(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 022 600**
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **10.11.82**

(51) Int. Cl.³: **C 22 C 1/03**

(21) Application number: **80200670.0**

(22) Date of filing: **09.07.80**

(54) **Method for the addition of metallic alloying agents to a bath of molten aluminium.**

(30) Priority: **17.07.79 NL 7905547**

(43) Date of publication of application:
21.01.81 Bulletin 81/3

(45) Publication of the grant of the patent:
10.11.82 Bulletin 82/45

(84) Designated Contracting States:
BE CH DE FR GB LI

(56) References cited:
US - A - 3 788 839

ROBERT J. ANDERSON: "The metallurgy of Aluminium and Aluminium Alloys", 1925, Edited by Henry Carey Baird & Co., pages 370—372: "Preparation of manganese-bearing aluminium alloys" New York, U.S.A.
L. F. Mondolfo "Aluminium alloys: Structure and Properties" (1979). Butterworths, London-Boston. pp. 529—530

(73) Proprietor: **Aluminium Delfzijl B.V.**
Postbox 133
NL-9930 AC Delfzijl (NL)

(72) Inventor: **van Wijk, Gijsbert Willem Meindert**
Spijksterweg 3
NL-9906 PA Bierum (NL)

(74) Representative: **Zuidema, Bert, Ir. et al,**
p/a HOOGOVENS IJMUIDEN B.V. P.O. Box 10.000
NL-1970 CA IJmuiden (NL)

EP 0 022 600 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Courier Press, Leamington Spa, England.

Method for the addition of metallic alloying agents to a bath of molten aluminium

The present invention relates to a method for the addition of metallic alloying agents to a bath of molten aluminium.

It is known to add various elements as an alloy to aluminium in order to make it more suitable for various operations, e.g. casting, kneading or rolling, for various applications such as building material or covering material for household use. For example, manganese, chromium, iron, boron, titanium and silicon have been used. These elements are usually added as pure metal to the aluminium bath, or alternatively as a master alloy with aluminium. For special applications, for example for grain refinement, master alloys of aluminium with a combination of titanium and boron may be used.

When alloying with these alloying agents, it is important that they dissolve sufficiently rapidly. For example, chromium dissolves insufficiently rapidly at a high temperature. For this reason, the master alloys of the pure metals with aluminium are frequently used. Manganese dissolves too slowly at temperatures up to 750°C. At higher temperatures, for example 850 to 900°C, which occur in transport ladles conveying electrolytic metal to the foundry, manganese dissolves sufficiently rapidly.

Hitherto it has been conventional to produce master alloys by adding pure alloying metal to liquid aluminium, which has been heated to a high temperature. Also pure alloying metals have been used for direct alloying. This involves considerable costs.

In the book "The Metallurgy of Aluminium and Aluminium Alloys" by Robert J. Anderson, published by Henry Carey Baird & Co. in New York in 1925 the use of a manganese-aluminium alloy as a master alloy is discussed on pages 370 to 373.

On page 371 Anderson discusses the use of a ferro-manganese-aluminium alloy with a aluminium concentration of 20%, but Anderson states that the presence of iron is normally regarded as objectionable. The reason for this now appears to be that ferro-alloys, such as the ferro-manganese alloy discussed by Anderson, often contain sulphur, phosphorus or carbon. It seems hitherto to have been presumed that, since these elements are capable to dissolving in the aluminium, undesirable compounds may be formed. It has also been thought that master alloys which contain ferro alloys would dissolve too slowly, certainly more slowly than the alloyed elements themselves.

It has now been found that, despite the prejudices of those skilled in the art against the use of master alloys containing ferro-alloys, the use of such master alloys with an aluminium concentration of at least 25% provides satisfactory results. Preferably the aluminium content should be at least 30%. The invention as claimed also has the advantage that the use of ferro alloys instead of pure metal in the master alloy reduces the cost of production of the desired aluminium alloy. This is particularly significant when alloying occurs at a relatively low temperature (e.g. 700 to 750°C).

