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Lloyd

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[54] BEARING MATERIALS

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[51] Int. Cl. C22c 21/02

[58] Field of Search 75/138, 139, 143, 75/148, 144; 148/32, 32.5; 29/196.2

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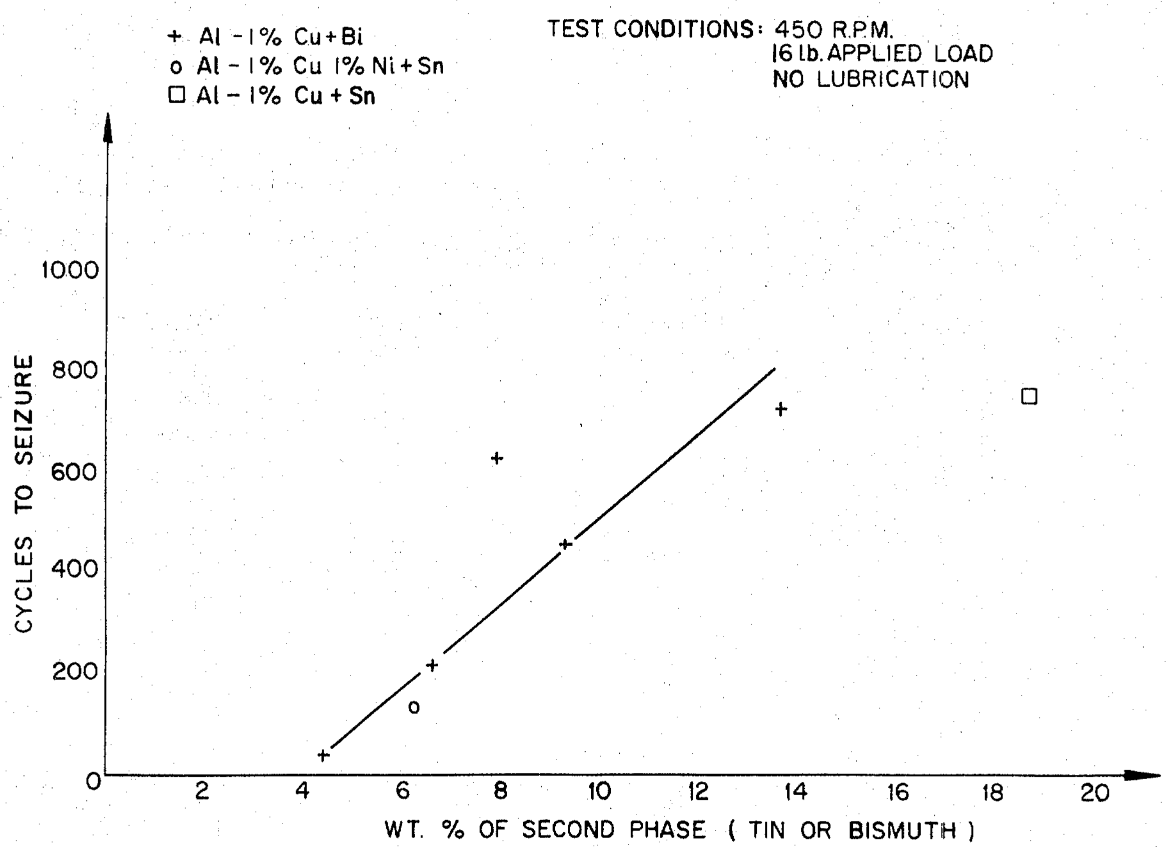
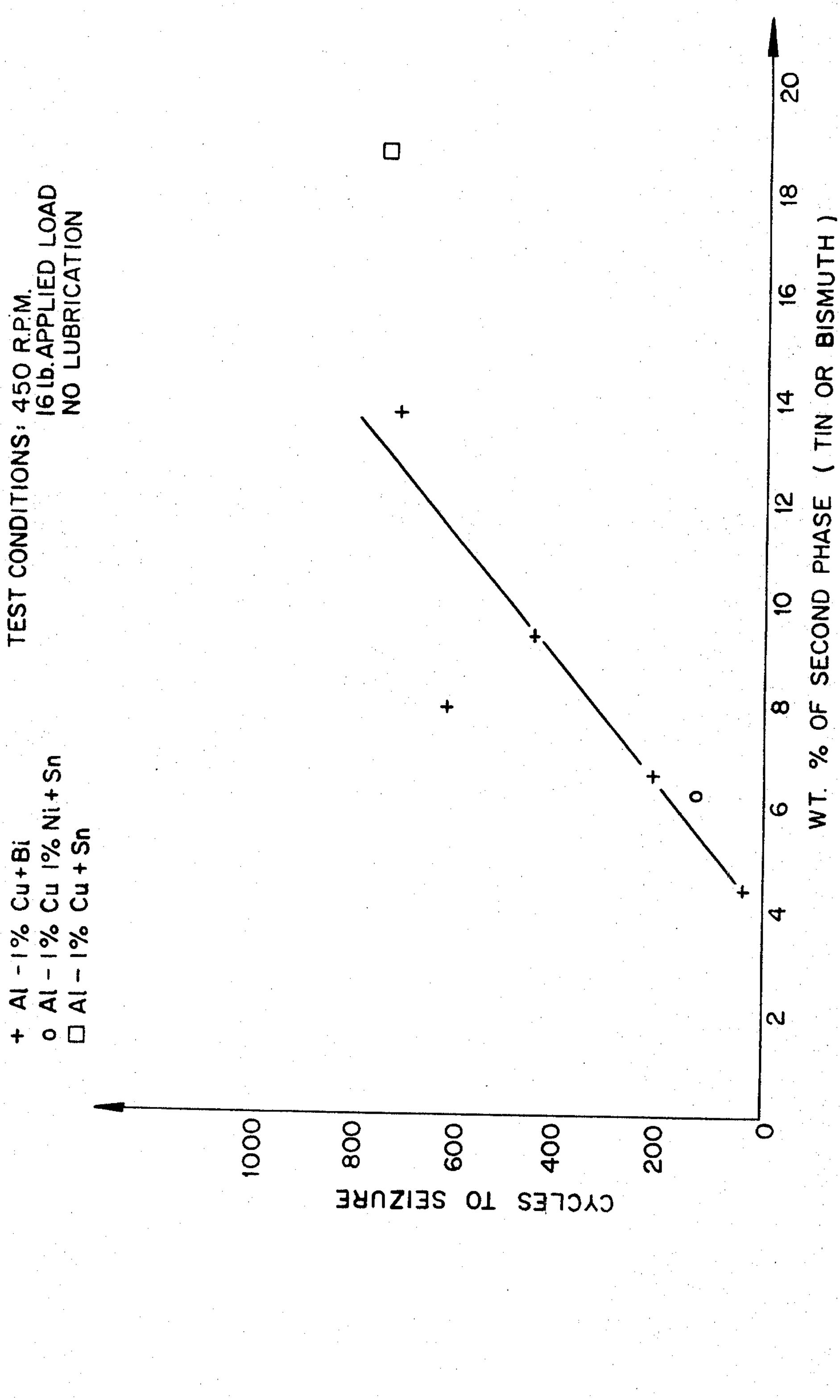
[57] ABSTRACT

