UNITED STATES PATENT OFFICE.

FREDERICK M. BECKET, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO ELECTRO METALLURGICAL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF WEST VIRGINIA.

PROCESS OF MAKING TITANIUM ALLOYS.

No. 910,894. Specification of Letters Patent. Patented Jan. 26, 1909.

Application filed June 5, 1907. Serial No. 377,335.

To all whom it may concern:

Be it known that I, FREDERICK M. BECKET, a subject of the King of Great Britain, residing at Niagara Falls, in the county of Niagara and State of New York, have invented certain new and useful Improvements in Processes of Making Titanium Alloys, of which the following is a specification.

This invention is a process of making an alloy or mixture containing as its essential constituents titanium, silicon and carbon in proportions substantially as hereinafter described and usually in association with iron.

The product is chiefly intended for use in the treatment of iron or steel for the purpose of removing therefrom the occluded gases and other impurities such as dissolved metallic oxids, or of producing therewith certain alloys of which titanium is a constituent.

When titanium ores or ores of titanium and iron are reduced by carbon in an electric furnace, sufficient carbon being employed to insure fair commercial efficiency of the operation, there is formed a product containing a large proportion of carbon, such proportion amounting in the case of titanium carbid to approximately twenty per cent. by weight of the product. A compound of this character is extremely hard, difficultly fusible, and dissolves but slowly in molten metal. It is moreover objectionable by reason of its high carbon content, inasmuch as the quantity of the titanium compound which may be added to a given weight of iron or steel is necessarily limited by the carbon content permissible in the resulting metal.

I have discovered that by associating silicon in substantial proportions with the titanium, and by effecting the reduction under proper conditions, the proportion of carbon in the product may be greatly reduced and the product acquires new and valuable characteristics. The silicon in this case acts to some extent as a carbon-excluding agent. That is to say, a reduced product containing titanium and silicon exhibits a far lower affinity for or tendency to combine with carbon than a product containing no silicon; and the higher the proportion of silicon, the less carbon is absorbed under otherwise similar conditions.

It is essential that the titanium should be present in the alloy in proportion to render it of value for technical purposes, say in excess of five per cent., and the percentage of silicon should be sufficient to exert a marked effect upon the carbon content, that is to say to reduce the carbon content to ten per cent. or less. It should be understood that the percentage of silicon required to effect this result is not fixed and invariable, but bears a general proportion to the percentage of titanium present, for the reason that a given percentage of silicon exerts less effect in reducing the carbon content of an alloy high in titanium than is the case with an alloy relatively low in titanium.

A specific example of the process is as follows: A charge containing approximately

Rutile	38%
Ferro silicon (50%)	22
Scrap iron	20
Carbon	20

was reduced in an electric furnace between carbon electrodes yielding a product containing

Titanium	33.70
Iron	43.69
Silicon	14.23
Carbon	8.32
Aluminum	0.08
Calcium	Trace.

In case of alloys lower in titanium the percentage of silicon above noted would yield a product of lower carbon content; and in case of alloys still richer in titanium it will be necessary to increase very considerably the percentage of silicon in order to maintain the carbon content of the alloy within desirable limits. In case still lower carbon contents are desired, these can be secured by suitably increasing the proportion of silicon in the alloy. By using a high-grade rutile, products may be obtained containing less iron than is indicated by the above analysis.

Titanium alloys produced in accordance with my process present as compared with ferro-titanium the advantages of a lower melting point and a capacity for entering more freely into solution in molten iron or steel; furthermore, by reason of their comparatively low carbon content they may be added, if desired, in relatively large proportions without unduly increasing the proportion of carbon in the resulting metal. Their appearance varies somewhat in accordance with the mode of their production, rate of cooling, etc.; in general they have a metallic

luster and a more or less distinct crystalline fracture; they are very fusible as compared with titanium carbid or metallic titanium, and much softer than these products. They are comparatively brittle and are readily crushed to such state of subdivision as is desirable for insuring their complete solution in molten iron or steel.

The process may be carried out under varying conditions, the essential feature being the reduction in an electric furnace of an ore containing titanium, in presence of carbon and of sufficient silicon to exclude from the product carbon in excess of ten per cent. The following methods are satisfactory: (1), by reducing by carbon in an electric furnace a charge containing oxids of titanium and silicon; (2), by reducing oxid of titanium by carbon in an electric furnace, ferro-silicon or silicon being incorporated with the charge or added to the bath. The carbon is usually employed in substantially the proportion required to unite with the oxygen of the oxid or oxids of the charge. In any case the process is preferably rendered continuous by adding fresh portions of the charge and removing the products from time to time.

I claim:

1. The process which consists in reducing a titanium ore in an electric furnace by means of carbon in presence of sufficient silicon to exclude from the product carbon in excess of ten per cent.

2. The process which consists in reducing in an electric furnace by means of carbon a charge containing ores of titanium and silicon, the silicon being present in sufficient proportion to exclude from the product carbon in excess of ten per cent.

3. The process which consists in reducing a titanium ore in an electric furnace by means of carbon in presence of sufficient silicon to exclude from the product carbon in excess of ten per cent., the carbon being in substantially the proportion required to unite with the oxygen of the oxid or oxids of the charge.

4. The continuous process which consists in reducing a titanium ore in an electric furnace by means of carbon in presence of sufficient silicon to exclude from the product carbon in excess of ten per cent., adding fresh portions of the charge and withdrawing the products as desired.

5. The continuous process which consists in reducing in an electric furnace by means of carbon a charge containing ores of titanium and silicon, the silicon being present in sufficient proportion to exclude from the product carbon in excess of ten per cent., adding fresh portions of the charge and withdrawing the products as desired.

6. The continuous process which consists in reducing a titanium ore in an electric furnace by means of carbon in presence of sufficient silicon to exclude from the product carbon in excess of ten per cent., the carbon being in substantially the proportion required to unite with the oxygen of the oxid or oxids of the charge, adding fresh portions of the charge and withdrawing the products as desired.

In testimony whereof, I affix my signature in presence of two witnesses.

FREDERICK M. BECKET.

Witnesses:

CARLETON F. BROWN,

C. C. MOSHER.