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SILVER-THALLIUM BEARING

Franz R. Hensel, Indianapolis, Ind., assignor to P. R. Mallory & Co., Inc., Indianapolis, Ind., a corporation of Delaware

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This invention relates to an improved bearing of high efficiency and durability.

It is an object of the present invention to provide an improved silver base bearing which has a high fatigue resistance, which will not score under excessive loads or at high speeds and which possesses unusual wear resisting qualities.

It is a special object to produce a silver base bearing having a greater resistance to oil and acid corrosion than silver base bearings of the present commercial art.

Another object is the provision of a silver alloy bearing which possesses improved properties over silver alloy bearings previously used or described.

It is a further object of the invention to provide a bearing metal which has a low coefficient of friction.

It is another object of the invention to provide a bearing metal which has a comparatively high thermal conductivity.

It is a further object of the invention to provide a bearing which possesses the ability to run in and to conform to local excess pressures.

It is a further object of the invention to provide a bearing which has the property of imbedding grit.

Other objects of the invention will in part be obvious and in part appear hereinafter. The invention accordingly comprises the features of construction and a combination of elements and arrangements of parts which will be exemplified in the descriptions hereinafter set forth and the scope of the application, of which will be indicated in the claims.

In the prior art, pure silver has been used for bearing purposes. Attempts have also been made to produce silver-lead alloys in the form of bearings or bushings. These bearings have been produced by either casting the silver or silver and lead combinations onto ferrous backings or by electroplating silver and/or silver-lead. In the case of pure silver, it was found that the material does not prevent scoring, while in the case of silver and lead, difficulties have been experienced in obtaining a uniform lead distribution.

Certain methods have been suggested to overcome these difficulties. It is general practice now to apply a lead coating to the silver, so that the actual bearing surface is pure lead or indium-lead and not the silver. There is, however, a danger that in thin lead coatings, the shaft might actually wear through the lead and run on pure silver, which might give rise to failures, particularly due to scoring.

The present invention attempts to overcome the difficulties described above by providing a new material which eliminates the scoring tendencies of fine silver and which also eliminates the segregations found in silver-lead.

It is contemplated that alloys of the new invention may have the following approximate composition:

Thallium	per cent 1–20
Silver	Substantially the balance

The addition of thallium is equally effective in solid solution silver alloys and therefore such elements as cadmium, indium, manganese, lead, tin, zinc, aluminum and magnesium, may be present. Other additions such as nickel, bismuth and arsenic may also be made, provided that such additions are held within limits which do not affect the bearing performance deleteriously. These additions may have the purpose of increasing the strength and fatigue properties and the corrosion resistance of the silver matrix.

A careful study has been made of the alloys containing from 1–20% of thallium, and the fact has been established that a considerable amount of thallium will be taken up in solid solution by the silver. The solid solubility of thallium in silver, however, seems to be a function of the temperature and seems to decrease with lower temperatures. Extensive experiments have been made with a silver-thallium alloy containing 3½% thallium. This alloy is normally within the solid solution range; however, in the form of a casting, thallium-rich areas can be found when observed under the microscope. In order to obtain a stable condition, these alloys may be heated for several hours at 500° C. and then the microstructure shows a completely homogeneous grain structure, typical of the solid solution type of alloys. If this heat treatment is carried out at lower temperatures, such as 300–400° C., only a part of the thallium phase will be dissolved.

Tests have been conducted with this 3½% thallium alloy on the Amsler testing machine and they were compared with fine silver. The Amsler test results on the ground shaft indicated an appreciable improvement, due to the thallium.

The bearing was also tested on the test set-up of one of the largest manufacturers of aircraft engines. This test was run at a speed of 3500 R. P. M. or 1830 surface feet per minute. At this speed, the load on the bearings was

2290 lb. per sq. in., considerably higher than automotive bearing loads. The oil used was SAE 30 to which 1% of oleic acid had been added so that corrosive conditions would develop during testing. The bearing temperatures were maintained at 300° F. during the whole of the test. The test was run for 50 hours at the above mentioned test speed, after a short break in run of 1 hour at 1750 R. P. M. and 2 hours at 2450 R. P. M.

The test was completed uneventfully, with no signs of distress from the bearings. Upon disassembly of the test machine at the conclusion of the run, it was found that the bearings were in excellent condition, there being no cracking or signs of scoring. The shaft on which the bearings were run was also in good condition. It was not scored in spite of the fact that it was made of soft steel, around 250 Brinell.

The bearings showed no signs of being subject to acid corrosion in the oil, since they lost no weight during the test in the acid oil. In fact, the bearings even gained weight, presumably due to pickup of sulphur from the oil, since there was a heavy coating of a material with the appearance of silver sulphide on the surface. There was a pickup of 0.027 gram in the weight of the two bearings, and this would correspond to a sulphide film of 0.0001" thickness.

Tests were also conducted with the following materials:

Silver and 5% thallium
Silver and 10% thallium and 3% lead
Silver and 20% thallium

These materials were tested and in all cases, the material exhibited good antifriction properties, as determined by the score test developed by the research laboratories of the aircraft engine manufacturers above referred to.

A binary alloy containing 3.5% thallium, has a cast ultimate tensile strength of approximately 25,000 p. s. i. The Brinell hardness of these materials is in the range desirable for bearing materials. Any alloy, for instance, with 5% thallium, has a Brinell hardness of 32.4 when tested at 80° F., and a Brinell hardness of 28, when tested at 345° F. By increasing the thallium content to 20%, the Brinell hardness at 80° F. is 28.9, and at 345° F., 20.8.

