

UNITED STATES PATENT OFFICE

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PROCESS OF MANUFACTURE OF ALUMINUM-SILICON ALLOYS

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The manufacture of aluminum-silicon alloys having high mechanical resistance necessitates the preparation beforehand of starting or preliminary alloys of great purity, that is to say, very poor in iron, carbon and titanium, and testing about 87% Al and 13% Si.

On the other hand, metallurgy, and particularly the iron industry, and the chemical industries have need for aluminum-silicon alloys testing relatively high in silicon and in which the presence of iron, titanium, and carbon is not an obstacle to their particular use.

The starting alloys have first of all been prepared by fusion of aluminum and silicon as pure as possible, but such a process is costly.

Subsequently it was attempted to produce starting alloys by electro-thermic means. It is thus that we now know how to produce by electro-thermic means, and under very satisfactory technical conditions, aluminum-silicon alloys with an aluminum content greater than 67%.

But in spite of the new arrangements which were necessary to adopt in this kind of manufacturing, there is obtained, in general, starting alloys having a content in silicon greater than 15% and containing as impurities, iron, titanium and carbon, with an inadmissible percentage for the manufacturing of the final alloy of high mechanical resistance. This led to remelting these alloys for obtaining the so-called starting alloy, before subjecting them to the final treatment, with a suitable quantity of aluminum in pure state, which adjusted the alloy in definite aluminum and silicon content and at the same time diluted the impurities thus giving the desired final alloy.

The present invention has for an object a process which permits of obtaining simultaneously, without the use of silicon or aluminum previously prepared, on the one hand,

an aluminum-silicon starting alloy of great purity and of a composition near to that required in a final alloy for the mechanical applications, and, on the other hand, an unpurified aluminum-silicon low grade alloy, relatively rich in silicon and immediately utilisable for chemical and metallurgical operations.

The present process consists first of all in subjecting to liquation a primary alloy containing too little aluminum, too much silicon and at times too much impurities (iron, carbon and titanium) to be serviceable as a starting alloy for obtaining final alloys of high mechanical resistance, such as for example, an alloy of more than 67% aluminum obtained directly in the electric furnace.

The invention further consists in effecting this operation of liquation with the intervention of operative steps hereinafter described, applied separately or simultaneously, which steps permit of obtaining, during liquation, outputs of an aluminum-silicon starting alloy of a composition near to that required in a final alloy for mechanical uses, together with the obtaining of a marketable by-product.

The steps in question are essentially as follows:

First. Bringing to a form of large crystals, the silicon contained in the primary alloy, said crystallization being obtained, for example, by the slow solidification of silicon in the heart of the alloy, or by oscillations of a slow nature obtained by reheating and re-cooling during solidification.

Second. Heating the whole mass, and stirring during the time it is maintained at a temperature near and slightly above the fusion point of the eutectic, in a way to break up the aggregations of crystals likely to retain the eutectic between them.

Third. In filtering the mass of the alloy and crystals thus obtained with the optional intervention of mechanical means such as

mechanical pressure, vacuum, gaseous pressure, centrifugal force, and the like.

Fourth. In washing with melted salts or metals the cake of crystals remaining in the filter.

In this operation of liquation, the body of alloy separates into two parts, one, a liquid, which is the aluminum-silicon eutectic alloy melting in the neighborhood of 575° C. and forming a starting alloy of a composition, after special treatment, of about or equal to that of the final alloy for use in mechanical applications; and the other a solid low grade alloy containing the major part of silicon. Further, this separation takes place with the surprising result that the impurities of the primary alloy, iron, titanium, carbon, and the like, become concentrated in the low grade alloy remaining solid and rich in silicon and this concentration takes place in a ratio which depends upon the initial proportions of impurities and above all on the difference of temperature between the eutectic temperature and that at which the operations take place. From this it may be deduced that even if the proportion of the impurities is considerable, the eutectic alloy which runs freely can, subject to a suitable choice in temperature, become purified during the same operation, in a proportion such that with its composition it becomes immediately ready for suitable manufacture of alloys for mechanical uses.

