

# UNITED STATES PATENT OFFICE.

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## PROCESS OF TREATING MOLTEN METAL WITH NATURAL GAS.

SPECIFICATION forming part of Letters Patent No. 411,205, dated September 17, 1889.

Application filed March 15, 1886. Serial No. 195,327. (No model.)

*To all whom it may concern:*

Be it known that we, FRANK L. SLOCUM and HORACE W. LASH, of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in the Process of Treating Molten Metals with Natural Gas; and we do hereby declare the following to be a full, clear, and exact description thereof.

Our invention relates to the treatment of molten iron, steel, and other metals or alloys for the formation of carbides thereof and the purification thereof from admixed elements or compounds, as well as the removal of free or combined oxygen therefrom, its special object being to deoxidize, purify, and carburize molten iron in the manufacture of all classes of steel or iron, whether crucible, open-hearth, crome, Bessemer, or other steels, as well as to obtain any degree of carbon in the resultant metal from puddled iron containing but a trace thereof to the highest percentage required. It may also be employed to advantage in the manufacture of different alloys, such as self-hardening steel, phosphor-bronze, carbon-bronze, manganese-iron bronze, &c.

Our invention relates specially to the use of natural gas or methane to deoxidize the metal to purify the same by removing therefrom the sulphur and other impurities, and to form a carbide with or recarburize the metal, raising it to the required percentage of carbon.

Our invention consists in heating the natural gas or methane to a point below the temperature at which it decomposes, and then passing the heated natural gas through the metal when in a molten condition, so providing for the treatment of the molten metal without chilling it or reducing it in fluidity, and enabling us to control better the treatment of the metal for deoxidizing, purifying, and recarburizing, as may be found necessary.

To enable others skilled in the art to make and use our invention, we will describe the same more fully.

Our invention can be practiced with any of the ordinary furnaces or other apparatus em-

ployed with the different processes of manufacturing iron, steel, or other metals with which it is employed, and for this reason we have not illustrated the same. In the manufacture of steel by the Bessemer and kindred processes, our invention may be employed in the following manner: The molten pig metal is charged into the converter in the ordinary manner and the ordinary air-blast forced through it to remove the carbon and other impurities, this being commonly termed "decarburizing." The natural gas employed for treating the metal decomposes at a lower heat than the melting-point of the metal, and yet can be raised to a comparatively high heat before it is decomposed, and can therefore be so heated as to prevent the chilling of the metal and decreasing its fluidity when introduced, which would take place if the cold gas were introduced and necessarily absorbed from the metal sufficient heat to cause the decomposition of the gas, as has been practically proven. For the purpose of heating the gas we employ any suitable form of hot-blast oven, which it is not considered necessary to illustrate. The gas is heated to any point below that of its decomposition—say about 1,500° centigrade—before it is forced through the molten metal within the converter, being introduced through the ordinary tuyeres, and being forced through the metal either by its natural pressure or under artificial pressure, as may be found necessary. As so introduced, the gas is quickly decomposed by the molten metal without reducing the temperature thereof to any appreciable extent, the gas being decomposed into hydrogen and carbon. These gases first act to deoxidize the metal, the hydrogen uniting with the oxygen therein to form steam, and the carbon uniting therewith to form carbonic oxide, both of which pass off in gaseous form. Where the molten metal contains any sulphur, the hydrogen will unite therewith to form sulphureted hydrogen, or, under certain circumstances, the carbon will unite with the sulphur to form bisulphide of carbon and pass off in a gaseous form. Where the metal contains phosphorus, a portion thereof will unite

with the hydrogen and pass off as phospho-  
reted hydrogen; but, so far as now known, all  
the phosphorus cannot be eliminated in this  
manner. As the stream of gas continues, the  
5 free carbon in an amorphous state at a regu-  
lar speed unites with the molten metal to car-  
burize it, or otherwise form carbide of iron  
or steel. The decomposition of the gas takes  
place regularly and quietly, while the heat  
10 generated by the chemical actions, aided by  
the lowering of the melting-point of the metal  
by the addition of carbon thereto, keeps the  
bath in a highly liquid state. The current of  
gas is continued until the desired percentage  
15 of carbon is obtained therein, this being as-  
certained by tests, as usual, and the metal is  
then ready to pour. The resultant product  
is a true steel practically free from oxygen  
or oxides and raised to the percentage of car-  
20 bon required.

In employing our invention in connection  
with the open-hearth and kindred processes  
of making steel of homogeneous iron, the  
heated natural gas may be introduced into and  
25 caused to pass upwardly through the bath of  
decarburized molten metal by means of one or  
more movable tuyeres entering through the  
roof, door, or side walls of the furnace, and the  
process and results obtained are substantially  
30 the same as when used in the Bessemer pro-  
cess, as above described.

The steel so produced in either the open  
hearth or converter is practically of as fine  
quality as the ordinary crucible steel, and  
35 may be employed for substantially all the  
uses of such steel. If, however, our improve-  
ments are to be applied to crucible steel, after  
it is melted in the crucible it may be teemed  
into a ladle or converter and the heated gas  
40 passed through it to thoroughly deoxidize and  
purify it.

In employing our invention in the manu-  
facture of alloys, its advantages may be illus-  
trated in the manufacture of manganese-iron  
bronze, which has heretofore been exceed- 45  
ingly difficult to obtain without the admix-  
ture of slag or scoria on account of its liabil-  
ity to oxidize. The ferro-manganese and cop-  
per may be melted together in the proper pro-  
portions without regard to their oxidation, 50  
and when melted the heated natural gas  
passed through the molten metal, the gas de-  
composing when in contact with and at the  
heat of the metals and acting to thoroughly  
deoxidize them, in which condition they will 55  
alloy perfectly.

By heating the natural gas or methane be-  
fore introducing it into the molten metal, we  
are enabled to produce better results than by  
the introduction of the gas when cold, as the 60  
metal can be maintained at a higher tempera-  
ture and its fluidity assured even when very  
low in carbon.

What we claim as our invention, and de-  
sire to secure by Letters Patent, is— 65

The herein-described improvement in the  
art of treating metals, consisting in heating  
natural gas or methane to a point below the  
temperature at which it decomposes, and then  
70 passing it through the metals when in a molten  
condition, substantially as and for the pur-  
poses set forth.

In testimony whereof we, the said FRANK  
L. SLOCUM and HORACE W. LASH, have here-  
unto set our hands.

FRANK L. SLOCUM.  
HORACE W. LASH.

Witnesses:

JAMES I. KAY,  
I. E. BARNES.