It has also been found that the use of an aluminium ferro-alloy as the master alloy does not cause undesirable compounds to be formed to any significant degree in the aluminium. With modern metal treatment techniques, removed of phosphorus, sulphur or carbon from the iron is relatively simple. For example, phosphorus may be removed in the form of a carbide or a sulphide. Also, it has been found that, even when these elements are present they are frequently not taken up in the molten bath.

The difficulty of the relative slow rate of solution of ferro-alloys has been found to be relatively unimportant. Alternatively, the problem may be overcome completely by alloying at a temperature which is not too low, for example a temperature of 900°C. This can be achieved directly after tapping of the aluminium bath which is obtained by reduction in electrolytic cells, by alloying the aluminium in the transport ladles by which the bath is conveyed to holding furnaces.

It is also preferable that the master alloy of the ferro-alloy with aluminium, is converted into powder form prior to feeding it into the bath. This has the advantage that solubility is thereby increased, but care must be taken to ensure that such particles do not remain lying on the bath in consequence of the high surface tension or of the presence of an oxide film on the bath and/or about the particles. In order to prevent this, it is possible to blow the powder form alloying agent into the bath in a manner known *per se*. The powder may be blown under the bath surface with the aid of a lance and with air or nitrogen as an activating medium.

Another possibility is that the powder-form alloying agent is provided, in a manner known *per se*, the form of pellets which lose their cohesion at the smelting temperature. It is known to convert alloying elements to such pellet form. In particular, this is a technique well-known for the dosing of manganese into the bath. However, this known technique has not previously been applied to the dosing of ferro alloys and/or of master alloys of ferro alloys with aluminium.

Methods for increasing the solubility of, for example, manganese in aluminium, by providing the particles to be added to the aluminium with a skin from a salt mixture which decreases the surface tension are known. Such methods may be used with the ferro-alloys proposed herein.

It is an object of the present invention to provide a method for the addition of a metallic alloying element to a bath of molten aluminium, in which solution of the added element in the bath occur easily.

It is a second object of the present invention to provide an inexpensive way of producing an aluminium alloy.

Table 1 shows, by way of example, four master alloys of aluminium with ferro alloys which may be used successfully in the refinement of aluminium.

Table 1

AlMnSiFe	$Al_{30-85\%}$	$Mn_{50-10\%}$	$Si_{20-4\%}$	$Fe_{25-3\%}$
AlFeSiCr	$Al_{60-90\%}$	$Fe_{15-3\%}$	$Si_{15-3\%}$	$Cr_{15-3\%}$
AlFeSi	$Al_{30-60\%}$	$Fe_{20-10\%}$	$Si_{30-60\%}$	
AlFeB	$Al_{80-95\%}$	$Fe_{20-5\%}$	$B_{2-3\%}$	

The residue always less than 1%

At first sight, it would seem to be possible to use ferro-alloys which are not pre-alloyed with aluminium and which correspond to the alloys indicated in the Table with the omission of aluminium. However, it has been found that the aluminium master alloys can be dosed more accurately and are absorbed more rapidly in the bath. It is possible to prepare these aluminium master alloys by adding the iron alloys to molten aluminium but alternatively a method is possible in which aluminium is supplied during the production of the iron alloy.

The possible savings in cost which may be achieved with the present invention are illustrated with reference to the following Example.

The alloying of 1 tonne of electrolytic metal (socalled E-metal) to form alloy having 1% by weight of Mn (AlMn1) can be set out as follows:

	Si	Fe	Mn
composition of E-metal (% by weight)	0.04	0.12	0.002 residue Al
composition of AlMn1 (% by weight)	0.25	0.53	1.10 residue Al
to be added (% by weight)	0.21	0.41	1.1
in kilos per tonne of melt	2.1	4.1	11

The costs in Dutch guilders (f) when employing pure metals are (approximately, at 17th July 1979 which was the date of filing of the priority application)

2.1 kg Si at f 2.70 per kg	f 5.67
4.1 kg Fe at f 0.60 per kg	2.46
11 kg Mn at f 2.50 per kg	27.50
total	f 35.63 per tonne of alloyed metal

With the use of non-ferro-aluminium master alloys the costs increase considerably.

