PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Babbitt Metal

We, VEREINIGTE ÖSTERREICHISCHE EISEN- UND STAHLWERKE AKTIENGESELLSCHAFT, a Company organized under the laws of Austria, of 5, Muldenstrasse, Linz, Austria, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a babbitt metal on Al-Zn-alloy base and containing 27 to 70% Al, 0 to 5% Cu and 0 to 5% Si.

The usability of an alloy as a babbitt is dependent upon a heterogeneous structure. Heterogeneity may be found in the following types of alloys:

Alloys having carrying hard crystals incorporated in a soft matrix such as most of the babbitt metals on a lead-antimony-tin base, zinc alloys with primary crystallising aluminides, or antimonides;

alloys with primary crystals in the eutectic or monotectic, such as Al-Zn-alloys containing up to 17% Al, Al-Si-alloys, and lead bronzes;

mixed crystal alloys of a zone-like structure (because of crystal micro-segregation) or alloys having a comparatively hard rim or outer zone, e.g. copper-tin-alloys or Al-Zn-alloys having a high Al-content (the latter having harder rim zones because of copper or silicon additions).

As regards Al-Zn-alloys, the solid solution (β-mixed crystals) ranges from 100% Al to 17% Al + 83% Zn. Because of the zoned structure of the mixed crystals, cast Al-Zn-alloys are heterogeneous depending upon the solidification rate. In practice, however — as e.g. when casting these alloys in iron moulds — differences occur compared with the theoretical equilibrium result, which are illustrated in the following table, wherein "Case A" stands for the case of equilibrium, corresponding to an infinitely slow solidification or a homogeneous annealing, and "Case B" stands for the practical case corresponding to a micro-segregation by quick solidification. The solidification interval is the difference in temperature (centigrade) between beginning and end of the solidification.

Al %	Zn %	Solidification interval, °C. Case A	Case B	Structure A	B
100	0	0	0	H.M.	H.M.
80	20	55	95	H.M.	Z.M. (start)
70	30	68	115	H.M.	Z.M.
50	50	77	120	H.M.	Z.M.
30	70	69	104	H.M.	Z.M.
25	75	68	100	H.M.	Z.M.+E. (1%)
20	80	67	84	H.M.	Z.M.+E. (20%)

where H.M. = homogeneous mixed crystals
Z.M. = zoned mixed crystals
E. = eutectic

[Price 4s. 6d.]

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Thus, the table shows that the solidification interval of all alloys of Case B is considerably increased, as compared with the case of equilibrium.

While alloys containing up to 27% Al show a eutectic rich in zinc, this structural component is not present in alloys containing more than 27% Al. The latter contain only zoned mixed crystals. In babbitt metals, a eutectic component rich in zinc should be avoided, as it is the cause of insufficient dimensional stability. Thus, in the range of 27 to 70% Al, there is a sufficiently large solidification interval for the forming of definite zoned mixed crystals without occurrence of the undesirable eutectic rich in zinc.

In the practical use of such Al-Zn-alloys, there are often difficulties insofar as, in spite of an equal composition of the babbitt metal, the frictional behavior during lubricant-free operation (in emergency cases) varies. An investigation of this phenomenon shows:

1) In order to attain an equally good behavior of an Al-Zn-bearing alloy containing 27 to 70% Al under any stress conditions, it is required that a bearing member, i.e. the bushing, has a completely uniform structure. This condition is not fulfilled in known alloys. As the cooling rate determines the grade of heterogeneity by crystal segregation, the structure is dependent on the size of the casting or the thickness of wall of a casting, respectively. Structural differences appear between the outer zone and the middle part of a casting.

2) A strong crystal segregation in the outer zone of a casting also causes a varying or non-uniform structure of the bushing due to ingot segregation.

3) Immediately before solidification is completed, an intercrystalline melt is present beside the zoned mixed crystals, which melt may solidify, while shrinking and leaving pores, if this is not prevented by a sufficient fluid pressure. Thus, micropores in the surface of the bearing body or the bushing result, which in actual use interrupt the lubricating film and cause considerable wear.

In the literature, different proposals for the utilization of zinc-alloys having a high aluminium-content as bushing material exist. Many proposals have as their object the formation of a definite heterogeneity of the structure. There are, for example processes for influencing the structure of an alloy of given composition by heat-treatment, with a view to improving the bearing properties; there are also methods for influencing the structure by adding further alloy components to a given base composition, e.g. by additions which form a eutectic outer structure (to that effect copper or silicon in an amount of up to 5% may be added). Also the incorporation of additional component, which *per se* are primary crystallising, such as high percentages of silicon, boron, carbon, or additions forming aluminides, silicides, borides, phosphides. Such additions, however, usually deteriorate the bearing properties and, especially during lubricant-free emergency operation, cause wear of the bearing, e.g. of a journal.

The main object of this invention is to provide a babbitt metal of an Al-Zn-alloy containing 27 to 70% Al, 0 to 5% Cu, and 0 to 5% Si, in which these disadvantages are minimised or eliminated.

