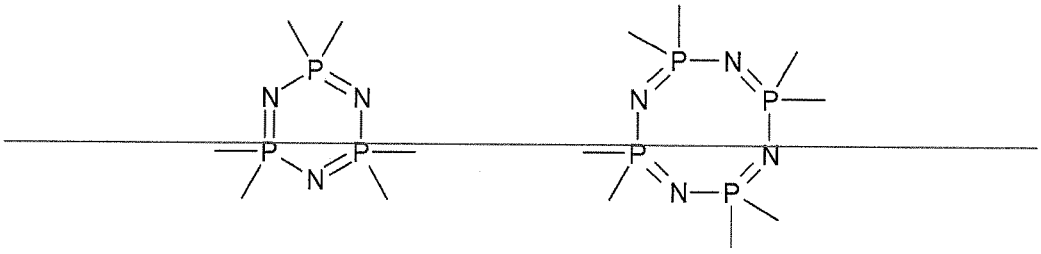
Claims

1. ~~The use of a~~A lubricant composition comprising:

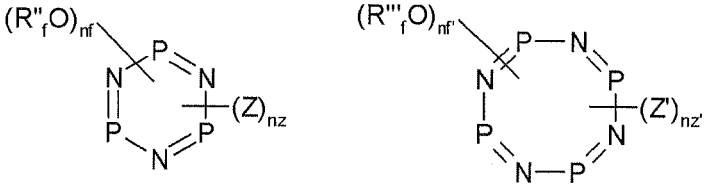
(A) at least one non-functional (per)fluoropolyether oil (non-functional PFPE oil) comprising at least one (per)fluoropolyoxyalkylene chain (chain R_F);

(B) at least one cyclic phosphazene compound [compound (P)] comprising one or more cyclic moieties having formula (I-B) or (II-B) ~~(I) or (II)~~ here below:



(I) (II)

~~said cyclic moieties comprising, bound to one or more phosphorus atoms, at least one substituent comprising at least one (per)fluoropolyoxyalkylene chain (chain R'_F);~~



(I-B) (II-B)

wherein:

- R''_f and R'''_f, equal to or different from each other, independently represent a (per)fluoropolyoxyalkylene chain comprising one or more recurring units selected from:

(i) -CFYO-, wherein Y is a fluorine atom or a $-CF_3$ group,

(ii) $-CF_2CFYO-$, wherein Y has the same meaning as defined above,

(iii) $-CF_2CF_2CF_2O-$,

(iv) $-CF_2CF_2CF_2CF_2O-$,

said recurring units being generally statistically distributed along the (per)fluoropolyoxyalkylene chain;

- Z and Z', equal to or different from each other, independently represent a polar group of formula $-O^-M^+$, wherein M is selected from hydrogen, a monovalent metal, preferably an alkaline metal, and an ammonium radical having formula $NR_1R_2R_3R_4^+$, wherein each of R_1, R_2, R_3, R_4 is, independently, a hydrogen atom or a C_1-C_{12} hydrocarbon group, optionally fluorinated, or a polar group of formula $-O^-)_2M'^{2+}$, wherein M' is a divalent metal, preferably an alkaline earth metal;
- n_Z is an integer comprised between 1 and 3, preferably equal to 1;
- $n_{Z'}$ is an integer comprised between 1 and 4, preferably equal to 1;
- n_f is an integer such that $n_Z + n_f$ is equal to 6;
- $n_{f'}$ is an integer such that $n_{Z'} + n_{f'}$ is equal to 8

(C) at least one functional (per)fluoropolyether derivative (functional PFPE derivative) different from compound (P) comprising at least one (per)fluoropolyoxyalkylene chain (chain R'_F) and at least one functional group comprising at least one monocyclic or polycyclic aromatic ring, said aromatic ring optionally containing one or more heteroatoms selected from N, O and S and one or more substituents different from hydrogen atom ~~for lubricating vacuum pumps~~.

