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TREATMENT OF METALLIC FRICTIONAL SURFACES

Bruce B. Farrington and Ronald T. Macdonald, Berkeley, Calif., assignors to Standard Oil Company of California, San Francisco, Calif., a corporation of Delaware

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This invention relates to the treatment of metallic frictional surfaces of machine elements and especially to a treatment which facilitates breaking-in thereof and which prevents scuffing, scoring or seizing of moving metal surfaces in frictional contact. This application is a continuation-in-part of our application Serial No. 108,388, filed October 30, 1936.

Because of the increased power and increased speed of moving parts of recently designed automobiles, it has been found that formerly suitable lubricants are not capable of providing safe lubrication under all conditions of operation. This is especially true during breaking-in of cars provided with hypoid gears. Various lubricants have been developed in an effort to meet the extreme requirements necessary to insure absolutely safe lubrication under the high pressures and sliding friction encountered in modern machines.

The problem of lubricating hypoid gears has become particularly acute. Lubricants which have been provided for these gears may be classified into two general types, namely, (1) corrosive extreme pressure lubricants containing, for instance, free sulfur or corrosive oil soluble sulfur compounds, and (2) milder extreme pressure lubricants containing non-corrosive oil soluble compounds of sulfur or other materials which aid lubrication and increase resistance to scuffing or seizure. Although these lubricants are highly useful they are not entirely satisfactory.

It has been found, for example, that corrosive extreme pressure lubricants are not always desirable for lubrication of well "run in" gears because of detrimental effects on bearings and other parts and because of an accelerated rate of wear produced on the gears themselves. It has also been observed that less corrosive lubricants are not as desirable as corrosive lubricants for use during the breaking-in period.

Difficulties have also been encountered during breaking-in of internal combustion engines. The piston rings, cylinder walls, cam shafts and the like tend to score or scratch unless speed and load on the engine are properly controlled during the first 500 to 1,000 miles of operation. It is not desirable to use extreme pressure lubricants in the crankcase of internal combustion engines because of corrosive effects resulting therefrom.

This invention avoids difficulties heretofore encountered and provides a method of pretreating machine elements prior to breaking-in which not only insures against scuffing and scoring but also greatly facilitates and accelerates the running-in process. The invention is useful whether corrosive extreme pressure lubricants, non-corrosive extreme pressure lubricants or merely straight mineral oils are used for lubrication during the breaking-in process.

Accordingly, it is an object of the invention to provide a process of treating gears, pistons, piston rings, cylinder walls, cam shafts and other frictional surfaces of machine elements which are subject to metal contact so that danger of scuffing or seizing is avoided during the breaking-in process.

Another object of the invention is to provide a method of pretreating machine elements which will accelerate the wearing-in process.

A still further object of the invention is to provide a method of chemically treating machine elements prior to breaking-in to produce an integral, thin, tenacious sulfide coating on the frictional surfaces thereof, whereby breaking-in will be facilitated.

Another object of the invention is to provide an integral, thin tenacious sulfide coating on pistons, piston rings and cylinder walls of an internal combustion engine by chemically reacting on the surface with an aqueous alkaline bath containing sulfur, whereby wearing-in is accelerated and blow-by is reduced during breaking-in.

A further object of the invention is to provide a new and useful metal treating bath.

An additional object of the invention is to provide a novel metal treating bath which is economical in operation and produces sulfide films capable of withstanding extremely high loads.

A pretreating method which has been found to be particularly efficient and economical comprises contacting the articles to be treated with an aqueous alkaline bath containing sulfur. Specific examples of the preparation of treating baths and of treating methods utilizing the present invention are as follows:

Example 1.—A treating solution is made up by using 1,000 grams of 47% NaOH solution and adding 50 grams of sulfur thereto. This mixture was heated to 265° F. and stirred until the sulfur was dissolved and the solution became clear. A pair of Timken cups (such as used for the determination of film strengths in the S. A. E. lubricants testing machine described in the S. A. E. Journal, volume 33, page 402, 1933) were immersed in this bath for one minute after having been brought to about 210° F. by preheating in boiling water. This treatment left a dull black coating on the cups. When subjected to test in

the above mentioned testing machine the film was found to stand the full load (550 lbs.) of the machine without cutting, whereas the same cups without the above treatment but lubricated with the same non-corrosive type extreme pressure lubricant stood a load of only 85 lbs. when cutting occurred.

Example 2.—The bath for this treatment was prepared by first heating 140 gallons of caustic soda solution (48 to 50% NaOH) to approximately 220° F. At this point 0.6 by weight of powdered sulfur was added and the solution agitated slightly by means of air for a period of about two hours. During this time heating was continued to bring the temperature up to about 250° F., at which time the bath was ready for use.

Cylinder liners for internal combustion engines were washed in a suitable solvent such as a volatile hydrocarbon thinner and allowed to drain in order to remove a grease coating which was found to be on them. The liners were hung vertically in a rack and introduced into the bath in this position. A small stream of air bubbles was passed through the center of each liner during immersion, thereby furnishing adequate agitation of the solution. A treatment of ten minutes in this bath at a temperature of approximately 250° F. produced a distinct black color on the frictional surface of these machine elements. Upon removal of the treated liners from the bath at the end of the ten minute period, they were thoroughly washed with hot water to remove the treating solution. Because of their elevated temperature the liners dry within a few minutes, after which they are carefully wiped clean. In order to protect the film from the action of air, a coating of petroleum jelly or other suitable heavy oil is applied.

