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ALUMINIUM-COPPER ALLOYS

John Wood, Aylesbury, England, assignor to International Alloys Limited, Aylesbury, England

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4 Claims. (Cl. 75—140)

This invention relates to aluminium base alloys containing copper together with either no magnesium or magnesium in an amount less than 1% by weight, antimony and/or bismuth and/or lithium, and to a method of preventing the formation of a tough and thick skin on the molten surface, especially during casting of such alloys.

In the production of aluminium base alloys containing copper and some constituents, such as small amounts of antimony for the purpose of improving machinability and strength at high temperatures, difficulties occur due to the formation of a very tough and rather thick surface skin on the liquid metal which impedes the free flow of the said metal in the mould and causes drossy patches or folds to form, according to whether or not the pressure of the liquid metal under this skin is high enough to burst the skin before the surface metal solidifies. Antimony is generally added in the range of 0.1% and 1% by weight.

Similar difficulties, generally to a less pronounced degree, have also been observed in aluminium alloys containing copper and additions of bismuth or lithium in amount 0.03% to 1%.

The present invention is concerned with removing or reducing the defects caused by this skin. In accordance with the invention this is achieved by the addition of very small amounts of beryllium, of the order of 0.005% by weight and in the range 0.002% to less than 0.01% by weight to a copper containing aluminium base alloy having no magnesium constituent or less than 1% by weight magnesium and containing one or more of the constituents antimony, bismuth and lithium in respect amounts above 0.1% up to 1%, from 0.03% up to 1%, and from 0.03% up to 1% by weight. Copper-containing aluminium base alloys having no magnesium content or less than 1% by weight magnesium and containing antimony and/or bismuth and/or lithium with beryllium additions in the amounts indicated, form a skin of significantly

different mechanical properties, that is, a skin much less tough and heavy; consequently, the metal can flow freely in the mould and folds and dross patches are avoided.

Example 1

In the casting of cylindrical billets by the continuous casting process from aluminium base alloys containing in weight ratios approximately Cu 3%, Mg 0.5%, Sb 0.6%, Sn 0.15%, a considerable percentage — up to 50%—of the production had to be rejected owing to the formation of folds. The cause of these folds was found to be the obstruction presented to the free flow of metal from the centre of the mould to the wall. An alloy of the same composition except for the addition of 0.004% by weight Be when cast under identical conditions produced billets of which only about 5% had to be rejected for folds.

Example 2

Melts of three alloys with compositions as given in the table that follows were prepared, skimmed and kept at 750° C. exposed to still air. To assess the relative tendency towards formation of a tough surface skin qualitatively and quantitatively, the exposed surface of each melt was hand skimmed six times at 5 minute intervals, and finally a seventh time 1 hour after the first skimming. The visual observations when skimming were noted, and the total weight of skimmings produced determined. The results were as follows:

Alloy No.	Nominal composition percent by weight									Weight of skimmings g./100 cm²	Remarks
	Cu	Mn	Ni	Ti	Co	Zr	Sb	Be	Al		
1	5	0.25	1.5	0.2	0.3	0.2	------	------	Bal.	9.3	Skin bright clean and collapsible.
2	5	0.25	1.5	0.2	0.3	0.2	0.25	------	Bal.	21.0	Skin thick and tenacious.
3	5	0.25	1.5	0.2	0.3	0.2	0.25	.004	Bal.	14.0	Skin thin clean, collapsible.

The table shows that the addition of Sb to the Sb free alloy causes the oxide film to become thick and tenacious, but that the further addition of Be reduces the thickness and mechanical resistance of the film.