2. The ~~use~~ lubricant composition according to claim 1, wherein the non- functional PFPE oil in the composition is selected from the followings:

(1) T^1-O-$(C_2F_4O)_{b1'}(CF_2O)_{b2'}$-$T^{1'}$

wherein:

- T^1 and $T^{1'}$, equal to or different from each other, are independently selected from $-CF_3$, $-C_2F_5$ and $-C_3F_7$ groups;
- b1' and b2', equal to or different from each other, are independently integers

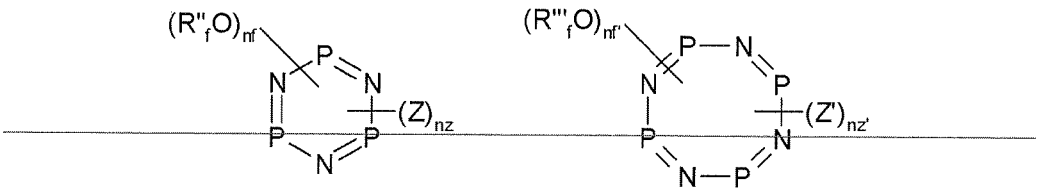
and a C_1-C_6 perfluoroalkyl group;

- j1' is equal to 1 or 2;

- j2' is an integer comprised between 5 and 250.

3. The ~~use~~ lubricant composition according to claim 1 or 2, wherein a mixture of more than one non-functional PFPE oil is used in the composition.

~~4. The use according to anyone of claims 1 to 3, wherein the cyclic phosphazene compound [compound (P)] in the composition complies with formula (I-B) or (II-B) here below:~~



(I-B) (II-B)

~~wherein:~~

~~- R"$_f$ and R'"$_f$, equal to or different from each other, independently represent a (per)fluoropolyoxyalkylene chain comprising one or more recurring units selected from:~~

~~(i) -CFYO-, wherein Y is a fluorine atom or a -CF_3 group,~~

~~(ii) -CF_2CFYO-, wherein Y has the same meaning as defined above,~~

~~(iii) -$CF_2CF_2CF_2O$-,~~

~~(iv) -$CF_2CF_2CF_2CF_2O$-,~~

~~said recurring units being generally statistically distributed along the (per)fluoropolyoxyalkylene chain;~~

~~- Z and Z', equal to or different from each other, independently represent a polar group of formula -O$^-M^+$, wherein M is selected from hydrogen, a monovalent metal, preferably an alkaline metal, and an ammonium radical having formula $NR_1R_2R_3R_4^+$, wherein each of R_1, R_2, R_3, R_4 is, independently, a hydrogen atom or a C_1-C_{12} hydrocarbon group, optionally~~

fluorinated, or a polar group of formula $-O^-)_2M'^{2+}$, wherein M' is a divalent metal, preferably an alkaline earth metal;

- n_Z is an integer comprised between 1 and 3, preferably equal to 1;

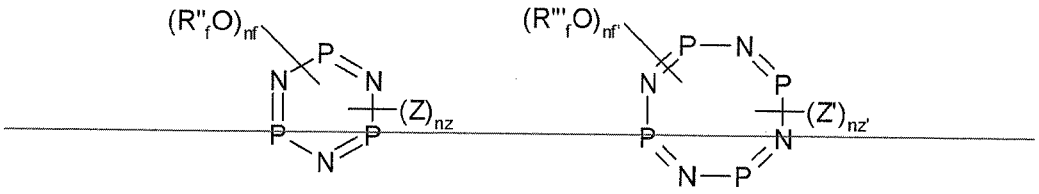
- $n_{Z'}$ is an integer comprised between 1 and 4, preferably equal to 1;

- n_f is an integer such that $n_Z + n_f$ is equal to 6;

- $n_{f'}$ is an integer such that $n_{Z'} + n_{f'}$ is equal to 8.

5. A lubricant composition comprising: (A) at least one non-functional (per)fluoropolyether oil (non-functional PFPE oil) comprising at least one (per)fluoropolyoxyalkylene chain (chain R_F);

(B) at least one cyclic phosphazene compound [compound (P)] complying with formula (I-B) or (II-B) here below:



(I-B) (II-B)

wherein:

- R''_f and R'''_f, equal to or different from each other, independently represent a (per)fluoropolyoxyalkylene chain comprising one or more recurring units selected from:

(i) -CFYO-, wherein Y is a fluorine atom or a $-CF_3$ group,

(ii) $-CF_2CFYO-$, wherein Y has the same meaning as defined above,

(iii) $-CF_2CF_2CF_2O-$,

(iv) $-CF_2CF_2CF_2CF_2O-$,

said recurring units being generally statistically distributed along the (per)fluoropolyoxyalkylene chain;