When treating piston rings it has been found that a much longer period of treatment, for example approximately 45 minutes in the above bath at a temperature of 250° F., is required to produce a ray film. As in the above case, the rings after treatment should be thoroughly washed with hot water, carefully dried and dipped in oil.

Pistons treated for a period in the order of 45 minutes were found to have a black coating thereon which facilitated breaking-in of an engine. It is desirable to protect the wrist pin bearings from the action of the treating bath by plugging the holes in the piston wall or covering the surface with a suitable inert coating.

Piston rings and liners treated as above were found to wear-in much more rapidly than untreated rings. Furthermore, it was observed in actual engine tests that less blow-by was produced than ordinarily results during the breaking-in period from gases escaping through irregularities and between parts which do not fit exactly. Elimination or reduction of blow-by decreases formation of carbon on or around the rings and the consequent tendency to accelerate piston ring sticking.

Pretreatment of gears accelerates the wearing-in of the frictional surface of the gear teeth and the production of a highly polished surface. The pretreatment also serves to prevent scuffing or seizing of highly loaded gears during breaking-in when the extreme pressure lubricant has a film strength inadequate to carry loads which may be encountered in emergencies or under conditions of operation. As a result of pretreatment, less corrosive extreme pressure lubricants may be used during breaking-in of gears than are otherwise required.

Pretreatment of cam shafts and similar surfaces in internal combustion engines serves to prevent scratching or scoring during the initial period of operation of the motor.

The character of the coating produced by the treatment is of preeminent importance. The time, temperature and concentration of bath ingredients necessary to obtain a satisfactory treatment varies greatly with the particular article being treated. For example, cast iron liners were found to have a definite black coating after ten minutes of treatment according to Example 2, previously described. Treatment in the same bath under the same conditions required a period of 45 minutes to produce a gray coating on steel piston rings. It is therefore apparent that the conditions of treatment must be adapted to the article being treated and that these conditions can be determined by simple experiment.

The above description gives two specific examples of processes which can be carried out according to the present invention. The invention is not to be limited to the proportions, temperatures or time of treatment above disclosed. It has been found, for example, that temperatures of from 150° F. to 275° F. are highly satisfactory. At temperatures lower than 150° F. the rate of chemical reaction is considerably reduced, which necessitates a longer time of treatment, and at temperatures higher than 275° F. difficulties from warping or distortion of the machine elements may result. However, such alternative temperatures are operative and are not to be regarded as outside the scope of the invention in its broad aspect.

The strength of the alkali solution utilized may vary widely. In general, it is found desirable to have at least 25% of caustic soda and that more than 60% is unjustifiable. From approximately 30% to approximately 50% NaOH appears at present to be the optimum proportion, although higher concentrations may be used in special cases. In order to have a practical rate of reaction at least ½% of sulfur should be present in the bath; and in order to avoid unduly fast chemical reaction with attending difficulties of control and flaking of the coating, no more than 15% of sulfur is desirable. The preferred range of sulfur content is from approximately 1% to approximately 5%.

The composition of the treating bath has not been established. The bath probably contains a complex mixture of sulfides, polysulfides, sulfites and/or thiosulfates. Experiments indicate that the sulfur need not necessarily be introduced into the aqueous alkali solution in the free form, as described in the above specific examples. It may be introduced in the form of compounds, such as sodium thiosulfate, a mixture of sodium sulfide and sodium sulfite; or in the form of compounds which decompose to yield free or active sulfur, such as calcium pentasulfide or sodium polysulfides, for example.

In the specification and claims the term "dissolved sulfur" is used to designate sulfur in the form which it assumes when dissolved in the alkali solution, whether the sulfur be initially dissolved as free powdered sulfur or as compounds which decompose to give free active sulfur, such as sodium thiosulfate, a mixture of sodium sulfide and sodium sulfite, calcium pentasulfide and sodium polysulfides.

Other alkali hydroxides may be substituted for the sodium hydroxide used in the bath. It has been observed that the strong hydroxides give a better and faster rate of treatment. A bath containing calcium hydroxide and sulfur is operative to produce a sulfide film, but the treatment is much less satisfactory than when stronger alkalies are utilized.

As an example of the treatment with an aqueous lime sulfur bath the following test data are given: Timken cups were treated for 30 minutes at 200° F. in an aqueous solution saturated with calcium hydroxide and containing a small amount of dissolved sulfur. The surface so treated carried a load of 344 lbs. in the S. A. E. tester when operated at 534 R. P. M., 14.6 rolling ratio and a load rate of 83.5 lbs. per second.

