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TREATMENT OF FERROUS BEARING METALS

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1 Claim. (Cl. 148—6.5)

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 as, for example, ferrous gears of the hypoid or similar type. The invention especially relates to the improvement of rubbing surfaces secured by a chemical pre-treatment of the said surfaces.

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

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 sulphurized or chlorinated mineral or vegetable oils in combination with lead soaps. These extreme pressure 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. These extreme pressure 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.

The improved ferrous rubbing surfaces such as gears, bearings, cams, journals, pistons, cylinders, rings, races, valve stems, and the like, are secured by treating the metal with a chemical reagent selected from the group consisting of acids of phosphorus, acids of boron and the salts thereof. Preferred rubbing surfaces are secured by treating the ferrous metal with a phosphate, phosphite, thiophosphate or thiophosphite, especially by treating with a phosphate in the presence of a small quantity of phosphoric acid. The temperature of the treating solution is preferably maintained at approximately the boiling point. The mono phosphate and di or tri phosphate containing some free phosphoric acid group are all satisfactory for this purpose, or any combination of these materials. It is preferred to use the sodium salt of the oxyacids of phosphorus or boron although other metallic salts are equally satisfactory.

The marked improvement secured by this process is shown by the following data where specific examples 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

The steel rod tested on the Almen machine using an uncompounded mineral lubricating oil,

S. A. E. 20, carried three weights before seizure occured. This mineral lubricating oil was used as the lubricant in all the following examples.

Example 2

An aqueous solution having approximately 10% concentration of dibasic sodium phosphate was heated to boiling and the steel rod immersed in said solution for approximately 30 minutes. This rod was then removed and dried in air. The rod when tested on the Almen machine using the mineral lubricating oil described above carried 14 weights.

Example 3

An acid aqueous solution having a concentration of approximately 5% of dibasic sodium phosphate was heated to boiling and the steel rod immersed for approximately 15 minutes. This rod was then dried and tested in the manner described in the preceding example. The rod carried 14 weights on the Almen machine.

Example 4

An aqueous solution of 2% tribasic sodium phosphate was heated to boiling and the steel rod immersed in said solution for approximately 15 minutes. This rod was then dried and tested in the manner described above. The rod carried five weights.

Example 5

An aqueous solution of 2% tribasic sodium phosphate and ½% phosphoric acid was heated to a temperature of approximately 80° F. and the steel rod immersed in said solution for approximately 15 minutes. This rod, after being dried, carried 10 weights when tested on the Almen machine.

Example 6

Procedure in accordance with the preceding example except that said solution was heated to boiling and the steel rod immersed for 15 minutes. The rod, when tested on the Almen machine, carried 13 weights.

Example 7

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

Example 8

An aqueous solution containing 2% boric acid and ½% phosphoric acid was heated to boiling and the steel rod immersed in the solution for about 30 minutes. This rod, upon being dried and tested on the Almen machine, carried 14 weights.

Example 9

An aqueous solution containing 2% phosphorous acid was heated to boiling and the steel rod immersed in the solution for 20 minutes. This rod, upon being dried and tested on the Almen machine in the manner described above, carried 10 weights.

Other concentrations other than shown above may be within the scope of this invention, for example somewhat higher proportions of boric acid may be used or a combination of a borate salt with boric acid and phosphoric acid is also satisfactory.

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 a time of treatment 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 but only by the following claim in which it is desired to claim all novelty in so far as the prior art permits.

We claim:

A process of preparing a ferrous metal bearing surface for use with a mineral lubricating oil comprising chemically treating said surface with an aqueous solution of dibasic sodium phosphate which will react therewith to form a coating of iron phosphate thereon.

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