- Z and Z', equal to or different from each other, independently represent a

~~polar group of formula $-O^-M^+$, wherein M is selected from hydrogen, a monovalent metal, preferably an alkaline metal, and an ammonium radical having formula $NR_1R_2R_3R_4^+$, wherein each of R_1, R_2, R_3, R_4 is, independently, a hydrogen atom or a C_1-C_{12} hydrocarbon group, optionally fluorinated, or a polar group of formula $-O^-)_2M'^{2+}$, wherein M' is a divalent metal, preferably an alkaline earth metal;~~

~~- n_Z is an integer comprised between 1 and 3, preferably equal to 1;~~

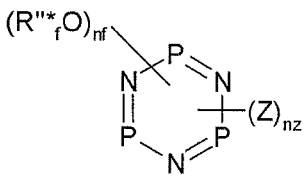
~~- $n_{Z'}$ is an integer comprised between 1 and 4, preferably equal to 1;~~

~~- n_f is an integer such that n_Z + n_f is equal to 6;~~

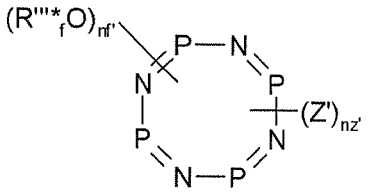
~~- $n_{f'}$ is an integer such that $n_{Z'}$ + $n_{f'}$ is equal to 8.~~

~~(C) at least one functional (per)fluoropolyether derivative (functional PFPE derivative) different from compound (P) comprising at least one (per)fluoropolyoxyalkylene chain (chain R'_F) and at least one functional group comprising at least one monocyclic or polycyclic aromatic ring, said aromatic ring optionally containing one or more heteroatoms selected from N, O and S and one or more substituents different from hydrogen atoms.~~

~~6~~4. The lubricant composition of any one of claims ~~5~~1 to 3, wherein the cyclic phosphazene compound [compound (P)] complies with formula (I-B*) or (II-B*) here below:



(I-B*)



(II-B*)

wherein:

- Z, Z', n_Z, $n_{Z'}$, n_f and $n_{f'}$ have the same meaning as defined in claim 4;

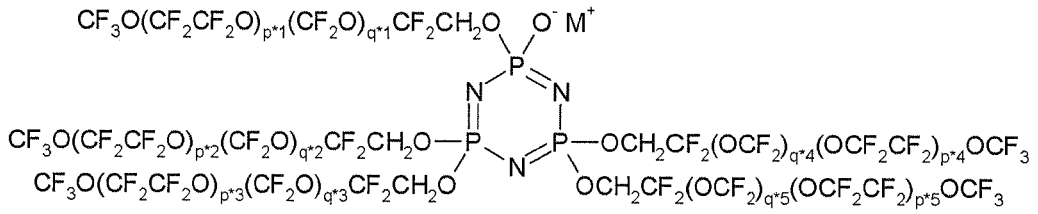
- $R''*_f O$- and $R'''*_f O$-, equal to or different from each other, represent a (per)fluoropolyoxyalkylene chain having formula:

T^*-O-$(CF_2CF_2O)_{p^*}(CF_2O)_{q^*}$-$CF_2$-$CH_2O(CH_2CH_2O)_{s^*}$-

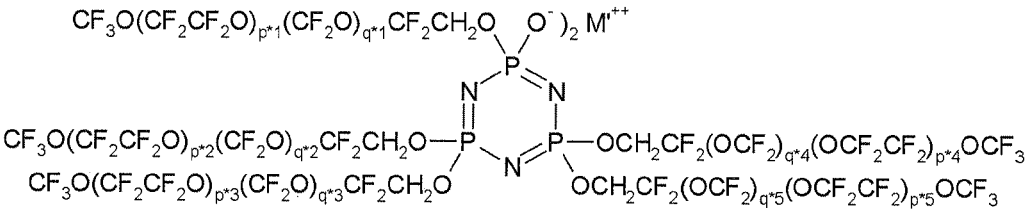
wherein:

- T* is selected from $-CF_3$, $-CF_2CF_3$ and $-CF_2CF_2CF_3$ groups;
- p* and q* are numbers such that the (p*+q*) sum is comprised between 1 and 50 and the q*/p* ratio is comprised between 0.1 and 10;
- s* is a number comprised between 0 and 5.