In general, alkaline substances capable of dissolving sulfur in aqueous solutions may be substituted for the sodium hydroxide or calcium hydroxide hereinabove specifically disclosed to produce a frictional surface having, at least to some degree, the improved properties herein described. Alkaline materials falling within this broader scope of the invention include alkaline salts such as trisodium phosphate, alkaline sodium silicates, sodium phenolate and the like. Organic bases such as triethanolamine, nitrogen bases from petroleum and such nitrogen compounds when dehydrogenated also comprise alkaline materials within the broader scope of the invention.

It has also been observed that a bath comprising a concentrated solution of a strong alkali hydroxide, for example a 50% solution of sodium hydroxide in water, produces, even in the total absence of sulfur, a frictional surface having to some degree the improved load carrying characteristics involved herein. However, the presence of dissolved sulfur greatly enhances the benefits to be obtained by the process of this invention and comprises an essential ingredient in the preferred species of our process and metal treating composition.

It is to be understood that modifications and variations falling within the terms and spirit of the appended claims are to be included within the scope of the invention which is not limited by the various details herein previously disclosed and described.

We claim:

1. A metal treating composition for the treatment of ferrous metal frictional surfaces to enhance the wearing qualities of said surfaces comprising an aqueous solution containing from approximately 25% to approximately 60% caustic soda and the reaction products formed by addition of from approximately ½% to 15% sulfur.

2. A metal treating composition for the treatment of ferrous metal frictional surfaces to enhance the wearing qualities of said surfaces comprising an aqueous solution containing from approximately 30% to 50% caustic soda and the reaction products formed by the addition of from approximately 1% to 5% sulfur.

3. A process of treating, prior to assembly, machine elements having ferrous metal frictional surfaces which comprises contacting the frictional surfaces thereof with an aqueous solution containing from approximately 25% to approximately 60% caustic soda and the reaction products formed by addition of from approximately ½% to 15% sulfur.

4. A process of treating, prior to assembly, machine elements having ferrous metal frictional surfaces which comprises contacting the frictional surfaces thereof with an aqueous solution containing from approximately 30% to 50% caustic soda and the reaction products formed by the addition of from approximately 1% to 5% sulfur.

5. A process of treating machine elements having ferrous frictional surfaces and selected from the group consisting of pistons, piston rings and cylinder walls of an internal combustion engine which comprises contacting the frictional surface of said elements with an aqueous solution containing from approximately 25% to approximately 60% caustic soda and the reaction products formed by addition or from approximately ½% to 15% sulfur.

6. A process of treating machine elements having ferrous frictional surfaces and selected from the group consisting of pistons, piston rings and cylinder walls of an internal combustion engine which comprises contacting the frictional surface of said elements with an aqueous solution containing from approximately 30% to 50% caustic soda and the reaction products formed by the addition of from approximately 1% to 5% sulfur.

7. A process of treating, prior to assembly, machine elements having ferrous metal frictional surfaces which comprises contacting the frictional surfaces thereof with an aqueous solution containing from approximately 30% to 50% caustic soda and the reaction products formed by the addition of from approximately 1% to 5% sulfur, the temperature of said solution being at from approximately 150° F. to 275° F.

8. A treating composition for ferrous metal frictional surfaces to inhibit failure due to extreme pressure loads which comprises an aqueous solution containing from approximately 25% to approximately 60% of an hydroxide of an alkali metal and a small amount of dissolved sulfur.

9. A process of treating machine elements having ferrous metal frictional surfaces which comprises contacting the frictional surfaces with an aqueous solution containing from approximately 25% to approximately 60% of an hydroxide of an alkali metal and the reaction products formed by the addition of a small amount of dissolved sulfur.

10. A process of treating machine elements having ferrous metal frictional surfaces and selected from the group consisting of pistons, piston rings and cylinder walls of an internal combustion engine which comprises contacting the frictional surface of said elements with an aqueous solution containing from approximately 25% to approximately 60% of an hydroxide of an alkali metal and the reaction products formed by the addition of a small amount of dissolved sulfur.

11. A process of treating machine elements having ferrous metal frictional surfaces which comprises contacting the frictional surfaces thereof with an aqueous solution containing from approximately 25% to approximately 60% of an hydroxide of an alkali metal and the reaction products formed by the addition of a small amount of dissolved sulfur, the temperature of said solution being at from approximately 150° F. to 275° F.

12. A process of treating ferrous metal frictional surfaces which comprises contacting said frictional surface with an aqueous alkaline solution containing a small amount of dissolved sulfur.

13. A process as defined in claim 12 in which said solution contains an alkaline hydroxide.

14. A process as defined in claim 12 in which said solution contains a calcium hydroxide.

15. A process as defined in claim 12 in which said solution contains an organic nitrogen base.

16. A metal treating bath for the treatment of ferrous metal frictional surfaces to enhance the wearing qualities of said surfaces comprising an aqueous solution of an alkaline hydroxide and from ½ to 15% of dissolved sulfur.

17. A process of treating machine elements having ferrous metal frictional surfaces subject to scuffing or scoring during initial use which comprises contacting the frictional surfaces thereof with an aqueous solution containing from approximately 25% to approximately 60% caustic soda and the reaction products formed by the addition of a small amount of sodium thiosulfate.

BRUCE B. FARRINGTON.
RONALD T. MACDONALD.