UNITED STATES PATENT OFFICE.

GEORGE W. SWETT, OF TROY, NEW YORK.

IMPROVEMENT IN MANUFACTURE OF IRON AND STEEL.

Specification forming part of Letters Patent No. **219,541**, dated September 9, 1879; application filed April 11, 1879.

To all whom it may concern:

Be it known that I, GEORGE W. SWETT, of Troy, Rensselaer county, New York, have invented an Improvement in the Manufacture of Iron, Steel, and Cast-Iron, of which the following is a specification.

My invention relates to the manufacture of an improved grade or quality of metal suitable for ordnance, machinery, or other castings by refining cast-iron in any of its commercial forms, and the subsequent admixture therewith of lower or higher grades of cast-iron, wrought-iron, or steel.

It has for its object the manufacture of a refined metal, highly decarburized, desiliconized, desulphurized, and dephosphorized, combining the maximum of density with the maximum of tensile strength and elasticity, specially adapted to the manufacture of cannon, car-wheels, chilled rolls, and similar heavy or lighter castings, and to puddled or wrought iron and steel.

Heretofore, in the manufacture of cast-iron guns by the old process, it has been the invariable practice to charge the furnace with a low grade of charcoal pig-iron, known as No. 1, No. 2, No. 3, or No. 4, (seldom No. 4,) and in some cases adding thereto a small proportion of remelted iron. After being melted, the iron was kept in the furnace for some hours under the refining influence of heat and oxygen until the desired portion of the silicon and carbon had been removed, and the density, ductility, and tensile strength were thereby correspondingly increased. When the metal had been thus treated until the maximum point in the development of these physical qualities best adapted for gun-metal was supposed to have been reached, it was drawn from the furnace and the gun was cast. Gun-metal thus treated presents, when cold, a gray appearance, with light clouded patches interspersed throughout the fracture.

Hitherto the metal so prepared has been considered the best attainable for cast-iron ordnance, it having been assumed that it combined the best possible union of the qualities of tensile strength, elasticity, ductility, and proper density. The same process, when continued beyond the point here indicated, increased the density at the expense of the elasticity and tensile strength.

Now I have discovered that at the point at which the above-described process leaves the metal the latter has hardly commenced to undergo the changes of which it is capable, and which are essential in order to obtain the best quality of metal, either for the construction of ordnance or for any of the other purposes herein named.

My process consists in refining cast-iron in an ordinary reverberatory or fining furnace, or of any modified form of such furnaces as may be best suited to produce the desired results, where it is refined to a point far beyond that which was the limit of the process heretofore in vogue, as above described, for producing gun-metal—that is, until the metal has reached either the condition known to the trade as "No. 6" or "No. 7" iron, or, if desirable, until the molten mass is converted successively into steel, semi-steel, semi-wrought-iron, pure or nearly pure iron, and becomes so freed from all impurities as to nearly reach its limit of fluidity under the ordinary degree of heat used.

The melted mass having been refined to the point required, according to the result or grade of metal it is desired to obtain, I either mix the refined product in its molten state with a lower grade of metal, intended to act as a carburizer, or with a still more highly refined metal, such as wrought-iron, acting as a decarburizer, for the purpose of recarburizing or still further decarburizing the melted mass to any desired degree; or the molten metal or refined, and without any admixture, may be run out into machinery castings, other cast forms or pigs, and slabs.

If at any time during the process of refining the metal should become so freed from carbon, silicon, and other impurities, as to reach a non-fluid or pasty state, a suitable quantity of some alkaline or carburizing substance may be introduced (using either of these substances singly or in combination in proper proportions) to restore the requisite fluidity. If, at this stage of the process, however, it should be desirable to recarburize the metal for purposes other than the simple restoration of its fluidity, then a specific amount of the recarburizing material, such as an iron containing the requisite amount of carbon and silicon, or carbon and manganese—for exam-

ple, low grades of pig-iron, franklinite, spiegeleisen, or ferro-manganese, may be introduced, both that the fluidity may be restored—and that the requisite amount of carbon may be added to produce the special grade of steel or other metal required, as well as to remove any of the remaining oxide.