~~7~~5. The lubricant composition of claims 3~~5~~ and 4~~6~~, wherein the cyclic phosphazene compound [compound (P)] complies with formula (III-B) or (III-B bis) here below:



(III-B)



(III-B bis)

wherein:

- M and M' have the same meaning as defined in claim 41, M being preferably an alkaline metal selected from Li, Na and K or an ammonium radical having formula $NR_1R_2R_3R_4^+$, wherein each of R_1, R_2, R_3, R_4 is, independently, a hydrogen atom or a C_1-C_{12} hydrocarbon group, preferably $R_1 = R_2 = R_3 = R_4$ = n-butyl, and M' being preferably an alkaline earth metal selected from Ca and Mg, more preferably M' being Ca;
- each of p*i (i = 1 to 5) and q*i (i = 1 to 5) is independently an integer ≥ 0 such that the (p*i+q*i) sum is comprised between 2 and 25 and the q*i/p*i ratio is comprised between 0.1 and 10.

86. The lubricant composition of anyone of claims 5-1 to 57, wherein the functional PFPE derivative complies with formula (V) here below:

$T\text{-}(CFW_1)_{p1}\text{-}O\text{-}R_F\text{-}(CFW_2)_{p1'}\text{-}T'$ (V)

wherein:

- R_F is a (per)fluoropolyoxyalkylene chain (chain R'_F);
- T and T', equal to or different from each other, are selected from:

i) functional end-groups comprising at least one ether, thioether, ester or amine group comprising at least one monocyclic or polycyclic aromatic ring, said

aromatic ring optionally containing one or more heteroatoms selected from N, O and S and one or more substituents different from hydrogen atoms,

ii) non-functional end-groups selected from a fluorine atom, a chlorine atom and a C_1-C_3 (per)fluoroalkyl group optionally containing one or more chlorine atoms,

with the proviso that at least one of T and T' is a functional end-group as defined hereinabove;

- W_1 and W_2, equal to or different from each other, independently represent a fluorine atom or a $-CF_3$ group;

- p1 and p1', equal to or different from each other, are independently integers comprised between 1 and 3, preferably being equal to 1 when W_1 and/or W_2 are $-CF_3$ groups.

97. The lubricant composition of claim 86, wherein the functional PFPE derivative complies with formula (VI) here below:

$T''-CF_2O(CF_2CF_2O)_{m^*}(CF_2O)_{n^*}CF_2-T'''$ (VI)

wherein:

- T'' and T''', equal to or different from each other, are selected from:

i) functional end-groups selected from those having formulae $-CH_2$-A-Y, $-CH(CF_3)$-A-Y, $-CHW'$-B-$(CH_2CH_2O)_{m'}$-Y and -COOY, wherein:

(a') A is selected from oxygen and sulphur atoms,

(b') B is selected from an oxygen atom, a sulphur atom and a -NH group,

(c') W' is selected from a hydrogen atom and a $-CF_3$ group,

(d') m' is an integer comprised between 0 and 6,

(e') Y is selected from phenyl, pyridine, triazine, benzoxazole, benzothiazole and benzopyrazine groups optionally substituted with one or more substituents different from hydrogen atoms,

ii) non-functional end-groups selected from a fluorine atom, a chlorine atom, a $-CF_3$ group, a $-C_2F_5$ group and a $-(CF_2)_nCl$ group, wherein n is an integer comprised between 1 and 3,

with the proviso that at least one of T'' and T''' is a functional end-group as defined hereinabove;

- m* and n* are integers such that the number average molecular weight of the functional PFPE derivative is comprised between 400 and 10000, the m*/n*

ratio being comprised between 0.1 and 10.

~~10~~8. The lubricant composition of anyone of claims ~~5~~-1 to 79, wherein at least one cyclic phosphazene compound [compound (P)] is comprised in an amount ranging from 0.3% to 5% by weight with respect to the weight of the non-functional PFPE oil and at least one functional PFPE derivative different from compound (P) is comprised in an amount ranging from 2% to 6% by weight with respect to the weight of the non-functional PFPE oil.

9. Use of the lubricant composition of any one of claims 1 to 8 for lubricating vacuum pumps.