Example 3

Tests similar to those referred to in Example 2 were carried out with five alloys with compositions as given in the table that follows. In this example, the total number of skimmings in each case was six, the skimmings being effected at five minute intervals over a period of thirty minutes. Two determinations were made of the weight of the skimmings in each case, one being for all six skimmings and labelled "total" in the table, and the other being for the five skimmings after the first and labelled "standing only" in the table, the latter determination thus omitting the first skimming in each case where some part of the skimming may have been de-

pendent on the surface condition of the metal piece used. The results were as follows:

Alloy No.	Nominal composition of alloy in percent by weight							Skimmings produced in 30 min. g./100 cm³		Remarks
	Cu	Mg	Si	Li	Bi	Be	Al	Total	Standing only	
1	3	0.1	6	-----	-----	-------	Bal.	Not determined	8.3	Clean surface.
2	3	0.1	6	-----	0.1	-------	Bal.	33	17.2	Thick, fluffy skin of oxide.
3	3	0.1	6	-----	0.1	0.004	Bal.	18	8.6	Fairly clean.
4	3	0.1	6	0.5	-----	-------	Bal.	115	68	Layer of brittle dross.
5	3	0.1	6	0.5	-----	0.007	Bal.	133	62	As alloy No. 4 but thinner layer.

This table shows that the addition of Bi (alloy No. 2) or Li (alloy No. 4) to the alloy free from these elements (alloy No. 1) cause the formation of an oxide skin which is thick and fluffy or hard and brittle. The further addition of Be, however, to alloy No. 2 causes changes both in the quantity of the dross and in the appearance of the alloy towards the condition observed as regards alloy No. 1, and as regards alloy No. 4, the further addition of Be significantly reduces the amount of dross produced.

It is known that beryllium and lithium together in low percentages have a protective influence in the case of surface oxidation of liquid aluminum alloys containing copper with high additions of magnesium, i.e., more than 1% by weight and generally in the order of 5% to 10% by weight, where the oxidation of the liquid metal is very rapid and penetrating. However, it was previously unknown that beryllium can also prevent the formation of the tough skins formed on aluminium alloys containing copper antimony, bismuth or lithium, but either no magnesium or magnesium in amounts less than 1% by weight.

Aluminium base alloys according to the invention may include incidental ingredients where addition is well known in the production of aluminium alloys.

I claim:

1. An aluminium base alloy having the characteristic that, during casting thereof a tough and thick skin does not form on the molten surface, said alloy being composed of:
(a) copper in an amount about 3% by weight;
(b) magnesium in an amount about 0.5% by weight;
(c) antimony in an amount about 0.6% by weight;
(d) tin in an amount about 0.15% by weight; and
(e) beryllium in an amount about 0.004% by weight;
the balance being aluminium.

2. An aluminium base alloy having the characteristic that, during casting thereof a tough and thick skin does not form on the molten surface, said alloy being composed of:

(a) copper in an amount about 5% by weight;
(b) manganese in an amount about 0.25% by weight;
(c) nickel in an amount about 1.5% by weight;
(d) titanium in an amount about 0.2% by weight;
(e) cobalt in an amount about 0.3% by weight;
(f) zirconium in an amount about 0.2% by weight;
(g) antimony in an amount about 0.25% by weight; and
(h) beryllium in an amount about 0.004% by weight;
the balance being aluminium.

3. An aluminium base alloy having the characteristic that, during casting thereof a tough and thick skin does not form on the molten surface, said alloy being composed of:
(a) copper in an amount about 3% by weight;
(b) magnesium in an amount about 0.1% by weight;
(c) silicon in an amount about 6% by weight;
(d) bismuth in an amount about 0.1% by weight; and
(e) beryllium in an amount about 0.004% by weight;
the balance being aluminium.

4. An aluminium base alloy having the characteristic that, during casting thereof a tough and thick skin does not form on the molten surface, said alloy being composed of:
(a) copper in an amount about 3% by weight;
(b) magnesium in an amount about 0.1% by weight;
(c) silicon in an amount about 6% by weight;
(d) lithium in an amount about 0.5% by weight; and
(e) beryllium in an amount about 0.007% by weight;
the balance being aluminium.

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DAVID L. RECK, *Examiner.*