H. E. SHELDON.

MANUFACTURE OF STEEL.

APPLICATION FILED MAR. 30, 1912.

1,185,252. Patented May 30, 1916.

FIG. 1.

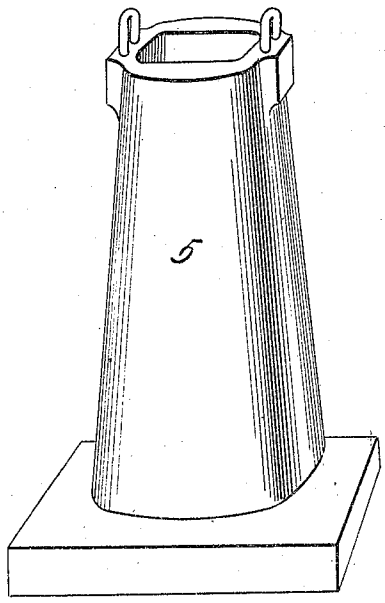
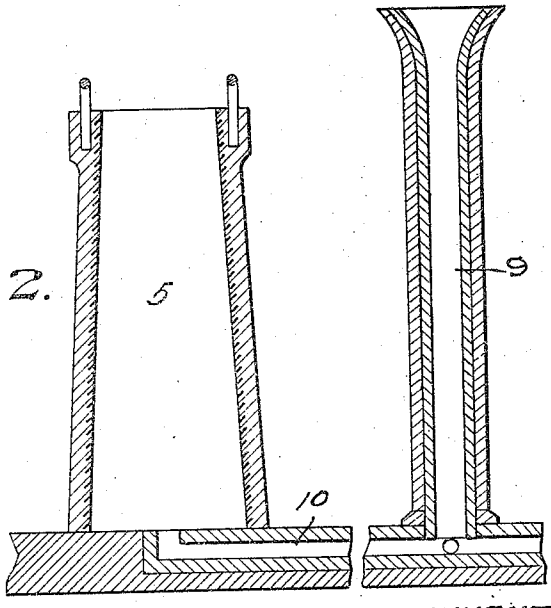


FIG. 2.



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MANUFACTURE OF STEEL.

1,185,252. Specification of Letters Patent. Patented May 30, 1916.

Application filed March 30, 1912. Serial No. 687,365.

To all whom it may concern:

Be it known that I, HARRY E. SHELDON, a citizen of the United States, and resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in the Manufacture of Steel; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the manufacture of steel.

As it is well known, steel has been made in different ways, such as by the Bessemer process, open-hearth process, and crucible processes, and in the electric heating furnace, and when properly refined and at a highly molten heat, has been poured into ingot molds, these molds being universally formed of cast iron. One great expense in the manufacture of steel has been the cost of these cast iron ingot molds which quickly wear out, the average life of such molds being about sixty casts. The reason that the molds are short lived is that recesses or cavities are formed in the inner surface thereof, particularly in the lower portion thereof, and that the molten steel supplied to the mold during the casting of the metal, enters within these recesses or cavities and upon solidification locks the ingot in the mold so that it cannot be stripped therefrom, thereby necessitating the destruction of the mold. Another more important difficulty in this manufacture of the steel and arising from the use of the cast iron molds, has been the entering of the mold metal into the molten steel, rendering it relatively impure. I have discovered that this is due to a phenomenon akin to osmotic action. This action can be described as follows: The cast iron ingot molds are relatively high in carbon, and may be higher than the molten steel in manganese, phosphorus, sulfur and other impurities, and a large proportion of carbon in such molds appears as free carbon, not being chemically united with the iron. The molten steel cast therein is of course much purer than this cast iron, having only a relatively small content of carbon and probably a lower content of manganese and other impurities chemically united with the iron of the steel body. When this steel is in a highly molten condition it is poured within the cold cast iron mold, and the molten steel which is composed of a more dilute alloy infuses itself or immigrates into the cast iron, or higher alloy, and causes, or tends to cause, an increase in the size and the dilution of the higher alloy until both alloys are of the same composition, there being a sharp separation between the higher alloy, or cast iron, and the lower alloy, or molten steel, which envelops it. During this infusion or immigration of the steel into the cast iron, globules or fragments of the cast iron separate therefrom and continue to be acted upon by the molten steel, or lower alloy, in the same fashion as above described with reference to the parent mass of the cast iron, or higher alloy, and in this way the globules or fragments are, as it were, dissolved within the molten steel, or lower alloy. If the infusion or immigration of the molten steel into the cast iron be checked at any stage previous to complete merger of the two metals or alloys, as by the solidification of the metal, the remaining globules or fragments, if any, of the cast iron or higher alloy separated from the mold body, will remain as hard spots in the mass of steel, or lower alloy. I have found that such infusion or immigration of the molten steel acts upon the walls of the cast iron molds and is responsible for the attack of the former upon the latter, causing the recesses or cavities in the inner mold faces hereinbefore referred to, and the appearance of hard spots in the sheets, plates or other products made from the ingots. While creating this difficulty with the molds and shortening their average life, a more serious difficulty is the change in the character of the steel, as it is well known that a very slight amount of such impurity dissolved within the steel of the ingot may, and often does, weaken the steel, or harden the same, affect its other physical characteristics, according to the impurities contained in the cast iron of which the mold is formed and which is thus taken up by the molten steel. Even if the body of the mold is thus carried into the steel in small granules and fully dissolved therein, the resultant steel may be seriously contaminated in this way, and as the object aimed at is to form the solidified steel ingot of the exact composition produced in the furnace or converter, it is very important to overcome this difficulty and produce the steel free from such contamination. The difficulty is of course intensified where the portions of the mold body so broken off are not entirely dissolved within

the molten steel of the ingot, but form hard spots which may be present in the rails, bars, sheets, and form hidden weaknesses therein.

