TO: USI/Scientific & Technical Information Division  
Attention: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General  
Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned  
U.S. Patents in STAR

In accordance with the procedures contained in the Code GP  
to Code US1 memorandum on this subject, dated June 8, 1970,  
the attached NASA-owned U.S. patent is being forwarded for  
abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,361,666

Corporate Source : Midwest Research Institute

Supplementary Corporate Source :

NASA Patent Case No.: XMF-03988

Please note that this patent covers an invention made by an  
employee of a NASA contractor. Pursuant to Section 305(a) of  
the National Aeronautics and Space Act, the name of the  
Administrator of NASA appears on the first page of the patent;  
however, the name of the actual inventor (author) appears at  
the heading of Column No. 1 of the Specification, following the  
words "... with respect to an invention of...".

Gayle Parker

Enclosure: Copy of Patent
Inorganic solid film lubricants having the following composition, in weight percent of total dry solids: molybdenum disulfide, 34 to 50; graphite, 4 to 25; and either gold, 20 to 25; or bismuth, 40 to 47. The aluminum phosphate serves as binder, and the remaining components are finely divided lubricating solids dispersed in the binder. These lubricants exhibit stability under space environmental conditions and a long wear life.

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

This invention relates to lubricants and more particularly to inorganic solid film lubricants for use in space environments.

One of the requirements for successful operation of mechanical devices with moving parts in space applications is the provision of a suitable lubricant. The lubricant should be able to withstand a wide range of temperatures and pressures from atmospheric down to below 10^-10 torr. It should also be stable in the presence of moisture, liquid oxygen and rocket fuels. In addition to these environmental requirements the lubricant must have effective lubricating characteristics, in particular, a low coefficient of friction and a long wear life.

Conventional organic lubricants fail rapidly in the high vacuum of space because of volatilization of organic components. This difficulty has been avoided by the use of inorganic solid film lubricants comprising various combinations of lubricating materials dispersed in an inorganic binder. These compositions are applied and bonded to the mating surfaces as a thin solid film. The binder usually forms a matrix and holds the lubricant particles in many tiny reservoirs. One previously known composition of this type employs molybdenum disulfide, graphite and gold as lubricating materials and sodium silicate, but the wear life is still too short for many applications.

Improved moisture resistance has been obtained by using potassium silicate, either by itself or modified with sodium fluoride, as the binder in place of sodium silicate. One previously known composition comprising of this type employs molybdenum disulfide, a minor proportion of graphite and a major proportion of either gold or bismuth.

Molybdenum disulfide exhibits a low coefficient of friction, along with other favorable properties, and is thus suitable as a major component. 34 to 50 weight percent of this component can be used. A minor proportion of graphite serves to decrease the initial friction, 4 to 5 weight percent graphite can be used. The remaining lubricating ingredient can either be gold at a proportion of 20 to 25 weight percent or bismuth at a proportion of 40 to 47 weight percent. Gold and bismuth are essentially equivalent in that either of them serves to impart increased thermal conductivity and flexibility to the composition. Two compositions which have been found particularly effective are as follows, in weight percent of total dry solids: Composition No. 1, molybdenum disulfide, 50; graphite, 5; aluminum phosphate, 20; and gold, 25; and Composition No. 2, molybdenum disulfide, 34; graphite, 4; aluminum phosphate, 15; and bismuth, 47.

Other lubricating materials which can be used in combination with the aluminum phosphate binder include finely divided TaS₂, WS₂, MoS₂, MoSe₂, TaSe₂, ReS₂, ReSe₂, and Re₂Se₆.

The lubricant compositions of the present invention are readily prepared by mixing the lubricating materials in finely divided form in an aqueous aluminum phosphate solution. Although not critical, an aluminum phosphate concentration of about 50 weight percent in the solution is preferred. The lubricating components must be finely divided to be effective, and a particle size smaller than 325 mesh size is suitable for these compositions.

The aqueous slurry obtained by mixing all of the components is applied to the mating surface to be lubricated to obtain a film of the desired thickness. Bonding of the film to the surface is effected by heating to a temperature of about 300 to 400°F for a period of at least 4 hours. This treatment also serves to remove substantially all of the water. The film thickness can be varied within the range of about .0002 to .0015 inch, depending on the requirements for the particular application. In general, high loads on the mating surfaces do not necessitate a thicker film since this film exhibits a low coefficient of friction and thus a higher effectiveness at higher applied pressures than at lower pressures.

This invention is illustrated by the following example. In this example proportions of ingredients are in weight percent of total dry solids, unless otherwise indicated.

EXAMPLE

Wear life runs were conducted using the compositions described above as composition numbers 1 and 2 and a previously known composition similar to composition number 1 except that the binder was sodium silicate. The latter composition comprised molybdenum disulfide, 51; graphite, 3; gold, 26; and sodium silicate, 18. In each case the composition was prepared by mixing the lubricating materials in finely divided (325 mesh size)
What is claimed is:

1. A solid film lubricant composition comprising, in weight percent of total dry solids,
   - Molybdenum disulfide ...................... 34 to 50
   - Graphite ................................... 4 to 5
   - Aluminum phosphate ....................... 15 to 20
   - And either gold ............................. 20 to 25
   - or Bismuth ................................. 40 to 47

2. A solid film lubricant composition consisting essentially of an aluminum phosphate binder at a proportion of 15 to 20 weight percent total dry solids and having dispersed therein in finely divided form 34 to 50 weight percent molybdenum disulfide, 4 to 5 weight percent graphite and either 20 to 25 weight percent gold or 40 to 47 weight percent bismuth.

3. The composition of claim 2 wherein the amounts of aluminum phosphate, molybdenum disulfide, graphite and gold in weight percent of total dry solids are 20, 50, 5 and 25, respectively.

4. The composition of claim 2 wherein the amounts of aluminum phosphate, molybdenum disulfide, graphite and bismuth in weight percent of total dry solids are 15, 34, 4 and 47, respectively.

5. A solid film lubricant composition comprising in weight percent dry solids, molybdenum disulfide 34, graphite 4, aluminum phosphate 15 and bismuth 47.

6. A solid film lubricant composition comprising in weight percent dry solids, molybdenum disulfide 34, graphite 4, aluminum phosphate 15 and bismuth 47.

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