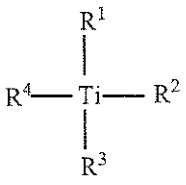
friction modifier selected from the group consisting essentially of an organomolybdenum friction modifier, a glycerol ester friction modifier, and mixtures thereof, and (c) an antiwear agent comprising an amount of at least one hydrocarbon soluble titanium compound effective to provide an increase in antiwear properties of the lubricant composition greater than an increase in antiwear properties of the lubricant composition devoid of the hydrocarbon soluble titanium compound, wherein the compound is essentially devoid of sulfur and phosphorus atoms. The '418 application further discloses that the hydrocarbon soluble titanium compound is a reaction product of a titanium alkoxide and an about C_6 to about C_{25} carboxylic acid. All of the examples disclosed in the '418 application disclose a hydrocarbon soluble titanium compound in combination with a zinc dithiophosphate.

[0009] Therefore, as demand for further decrease of the phosphorus content and a limit on the sulfur content of lubricating oils is very high, this reduction cannot be satisfied by the present measures in practice and still meet the severe antiwear and oxidation-corrosion inhibiting properties required of today's engine oils. Accordingly, it would be desirable to develop lubricating oil compositions having relatively low levels or free of any phosphorus content while also having relatively low levels of sulfur and sulfated ash but which still provide the needed wear protection now provided by lubricating oils containing a zinc dialkyldithiophosphate. It would also be desirable to develop lubricating oil compositions which are free of any zinc dialkyldithiophosphate.

SUMMARY OF THE DISCLOSURE~~INVENTION~~

[0010] In accordance with one embodiment of the present disclosure~~invention~~, a lubricating oil composition is provided which comprises (a) a major amount of an oil of lubricating viscosity; and (b) an oil-soluble titanium compound of Formula I:

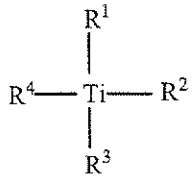


(I)

wherein R^1, R^2, R^3 and R^4 are independently a C_1-C_{20} alkoxy group, and further wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate.

[0011] In accordance with a second embodiment of the present disclosure~~invention~~, a method of reducing wear of metal parts in an internal combustion engine is provided comprising

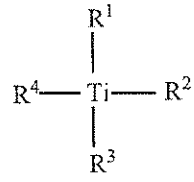
operating the engine with a lubricating oil composition comprising (i) a major amount of an oil of lubricating viscosity and (ii) an oil-soluble titanium compound of Formula I:



(I)

R^1, R^2, R^3 and R^4 are independently a C_1-C_{20} alkoxy group, and further wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate.

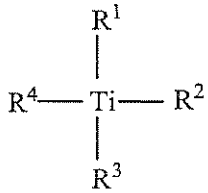
[0012] In accordance with a third embodiment of the present disclosure~~invention~~, there is provided an internal combustion engine lubricated with a lubricating oil composition comprising (a) a major amount of an oil of lubricating viscosity and (b) an oil-soluble titanium compound of Formula I:



(I)

R^1, R^2, R^3 and R^4 are independently a C_1-C_{20} alkoxy group, and further wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate.

[0012a] In a first aspect, there is provided a lubricating oil composition comprising (a) a major amount of an oil of lubricating viscosity; and (b) an oil-soluble titanium compound of Formula I:



(I)

wherein R^1, R^2, R^3 and R^4 are independently a C_1-C_{20} alkoxy group wherein the lubricating oil composition is free of any zinc dialkyldithiophosphate and phosphorus content, and further wherein the lubricating oil composition has a sulfur content not exceeding 0.7 wt. %.

[0012b] In a second aspect, there is provided a method of reducing wear of metal parts in an internal combustion engine, the method comprising operating the engine with the lubricating oil composition as defined above.

[0012c] In a third aspect, there is provided an internal combustion engine lubricated with the lubricating oil composition as defined above.

[0012d] In a fourth aspect, there is provided the use of the lubricating oil composition as defined above for reducing wear of metal parts in an internal combustion engine.

[0013] By employing the oil-soluble titanium compound disclosed herein in a lubricating oil composition of the present disclosure~~invention~~ in the absence of any zinc dialkyl dithiophosphate compound, it has unexpectedly been discovered that the lubricating oil composition advantageously possesses improved or relatively comparable wear reducing properties as compared to a corresponding lubricating oil composition in which the oil-soluble titanium compound disclosed herein in the lubricating oil composition is replaced with a zinc dialkyl dithiophosphate compound. In addition, the wear reducing properties can be achieved with the lubricating oil compositions of the present disclosure~~invention~~ while also employing relatively low levels or free of any phosphorus content as well as relatively low levels of sulfur and sulfated ash.