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# UNITED STATES PATENT OFFICE

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## EXTREME PRESSURE LUBRICANT

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2 Claims. (Cl. 252—54)

This invention relates to improvements in lubricants, and in particular, to improvements in extreme pressure lubricants adapted for use on bearing surfaces which are subjected to high pressures and high rubbing velocities during use.

High unit pressures which are encountered frequently in devices employed for the transmission of power, such as hypoid gears, worm gears, heavy duty bearings, planetary automatic shifts and the like, necessitate the use of lubricants having superior load carrying properties. Lubricants possessing superior load carrying properties which make them specially adapted for use under conditions of high pressure where the pressures encountered are of such magnitude that the separation of gear teeth or bearing surfaces by an ordinary oil film is not possible, are known in the art as extreme pressure lubricants. Extreme pressure lubricants are likewise important in cutting and drawing operations where the oil must withstand the high pressures encountered under those conditions of use.

It is an object of this invention to provide an improved extreme pressure lubricant which will give superior lubrication to bearing surfaces which are subjected to high pressures and/or high rubbing velocities.

Another object of this invention is to provide a lubricant which will prevent gear teeth or bearing failure from scoring or galling caused by the welding of small areas of the mating surfaces due to high pressure and high temperature.

We have found that the foregoing objects can be attained by adding small amounts of halogenated organic silicates to lubricants such as oils and soft greases. We have found that oils and soft greases so compounded will effectively lubricate bearing surfaces subjected to high pressures and high rubbing velocities. Similarly these halogenated organic silicates may be compounded with drawing and/or cutting lubricants.

We have found that the extreme pressure lubricants can be prepared by adding to oils or soft greases a small amount, preferably 0.01% to 10% of a halogenated organic silicate selected from the group consisting of compounds having the general formula $(R'X)_nSiY_{4-n}$ in which R' is a radical selected from the group consisting of a halogenated alkyl radical, a halogenated aryl radical and a halogenated aralkyl radical X is an element selected from the group consisting of oxygen and sulfur, Y is a halogen and $n$ is an integer selected from the group of whole numbers consisting of 1, 2, 3 and 4, and compounds having the general formula $(RX)_nSiY_{4-n}$ in which R is a radical selected from the group consisting of alkyl, aryl, and aralkyl radicals, X is an element selected from the group consisting of oxygen and sulfur, Y is a halogen and $n$ is an integer selected from the group of whole numbers consisting of 1, 2, and 3. The lubricating oils are preferably those ranging in viscosity upwards from about 90 Saybolt at 210° F. If desired, calcium, lead, aluminum or other soaps of high molecular weight organic acids may be added to the composition to increase the viscosity or consistency of the lubricant. Likewise, these halogenated organic silicates may be used in conjunction with other extreme pressure compounds.

Specific examples of the type of halogenated organic silicates which we may use are the following:

Tetra chloropropyl silicate, $(ClC_3H_6O)_4Si$
Tri chloropropyl chlorosilicate, $(ClC_3H_6O)_3SiCl$
Tetra chlorobutyl silicate, $(ClC_4H_8O)_4Si$
Tetra bromamyl silicate, $(BrC_5H_{10}O)_4Si$
Tetra chlorotolyl silicate, $(ClCH_3C_6H_3O)_4Si$
Chlorotolyl trichlorosilicate, $(ClCH_3C_6H_3O)SiCl_3$
Tetra chloropropyl thiosilicate, $(ClC_3H_6S)_4Si$
Propyl trichlorosilicate, $(C_3H_7O)SiCl_3$
Dibutyl dichlorosilicate, $(C_4H_9O)_2SiCl_2$
Triphenyl chlorosilicate, $(C_6H_5O)_3SiCl$

The load carrying capacity of extreme pressure lubricants may be determined by extreme pressure testing machines such as the Almen testing machine described by Wolf and Mougey in their paper on "Extreme Pressure Lubricants" given at the 13th annual meeting of the A. P. I. at Houston, Texas, November 17, 1932. Briefly, it consists of a test pin or journal made of ¼ inch diameter drill rod which can be rotated in a ½ inch long split bushing with provisions for loading the bearing thus formed by clamping together the two halves of the split bushing. Provision is also made to measure the torque required to rotate the journal in the loaded bearing.

The standard method of making a test on the Almen machine consists in immersing the test pin and bushings in the lubricant to be tested and then rotating the test pin at 600 R. P. M. The load, which clamps the two halves of the split bushing, is increased at the rate of 2 lbs. added every 10 seconds. A record is made of the torque required to rotate the pin at each load increment and the test is completed either when 30 lbs. have been added to the loading device or when seizure occurs, whichever happens first.

The following example will illustrate the effectiveness of the addition of small amounts of halogenated organic silicates in lubricating oils under extreme pressure conditions, as determined by the Almen test machine. A mineral lubricating oil having a viscosity of about 125 seconds Saybolt at 130° F. and the same oil with 0.5% tetra chloropropyl silicate when tested in the Almen machine gave the following data

*Almen test*

| Oil | Load at which seizure occurred |
|---|---|
| | *Pounds* |
| Control | 8 |
| Control+0.5% tetrachloropropyl silicate | 14 to 16 |

The load carrying capacity of extreme pressure lubricants may be also determined by the so-called Timken testing machine, described in the S. A. E. Journal vol. 28, No. 1 (January, 1931) page 53, and in U. S. Patent 1,990,771. Testing samples of the same oils used in the Almen machine test on the Timken test machine the following data were obtained.

*Timken test*

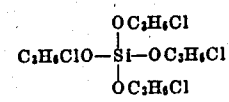
| Oil | Load at which seizure occurred |
|---|---|
| | *Pounds* |
| Control | Less than 8 |
| Control+0.5% tetrachloropropyl silicate | 20 to 30 |

The data obtained by these tests indicate that the addition of small amounts of halogenated organic silicates to a lubricant increases the load carrying capacity of the lubricant by from about 50% to about 300%.

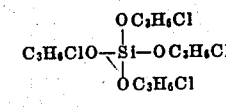
While we have described our invention with specific embodiments thereof, it is to be understood that the same is merely illustrative of the invention and not a limitation thereof, except insofar as the same is defined in the appended claims.

We claim:

1. An extreme pressure lubricant containing from about 0.01% to about 5% of tetra chloropropyl silicate, having the structural formula



2. The method of improving the extreme pressure lubricating properties of a lubricant which normally possesses poor extreme pressure properties which comprises adding to said lubricant from about 0.01% to about 5% of tetra chloropropyl silicate, having the structural formula



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