The invention is a bearing material of which a major constituent is aluminum characterised by between 1 percent and 16 percent (preferably between 3 percent and 7 percent or between 7 percent and 10 percent or between 10 percent and 16 percent of bismuth by weight, and optionally including 0 – 3 percent copper, 0 – 3 percent nickel, 0 – 3 percent manganese, 0 – 11 percent silicon.

5 Claims, 1 Drawing Figure




+ Al - 1% Cu + Bi
o Al - 1% Cu 1% Ni + Sn
□ Al - 1% Cu + Sn
TEST CONDITIONS: 450 R.P.M.
16 Lb. APPLIED LOAD
NO LUBRICATION
CYCLES TO SEIZURE
0
200
400
600
800
1000
WT. % OF SECOND PHASE (TIN OR BISMUTH)
2
4
6
8
10
12
14
16
18
20

BEARING MATERIALS

This invention relates to an aluminium base alloy for use as a bearing material, for example in thin shell bearings where the alloy requires to be bonded, by rolling for example, to a steel backing either directly or with an intermediate layer of metal foil, or after the backing has been plated with, say, nickel or cobalt.

According to the present invention, a bearing alloy comprises aluminium and more than 1 percent of bismuth by weight. Preferably there is from 7–10 percent bismuth; or for some purposes there may be up to 16 percent by weight bismuth. The aluminium may or not constitute the balance, but will usually constitute at least 50 percent by weight of the material.

It has been discovered that such a bearing has a surprising ability to survive without pick-up or siezure during momentary contact with the journal when for any reason the oil film thickness becomes locally less than the surface roughness. This property is known as compatibility. While softness of the material is a factor in obtaining this property, other factors are relevant, and the property is, in general, little understood. There are three known aluminium-based alloys having a soft low melting point phase which are used for their properties of having high compatibility. These are aluminium/tin, aluminium/lead and aluminium/cadmium.

Aluminium/bismuth is an alternative and is believed to have surface properties equal to or better than the three alloys for alloys with the same percentage of the low melting point constituent.

This desirable property of aluminium/bismuth is believed to be due to the Rhomboidal structure of bismuth. The corrosion resistance of bismuth in engine oils is believed to be better than, for example, a similar alloy of aluminium-lead. Tin is conventionally added to aluminium-lead alloys to increase the corrosion resistance to engine oils and in the comparison we are referring to aluminium-lead without a tin additive. Bismuth is also unusual in that it expands when solidifying, and it is believed that this phenomenon may assist in reducing the tension forces existing along the boundary between the soft material and the surrounding stronger matrix thereby increasing the fatigue strength of the material. Clearly the porosity of the alloy is reduced if the bismuth expands to fill the interstices in the surrounding aluminium.

