RAPID SPHEROIDIZING ANNEALING OF ROLLER BEARINGS WITH INDUCTION HEATING

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High-quality roller bearings are obtained with a homogeneous structure of fine-grained pearlite before hardening [1]. This structure provides the best combination of physicomechanical properties and also low hardness of the rollers for subsequent machining.

The use of progressive methods of hot deformation for manufacturing the rollers, with an allowance for grinding, makes it possible to omit turning, in which case low hardness of the blank and annealing are unnecessary to obtain finely dispersed divorced pearlite, ensuring good properties after hardening.

To obtain fine-grained pearlite the blanks of steel ShKh15 are subjected to spheroidizing annealing in electric and gas furnaces at 780–800°C, with slow cooling. Divorced pearlite can be obtained also at a temperature somewhat below Ac_1 with holding for a longer time, since diffusion occurs at a low rate in α phase at these temperatures [1, 3-5].

In bearing and metallurgical plants steel ShKh15 is annealed in continuous roller and pusher furnaces [1, 2, 6]. The annealing time varies from 10 to 20 h at different plants.

Spheroidizing annealing is a long process and it is complicated to automate the heat treatment of massive roller bearings. The annealed blanks have a considerable decarburized layer.

To shorten the annealing time, improve the quality of roller bearings, and create conditions for automation of the process one can use rapid spheroidizing annealing with induction heating.

The possibility of using rapid annealing with induction heating for spheroidization of carbides was investigated on roller bearings of series 308 made of steel ShKh15, manufactured by expansion with an allowance for grinding.

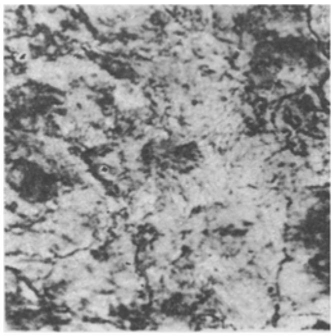

Fig. 1. Original microstructure of roller bearing (500 ×).

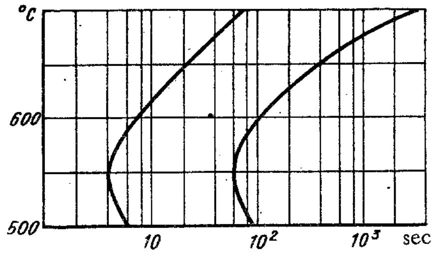

Fig. 2. Isothermal transformation of austenite in steel ShKh15 (308 bearings). Austenitizing at 850°C for 30 sec.

Moscow Evening Metallurgical Institute. All-Union Scientific-Research Institute of the Bearing Industry. Translated from Metallovedenie i Termicheskaya Obrabotka Metallov, No. 1, pp. 62-64, January, 1976.

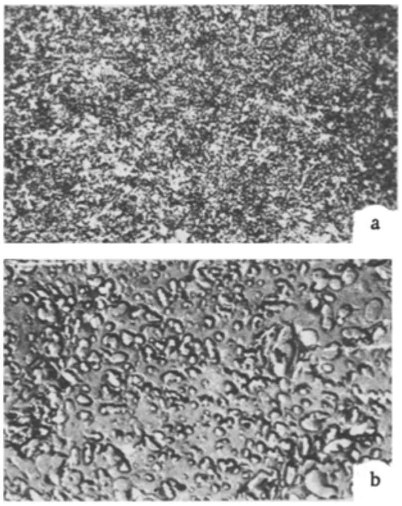

Fig. 3

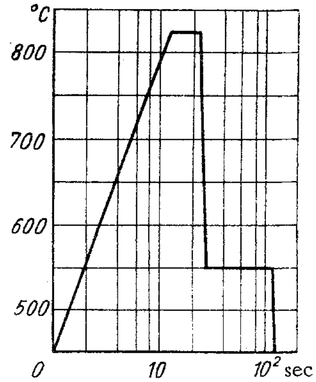

Fig. 4

Fig. 3. Microstructure of bearing after isothermal annealing at 550°C for 2 min. a) 500 ×; b) 10, 000 ×.

Fig. 4. Temperature graph for annealing roller bearings 308.

TABLE 1

Isothermal holding temp., °C	Incubation period, sec	Time (sec) to complete transformation	HB
700	80	3600	217
680	40	1020	223
640	18	300	293
600	8	120	285
550	4	60	293
500	6	90	341

The chemical composition of the steel was 1.0% C, 0.26% Mn, 0.30% Si, 1.37% Cr, 0.012% S, 0.019% P.

After hot deformation, the blanks contained carbides of lamellar form and traces of a carbide network (Fig. 1). The hardness was HB 341-363.

Rapid heating consists of induction heating of the blanks for austenitizing, holding to equalize the temperature through the section, rapid cooling to isothermal transformation temperature in order to exclude decomposition of austenite, holding at this temperature until the austenite is completely transformed, and final cooling in water.

Induction heating of the blanks for austenitizing was conducted in a ring inductor powered by a machine generator with a power of 100 kW, current frequency 8000 Hz.

The desired heating conditions were ensured by using a special programmed automatic control. For experimental purposes the inductor voltage was strictly metered by means of a thermocouple measuring the temperature of the rollers. In actual production the voltage on the terminals of the inductor was stabilized.

Heating was controlled by means of a regulator of the ARNI type (designed by the Moscow Evening Metallurgical Institute).

To obtain a structure of divorced pearlite the steel should be heated to a temperature at which the austenite retains considerable heterogeneity, with a large number of undissolved fine carbides.

We investigated heating of the blanks at 820, 850, and 880°C. The results showed that the optimal austenitizing temperature is 850°, with holding for 30 sec. At higher temperatures the carbide phase is lamellar after annealing, which is explained by the almost complete solution of fine carbides in the solid solution at such a high temperature and the homogenization of austenite.

After heating at 820° undissolved lamellar carbides from the original structure remain in solution.

To select the optimal temperature and holding time for rapid annealing we investigated the isothermal decomposition of austenite in 308 bearings.

Studies of the microstructure and hardness after different holding times (2-90 min) at 500, 550, 600, 640, 680, and 700° made it possible to determine the initial, final, and intermediate stages of the transformation.

The results (Table 1, Fig. 2) show that the holding time is shortest (60 sec) at 550°.

With increasing isothermal transformation temperatures the hardness of the rollers decreases due to coalescence of the carbides. At isothermal holding temperatures at 550-640° the hardness of the bearings is practically the same.

After annealing at 550° the microstructure consists of divorced highly dispersed sorbite-like pearlite (Fig. 3).

The total annealing time at 550° is 3 min (Fig. 4). Annealing under these conditions is recommended for bearings manufactured with an allowance for grinding and was taken as the basis for designing automatic heat treatment apparatus for these bearings.

For bearings that are machined before hardening we recommend annealing at 680°. In this case the structure consists of fine divorced pearlite (HB 220). The total annealing time is 20 min, the isothermal holding time for decomposition of austenite 17 min (see Table 1).

CONCLUSIONS

1. The conditions were established for rapid spheroidizing annealing of roller bearings made of steel ShKh15 with use of induction heating.

2. As compared with the treatments used in bearing factories, the new treatment has the following advantages:

a) The spheroidizing annealing time is reduced from 10-20 h to 3 min;

b) Conditions are created for mechanization and automation of the heat treatment for roller bearings so that it can be conducted in the production line;

c) Rapid annealing of steel ShKh15 with induction heating makes it possible to obtain a highly dispersed structure of sorbite-like pearlite;

d) The quality and service life of roller bearings increase due to the more dispersed structure, and decarburization decreases due to rapid induction heating.

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