It will be noticed that the importance of this mode of purification consists in that it allows an appreciable tolerance in electrothermic manufacture and permits, for example, the dependable use of kaolin in the electric furnace, while at the same time, by means of the subsequent thermic separation by liquation, it leads easily to a liquid alloy of less than 0.6% iron.

It is well to notice that the content in silicon of the liquid alloy thus obtained depends, other things being equal, on the temperature at which the operations take place.

There is thus obtained, at will, all contents in silicon included between the content of the eutectic and that of the starting alloy, with a proportion of impurities less than that of the starting alloys.

As to the impurities which accumulate in the solidified low grade alloy rich in silicon; they are without importance for the metallurgical applications of this alloy, such as deoxidation in the iron industry, silico and aluminothermic reduction, manufacture of hydrogen and the like. It will be noticed, however, that such impurities prevent in a most distinct fashion, the reutilization of this alloy in the electric furnace with a view to the production of a new quantity of primary or initial aluminum-silicon alloy.

Another advantage of the invention is as follows:

The alloy rich in aluminum, obtained in

the manner hereinbefore described, has a very high aluminum content, which, if desired, may be close to 85%. If it is desired to produce the silicon-aluminum alloys at 12 to 14% Si, for example, one can do so, either by using directly the alloy obtained by separation, or by proceeding with an adjustment by remelting the alloy with a very small addition of electrolytic aluminum. The present invention therefore permits eliminating, either entirely, or nearly entirely, the amount of electrolytic aluminum necessary for elaborating the alloy to an aluminum-silicon alloy of more than 12% silicon and to reduce very considerably the amount necessary for elaborating the alloy to an aluminum-silicon alloy of less than 12% Si.

The invention is therefore an application of the liquation process to alloys determined by aluminium for obtaining an industrial result, to wit, the simultaneous production of two alloys, one suitable for mechanical uses, the other adapted to serve in metallurgical or chemical uses.

An example of the execution of the process forming the object of the invention will now be described, although the invention is not limited to such specific example.

There was poured from the electric furnace a raw alloy having the following composition:

	Per cent
Aluminum -----	67.87
Silicon -----	28.68
Iron -----	1.68
Titanium -----	0.40
Carbon -----	0.62

This alloy was subjected to a slow cooling from a temperature slightly higher than the temperature at which solidification commences, to wit, at about 1000° C. An alloy was thus obtained whose fracture reveals faces corresponding to the crystals of silicon of a length extending up to 4 millimeters.

The cake obtained was crushed and then was reheated and maintained at a temperature scarcely greater than the point of fusion of the eutectic.

The whole was stirred continually during the heating operation which had for effect to break up the aggregates of crystals and to reassemble the small eutectic melted drops, while rendering the temperature very uniform throughout the whole mass.

The product obtained was poured on to a filter and covered over with 15 kilograms of a mixture of chlorides in melted condition, the filter and the salts being at a temperature in the neighborhood of 600° C. At this moment a vacuum was formed. By filtering across the cake of crystals, the chlorides carried away the eutectic remaining adherent,

thus producing a washing of the solid residue.

The lighter chlorides were easily separated from the eutectic alloy and could be utilized for a new operation.

There was obtained 16.150 kgs. of an alloy (starting alloy) having the following contents:

	Per cent
10 Aluminum -----	83.86
Silicon -----	14.57
Iron -----	0.58
Titanium -----	0.10
Carbon -----	0.10

What is claimed as new and is desired to be secured by Letters Patent is:

1. A process of obtaining aluminum-silicon alloys which comprises slowly cooling an alloy obtained directly from the electric furnace, and containing too little aluminum, too much silicon and too much iron, carbon and titanium for mechanical uses, thereby effecting crystallization of the silicon in the alloy in the form of large crystals, and subjecting the resultant mass to liquation at a temperature slightly above the fusion point of the eutectic while mechanically dispersing and breaking up the aggregates of large crystals thus formed.

