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TREATMENT OF BEARING SURFACES WITH LUBRICANTS

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This invention relates to the treating of bearing surfaces carrying solid lubricants thereon; more particularly, treating surfaces having lubricants exemplified by the class comprising molybdenum sulphide, molybdenum selenide and tungsten sulphide.

The object of this invention is to provide for so treating bearing surfaces carrying applied lubricating substances of the type of molybdenum sulphide as to impart thereto improved anti-friction properties.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

While it has been known heretofore that molybdenum sulphide, molybdenum telluride, molybdenum selenide, tungsten telluride, tungsten sulphide, titanium sulphide, titanium telluride, and minerals of an equivalent physical structure, have certain anti-friction characteristics when applied to bearing surfaces, none of these minerals has been extensively applied, since their ordinary characteristics do not show any noteworthy improvement over prior art lubricants which in many cases are as convenient to apply and are less expensive.

According to this invention, it has been discovered that the minerals of the class of molybdenum sulphide and the like have exceptionally good anti-friction characteristics when applied to metallic bearing surfaces after a predetermined treatment of the mineral on the bearing surfaces. Without this treatment the minerals do not evidence any outstanding anti-friction characteristics.

In applying this invention to bearing surfaces, it is intended to employ mineral compounds selected from at least one of the group consisting of molybdenum sulphide, molybdenum selenide, molybdenum telluride, tungsten sulphide, tungsten telluride, titanium sulphide, and titanium telluride and similar metallic compounds. These compounds have a common physical and mineral structure. Molybdenum sulphide, for example, forms crystals having a plate-like structure in which molybdenum atoms are arranged in substantially the same plane with two layers of sulphur atoms arranged in planes at each side of the molybdenum atom plane. The atoms in each layer lie in a plane hexagonal array. Large crystals of molybdenum sulphide are built up of a number of layers of this type. The molybdenum atoms are attached by strong ionic linkages to adjacent sulphur atoms, while sulphur atoms in the crystals are held together by weak homopolar bonds. Accordingly, crystals of molybdenum sulphide tend to separate easily in the form of flakes or sheets. Mechanical forces may be employed to readily separate masses of molybdenum sulphide into exceedingly fine flakes. Molybdenum sulphide has a greasy feel.

While the sulphur atoms or layers of sulphur atoms have only a weak attraction for each other, the same sulphur atoms have a much greater affinity for metals. Therefore, under certain conditions, the molybdenum sulphide flakes will attach themselves quite firmly to metal surfaces. When applied under predetermined conditions a single layer of molybdenum sulphide will be attached to the metal surface with a strong adhesive force derived from the attraction of a layer of sulphur atoms thereto. Successive flakes or plates of molybdenum sulphide will not be attracted with a force as great as that holding the initial layer of molybdenum sulphide. This property, however, is believed to be exceedingly important in providing for exceptional lubrication.

The surface of a metal properly treated to adhesively retain molybdenum sulphide thereon is believed to present a configuration in which one layer of sulphur atoms is adjacent to and tenaciously attached to the metal with a superimposed layer of molybdenum atoms and an external layer of sulphur atoms. When another bearing surface similarly treated approaches a surface carrying molybdenum sulphide, the outermost layers of sulphur atoms have substantially little attraction for one another, and good anti-friction properties are evidenced.

For the purpose of this invention, compounds having a similar structure to that of molybdenum sulphide and behaving in the same manner when applied to metal surfaces will be found to function to produce the desired result of cooperating with the metal to provide for improved anti-friction properties to metal bearing surfaces. In the following detailed description of the invention molybdenum sulphide will be used as exemplary of the invention, it being understood that the other compounds listed may also be so applied.

In applying molybdenum sulphide and equivalent compounds to bearing surfaces, it has been discovered that while molybdenum sulphide applied loosely thereto will reduce the coefficient of friction somewhat, in this state it is relatively deficient in beneficial properties differing markedly over those obtained by using graphite, for example.

From tests conducted, it has been discovered that it is initially necessary to subject the molybdenum sulphide to light impacts or blows to drive the molybdenum sulphide into intimate contact with the bearing surface. Upon applying a sufficient number of distributed impacts, it will be discovered that a light gray film of molybdenum sulphide will have been adherently acquired by the metal surfaces. One convenient method of accomplishing this step upon ball bearings, for example, is to disassemble the bearing, if a completed bearing is being treated, or to take the component parts of a bearing, and place the balls thereof in a small ball mill, such as is used in a laboratory, with a quantity of molybdenum sulphide and set the ball mill in operation for several hours. The rotation of the ball mill will cause the balls to drop upon one another and any intervening molybdenum sulphide will be impacted upon the surfaces. Depending upon the quantity of balls or other members being treated in the ball mill, the time of treatment will vary from a few hours to as much as twelve hours or even longer. The ball mill is simply a convenient method of producing the impacting of the molybdenum sulphide. Other methods may be employed to produce the same result.

Ordinarily, it is not necessary to treat all the surfaces of the bearing. Usually the treatment of one of any two opposing bearing surfaces with molybdenum sulphide under conditions where the molybdenum sulphide is lightly impacted against the bearing surfaces will be sufficient. The amount of molybdenum sulphide adhering to the bearing surface will be relatively small but unexpectedly effective.

In order to obtain the maximum efficiency of effectiveness from the lubricating films, it has been discovered that the bearing surface carrying the adhering coating or film of molybdenum sulphide as produced by prolonged impacts should be further treated. Experimental tests have shown that molybdenum sulphide applied to bearing surfaces and heat treated at temperature above 200° C., preferably at temperatures of the order of 500° C., in an evacuated chamber in which the vacuum is maintained at less than 1 millimeter of mercury have exceptionally good anti-friction properties. The components of bearings may be treated separately or assembled in operative position while subjected to the heat treatment in the evacuated chamber. In some cases, it has been discovered that if the bearing is operated while being heat treated during the process, it will acquire optimum anti-friction characteristics.

