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FORGED FINE CARBIDE ANTI-FRICTION BEARING COMPONENT MANUFACTURE

Richard L. Faunce and William M. Justusson, Farmington, Mich., assignors to Ford Motor Company, Dearborn, Mich.

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ABSTRACT OF THE DISCLOSURE

This invention relates to a process for the manufacture of races for anti-friction bearings by a forging process and a thermal treatment that results in the production of a metallurgical structure characterized by uniformly distributed primary carbides ranging downward in size from one micron with the bulk of such carbides measuring between one half and one micron.

THE BACKGROUND

Anti-friction bearings, and more particularly ball bearings, have been the object of intensive research in recent years. This research plus the advent of very clean vacuum degassed steels have resulted in the production of bearings of much longer dependable life and higher load carrying ability.

The critical element in ball bearings insofar as failure is concerned is almost inevitably the inner race. The inner races fail in fatigue as the result of the repeated application of extremely high compressive loads locally when a bearing ball passes over the race.

The ball bearings employed in the automotive industry are almost invariably prepared from a steel designated commercially as SAE 52100. This is an economical hypereutectoid steel containing one per cent of carbon and about one and one-half per cent chromium as the principal alloying ingredients. This steel is purchased in the form of seamless tubing and the individual inner race blanks are obtained by cutting off lengths of this tubing. These lengths must be machined, heat treated and ground to size to form the finshed inner race.

THE INVENTION

This invention forms the ball bearing race by a procedure which has been modified to increase the B-10 life of these inner races by an order of magnitude. The B-10 life of anti-friction bearings is defined as the time required to fail ten per cent of any given bearing population when tested under carefully standardized and controlled conditions.

The steel employed for the production of inner races according to this invention is also SAE 52100, but is obtained in the form of discs. These discs are heated to a temperature to render them completely austenitic and to dissolve essentially all carbides. A suitable temperature is 2000° F. At this temperature the disc is forged by back extrusion to form it into a blank for an inner race.

After the forging operation the forged blank is permitted to air cool. The air cooling must be sufficiently rapid to prevent the formation of any massive carbides and to produce a very finely divided pearlitic structure. This very finely divided pearlitic structure is spheroidized by exposure to a temperature of between 1200° and 1500° F. The time required for this operation is a function of the temperature employed as is well understood in the art. A typical treatment for this purpose involves heating to a temperature of 1395° F. for approximately two hours. This treatment produces uniformly distributed

spherical primary carbide particles ranging downward in size from one micron. The bulk of the particles of primary carbide will fall in size between one half and one micron.

An necessary machining other than grinding is now done and the races are hardened. The hardening treatment involves heating to a temperature and for a time that will establish thermodynamic equilibrium between the austenite and the undissolved carbides. This temperature must be kept low enough to prevent the formation of massive carbides. A treatment of one hour at a temperature between 1525° and 1600° F. has been found to be satisfactory. The hardening operation is completed by quenching the heated blanks in a coolant which will give a rate of heat abstraction similar to that obtained with the usual petroleum base quenchant. Oil is conventionally used for this step.

These very hard inner races are now tempered to yield a Rockwell C hardness of 60 to 64. The tempering temperature will range between 300° and 400° F.

Bearings known commercially as F-206 which are widely used in automotive transmissions have been fabricated from the conventional tubing and by the forging process described in this invention. The inner races of the bearings produced from forgings have exhibited a B–10 life up to ten times greater than comparable bearings produced from tubing.

This invention has been described particularly in connection with the production of anti-friction bearing inner races in contradistinction to the balls and the outer races. This is because the inner race durability is normally the factor limiting the life of anti-friction bearings. However, the sharp improvement effected by the application of the process of this invention to inner races may well shift the Achilles' heel of the bearing as a unit to the balls or the outer race. In this event further improvement in bearing life may be obtained by applying this process to the balls or the outer races and such is clearly within the scope of this invention.

It is desired to make of record in this document the following publications:

Bamberger, E. N.; "The Effect of Ausforming on the Rolling Contact Fatigue Life of a Typical Bearing Steel," Transactions of the ASME Journal of Engineering for Power, Paper No. 65–Lub–9, pp. 1–10, October 1965.

Bush, J. J., Grube, W. L., Robinson, G. H.: "Microstructural and Residual Stress Changes in Hardened Steel Due to Rolling Contact," Procedure of a Symposium on Rolling Contact Phenomena, pp. 365–399, October 1960, Elsevier Publishing Company, New York, 1962.

We claim as our invention:

1. The process of preparing inner races for anti-friction bearings comprising heating a blank of steel effectively devoid of elements forming carbides more refractory than chromium and having metallurgical characteristics indistinguishable from a steel containing 1.00% carbon, 0.35% manganese, 0.30% silicon and 1.45% chromium to a temperature resulting in a completely austenitic structure, forging the inner races at such temperature, air cooling the forged races sufficiently rapidly to avoid the formation of any massive carbides and to yield a very finely divided pearlitic structure, annealing the cooled blanks at a temperature from 1200° to 1500° F. and for a time sufficient to produce uniformly distributed, predominantly spherical particles of primary carbide ranging downward in size from a maximum of one micron, hardening the forged and annealed blanks by heating to a temperature and for a period of time insufficient to produce carbide growth, but sufficient to establish a thermodynamic equilibrium between austenite and undissolved carbide, quenching the heated blanks in a coolant producing a cooling rate approximating that of oil and finally

tempering quenched races to a Rockwell C hardness of 60 to 64.

2. The process recited in claim **1** in which the annealing step is carried out at about 1395° F. and for a time period of about two hours.

3. The process recited in claim **1** in which the heating prior to hardening is at a temperature of 1525° F. for about one hour.

4. The process recited in claim **1** in which the temperature employed for hardening is between 1525° and 1600° F.

5. The process of preparing bearing components for anti-friction bearings comprising heating a blank of steel effectively devoid of elements forming carbides more refractory than chromium and having metallurgical characteristics indistinguishable from a steel containing 1.00% carbon, 0.35% manganese, 0.30% silicon and 1.45% chromium to a temperature resulting in a completely austenitic structure, forging the bearing components at such temperature, air cooling the bearing components sufficiently rapidly to avoid the formation of any massive carbides and to yield a very finely divided pearlitic structure, forging the bearing components at such temperature, air cooling the bearing components sufficiently rapidly to avoid the formation of any massive carbides and to yield a very finely divided pearlitic structure, annealing the cooled blanks at a temperature from 1200° to 1500° F. and for a time sufficient to produce uniformly distributed, predominantly spherical particles of primary carbide ranging downward in size from a maximum of

one micron, hardening the forged and annealed blanks by heating to a temperature and for a period of time insufficient to produce carbide growth, but sufficient to establish a thermodynamic equilibrium between austenite and undissolved carbide, quenching the heated blanks in a coolant producing a cooling rate approximating that of oil and finally tempering quenched bearing components to a Rockwell C hardness of 60 to 64.

6. The process recited in claim **5** in which the annealing step is carried out at about 1395° F. and for a time period of about two hours.

7. The process recited in claim **5** in which the heating prior to hardening is at a temperature of 1525° F. for about one hour.

8. The process recited in claim **5** in which the temperature employed for hardening is between 1525° and 1600° F.

References Cited

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L. DEWAYNE, RUTLEDGE, Primary Examiner

W. W. STALLARD, Assistant Examiner

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