2. A process of obtaining aluminum-silicon alloys from a primary alloy containing too little aluminum and too much silicon, iron, carbon and titanium to serve as a starting alloy for a product suitable for mechanical uses, said process consisting in subjecting said primary alloy to liquation and separating the mass into two parts, one a liquid aluminum-silicon alloy containing a high percentage of aluminum, the other a solid mass containing the major part of the silicon, iron, carbon and titanium.

3. A process of obtaining aluminum-silicon alloys which consists in slowly cooling an alloy obtained directly from the electric furnace, said alloy containing too little aluminum and too much silicon, iron, carbon and titanium to be serviceable as a starting alloy for a product suitable for mechanical uses, thereby effecting the crystallization of the contained silicon in the form of large crystals and thereafter subjecting the mass to liquation and separating the solid part of the mass containing the major part of the silicon and of the specified impurities from the liquid aluminum-silicon alloy rich in aluminum.

4. A process of obtaining aluminum-silicon alloys which consists in slowly cooling an alloy obtained directly from the electric furnace, said alloy containing too little aluminum and too much silicon, iron, carbon and titanium to be serviceable as a starting alloy for a product suitable for mechanical uses, thereby effecting the crystallization of the contained silicon in the form of large crystals,

and thereafter subjecting the mass to liquation at a temperature slightly above the fusion point of the eutectic while mechanically breaking up and dispersing the aggregate of large crystals thus formed and separating the solidified part of the mass, containing the major part of the silicon and of the specified impurities, from the liquid alloy.

5. A process of obtaining aluminum-silicon alloys which consists in slowly cooling an alloy obtained directly from the electric furnace, said alloy containing too little aluminum and too much silicon, iron, carbon and titanium to be serviceable as a starting alloy for a product suitable for mechanical uses, thereby effecting the crystallization of the contained silicon in the form of large crystals, and thereafter subjecting the mass to liquation at a temperature slightly above the fusion point of the eutectic while mechanically breaking up and dispersing the aggregate of large crystals thus formed and filtering the partly melted mass of alloy thereby separating the solid from the liquid part, the former containing the major portion of the silicon and of the specified impurities.

6. A process of obtaining simultaneously a liquid aluminum-silicon alloy, purified and containing a high percentage of aluminum, and a solid aluminum-silicon alloy with high percentage of silicon and containing alloys of aluminum with the impurities contained in the starting alloy obtained from the electric furnace and containing too little aluminum, too much silicon and too much impurities, said process consisting in cooling slowly the starting alloy issued from the electric furnace in such a way that large crystals are caused to be formed, in subjecting the resultant mass to liquation under agitation, and in separating the purified alloy containing a high percentage of aluminum.

7. A process of obtaining simultaneously a liquid aluminum-silicon alloy, purified and containing a high percentage of aluminum, and a solid aluminum-silicon alloy with high percentage of silicon and containing alloys of aluminum with the impurities contained in the starting alloy, said process consisting in transforming the starting alloy into the form of a solid aggregate in which the silicon is in the form of large crystals, in breaking said aggregate, in subjecting the broken mass to a liquation under agitation, and in separating the eutectic from the residue.

8. A process of obtaining simultaneously a liquid aluminum-silicon alloy, purified and containing a high percentage of aluminum, and a solid aluminum-silicon alloy with high percentage of silicon and containing alloys of aluminum with the impurities contained in the starting alloy obtained from the electric furnace and containing too little

aluminum, too much silicon and too much impurities, said process consisting in slowly cooling the alloy, cast from the electric furnace, from a temperature about above that of the solidification in view of obtaining a starting alloy whose fracture reveals faces corresponding to silicon crystals of about 4 mm. length, in cooling the resultant mass in an aggregate, in breaking up said aggregate and in heating the same at a temperature slightly above the fusion point of the eutectic, under agitation for breaking up the crystal aggregates, in grouping the drops of eutectic and in maintaining a practically constant temperature in the mass.

In testimony whereof we have signed this specification.

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