

## UNITED STATES PATENT OFFICE

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## EXTREME PRESSURE LUBRICANT

Clarence M. Loane and Bernard H. Shoemaker,  
Hammond, Ind., assignors to Standard Oil Com-  
pany, Chicago, Ill., a corporation of Indiana

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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 if small amounts of halogenated organic borates are added to lubricants such as oils and soft greases. We have found that the addition of small amounts of certain halogenated organic borates to lubricating oils and soft greases will provide lubricants which will enable the bearing surfaces to withstand high pressures and high lubricating velocities without noticeable wear. Similarly, these halogenated organic borates may be compounded with drawing and/or cutting lubricants.

We have found that the extreme pressure lubricants can be prepared by adding to lubricating oils a small amount, preferably 0.01% to 5% of halogenated organic borates having the general formulas  $(MX)_3B$  and  $(MX)_2B=X$  in which M is a halogenated alkyl radical, a halogenated aryl radical or a halogenated aralkyl radical, and X is either oxygen or sulfur. The lubricating oils are preferably those ranging in viscosity from about 50 to 200 seconds Saybolt at 210° F., or those oils designated as S. A. E. 20, 30, 40, 50 and 60 oils. 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 the consistency of the lubricant.

Specific examples of the type of halogenated

organic borates which we may use are the following:

Chlor propyl borate  $(ClC_3H_7O)_3B$   
Brom propyl borate  $(BrC_3H_7O)_3B$   
Di chlor butyl borate  $(Cl_2C_4H_9O)_3B$   
Chlor phenyl borate  $(ClC_6H_5O)_3B$   
Brom phenyl borate  $(BrC_6H_5O)_3B$   
Chlor propyl boron sulfide  $(ClC_3H_7S)_3B$   
Chlor propyl metal borate  $(ClC_3H_7O)_2B=O$   
Chlor phenyl meta borate  $(ClC_6H_4O)_2B=O$

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 1/4 inch diameter drill rod which can be rotated in a 1/2 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 borates in lubricating oils under extreme pressure conditions. A mineral lubricating oil having a viscosity of about 58 seconds at 210° F. and the same oil with 0.5% of chlor propyl borate when tested in the Almen testing machine gave the following results:

	Load at which seizure occurred		
	Pounds	Pounds	Pounds
Control.....	8	8	8
Control+0.5% chlor propyl borate.....	16	20	22

The above results indicate that lubricants containing small amounts of the halogenated organic borates are from 100% to almost 200% better than the oil without the addition of halogenated organic borates.

While we have described our invention with a specific embodiment thereof, it is to be understood that the same is merely illustrative of the inven-

tion and not a limitation thereof, except insofar as the same is defined in the appended claims.

We claim:

1. An extreme pressure lubricant comprising a mineral lubricating oil and a small amount of a halogenated organic borate.

2. An extreme pressure lubricant comprising a mineral lubricating oil and a small amount of an organic compound selected from the group consisting of halogenated organic borates having the general formula  $(MX)_3B$  and the halogenated organic meta borates having the general formula  $(MX)B=X$  in which M is a substituent selected from the group consisting of a halogenated alkyl radical, halogenated aryl radical and a halogenated aralkyl radical, and X is an element selected from the group consisting of oxygen and sulfur.

3. An extreme pressure lubricant comprising a mineral lubricating oil having a viscosity ranging from about 50 seconds Saybolt to about 200 seconds Saybolt at 210° F. and 0.01% to 5% of a halogenated organic borate having the general

formula  $(MX)_3B$  in which M is a substituent selected from the group consisting of a halogenated alkyl radical, a halogenated aryl radical and a halogenated aralkyl radical, and X is an element selected from the group consisting of oxygen and sulfur.

4. An extreme pressure lubricant comprising a mineral lubricating oil and 0.01% to about 5% of a halogenated organic borate having the general formula  $(MO)_3B$  in which M is a halogenated alkyl radical.

5. An extreme pressure lubricant comprising a mineral lubricating oil and 0.01% to about 5% of a halogenated organic borate having the general formula  $(MO)_3B$  in which M is a halogenated aryl radical.

6. An extreme pressure lubricant comprising a mineral lubricating oil having a viscosity from about 50 seconds to about 200 seconds Saybolt at 210° F. and 0.01% to about 5% of chlor propyl borate.

CLARENCE M. LOANE.  
BERNARD H. SHOEMAKER.