My invention has for its object to produce a purer steel by practically overcoming this so-called osmotic action during the cooling and solidification of the ingot.

It consists in melting and refining the steel and then pouring it into an ingot mold having a steel inner face and permitting it to solidify in contact with such face; it being found that as the chemical content of the steel mold does not differ greatly from the chemical content of the molten steel, and the carbon content of the steel from which the mold was formed is chemically united with the iron, this osmotic action is practically overcome and thus the molten steel cast within the steel molds is kept pure and free from impurities taken up from the mold body and the formation of the solidified ingot as pure as the metal produced in the furnace or converter and free from contamination from the mold can be insured; while the life of the mold itself is greatly extended and the cost of manufacture of the steel is thus reduced.

The special form of mold hereinafter described is not claimed in this application since it forms the subject matter of applicant's co-pending application, No. 687,366, filed March 30, 1912.

In the accompanying drawings Figure 1 shows an ingot mold; and Fig. 2 shows the same in vertical section illustrating one manner of pouring the metal.

For the practice of the invention the ingot molds are formed of cast steel, for example, either Bessemer or open-hearth steel, being formed in the ordinary way of forming steel castings. They can be formed in the steel-making plant where they are to be used and are thus easily formed of the same or approximately the same carbon content as the steel produced in the plant. I prefer to employ in the molds a steel which is practically the same as the molten steel ingots to be cast therein, for example, say, having its impurities within ten or twenty points of like impurities in the molten steel. However, from my experience in the practice of the invention, it is believed that this osmotic action can be practically prevented if the content of either of the main impurities, carbon or manganese, shall not differ from the like elements in the molds by more than two per cent. That is, if the steel to be cast contains, for example, .20 per cent. of carbon the steel of the mold should not be of a higher carbon content than, say 2.20 per cent., and its carbon content may extend all the way from this to practically nothing.

In the practice of the invention the steel is refined and cast in the usual way. The cast iron may be melted in cupolas, and refined in converters, received in a casting ladle and cast in the steel ingot molds 5. Or, in the open hearth plant, the steel may be refined in furnaces and received in a ladle and cast by bottom casting in the cluster of molds, the metal passing down through the central runner 9 and being distributed by side runners 10 into the steel ingot molds 5, the molds being of the ordinary shape as employed with the cast iron mold.

The metal enters the molds at an extremely high heat, probably from 2700° to 3000° F., and is permitted to cool therein in contact with the steel inner face thereof until properly solidified ready for withdrawing from the molds when they are stripped therefrom in the usual way. It is evident that until the metal is properly solidified it is open to contamination by any impurity which can enter the same. But as the molten steel is cast within the steel mold and during all the time of cooling, as the alloy of the steel molds is approximately close to the alow of the molten steel, practically all osmotic action is prevented and there is no passage of any contaminating metal or impurity from the body of the steel mold into the molten steel and therefore the ingot is solidified, passing from the molten to the solid state, practically as produced in the converter or furnace, and a much purer ingot is obtained, one free from the impurities formed by the alloying of the metal of the mold body with the metal of the ingot, such as where it is actually dissolved therein, as above described, while hard spots in the ingot from undissolved portions of the mold body entering into the same are prevented, and hidden weaknesses of the ingot or the metal produced therefrom arising from contamination in the formation of the ingot are entirely avoided.

As set forth in a companion application of even date herewith, Serial No. 687,366, the life of the ingot molds is largely extended, practical use showing that they outlast the cast iron molds many times. The limit of wear has not yet been fully ascertained.

What I claim is:

1. The herein described method of manufacturing and casting steel consisting in melting and refining the crude metal to produce the steel, and casting the molten steel into an ingot within an ingot mold having a steel inner face, such steel inner face of the ingot mold being approximately of the same carbon content as that of the molten steel cast within the mold.

2. The herein described method of manufacturing and casting steel, consisting in melting and refining the crude metal to produce the steel, and casting the molten

steel into an ingot within an ingot mold having a steel inner face, the proportion of any one of the main alloying elements of the steel forming the inner face of the mold not being more than two per cent. above the content of like alloying element of the molten steel cast within the mold.

In testimony whereof I the said HARRY E. SHELDON have hereunto set my hand.

HARRY E. SHELDON.

Witnesses:
ROBERT C. TOTTEN,
JOHN F. WILL.