to be understood as intending to cover only such materials (as ferromanganese, chromium, tungsten, &c.) as have a high specific gravity as compared with such materials as pulverized carbon, of the most common forms of which is granular charcoal. The last-mentioned substance has a relatively low specific gravity and tends, as I find by experiment, to rise in the mold and does not thoroughly and effectively intermingle and distribute itself through the casting, in view of which it is not suitable for use in connection with my process.

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

1. The described process of making hardenable steel castings consisting in reducing the metal to a molten state, pouring the same into a mold and during the act of pouring, introducing a finely-divided hardening element of higher specific gravity into the metal, and thoroughly distributing the hardening element through the steel, in proportion to render the casting capable of being tempered to uniform hardness.

2. The process of making steel castings which consists in pouring molten steel into a mold and continuously during the act of pouring introducing into the stream of molten metal a finely-divided hardening element, uniformly distributing the said hardening element throughout the mass of metal, in order that the same may be hardened after being again heated.

3. The process of making hardenable steel castings which consists in pouring molten steel into a mold and thoroughly mixing therein at the time of pouring about one to two per cent. of manganese, whereby the parts of the casting desired to be subsequently hardened are rendered immediately tough, but may be subsequently reheated and tempered in the usual manner.

4. The process of making steel castings which consists in pouring molten steel into a mold, introducing into the metal continuously during the act of pouring a finely-divided hardening element, machining the casting and afterward reheating and suddenly cooling to temper the same, substantially as described.

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Witnesses:
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