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CHEMICAL SURFACE TREATMENT OF FERROUS BEARING METALS

John C. Zimmer, Union, and Arnold J. Morway, Clark Township, Union County, N. J., assignors to Standard Oil Development Company, a corporation of Delaware

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1 Claim. (Cl. 148—6.14)

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This invention relates to improved extreme pressure rubbing surfaces. It is concerned with the improvement of ferrous gears or other ferrous bearing elements which are subjected to high pressures, for example, ferrous gears of the hypoid or similar type. The invention especially relates to the improvement of rubbing surfaces secured by a chemical pretreatment of the said surfaces.

This application is a division of our copending application Serial Number 469,512, filed December 19, 1942, now abandoned, which is a continuation-in-part of application Serial Number 177,928, filed December 3, 1937, now Patent No. 2,310,381, granted February 9, 1943.

The present invention is to be distinguished from the mere cleansing of metallic surfaces with acid pickling materials or the treatment of surfaces for the prevention of secondary reactions such as oxidation. The invention secures improved rubbing ferrous surfaces by treating the said surfaces with acids of boron and the salts thereof, thereby increasing and improving their load carrying capacity, as well as reducing corrosion in the presence of moisture.

It is well known in the art to improve the load carrying capacity of rubbing surfaces, particularly hypoid gears, by the use of so-called "extreme pressure lubricants." These extreme pressure lubricants are usually sulfurized or chlorinated mineral or vegetable oils in combination with lead soaps. These lubricants are helpful in improving the load carrying capacity of the rubbing surfaces but still are not entirely satisfactory at relatively high pressures under certain operating conditions. Such lubricants require activation to form an extreme pressure film, which film is formed by the development of a high temperature associated with bearing seizure. It is also known to plate steel gears with copper or tin in order to decrease wear and thus avoid failures by seizure of the bearing surfaces. This process has the inherent disadvantages that the plating chips and cracks or wears off rather readily. In addition, particularly in the case with copper plated gears, the metal seems to act as an accelerator for oxidation and thickening of the gear lubricant.

The present invention secures improved load carrying capacity by preactivation of the gears or rubbing surfaces and thereafter permits the use of an ordinary lubricant which would otherwise be entirely unsatisfactory. The process of the present invention may also be used in conjunction with extreme pressure lubricants in order to further increase load carrying capacity and minimize bearing seizure.

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The improved ferrous rubbing surfaces of machine elements, such as gears, bearings, cams, journals, pistons, cylinders, rings, races, valve stems and the like, are secured by treating the metal with a solution containing an anion of an acid of boron, more particularly an acid of boron or a salt thereof. The improvement appears to be secured by the formation of a coating of iron borate on the metallic surfaces. Especially suitable are the oxyacids of boron and their salts. Preferred rubbing surfaces are secured by treating the ferrous metals with an aqueous solution of boric acid or of a borate, such as sodium tetraborate, or with an aqueous solution containing a mixture of an acid of boron and a salt thereof. Solutions containing mixtures of an acid of boron and an acid of phosphorus are also quite effective, for example, a mixture of boric acid and phosphoric acid. Treatment of the ferrous surfaces with solutions of the type described not only improve the load carrying capacity of the surfaces but markedly improve the ability of the surfaces to resist corrosion in the presence of moist air.

The marked improvement secured by this process is shown by the following data obtained in specific examples which serve to illustrate the invention. Steel rods were treated in the manner described and then were tested on the Almen machine, which is described in detail in the "National Petroleum News," November 16, 1932. The operation of this machine can be briefly summarized as follows:

The machine is portable and employs a ¼-inch drill-rod journal and a ½-inch split bushing made of S. A. E. 2315 cold-drawn steel. The journal is polished and the bushing after splitting is ground on the bearing surface with a form grinding wheel. A clearance of 0.007 inch is provided between the journal and the normal diameter of the bushing. Pressure is applied to the bushing by means of a hydraulic and mechanical loading system. The friction torque developed is indicated through a second hydraulic system by a Bourdon gage.

In conducting a test the oil container is first filled with oil to be tested (about 25 ml.) submerging the test journal. The machine is then started and run for 30 seconds at no load to insure thorough lubrication of the journal and bushing. The load is then applied at the rate of 2 lb. every 10 seconds until seizure occurs or until 30 lb. have been applied. The speed of

rotation is 600 R. P. M. For timing the application of weights, a bell is provided and so arranged as to ring at 10 second intervals. Each 2-lb. weight produces a pressure of approximately 1,000 lb. per sq. in. of projected area on the test bearing.

EXAMPLE 1

A steel rod tested on the Almen machine using an uncompounded mineral lubricating oil of S. A. E. 20 grade carried 3 weights before seizure occurred. This mineral lubricating oil was used as the lubricant in Examples 2 and 3.

EXAMPLE 2

An aqueous solution containing approximately 5% boric acid was heated to boiling and the steel rod of the Almen machine immersed in said boiling solution for about 30 minutes. The rod, upon being dried and tested on the Almen machine, carried 11 weights.

EXAMPLE 3

An aqueous solution containing 2% boric acid and 0.5% phosphoric acid was heated to boiling and the steel rod of the Almen machine immersed in the boiling solution for about 30 minutes. This rod, upon being dried and tested in the Almen machine, carried 14 weights.

EXAMPLE 4

A series of corrosion tests were made on ferrous Almen machine journals and bushings after these had been treated with boiling aqueous solutions of various compounds of boron and mixtures of the same for various periods of time. The corrosion tests were conducted by hanging the treated journals and bushings in an insulated humidifier box of approximately 2' x 2' x 4' dimensions, passing in air saturated with moisture at about 140° F. at the rate of about 15 cu. ft. of air per hour, the temperature in the interior of the box being about 100° F. The test was conducted in each case for 48 hours. The air within the box under these conditions was therefore not only saturated with moisture but contained condensing moisture. The results of the corrosion tests are shown in the following table:

Table I

Treating Agent	Strength of Aqueous Solution	Time of Treatment, min.	48 Hour Corrosion Test
No treatment			Badly corroded.
Sodium tetraborate	2%	15	Slightly corroded.
Do	2%	30	Very slightly spotted.
Do	5%	15	Untouched.
Boric acid	2%	15	Slightly corroded.
Do	2%	30	Do.
Do	5%	15	Do.
Boric acid and sodium tetraborate.	1% of each	15	Do.
Do	1.5% of each	15	Do.
Sodium tetraborate	Saturated	15	Do.

The operating conditions may be varied over wide limits. The treating operation may be carried out under pressure or vacuum although it is preferred to treat at atmospheric pressure. The temperature of the treating bath may be as high as 300° F. although the preferred range is from about 80° F. to the boiling point of the bath. It is preferred to maintain a temperature a few degrees below the boiling point of the respective baths. The time of treatment is less than about one hour, preferably from 15 minutes to 30 minutes. The concentration of inorganic material is maintained below about 20%. Concentrations from ½% to 10% are preferred.

The invention is not to be limited by any theory of operation nor by the examples of its embodiment which are described herein, but only by the following claim.

We claim:

In the method of improving load-carrying capacity of the finished surface of a ferrous alloy machine element which is to be subjected to extreme pressure rubbing contact, the improvement consisting in chemically treating said surface with a boiling aqueous solution composed essentially of boric acid of approximately 5% concentration for a time period of from about 15 to 30 minutes, then removing the treated surface and drying the same.

JOHN C. ZIMMER,
ARNOLD J. MORWAY.

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