UNITED STATES PATENT OFFICE.

BENJAMIN TALBOT, OF CHATTANOOGA, TENNESSEE.

PROCESS OF REFINING METALS.

SPECIFICATION forming part of Letters Patent No. 476,092, dated May 31, 1892.

Original application filed January 19, 1892, Serial No. 418,583. Divided and this application filed April 6, 1892. Serial No. 428,033. (No specimens.)

To all whom it may concern:

Be it known that I, BENJAMIN TALBOT, a resident of Chattanooga, county of Hamilton, and State of Tennessee, formerly a subject of Great Britain, but having declared my intention of becoming a citizen of the United States, have invented a new and useful Improvement in the Process of Refining Metals, being a division of an application for Letters Patent of the United States filed by me on the 19th day of January, A. D. 1892, Serial No. 418,583, of which the following is a specification.

This invention has in view the manufacture of steel which shall contain an exceedingly small percentage of phosphorus.

Acid Bessemer steel is made as follows: Molten pig-iron of known chemical composition is poured into a Bessemer converter and blast is forced through it at a high pressure. The oxygen of the blast burns some of the metallic iron to an oxide as it enters the converter, and this oxide eliminates the silicon and carbon from the metal. When these metalloids have been expelled, the converter is turned down and the blast taken off. The metal is deoxidized by the addition of manganese either in the form of ferro-manganese or spiegel. Ferro-manganese is generally used if soft steel is required—*i. e.*, .10 to .12 carbon—and as a rule is added to the metal as it is being poured from the converter into the casting-ladle. When hard steel is required for rails, about .40 or .50 carbon spiegel is used, and is poured into the decarbonized metal in the converter after it has been turned down and the blast taken off. As any considerable percentage of phosphorus in steel renders it commercially useless on account of the brittleness this metalloid imparts to the metal and as it is impossible to remove phosphorus from metal by any acid process, it is therefore necessary that the molten pig-iron should contain less phosphorus than it is desired to have in the finished steel.

Steel that is used for rails and other common purposes is required to have not more than a tenth of one per cent. of phosphorus, while if the steel should contain two-tenths it would be useless. If an acid steel is only to contain .03 of one per cent., this high grade of metal is much more expensive than the ordinary quality, which contains .10 phosphorus. The higher grade of steel is much more reliable than the ordinary. In the absence of phosphorus it is more ductile, will weld easier, and is not subject to crystallization, as steel is when it contains phosphorus. It is for the above reason that steels when used for boiler-flues and other purposes where expansion and contraction is very severe have the phosphorus confined to very low limits, (about .03.) Manufacturers of special soft steels demand considerable more money for the low-phosphorus steels. It is more expensive to work because they have to obtain very pure raw materials. By my process I propose to take the ordinary quality of steel and convert it to the higher grade—that is, I will use the metal which contains .10 of phosphorus and eliminate the phosphorus to .03.

I prefer to install the process as follows: I blow the iron in the usual acid converter, as is done when making ordinary acid steel. I eliminate the silicon and practically all the carbon, and as soon as I perceive the flame is dropping, which indicates that the metal is nearly decarbonized, I turn the vessel down and take off the blast. If this metal were now poured into the casting-ladle and manganese added, a fair quality of steel would be the result, as it would contain .10 phosphorus. Instead of doing this I arrange a center crane, which commands the Bessemer converter. On this center crane I place, preferably a cylindrically-shaped vessel, into which I have put previously a stated quantity of liquid basic slag. The center crane is placed under the converter and the vessel emptied of its metal into the filter which contains the slag. I take care, however, that no silicious slag is emptied from the converter into the basic slag, as this silicious slag is kept back. If desirable, I place a small vessel which contains several medium-sized perforations in its bottom (say about one inch round) in the top of the filter-vessel, and the metal is poured from the converter through these holes. By this means the surface of the metal is better exposed to the purifying action of the slag and what impurities were in the metal are immediately eliminated. The composition of the metal will be about as fol-

lows when the converter is turned down: The carbon may be about two or three tenths, or probably a little more. The silicon may be about .10 or more, depending upon the quantity of silicon that had been in the molten pig metal when it was introduced into the converter. The phosphorus will be the same as was in the cast-iron, or may be a little more, as, owing to the waste of metallic iron which occurs in the process, the original amount of phosphorus is concentrated into the lesser amount of metal. As this metal descends through the body of liquid basic slag, the remaining traces of silicon and practically all the carbon and phosphorus are expelled and the metal is a liquid bath of pure metallic iron. I swing the center crane, with the filter which contains this metal, over the casting-ladle and tap the metal out, preferably from the bottom. As the metal is running out I introduce the ferro-manganese or spiegel into the casting-ladle, so that it becomes deoxidized and is then poured from the casting-ladle into the ingots.

I do not introduce the ferro-manganese into the metal before filtering it, as the iron-oxidizing basic slag would expel the manganese from the metal. This would cause extra expense and would not be economical. So I prefer to add the necessary manganese or other deoxidizing material to the metal when it is being discharged into the casting-ladle after filtration. The effect of this operation changes the grade of steel from ordinary, containing .10 phosphorus, to a very superior quality containing .03 or less and greatly increases its value in the market.

If I take the Bessemerized metal, which contains .25 or more of phosphorus, I turn the vessel down a few seconds earlier than I do when the metal contains only .10. This is done to leave a little more carbon in the metal, which causes a much more active reaction between the slag and molten metal than if it contained less carbon. This gives the slag a better chance of getting hold of the phosphorus and expels it from the metal more rapidly. If the metal is divided into streams, these can be smaller than when treating the purer metal, so as to more intimately expose the surface of the metal. By this means steel will be made containing .10 phosphorus or less which will be of good commercial quality.

When acid steel is made in the Siemens open-hearth furnace, I proceed exactly in the same way as when it is made in the converter—that is, the metal is tapped from the furnace, filtered, phosphorus-reduced, and then deoxidized in the casting-ladle and poured into ingots.

Under conditions where metallic manganese is expensive to use for deoxidizing purposes I prefer to employ as a dephosporizing agent basic slag containing a manganiferous oxidizing base. The carbon in the metal reduces the manganese to a metallic state, and consequently little or no metallic manganese is needed in the casting-ladle. Phosphorus will also be eliminated at the same time.

The slag employed in my process may be used repeatedly for the filtration of successive charges with the double benefit of securing economy and of enriching the slag, so that it will be valuable for fertilizing purposes. The filtering action may be prolonged and improved by rotating the filtering-vessel around its vertical axis, the centrifugal force developed causing the heavy metal to seek the outer part of the vessel while descending, consequently lengthening its course and causing it to pass through the slag both vertically and laterally.

Having thus described my invention, what I claim is—

1. The improvement in the art of manufacturing steel, which consists in first desiliconizing and decarburizing the molten iron in a converter or furnace having an acid lining and thereafter filtering the metal through liquid basic slag to reduce the percentage of phosphorus.

2. The improvement in the art of making steel, which consists in first desiliconizing and decarburizing the molten iron in a converter or furnace having an acid lining and thereafter filtering the desiliconized and decarbonized metal through a body of liquid basic slag and finally adding manganese.

3. The improvement in the art of making steel, consisting in first desiliconizing and decarburizing the molten iron in a converter or furnace having an acid lining and thereafter filtering the same through liquid manganiferous basic slag, thereby reducing the phosphorus, and adding metallic manganese to the metal.

In testimony whereof I hereunto set my hand, this 6th day of April, 1892, in the presence of two attesting witnesses.

BENJAMIN TALBOT.

Witnesses:
W. R. KENNEDY,
F. S. ELMORE.