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POROUS BRONZE CASTINGS FOR BEARING AND THE LIKE USES

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Fig. 1.

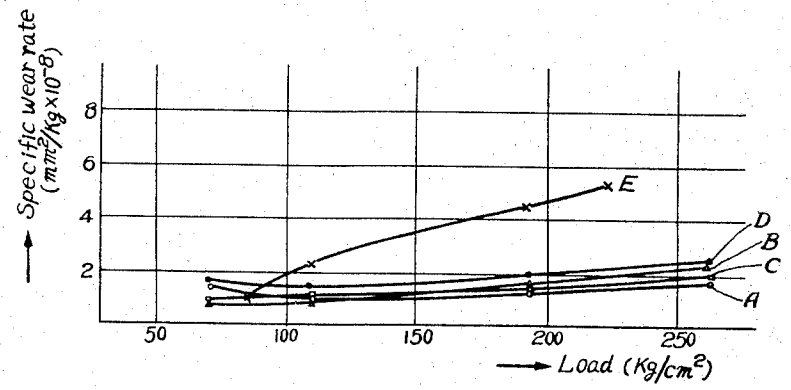
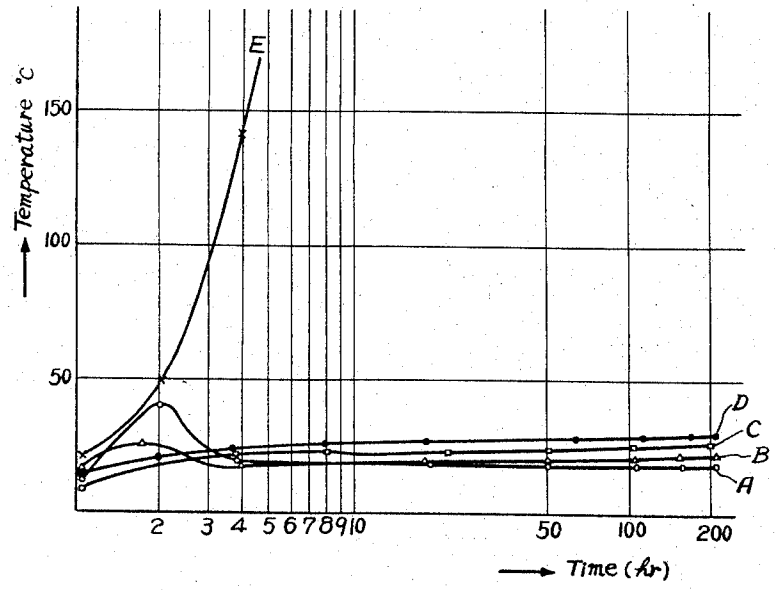


Fig. 2.

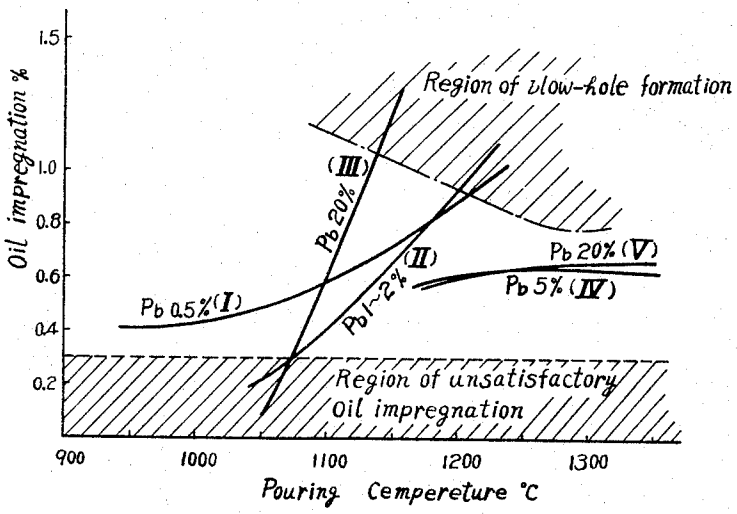


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POROUS BRONZE CASTINGS FOR BEARING AND THE LIKE USES

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Fig. 3.



