CLAIMS

WHAT IS CLAIMED IS

1. A detergent-free and low-ash lubricating composition comprising:

one or more base oils of lubricating viscosity;

a total sulfated ash (SASH) as measured by ASTM D874 of less than about 0.2 weight percent;

one or more succinimide dispersants derived from a polyisobutylene having a number average molecular weight of at least about 1000, wherein the succinimide dispersants each have up to about 2 weight percent of nitrogen and wherein at least one of the succinimide dispersants is post treated with a boron compound;

one or more ashless antiwear additives;

one or more antioxidants;

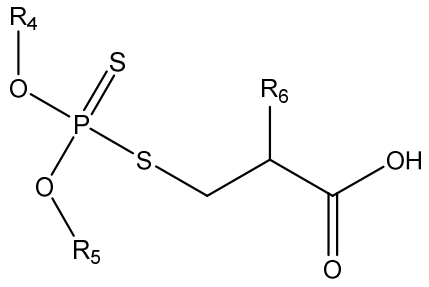
a total base number (TBN) pursuant to ASTM D2896 of at least about 4;

at least about 1000 ppm of nitrogen, no more than 100 ppm of boron, no more than 800 ppm of sulfur, and a sulfur-to-phosphorus ratio of 2.0 or less, and a ratio of nitrogen-to-TBN of about 150 or greater; and

wherein the detergent-free, low ash lubricating composition is substantially free of calcium, barium, copper, lead, lithium, magnesium, sodium, molybdenum, zinc, and potassium.

2. The detergent-free and low-ash lubricating composition of claim 1, further comprising less than about 10 ppm of each of calcium, barium, copper, lead, lithium, magnesium, sodium, molybdenum, zinc, and potassium; and/or further comprising no more than about 500 ppm of phosphorus and no more than about 600 ppm of sulfur; and/or wherein the composition includes at least about 6 times more of the one or more antioxidants relative to the one or more ashless antiwear additives; and/or wherein the total sulfated ash (SASH) measured pursuant to ASTM D874 is less than about 0.1 weight percent.

3. The detergent-free and low-ash lubricating composition of claim 1, wherein the one or more ashless antiwear additives includes one or more ashless dialkyl dithiophosphate antiwear additives, and preferably wherein the one or more ashless, dialkyl dithiophosphate antiwear additives have a structure of Formula I, or a salt thereof:



(Formula I)

wherein R_4 and R_5 are, independently, a C3 to C8 linear or branched alkyl group, and R_6 is -H or $-CH_3$.

4. The detergent-free and low-ash lubricating composition of claim 1, wherein the one or more antioxidants includes an aminic antioxidant, a hindered phenolic antioxidant, or combinations thereof, and preferably wherein the aminic antioxidant is selected from the group comprising aromatic amines, alkylated diphenyl amines, alkyl diphenylamine, di-alkyl diphenylamine, octyl diphenylamine, di-octyl diphenylamine, phenyl-alpha-naphthylamines, alkylated phenyl-alpha-naphthylamines, hindered non-aromatic amines, or combinations thereof.

5. The detergent-free and low-ash lubricating composition of claim 1, wherein the one or more succinimide dispersants includes (i) a succinimide dispersant derived from a polyisobutylene having a number average molecular weight of about 1000 to about 2000 and post treated with a boron compound; (ii) a succinimide dispersant derived from a polyisobutylene having a number average molecular weight greater than about 2000; and (iii) a succinimide derived from a polyisobutylene having a number average molecular weight of 1000 to about 2000.

6. The detergent-free and low-ash lubricating composition of claim 1, wherein more than 50 weight percent of the total nitrogen is provided by the one or more antioxidants.

7. The detergent-free and low-ash lubricating composition of claim 1, further comprising a dispersant olefin copolymer viscosity index improver including the reaction product of an acylated olefin copolymer and a polyamine, wherein the acylated olefin copolymer includes an olefin copolymer having grafted thereon about 0.3 to about 0.75 carboxylic groups per 1000 number average molecular weight units of the olefin copolymer, wherein the olefin

copolymer has a number average molecular weight of about 40,000 to about 150,000, and wherein the polyamine is a N-arylphenylenediamine, and preferably wherein the lubricating composition includes about 1 weight percent to about 4 weight percent of the dispersant olefin copolymer viscosity index improver.

8. The detergent-free and low-ash lubricating composition of claim 1, wherein the lubricating composition cleans up piston deposits pursuant to the Sequence IIIH Engine Test (ASTM D8111) with a merit rating of at least about 4 total weighted piston deposits, and wherein the lubricating composition exhibits an average engine varnish (AES) of at least 8 merits and/or an average engine sludge rating of at least 7.6 merits pursuant to the Sequence VH test (ASTM D8256).