According to a feature of the invention an aluminium base alloy, suitable for use as a bearing alloy and capable of being bonded to a steel backing contains by weight from 1 percent or 3–7 percent bismuth including lead impurities, the balance being aluminium except for normal impurities and from 0 to 3 percent of each of one or more of the elements copper, nickel and manganese to improve the strength of the aluminium matrix. In addition up to 5 percent or 11 percent silicon may be added with, say, 1 percent copper or nickel or both. It may be desirable to include a small percentage of a metal or other substance which improves resistance to corrosion.

The bismuth provides the surface properties required of a bearing alloy and so the defined composition could be only at or near the bearing surface. However, the whole alloy could also be of uniform composition.

It seems that providing there is bismuth at the bearing surface it is not necessary to have bismuth throughout the thickness of the bearing material. The bismuth has

good surface properties in that it can accommodate dirt being embodied in it without its bearing properties being seriously lost and accordingly it is not necessary to provide a lead/tin or other plated over-lay on the bearing surface as has been found to be necessary in the past for many bearing materials which are primarily of aluminium. The extra expense of including the bismuth is, therefore, compensated for by avoiding the need for such an overlay.

The invention includes a bearing comprising at least a bearing-surface-layer of an alloy as defined, and also a layer of the alloy bonded to a steel or other backing.

It is believed that the fatigue strength of aluminium/lead alloys is less than that of an aluminium/bismuth alloy having the same proportion of bismuth. The bismuth in an aluminium alloy when rolled down to a thickness suitable for bonding to a steel backing tends to form long stringers which readily form into globules when the alloy is annealed. This contrasts with aluminium/lead alloys which do not form globules readily on annealing. This property of aluminium/bismuth in conjunction with the expansion on solidification, reduces the forces occurring along the aluminium boundary as compared with tin or lead and provides a potentially greater fatigue strength. Tests have been carried out on aluminium/bismuth bearing materials which suggest that the percentage of bismuth in aluminium to provide adequate surface properties can be less than those of tin or lead and this also tends to increase the fatigue strength because less of the softer inclusion is required in the surrounding matrix of aluminium.

Certain examples of alloys embodying the invention will now be described.

EXAMPLE I

A bearing alloy consists of:
Bismuth 3 percent by weight
Copper 1 percent by weight
Aluminium 96 percent by weight

The component metals in correct proportions are introduced into a tun dish and raised to a temperature sufficient to melt them all, after which a billet of the alloy is cast and subsequently rolled into a slab with a thickness of about 0.050 inches. The slab is then bonded to a steel backing to make a bearing strip.

EXAMPLE II

A bearing strip is made by the same method described in Example I but the proportions are:
Bismuth 7 percent by weight
Nickel 2 percent by weight
Silicon 4 percent by weight
Aluminium 87 percent by weight

EXAMPLE III

A bearing alloy with the following composition:
Bismuth 16 percent by weight
Copper 1 percent by weight
Nickel 1 percent by weight
Manganese 1 percent by weight
Silicon 11 percent by weight
Aluminium 70 percent by weight

is melted in a tun dish and poured as a slab into a shallow mould. The alloy is allowed to cool slowly so that most of the bismuth tends to drop through the aluminium which is much lighter, so that at the bottom surface the percentage of bismuth is high, whereas at the top surface there may be very little bismuth. This forms a satisfactory bearing with the high bismuth surface acting as the bearing surface and the low bismuth surface bonded to the steel backing.

EXAMPLE IV

A bearing material was made with metals in the following proportions:

Bismuth 10 percent by weight
Copper 2 percent by weight
Silicon 1 percent by weight
Aluminium 87 percent by weight

The appropriate proportions of the metals were mixed in powder form and the composite powder was sintered on a backing and bonded to the backing by rolling.

The accompanying drawing shows some test results obtained with aluminium based alloys with bismuth and tin as the second phase. It will be seen that even an alloy with a tin content of about 18.3 percent by weight its cycle to seizure is not significantly better than an alloy with a bismuth content of 13.6 percent. The drawing also shows that an alloy containing 6.2 percent by weight of bismuth gives 200 cycles of seizure while an alloy containing 6.2 percent of tin gives only 140 cycles to seizure.

It is also possible to include bismuth in a shaft which is co-operating with a bearing.

There could be 1 percent, 3 percent, 6 percent, 8 percent, 12 percent or 16 percent say, of bismuth by weight, whether the shaft is steel or aluminium or any other metal.

What I claim as my invention and desire to secure by Letters Patent is:

1. A bearing material consisting essentially of
bismuth — about 16 wt. %,
silicon — about 11 wt. %,
copper — about 1 wt. %,
nickel — about 1 wt. %,
manganese — about 1 wt. %, and
aluminum — about 70 wt. %.

2. A bearing material as claimed in claim **1**, in the form of a slab whose thickness is small compared with its length and breadth.

3. A bearing material as claimed in claim **2**, in which the proportion of bismuth at one of the larger surfaces of the slab is greater than the proportion of bismuth at the other of the larger surfaces.

4. A bearing material as claimed in claim **3**, in which there is about 16% by weight of bismuth at the one of the larger surfaces.

5. A bearing material as claimed in claim **3**, in which there is substantially no bismuth at the said other of the larger surfaces.

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