The material thus prepared is now ready either for being run into machinery or other castings, into ingots or slabs, or for yet further manipulation in a suitable rotary or other puddling-furnace, or in the Bessemer converter or open-hearth furnace, or for treatment in crucibles.

For the Siemens-Martin or other variety of open-hearth, or for the crucible or Bessemer-steel process, the refined metal at any stage of its refinement may be mixed with a purer metal, such as steel or wrought-iron, either in the molten condition or in the solid form. This enables the manufacturer to use a very large proportion of the refined metal herein described in place of the more costly wrought-iron, and to produce in any open-hearth furnace a steel superior in fineness, homogeneousness, and soundness to any which can be obtained by the Bessemer process.

The purification of the metal by the process here described may be facilitated by lining the refining-furnace with a suitable fettling or hearth, in which any one, or two, or more, in combination, of the following substances may be used in suitable proportions, viz: protoxides of iron, magnetic iron ores, hematite ores, hammer-scale, iron oxides, manganiferous oxides of iron, oxides of iron combined with chrome, wrought-iron scrap, steel-turnings or scrap steel.

The exact proportions of the particular substance or substances above enumerated must necessarily be determined by the nature of the product sought, and be governed to a great extent by the character of the material used—as, for instance, when a pig metal containing a sufficient quantity of manganese is used, a smaller proportion, or possibly no manganese or spiegeleisen would be required. Again, when the pig metal contained phosphorus, the fettling or lining should contain more of the oxides of iron for the purpose of washing out and eliminating this element.

Thus it will be perceived that the proportions of the admixtures here indicated must necessarily be varied according to the nature of the ingredients or material used and the products we are seeking to obtain.

Manganese or compounds of manganese and iron will be found of great advantage in this, as it is in many of the different iron and steel processes, and may be added to the metal in the course of the purifying process to any extent from one to fifty per cent. and upward; but it will not be to the advantage or benefit of the metal under treatment to add more manganese than just so much as will remove or neutralize the oxygen which may be present in the metal under treatment.

As regards the proper moment for the introduction of the refining and recarburizing agents, they may be used at any stage of the process; but it is preferable to use the manganese, ferro-manganese, or spiegeleisen at or nearly at the close of the refining process, as is practiced in the Bessemer treatment.

The characteristics of soundness and homogeneousness mentioned, in connection with the superiority of steel prepared by my process over that made by the Bessemer plan, are among its most valuable features, and for the following reasons:

It is a well-known fact that, by blowing atmospheric air into or through the molten metal in the manner as now practiced in the Bessemer process, gas is generated in the metal by the oxidizing-blast, being in part the carbonic oxide formed by the action of the oxide of iron upon the carbon of the steel, and in part the gases taken up by the steel during its formation or melting, which continue to be evolved as long as the metal remains in the molten condition, and, being unable to force their way to the surface as rapidly as they are generated, become caught in the mass as it cools, and thus produce a greater or less number of blow-holes in the castings. Hence it is evident that as the Bessemer process is now conducted it is practically impossible to obtain castings perfectly compact. This difficulty is less apparent in open-hearth steel and still less in crucible steel.

In the process of refining above described these defects are entirely avoided, and a compact steel free from blow-holes is produced at a much less cost.

The great advantage and superiority of my process for the manufacture of iron and steel, as herein described, over other processes consists in purifying the pig or other cast iron previous to adding to it or mixing with it a lower grade of metal containing the requisite amount of carbon, or of carbon and silicon, or a purer and more refined metal, such as wrought iron or steel.

Having thus described my invention or process, what I claim as new, and desire to secure by Letters Patent of the United States, is—

The process of manufacturing a refined metal, consisting in refining iron in an ordinary reverberatory or fining furnace, or in any modified form of such furnace, to a point equal to or beyond that known as "No. 6," and then mixing the metal thus refined with a lower or different grade of metal, as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

GEORGE W. SWETT.

Witnesses:
WM. A. FELTON,
F. W. SWETT.