The bearing metals containing up to 5% thallium lend themselves very readily to hot and cold working, provided that homogenizing treatments are given to the material. They can be produced in the form of strip, rod, cylinders or any other form and in the cold worked condition the tensile strength may be increased to above 50,000 p. s. i.

The alloys may also be produced by means of plating. The silver alloy plating solution which gave satisfactory results was as follows:

	Grams
Silver cyanide	35
Potassium cyanide	19
Potassium carbonate	38
2 drops carbon bisulphide to the litre.	

To this was added 25 ml. of thallous perchlorate, containing .4 gram of metallic thallium. This bath was operated at room temperature and with an approximate current density of .75 ampere per square decimeter. The plated samples showed a thallium content of 4.32% thallium. Variations can be made in the solution in the bath temperature, agitation, current density and the like, in order to improve the deposits or to speed up the process of plating. The plated silver-thallium alloy did not react with diluted and concentrated nitric acid. Treatments with almost all acids except hydrochloric acid, did not affect the alloy.

The tests made with the various alloys seem to indicate that both the solid solution type alloys of silver and thallium and the alloys where part of the thallium is in solution and a remaining part is suspended homogeneously in the silver matrix in the form of small particles, which are very soft and ductile, are suited for bearing purposes. The free thallium particles will melt at a temperature of approximately 578° and if the bearings run out hot, will afford liquid lubrication.

It is likewise possible to produce a thallium containing silver by diffusion processes. This latter method usually entails the coating of the silver with thallium by any suitable means, including electrodeposition and then heating same to a temperature where it will penetrate into the silver.

If the alloys are made by melting, the silver base material is melted first and then the thallium is introduced under a flux. The melt is thoroughly stirred and then cast into desirable shapes.

The silver-thallium alloys may be bonded to backings of ferrous alloys or copper base alloys by such means as brazing, con-joint extrusion, hot rolling into the form of a bimetal and then forming, casting into a pre-heated shell in a non-oxidizing atmosphere, etc.

For certain applications, it has been found desirable to add a certain percentage of lead to the new thallium alloys, with thallium and lead forming a continuous series of solid solutions with no phases of low melting points. Up to 10% lead may be added.

It has also been found of advantage in certain instances to add to the present materials, small amounts of alkaline metals or alkaline earth metals, such as lithium, sodium, calcium, strontium and barium, in order to completely deoxidize the matrix, effect grain refinement and to increase the hardness of the thallium or thallium-lead phase. The range of thallium covers a number of classes of bearings, to which the addition of thallium has been found useful. Some of the lower percentage alloys may be used in bearings which operate without a steel backing. These alloys may be used in the form of castings or forgings. The alloys with a higher thallium content are used for special applications which are more generally backed up with steel or a similar metal. Since the use of bearings are manifold, the alloy compositions must be adjusted to the specific application. The silver-thallium base alloys do not constitute just one bearing composition, but a new class of bearing materials, and therefore the thallium content necessarily must be proportioned, in order to meet specific requirements.

When silver base thallium bearing alloys are attached to a backing material by means of soldering, it is advantageous to place a layer of fine silver between the steel and the silver-thallium alloy. In order to still further improve the corrosion resistant characteristics of the new alloy, it has been found of advantage to add a certain percentage of indium, such as .1–10% of indium, to the alloy or to apply an indium coating by means of electrolysis to the finished bearing and then diffuse the indium into the surface. The indium and thallium form a series of solid solu-

tions which are highly corrosion resistant. If the finished bearings are indium plated and then heated to slightly elevated temperatures, the indium will diffuse into the thallium at a temperature of approximately 150° C. Alloys of indium and thallium, up to 50% thallium, are completely homogeneous. There may be certain cases where the silver-thallium may be used as the base, onto which a layer of lead or a lead alloy, may be plated. This would give the double assurance in bearing performance that no scoring would occur if the shaft should wear through the lead surface because it would run on the silver-thallium backing without causing any scoring.

In certain cases, the lead coating, which is placed on top of the silver-thallium backing, can be plated with indium and the indium diffused into the lead, in order to improve the corrosion resistance. Instead of lead and indium, it may also be possible to use a tin coating as the soft material, on top of the silver-thallium backing. This application is a continuation in part of my co-pending application S. N. 235,785, filed October 19, 1938.

While the present invention as to its objects and advantages has been described herein as carried out in specific embodiments thereof, it is not desired to be limited thereby, but is intended to cover the invention broadly, within the spirit and scope of the appended claims.

What is claimed is:

1. A bearing containing 1–20% of thallium, balance predominantly silver.

2. A bearing containing 2–5% thallium, balance predominantly silver.

3. A bearing containing 1–20% thallium, balance predominantly silver, produced by electroplating.

4. A bearing containing 1–20% thallium, balance predominantly silver, having a uniform grain structure, produced by a low temperature anneal.

5. A bearing containing 1–20% of thallium, balance predominantly silver, and containing approximately up to 10% lead.

6. A bearing containing 1–20% thallium, balance predominantly silver, said bearing being strengthened by a ferrous alloy backing.

7. A bearing containing 1–20% thallium, balance predominantly silver, to which has been applied a coating of lead.

8. A bearing containing 1–20% thallium, balance predominantly silver, and containing up to 10% of indium.

9. A bearing containing 1–20% thallium, balance predominantly silver, to which has been applied a layer of indium, which is subsequently diffused into the bearing.

10. A bearing containing 1–20% thallium, balance predominantly silver, having a coating of lead and a coating of indium, which has subsequently been diffused at elevated temperatures to improve the corrosion resistance of this bearing combination.

11. A bearing comprising a steel backing and a lining of bearing metal consisting of .5 to 6 per cent thallium and the balance silver, bonded thereto.

FRANZ R. HENSEL.