UNITED STATES PATENT OFFICE.

FRANK J. TONE, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO THE CARBORUNDUM COMPANY, OF NIAGARA FALLS, NEW YORK, A CORPORATION OF PENNSYLVANIA.

MANUFACTURE OF IRON AND STEEL.

SPECIFICATION forming part of Letters Patent No. 708,941, dated September 9, 1902.

Application filed January 2, 1901. Serial No. 41,892. (No specimens.)

To all whom it may concern:

Be it known that I, FRANK J. TONE, of Niagara Falls, Niagara county, New York, have invented a new and useful Improvement in the Manufacture of Iron and Steel, of which the following is a full, clear, and exact description.

I have discovered that the manufacture of iron and steel can be greatly improved by the addition to the molten metal of metallic silicon instead of using silicides of iron, carbon, &c. In the case of these stable silicides silicon has satisfied a certain affinity which it has for iron or for carbon, and the combination of the two elements represents a certain amount of energy given up. Silicon, however, has a much greater affinity for oxygen than for carbon or iron, and when either the silicide of iron or of carbon is added to molten iron containing oxids—as, for example, ferric oxid—the silicides are decomposed if the temperature is sufficiently high, and the silicon thus freed unites with the oxid of iron, reducing the same. In order, however, to set free the silicon from the silicides, energy has been expended. Herein lies the advantage in the use of metallic silicon in place of the silicides, that no energy being necessary to free the silicon (it being already free) it exerts the maximum reducing and superheating power and can be used where in some cases the silicides remain passive and without effect. Take, for example, the iron drawn from the ordinary foundry-cupola. If silicide of carbon is added to the ladle during tapping, the silicon of the silicide has not sufficient affinity for the iron or its contained oxids to dissociate the silicide and set itself free, owing to the comparatively low temperature at which the cupola is commonly operated. If, on the other hand, we add metallic silicon, it enters vigorously into combination with the iron, reducing its oxids, and the remainder combines to form silicides of iron, the reaction resulting in superheating the metal. The same is true in the use of silicide of carbon in the steel-furnace to a less degree on account of the higher temperature of operation. The action of the silicide in the form of ferrosilicon differs from that of metallic silicon even more radically than that of silicide of carbon, the ferrosilicon carrying a much lower content of silicon. When added to steel in this dilute state, its oxidizing power is of necessity very low compared with metallic silicon. The action of metallic silicon therefore differs fundamentally from that of the silicides and resembles more closely that of metallic aluminium. Both when added to molten steel are powerful reducing agents, and both react with the oxids to superheat the metal. Silicon, however, is the better reducing agent, for the reason that in forming its normal oxid SiO_2 it takes up $1.14\left(\frac{2\times16}{28}\right)$ times its own amount of oxygen. Aluminium in forming Al_2O_3 takes up $0.87\left(\frac{3\times16}{2\times27.4}\right)$ times its own amount of oxygen. It is also a superior superheating agent, as one gram of silicon in forming its oxid generates 1.1 times as much heat as one gram of aluminium, and to these advantages may be added the fact that the silicon, being added in substantially its elemental form, does not entail the incorporations of the large amount of carbon and other elements which go with it when it is added in the form of a silicide or other compound.

In the practice of my invention in making steel castings I add the silicon to the steel preferably when the steel is tapped into the ladle or poured into it from the furnace or converter. The addition can be made by breaking the silicon into small pieces and placing it in the ladle before or during the act of pouring. It is possible to add the silicon by placing it in the mold in which the steel is poured. A like manner of adding the silicon may be adopted when it is added in the manufacture of steel ingots. The silicon is also useful in the manufacture of iron castings, in which the low temperature at which it combines with the iron gives it many advantages over the use of carbid of silicon or ferrosilicon. Thus although it has hitherto been considered impossible to incorporate silicon in cast-iron by placing ferrosilicon or silicon carbid in the ladle into which the iron is poured such procedure is quite feasible where silicon is used, for even at the low temperature at which the iron comes from the cupola it will readily take up the silicon. I have found the following proportions desirable, although those skilled in the art will be able to modify these proportions in order to suit the particular material and the purpose for which the addition is made.

In making steel castings from open-hearth steel I may add one-quarter of one per cent. of silicon, which will impart to the steel great fluidity and enable it to flow quietly into the mold without the formation of bubbles or blow-holes. In making iron castings I may add with advantage to the iron in the ladle one-half of one per cent. of silicon, the effect of which is to increase the percentage of graphitic carbon in the iron, to make a sounder casting, and one which is soft and can be readily machined.

I claim—

As an improvement in the art of making iron and steel, the improvement which consists in adding to molten iron or steel silicon in its elemental form; substantially as described.

In testimony whereof I have hereunto set my hand.

FRANK J. TONE.

Witnesses:
H. M. CORWIN,
L. M. REDMAN.