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(71) Applicant *(for all designated States except US):* AB SKF [SE/SE]; S-415 50 Göteborg (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only) :* SÖRSTRÖM, Per-Olof [SE/SE]; Håkons gata 3, S-442 34 Kungälv (SE). LUNDH, Thore [SE/SE]; Ågatan 14, S-813 33 Hofors (SE). BESWICK, John, Michael [GB/NL]; Th. Elsenstraat 59, NL-Montfoort (NL). HENGERER, Frank [AT/DE]; Am Kammerholtz 44, D-8721 Schwebheim (DE).

(74) Agents: ROSENQUIST, Per, Olof et al.; Bergenstråhle & Lindvall AB, P.O. Box 17704, S-118 93 Stockholm (SE).

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(54) Title: STEEL FOR BALL AND ROLLER BEARINGS

(57) Abstract

Steel for ball and roller bearings and similar applications, containing, in % by weight: 0.75 - 0.90 % carbon; 0.01 - 0.14 % silicon; 0.15 - 0.50 % manganese; 0.90 - 1.50 % chromium; 0.10 - 0.50 % molybdenum; the rest up to 100 % being iron and other residual elements normally present in steel, and with the further proviso that the total area percentage of oxide inclusions must not exceed 0.0012 %, that the area percentage of titanium-carbonitrides must not exceed 0.0015 %, and that the area percentage of sulphide inclusions must not exceed 0.030 %, the respective area percentages being measured according to the inclusion rating method defined in the Swedish Standard SS111116, wherein the field of vision shall be 0.8 mm and the number of fields of vision to be surveyed shall be at least 1000.

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STEEL FOR BALL AND ROLLER BEARINGS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a steel for ball and roller bearings and similar applications.

2. Description of the Prior Art

Ball and roller bearings have to withstand high loads under extended periods of time and at temperatures that may temporarily rise to 250°C. Many times they are working in contaminated environments and thus must withstand abrasion by hard and abrasive particulate material. Further, ball and roller bearings must have high dimensional stability and reproducibility while at the same time being as easy as possible to manufacture.

Known in the art are various kinds of steel, which are used or have been suggested for use in the production of ball and roller bearings, components thereof, and for similar applications.

One steel widely used for ball and roller bearings is SAE 52100, containing 0.98 - 1.10 % C, 0.15 - 0.35 % Si, 0.25 - 0.45 % Mn, max. 0.025 % P, max. 0.025 % S, 1.30 - 1.60 % Cr, and max. 0.10 % Mo. The strength of the steel, which is a mechanical property of major importance, is high and this steel results in ball and roller bearings of good mechanical properties, but still there is a need for even higher quality steel for manufacturing ball and roller bearings.

A further need is to accomplish a steel resulting in good mechanical properties while at the same time being improved with regard to ease of hot working, reproducibility of product properties such as dimensional stability and long life under high-load conditions, where resistance against fractures caused by fatigue and wear are important factors.

SUMMARY OF THE INVENTION

One object of the invention is to provide an improved steel for ball and roller bearings with improved functional properties

compared to prior art steels.

Another object of the invention is to provide an improved steel for ball and roller bearings with improved manufacturing properties.

These objects are achieved with the steel for ball and roller bearings and similar applications according to the invention containing, in % by weight:

0.75 - 0.90	%	Carbon
0.01 - 0.14	%	Silicon
0.15 - 0.50	%	Manganese
0.90 - 1.50	%	Chromium
0.10 - 0.50	%	Molybdenum

the rest up to 100% being iron and other residual elements normally present in steel, and

with the further proviso that the total area percentage of oxide inclusions must not exceed 0.0012 %, that the area percentage of titanium-carbonitrides must not exceed 0.0015 %, and that the area percentage of sulphide inclusions must not exceed 0.030 %, the respective area percentages being measured according to the inclusion rating method defined in the Swedish Standard SS111116, wherein the field of vision shall be 0.8 mm and the number of fields of vision to be surveyed shall be at least 1000.

According to a preferred embodiment of the invention the steel contains, in % by weight:

0.83 - 0.88	%	Carbon
0.05 - 0.14	%	Silicon
0.20 - 0.30	%	Manganese
0.005 - 0.015	%	Sulphur
1.05 - 1.15	%	Chromium
0.18 - 0.23	%	Molybdenum.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The features determining the characteristics of a steel are the content of alloying elements, microstructure and metallurgical imperfections. While the presence of certain elements in a steel of this kind is harmful and should be avoided as much as possible, that of others has both positive and negative consequ-

ences regarding properties and workability. One example of an alloying element of the latter sort is silicon. By substantially accumulating in the ferrite phase, silicon has a negative effect on the cold working properties.