9. A method of lubricating a combustion engine using a detergent-free and low-ash ash lubricating composition, the method comprising:

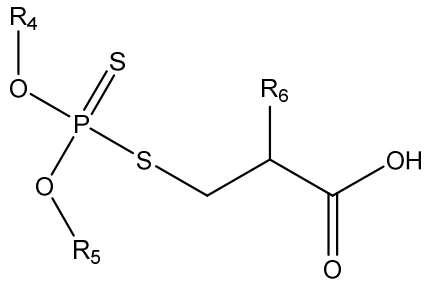
lubricating a combustion engine with a detergent-free and low-ash lubricating composition; wherein the detergent-free, low ash lubricating composition includes one or more base oils of lubricating viscosity; a total sulfated ash (SASH) as measured by ASTM D874 of less than about 0.2 weight percent; one or more succinimide dispersants derived from a polyisobutylene having a number average molecular weight of at least about 1000, wherein the succinimide dispersants each have up to about 2 weight percent of nitrogen and wherein at least one of the succinimide dispersants is post treated with a boron compound; one or more ashless antiwear additives; one or more antioxidants; a total base number (TBN) pursuant to ASTM D2896 of at least about 4; at least about 1000 ppm of nitrogen, no more than 100 ppm of boron, no more than 800 ppm of sulfur, and a sulfur-to-phosphorus ratio of 2.0 or less, and a ratio of nitrogen-to-TBN of about 150 or greater; and wherein the detergent-free, low ash lubricating composition is substantially free of calcium, barium, copper, lead, lithium, magnesium, sodium, molybdenum, zinc, and potassium; and

wherein the lubricating composition cleans up piston deposits pursuant to the Sequence IIIH Engine Test (ASTM D8111) with a merit rating of at least about 4 total weighted piston deposits, and wherein the lubricating composition exhibits an average engine varnish (AES) of at

least 8 merits and/or an average engine sludge rating of at least 7.6 merits pursuant to the Sequence VH test (ASTM D8256).

10. The method of claim 9, further comprising less than about 10 ppm of each of calcium, barium, copper, lead, lithium, magnesium, sodium, molybdenum, zinc, and potassium; and/or further comprising no more than about 500 ppm of phosphorus and no more than about 600 ppm of sulfur; and/or wherein the composition includes at least about 6 times more of the one or more antioxidants relative to the one or more ashless antiwear additives; and/or wherein the total sulfated ash (SASH) measured pursuant to ASTM D874 is less than about 0.1 weight percent.

11. The method of claim 9, wherein the one or more ashless antiwear additives includes one or more ashless dialkyl dithiophosphate antiwear additives, and preferably wherein the one or more ashless, dialkyl dithiophosphate antiwear additives have a structure of Formula I, or a salt thereof:



(Formula I)

wherein R_4 and R_5 are, independently, a C3 to C8 linear or branched alkyl group, and R_6 is -H or $-CH_3$.

12. The method of claim 9, wherein the one or more antioxidants includes an aminic antioxidant, a hindered phenolic antioxidant, or combinations thereof; and preferably wherein the aminic antioxidant is selected from the group comprising aromatic amines, alkylated diphenyl amines, alkyl diphenylamine, di-alkyl diphenylamine, octyl diphenylamine, di-octyl diphenylamine, phenyl-alpha-naphthylamines, alkylated phenyl-alpha-naphthylamines, hindered non-aromatic amines, or combinations thereof.

13. The method of claim 9, wherein the one or more succinimide dispersants includes (i) a succinimide dispersant derived from a polyisobutylene having a number average molecular weight of about 1000 to about 2000 and post treated with a boron compound; (ii) a succinimide dispersant derived from a polyisobutylene having a number average molecular weight greater than about 2000; and (iii) a succinimide derived from a polyisobutylene having a number average molecular weight of 1000 to about 2000.

14. The method of claim 9, wherein more than 50 weight percent of the total nitrogen is provided by the one or more antioxidants.

15. The method of claim 9, further comprising a dispersant olefin copolymer viscosity index improver including the reaction product of an acylated olefin copolymer and a polyamine, wherein the acylated olefin copolymer includes an olefin copolymer having grafted thereon about 0.3 to about 0.75 carboxylic groups per 1000 number average molecular weight units of the olefin copolymer, wherein the olefin copolymer has a number average molecular weight of about 40,000 to about 150,000, and wherein the polyamine is a N-arylphenylenediamine, and preferably wherein the lubricating composition includes about 1 weight percent to about 4 weight percent of the dispersant olefin copolymer viscosity index improver.