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POROUS BRONZE CASTINGS FOR BEARING AND THE LIKE USES

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ABSTRACT OF THE DISCLOSURE

A porous bronze casting formed of a bronze composition consisting essentially of 7–16%, Sn, 1–4% Fe, 0.01–6% Al, less than 20% Pb, less than 8% Zn, 0.03–0.75% P and the balance Cu.

This invention relates to porous bronze castings used for bearing metals and the like. An object of the present invention is to provide an alloy having a porosity sufficient to be impregnated with lubricant oil before being used as a bearing or other mechanical component requiring lubrication.

The present invention has for its object to provide porous bronze castings which are self-lubricating, having a good oil-retaining property.

Another object of the invention is to provide such bronze castings which contain iron as an additive in an amount appropriate to preclude directional solidification and facilitate the mass feeding of the casting material.

A further object of the present invention is to provide bronze castings which are made porous by accelerating the formation of shrinkage cavities or voids between grain boundaries during solidification and in which the grains are uniformly dispersed.

The bronze casting according to the present invention is characterized in that the material has a composition including a varying amount of iron, and is similar in external appearance to common bronze castings but micrographically it includes finger grains and has a porous structure including a homogeneous arrangement of minute three-dimensionally connected shrinkage cavities formed between the grain boundaries.

As pointed out above, the casting material according to the present invention contains iron as an additive effective to prevent directional solidification and facilitate mass-feeding of the material, thus enabling the formation of nuclei dispersed in the entire mass of the material and hence substantially simultaneous solidification thereof. The iron added to the material is thus effective also to hinder any replenishing flow of melt and promote formation of shrinkage cavities thereby to produce a porous casting which includes fine grains dispersed uniformly. At this point, it is to be noted that the addition of iron in an amount of 1% or less is hardly sufficient to obtain a satisfactorily fine cast structure while an iron content of 4% or more causes excessive formation of shrinkage cavities, making the casting process considerably difficult.

Aluminum as an additive is also effective to hinder melt flow and, during solidification, intervening along the grain boundaries, acts to hinder any replenishing flow of melt, thus causing a finely dispersed porosity. Also, aluminum itself segregates along the grain boundaries in the form of its oxide and, having a limited strengh at elevated temperatures, causes micro stress cracks in the material during its solidification and thus gives a substantial porosity to the casting obtained.

For better understanding of the present invention, some practical examples will now be described specifically.

EXAMPLE I

Bronze casting material of Japanese Industrial Standard BC3 of the following composition:

	Percent
Cu	86.5–89.5
Sn	9.0–11.0
Zn	1.0–3.0
Pb	<1.0
Impurities	<1.0

was melted in a crucible in a neutral atmosphere and 2.5% of iron and 0.01% of aluminum were first added to the melt. Then, immediately before pouring, 0.3% of phosphor copper including 15% of phosphorus was added. The melt was poured in a mold at 1150° C. The casting obtained in this manner was machined to specified dimensions and was impregnated with lubricant oil under pressure or in vacuum at a temperature of approximately 80° C. to obtain the desired oil-impregnated bearing component. The weight percentage of lubricant oil impregnated or oil content of the product was 1%.

EXAMPLE II

Bronze casting materials JIS BC6 of the following composition:

	Percent
Cu	81.0–87.0
Sn	4.0–6.0
Zn	4.0–7.0
Pb	3.0–6.0
Impurities	<2.0

was melted in a crucible in a neutral atmosphere and to the melt 2.5% of iron and 0.05% of aluminum were added. Then, immediately before pouring, 0.3% of phosphor copper including 15% of phosphorus was added. The melt was poured in a mold at 1200° C. Subsequently, an oil-impregnated bearing component was produced in the same manner as in Example I. The oil content of the product was 0.7%.

EXAMPLE III

Bronze casting material of JIS BC6 was melted in a crucible in a neutral atmosphere and to the melt 3% of iron and 2% of aluminum were added. Then, immediately before pouring, 0.3% of phosphor copper including 15% of phosphorus was added and the resulting melt was poured in a mold at 1300° C. Subsequently, an oil-impregnated bearing component including oil in weight percentage of 0.6% was produced in the same manner as in the preceding examples.