With the silicon content in the steel according to the invention good manufacturing properties are obtained. A reduction of the silicon content in itself gives a reduced hardenability for the steel, which however according to the invention is compensated for by the combination of the contents of chromium and molybdenum.

Carbon is the alloying element known to contribute the most to the hardenability and hardness of steel. However, increasing the carbon content too much above about 0.8 % carbon not only affects hardenability negatively, but it will also complicate the soft annealing procedure due to the carbide network formed.

Chromium and molybdenum are strong carbide forming elements, and contribute significantly to the properties and hardenability of the steel. When the amount of Mo is increased and the amount of Cr is decreased, this will result in enhanced strength properties.

Thus, the combination according to the invention of a moderate carbon content with a low silicon content, a comparatively high molybdenum content and reasonably high manganese and chromium contents, results in a product which has improved manufacturing properties, while, at the same time, the finished products have improved characteristics.

With a sulphur content within the limits accordng to the invention, a well regulated and controlled workability will be obtained, but it is still low enough to give good material properties. In the steel according to the invention the sulphide inclusions will be secondary, while the oxide inclusions and TiC-inclusions are very limited.

The steel according to the invention can be produced by known methods, their adaptation to allow control of the concentrations of major, minor and residual alloying elements according to the invention being within the easy reach of the expert in the art of producing bearing steel.

The invention is illustrated by the following examples.

Example

Workability

A steel, referred to as 720C was produced, having the following composition, in % by weight:

C	0.88	%
Si	0.07	%
Mn	0.26	%
P	0.007	%
S	0.007	%
Cr	1.06	%
Ni	0.08	%
Mo	0.20	%
Cu	0.11	%
V	0.01	%
Al	0.024	%
O	6.5	ppm
N	72	ppm

Workability tests were performed for comparing this steel with a conventional steel, corresponding to SAE 52100, defined in ASTM A295.

Workpieces in the form of tubes with thick walls were produced from the steels 720C and SKF 3. The workpieces were subjected to cold rolling (also referred to as cold rocking) at different reduction rates. The mean values of series of tests are reported in the following table, with the hardness expressed in H_V.

TABLE

Type of steel	Reduction rate	Hardness before reduction	Hardness after reduction
SAE 52100	50	200	300
SAE 52100	~60	200	rupture
720 C (*)	50	180	270
720 C (*)	75	180	290

(*) with the above composition.

From the Table it is clearly evident that the steel according to the invention has a significantly better workability, compared with the control, while the resulting final hardness is well within the prescribed limits 250 to 300 H_V, and close to that of the control.

Claims

1. Steel for ball and roller bearings and similar applications, containing, in % by weight:

0.75 - 0.90	%	Carbon
0.01 - 0.14	%	Silicon
0.15 - 0.50	%	Manganese
0.90 - 1.50	%	Chromium
0.10 - 0.50	%	Molybdenum,

the rest up to 100% being iron and other residual elements normally present in steel, and

with the further proviso that the total area percentage of oxide inclusions must not exceed 0.0012 %, that the area percentage of titanium-carbonitrides must not exceed 0.0015 %, and that the area percentage of sulphide inclusions must not exceed 0.030 %, the respective area percentages being measured according to the inclusion rating method defined in the Swedish Standard SS111116, wherein the field of vision shall be 0.8 mm and the number of fields of vision to be surveyed shall be at least 1000.

2. Steel according to claim 1, comprising, in % by weight:

0.83 - 0.88	%	Carbon
0.05 - 0.14	%	Silicon
0.20 - 0.30	%	Manganese
0.005 - 0.015	%	Sulphur
1.05 - 1.15	%	Chromium
0.18 - 0.23	%	Molybdenum.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00439

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: C22C 38/22
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: C22C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 3306734 (A.M. AKSOY ET AL), 28 February 1967 (28.02.67), table III and V --	1-2
A	US, A, 4642219 (YATSUKA TAKATA ET AL), 10 February 1987 (10.02.87), table 1 --	1-2
A	EP, A1, 0458646 (AICHI STEEL WORKS, LIMITED ET AL), 27 November 1991 (27.11.91), table 4, 6 and 8 -- --------	1-2

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3306734	28/02/67	NONE	
US-A- 4642219	10/02/87	DE-A- 3507785	19/09/85
		GB-A,B- 2155951	02/10/85
		JP-B- 4005742	03/02/92
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