As an example of the improvements produced by the heat treatment of bearings carrying adherent molybdenum sulphide in the evacuated chamber, the following test results are submitted. A number of motor armatures were each supported on two ball bearings, the ball bearings having been treated in a ball mill for twelve hours with molybdenum sulphide to produce an adherent film of the mineral thereon. The motor armature was placed in an evacuated chamber and subjected to an alternating field until a speed of around 3600 R. P. M. had been reached. The field was removed and the coasting time of the armature from this speed to a dead stop was taken as a measure of the coefficient of friction in the bearing. One armature coasted 3.5 minutes, while another armature coasted 5.5 minutes. Other armatures had coasting times within this range. The armature ball bearings were then subjected to a temperature of 500° C. as induced by a high-frequency field, the vacuum in the chamber during the heat treatment being maintained at about 1 micron of pressure. After two hours treatment, the armature was subjected to the same alternating-current field until a speed of 3600 R. P. M. had been reached. The coasting time of the same two armatures had increased to 15.5 minutes and 14.5 minutes. In other words, approximately a three-fold decrease in friction had been produced by the heat treatment in the vacuum.

While no particular theory of the function of the heat treatment in the vacuum is advanced as conclusive, it is believed that the high temperature and vacuum conditions probably cause a more tenacious adhesion of the molybdenum sulphide to the bearing surfaces. This is accomplished, it is believed, by the removing of any gas films which may be present on the metal surface. Regardless of any explanation, however, the results are highly significant.

The bearings after the heat treatment may be removed from the evacuated chamber and employed exposed to the atmosphere or under conditions to which the same bearings supplied with the usual petroleum or other oily lubricants are exposed. Bearings containing molybdenum sulphide are particularly desirable for use in delicate meters and instruments where the variable viscosity of fluid lubricants with temperature and the deterioration of such fluid lubricants results in an appreciable impairment of the accuracy of the instrument. There is substantially no change in friction with temperature when molybdenum sulphide is used until temperatures of over 300° C. in air are reached. Molybdenum sulphide and equivalent compounds do not deteriorate when exposed to moisture or oxygen as occurs with ordinary lubricants. To render these compounds ineffective it is required that temperatures of about 500° C. in an oxidizing atmosphere be reached in which event the sulphide may be converted to metallic oxide.

Bearings treated with molybdenum sulphide are satisfactory for service of a heavier duty than that met in meters. Motor bearings of all types may be treated with molybdenum sulphide to produce good anti-friction bearings. No liquid lubricant is required for use with the bearings. The molybdenum sulphide film after heat treatment cannot be rubbed off or wiped off except by abrading the bearing surfaces, since the molybdenum sulphide is exceedingly adherent. In addition, the molybdenum sulphide is electrically conducting as compared to lubricating oils which usually are electrical insulators. Therefore, electrical apparatus may be readily electrically grounded through the bearing supplied with molybdenum sulphide, and no special provision of the type required when oils are used need be made for grounding of members supported on bearings.

Since certain changes in carrying out the above process and certain modifications in the methods of preparing the articles which may embody the invention may be made without departing from its scope, it is intended that all the matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. The method of applying to bearing surfaces a compound selected from the group consisting of the sulphides, selenides and tellurides of tungsten, molybdenum and titanium, the compounds having a plate-like physical structure consisting of a layer of metallic atoms between two layers of the non-metal atoms, to render the compounds useful for reducing friction in bearing members,

comprising, applying the compound to a bearing surface, subjecting the applied compound to light impacts against the bearing surface for prolonged periods until an adherent coating of the compound is produced on the bearing surface, and subjecting the coated bearing surface to a heat treatment at temperatures between above 200° C. and below the decomposition temperature of the metallic compound in an evacuated chamber.

2. The method of applying to bearing surfaces a compound selected from the group consisting of the sulphides, selenides and tellurides of tungsten, molybdenum and titanium, the compounds having a plate-like physical structure consisting of a layer of metal atoms between two layers of non-metallic atoms to render the compounds useful for reducing friction in bearing members, comprising, applying the compound to a bearing surface, subjecting the applied compound to light impacts against the bearing surface for prolonged periods until an adherent coating of the compound is produced on the bearing surface, and subjecting the coated bearing surface to a heat treatment at temperatures of the order of 500° C. in an evacuated chamber maintained at a pressure of less than 1 mm. of mercury.

3. In the process of applying to bearing surfaces a compound selected from the group consisting of the sulphides, selenides and tellurides of tungsten, molybdenum and titanium, the compounds having a plate-like physical structure consisting of a layer of metallic atoms between two layers of the non-metal atoms to give the bearing surface anti-friction properties, the step of heat treating the compound when applied to the bearing surface at temperatures between above 200° C. and below the decomposition temperature of the metallic compound while subjecting the bearing surface to a vacuum of less than 1 mm. of mercury.

4. In the process of applying to bearing surfaces a compound selected from the group consisting of the sulphides, selenides and tellurides of tungsten, molybdenum and titanium, the compounds having a plate-like physical structure consisting of a layer of metallic atoms between two layers of non-metal atoms to give the bearing surface anti-friction properties, the step of heat treating the compound when applied to the bearing surface at temperatures of the order of 500° C. while subjecting the bearing surface to a vacuum of less than 1 mm. of mercury.

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