UNITED STATES PATENT OFFICE.

TAYLOR ALLDERDICE, OF SWISSVALE, ASSIGNOR TO THE CARNEGIE STEEL COMPANY, LIMITED, OF PITTSBURG, PENNSYLVANIA.

PROCESS OF MANUFACTURING STEEL.

SPECIFICATION forming part of Letters Patent No. 491,035, dated January 31, 1893.

Application filed February 3, 1892. Serial No. 420,219. (No specimens.)

To all whom it may concern:

Be it known that I, TAYLOR ALLDERDICE, of Swissvale, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in the Process of Manufacturing Steel, of which the following is a full, clear, and exact description.

My invention pertains to that branch of the manufacture of steel in which steel is made by the Bessemer, open-hearth, or similar process, and is subsequently carburized by the addition to it of free carbon, in the form of coke dust, graphite, wood-charcoal, &c.; and it has for its object to remedy certain practical defects in the modes of adding the carbon heretofore employed, and to provide means by which the carbon content of the finished product can be regulated and determined accurately. The principal defect in methods of supplying carbon has been their lack of certainty. The carbon content of the product has been dependent too much upon the care and attention of the workman managing the pouring of the steel, and has been apt to be affected so much by accidents as to detract materially from the value of the process and to render its successful working largely a matter of chance.

I have made the following discoveries with reference to the addition of free carbon in the manufacture of steel:—First, that the most satisfactory manner in which to add the carbon is to place it in the ladle in definite quantity determined by the percentage desired in the product, and to cause the metal to flow upon it from the furnace or converter. Second, that there is an important advantage derived from having in the ladle, before the introduction of the carbon a sufficient quantity of molten steel to cover the discharge opening controlled by the ladle-stopper. If this is not done, the carbon is apt to settle about the ladle-nozzle-opening, and when the stopper is lifted to teem the contents of the ladle, the access of air to this highly heated carbon may cause it to explode with violence and to throw the steel from the top of the ladle. The danger and loss thus occasioned are very considerable. The introduction of the carbon upon the layer of molten steel is also of advantage aside from prevention of danger, in that, by keeping the carbon from direct contact with the bottom of the ladle, its adherence to the lining is largely prevented, so that I am enabled to secure greater certainty of results in subsequent casts in the same ladle. The thorough mixture of the carbon by the churning action of the incoming steel and the complete and uniform cementation of the metal is also enhanced by thus interposing the carbon between the first introduced layer of steel and the subsequently poured charge, since in this way I get actual contact of every portion of the steel with the carburizing agent. Third, that the best and most certain results are attained when the carbon, in measured quantity, is put into a combustible or easily-fusible case, and such case is thrown into the ladle (preferably upon a bottom steel layer) and the steel then poured upon it. Loss of the carbon from dissipation by the strong currents of air and gas induced in the ladle by pouring of the steel is thus avoided, and by reason of the consequent greater certainty of predetermination of the degree of carburization which will be effected by a given carbon-addition, the process is brought to the highest perfection yet attained. In practice it will be found that the most convenient form of case in which to introduce the carbon is a paper bag, such as those used for containing flour, but easily destructible boxes made of paper, thin wood, or easily fusible metal may be employed with like advantages. Each of these discoveries above recited forms an individual part of my invention, and is made the basis of separate claim in this application, each claim being unlimited by conditions and qualifications peculiar to other claims.

I shall now describe my invention as heretofore practiced by me with the best results:

After the metal has been treated in the usual manner in the open-hearth furnace, or Bessemer converter, and is brought thereby into proper condition for recarburization and final addition of manganese, &c., I run into the ladle or other vessel intended to receive the molten steel, a sufficient quantity of the steel to cover the nozzle (discharge opening), generally introducing thus a layer of steel of from three to six inches in depth. Then, before introducing the remainder of the steel, I

throw into the ladle upon the molten layer a bag or case containing a measured quantity of fine particles of carbon, preferably in the form of well-dried, finely-ground coke, though wood-charcoal, anthracite coal, or graphite may be substituted. The ordinary charge of molten steel is then poured into the ladle upon the bag. The bag burns quickly, and its carbon contents, being exposed, mix with the metal and evenly carburize the same. Spiegeleisen and ferro-manganese or equivalent deoxidizing agent may be added to the steel in the usual manner.

In thus practicing my invention, in connection with the open-hearth furnace, one can rely with certainty on combining with the steel about fifty per cent., of the carbon introduced, the remainder being lost by combustion, &c. It will be seen therefore that the capacity of the ladle and the carbon percentage of the coke or other material used being known, it is easy to calculate with exactness the precise quantity of coke which must be charged into the case in order to raise the carbon-content of the steel from the amount ordinarily present in it when it is tapped from the furnace or converter (.10 of one per cent.,) to the content desired; and as this calculation may be made and the bags filled with carbon before they come into the hands of the less responsible persons who direct the tapping of the furnace, the liability of getting an ununiform product by careless feeding of the carbon, which detracts so much from the value of prior modes of operation, is absent from my improved process.

The following example will illustrate in detail the quantities of carbon which should be added to produce a given result.

Let the ordinary charge of the ladle used in the process be one ton of steel, the content of carbon of the metal when tapped from the open-hearth furnace, .10 of one per cent., and the carbon content desired to be produced in the finished product by this process of recarburization .30 of one per cent. Then calculating on a loss of fifty per cent., of the added free carbon, as above explained, and using coke containing about ninety-nine per cent of carbon, it is apparent that to carburize the steel to the extent desired, eight pounds of ground coke should be charged into the case or cases to be introduced into the ladles.

When using the process for recarburizing Bessemer steel, the loss of carbon is somewhat greater when the iron is to be highly recarburized, so that under the conditions just stated, about twelve pounds of coke dust should be added in the ladle to raise the carbon content of the steel .20 of one per cent.

Variations in the details of working of the process will suggest themselves to those skilled in the art.

By the term "free carbon" herein used, I mean solid carbon not chemically combined with metals.

I claim:—

1. In the manufacture of steel, the improvement which consists in treating the metal in the furnace or converter for conversion into steel, placing in a receiving vessel or ladle a definite amount of free carbon proper to raise the carbon content of the steel to the point desired, and then pouring the steel upon the same; substantially as and for the purposes described.

2. In the manufacture of steel, the improvement which consists in treating the metal in the furnace or converter for conversion into steel, introducing into a receiving vessel or ladle having a discharge opening a layer of molten steel sufficient to cover the opening, then introducing free carbon, and pouring the steel upon the carbon; substantially as and for the purposes described.

3. In the manufacture of steel, the improvement which consists in treating the metal in the furnace or converter for conversion into steel, introducing into a receiving vessel or ladle a layer of molten metal, then introducing upon said layer a definite amount of free carbon proper to raise the carbon content of the steel to the point desired, and pouring the steel upon the carbon; substantially as and for the purposes described.

4. In the manufacture of steel, the improvement which consists in treating the metal in the furnace or converter for conversion into steel, placing in a receiving vessel or ladle an easily destructible case containing a definite amount of subdivided free carbon proper to raise the carbon content of the steel to the point desired, and pouring the steel; substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 30th day of January, A. D. 1892.

TAYLOR ALLDERDICE.

Witnesses:
W. M. TAPPAN,
HARRY HECKLER.