EXAMPLE IV

Bronze casting material JIS LBC5 of the following composition:

	Percent
Sn	6.0–8.0
Pb	16.0–22.0
Ni	<1.0
Impurities:	
Zn	<1.0
Fe	<0.5
Others	<1.0

Remainder, Cu.

was melted in a crucible in a neutral atmosphere and to the melt 4% of iron and 6% of aluminum were added. Immediately before pouring, 0.3% of phosphor copper including 15% of phosphorus was added and the melt was then poured in a mold at a temperature of 1350° C. Subsequently, an oil-impregnated bearing component including oil in weight percentage of 0.6% was produced in the same manner as in the preceding examples.

The castings in the above examples had mechanical properties as shown in the following table.

Example	I	II	III	IV
Tensile strength, kg./mm.²	17–18	12–13	16–19	12–13
Elongation, percent	5–6	4–5	4–6	4–5
Brinnel hardness	60–64	45–50	70–75	45–55

The bearing components obtained according to the present invention exhibited characteristics as graphically shown in the accompanying drawings which represent results of various tests conducted with the components.

In the drawing, FIG. 1 illustrates the specific wear rate respectively, as compared with that of bronze casting material (E), JIS BC3, which contains from 86.5 to 89.5% of Cu, from 9.0 to 11.0% of Sn, from 1.0 to 3.0% of Zn, less than 1% Pb and/or less than 1% of impurities. This test was conducted on an Ogoshi Type SL–05 wear tester, employing #30 motor oil at a feed rate of 0.2 cc./sec. and a speed of 0.8 m./sec. As observed from the graphical illustration of the test results, the wear rate of the bronze castings made according to the present invention remains substantially constant even with increase of the bearing load.

FIG. 2 illustrates the temperature rise in continuous running tests of the bearing components of the above examples again in comparison with that of the casting material JIS BC3. (E).

With an aluminum content of up to 1%, the amount of Pb added to the material has a large influence upon the effect of the pouring temperature acting upon the porosity of oil content of the product, as observed from curves I, II and III in FIG. 3. The porosity increases with the pouring temperature and the increase becomes marked with an increase of the lead content. Moreover, variation of the pouring temperature even in a relatively narrow range generally involves the danger of causing unsatisfactory oil impregnation or formation of blow holes. This apparently necessitates an extremely strict temperature control during the casting process. In the range of aluminum content of from 1 to 6% however, the pouring temperature has no substantial effect upon the porosity or oil content of the cast product. Also, any variation in lead content has no substantial effect upon the porosity or oil content of the cast product. Also, any variation in lead content has no substantial effect upon the porosity obtained, as observed from curves IV and V of FIG. 3. Any

aluminum content exceeding 6% makes the material excessively hard and brittle and is to be avoided for bearing components. The effect of aluminum, contained in an amount of 0.01% or less, is very limited.

Phosphorus is effective to give an extended range of solidification to the casting material enabling its melt to remain liquid to a lower temperature, promote mass feeding and metal-mold reaction of the material, and cause the pressure gases dissipated and absorbed in the metal effectively to help obtaining porous castings.

Phosphorus added in any excessive amount makes the metal-mold reaction excessively intense and increases gas absorption to such an extent as to cause cracks in the casting. In view of this, it is preferable to add phosphor copper containing 15% of P to the bronze melt in an amount of from 0.2 to 0.5% which is equivalent to 0.3% to 0.75% of phosphorus.

What is claimed is:

1. A porous bronze casting formed of a bronze composition consisting essentially of 7 to 16% Sn, 1 to 4% Fe, 0.01 to 6% Al, less than 20% Pb, less than 8% Zn, 0.03 to 0.075% P and the balance Cu.

2. A porous bronze casting as claimed in claim 1 wherein Fe, Al and P are present respectively in amounts of 2.5%, 0.01% and 0.045%.

3. A porous bronze casting as claimed in claim 1 wherein Fe, Al and P are present respectively in amounts of 2.5%, 0.05% and 0.045%.

4. A porous bronze casting as claimed in claim 1 wherein Fe, Al and P are present respectively in amounts of 3%, 2% and 0.045%.

5. A porous bronze casting as claimed in claim 1 wherein Fe, Al and P are present respectively in amounts of 4%, 6% and 0.045%.

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