According to the present invention a babbitt metal having 27-70% Al, 0-5% Cu and 0-5% Si also contains 0.1-3% bismuth, or binary alloys of bismuth with up to 40% Cadmium, up to 44% lead, or up to 24% thallium, or 0.1 to 3.0% thallium, or binary alloys of thallium with up to 76% bismuth, up to 17% cadmium, or up to 38% lead, the remainder being zinc.

The additional components mentioned are still present in a molten state as an intercrystalline liquid, when the solidification of the Al-Zn-alloy is already completed; i.e. their solidification point is lower than that of the lowest melting mixed crystal. The babbitt metal alloy according to the invention guarantees a uniform heterogeneity independent of the solidification rate and of the annealing treatment.

The solidification point of the Al-Zn-alloys according to the invention lies, according to the following list, at:—

Al %	Temperature at finished solidification, °C.
27	430
40	460
50	483
60	510
70	537

Trial operations of bearings consisting of alloys according to the invention have shown excellent results during emergency operation. The specified additions of bismuth and/or thallium or their alloys in an amount of 0.1 to 3% are present as monotectically distributed phases and have sufficient wear resistance.

An alloy for bearings consisting of 50% Al, 49% Zn, 0.4% Cd, and 0.6% Bi, or of 50% Al, 49% Zn, 0.38% Pb, and 0.62% Tl has proved especially suitable.

The additional alloy components are soluble only to a limited extent in liquid aluminium as well as in liquid zinc; even contents from 0.1% upwards coarsen the as-cast structure of the pure metals. Surprisingly, it was found that the above-

mentioned metal additions have a grain-refining effect on Al-Zn-alloys having a large solidification interval, i.e. alloys containing 27 to 70% Al, widely independent of the cooling rate. Owing to the additional components according to the invention, the following results with respect to the aforementioned findings:

1) independent of the size of the casting, the zoned mixed crystals are finer:

2) outer zone and middle part of a casting, e.g. a shaft, have the same structure and the same composition, because the monotectically distributed liquid metal largely prevents an ingot segregation.

Thus, an alloy consisting of 50% Al and 50% Zn showed an Al-content of 58% in the outer zone of a chill cast bolt and of 41% in the middle. An alloy consisting of 50% Al, 2% Bi, 48% Zn did not show any discrepancies larger than ± 1%; the outer and inner Bi-content only varied between 1.8 and 2.2%.

3) The intercrystalline melt, which remains after the solidification of the mixed crystals is completed, practically corresponds to the desired composition. It expedites the contraction of the last solidification and assists in preventing formation of micro-pores.

An alloy consisting of 50% Al, 50% Zn has in its solid form a specific weight of 3.92 g/cm³. A chill cast bolt made from this alloy showed an apparent density of 3.70 g/cm³; this corresponds to a pore volume of 6%, which is in accordance with the investigation of its structure.

An alloy consisting of 50% Al with an addition of 1.5% of Bi or Tl or their alloys, according to the invention, has an all-over density of 3.93, the density taken at a chill cast bolt was 3.91, corresponding to a maximum pore volume of only 0.5%.

As mentioned, the Al-Zn-alloys according to the invention can show copper or silicon contents of up to 5%. Thereby the mechanical properties are improved. It must, however, be taken care that no primary crystals of the elements Si, Be, B, C or primary phases of Al- or Zn-alloys with Fe, Co, Ni, Cr, Mn, Mo, W, Ti, As, or Sb interfere with the effects of the monotectic melts. The low-melting tin causes intercrystalline corrosion and must not be used as component of the alloy.

The alloys according to the invention and based on Al-Zn fulfil high demands during trial operation of a bearing and in practice because of their defined heterogeneity. By suitable selection of the Al-content the properties of the alloys can be adapted to the requirements; for specifically light bearings, e.g., an alloy according to the invention and containing 70% Al is suitable. For high demands, an alloy according to the invention and containing 50% Al, 1% Cu or 1% Si, and for processing by casting at low temperatures and not too high demands upon the dimensional accuracy, an alloy according to the invention and containing 30% Al, 1% Cu or Si, is adequate.

For lubricant-free emergency operation, the metal additions according to the invention have proved extremely satisfactory, as the metallic abrasion between shaft and bearing with increased frictional heat first affects the finely divided addition metal forming a fine-grained self-lubricating intermediate layer between journal and bearing. As the addition metals and their alloys do not form alloys with iron, the journal is not affected. In the machining of bushings and bearing linings, the heterogeneous addition metals according to the invention have proved highly suitable as chip breakers.

WHAT WE CLAIM IS:—

1. A babbitt metal on an aluminium-zinc-alloy base containing 27 to 70% Aluminium, 0 to 5% copper, 0 to 5% silicon with an additional content of 0.1 to 3.0% bismuth, or binary alloys of bismuth with up to 40% Cadmium, up to 44% lead, or up to 24% thallium, or 0.1 to 3.0% thallium, or binary alloys of thallium with up to 76% bismuth, up to 17% cadmium, or up to 38% lead, the remainder being zinc.

2. A babbitt metal on aluminium-zinc-alloy base according to Claim 1 and as herein described.

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