The cost of using ferro-silico-manganese (Mn 70%, Si 18%, Fe 8%) and ferro manganese (Mn 75%, Fe 20%) amount to:

11.7 kg ferro-silico manganese at f 1.10	f 12.97
3.7 kg ferro-manganese at f 0.80	2.96
3 kg of iron at f 0.60	1.80
	f 17.73 per tonne of alloyed material

In the performance of this example, the ferro-silico-manganese and the ferro-manganese were converted into master alloys by addition of Al to a final Al content in each master alloy of at least 25%. These master alloys and the extra Fe are then added in the desired proportions to the E-metal melt in which they dissolve quickly, to provide the desired content of AlMn1.

Although these costs must be treated as rough, they nevertheless illustrate the significant cost advantage that can be achieved.

Claims

1. A method for alloying aluminium with at least one alloying element, comprising adding an alloying agent to a bath of molten aluminium the alloying agent consisting at least partially of a master alloy containing said at least one alloying element, characterised in that said master alloy comprises aluminium in a concentration of at least 25% and at least one ferro-alloy of said at least one alloying element.

2. A method according to claim 1 wherein the concentration of aluminium in the master alloy is at least 30%.

3. A method according to claim 1 or claim 2 wherein the bath is in a ladle, and alloying is effected at a temperature of approximately 900°C.

4. A method according to any one of claims 1 to 3 wherein the master alloy is in powder form when added to the bath.

5. A method according to claim 4 wherein the master alloy is blown into the bath.

6. A method according to claim 4 or claim 5 wherein the master alloy in powder form is added to the bath as pellets which lose their cohesion at the bath temperature.

Patentansprüche

1. Verfahren zum Legieren von Aluminium mit mindestens einem Legierungselement, bei dem einem Aluminiumschmelzenbad ein Legierungsmittel zugesetzt wird, das zumindest teilweise aus einer Grundlegierung besteht, die das mindestens eine Legierungselement enthält, dadurch gekennzeichnet, daß die Grundlegierung Aluminium in einer Konzentration von mindestens 25% sowie mindestens eine Ferrolegierung des mindestens einen Legierungselements enthält.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Konzentration des Aluminiums in der Grundlegierung mindestens 30% beträgt.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß sich das schmelzenbad in einer Gießpfanne befindet und daß das Legieren bei einer Temperatur von etwa 900°C durchgeführt wird.

4. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die Grundlegierung dem Schmelzenbad in Pulverform zugesetzt wird.

5. Verfahren nach Anspruch 4, dadurch gekennzeichnet, daß die Grundlegierung in das Schmelzenbad eingeblasen wird.

6. Verfahren nach Anspruch 4 oder 5, dadurch gekennzeichnet, daß die in Pulverform vorliegende Grundlegierung dem Schmelzenbad in Form von Pellets zugesetzt wird, die bei der Schmelzenbadtemperatur ihre Kohäsion bzw. ihren Zusammenhalt verlieren.

Revendications

1. Procédé pour allier l'aluminium avec au moins un constituant d'alliage, comprenant l'addition d'un agent d'alliage à un bain d'aluminium en fusion, l'agent d'alliage consistant au moins partiellement en un alliage maître contenant au moins le constituant d'alliage en question, caractérisé par le fait que ledit alliage maître comprend de l'aluminium à une concentration d'au moins 25% et au moins un ferro-alliage dudit constituant d'alliage.

2. Procédé selon la revendication 1 dans lequel la concentration de l'aluminium dans l'alliage maître est au moins de 30%.

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel le bain est dans une poche et l'alliage est effectué à une température d'environ 900°C.

4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'alliage maître est sous forme de poudre quand il est ajouté au bain.

5. Procédé selon la revendication 4, dans lequel l'alliage maître est insufflé dans le bain.

6. Procédé selon la revendication 4 ou la revendication 5, dans lequel l'alliage maître sous forme de poudre est ajouté au bain sous forme de pastilles qui perdent leur cohésion à la température du bain.